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SOUVENIR & ABSTRACT

INTERNATIONAL SYMPOSIUM
&
9th CONFERENCE OF INDIAN MEAT SCIENCE ASSOCIATION
on
NOVEMBER 6TH - 8TH, 2019

Department of Livestock Products Technology

Dr. G.C. Negi College of Veterinary & Animal Sciences

CSK HPKV, Palampur - H.P. INDIA

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thankfully acknowledge
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Compendium / Proceeding

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IMSA

Department of Livestock Products Technology
Dr. G.C. Negi College of Veterinary & Animal Sciences
CSK HPKV, Palampur - H.P. INDIA

9th IMSACON & International Symposium 06-08 November,2019

Compendium

9th Conference of Indian Meat Science Association & International Symposium

on

"Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved Health and Nutritional Security"

November 6th-8th, 2019, Palampur (HP), India.

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MESSAGE

Agriculture, Tribal Development
and Information Technology Minister
Himachal Pradesh

Livestock sector is an important pillar of socio-economic development in India. The sector has witnessed an appreciable growth in the recent past and has got immense potential for further expansion.

Muscle food processing is playing a major role in stimulating and strengthening the economic growth of the nation particularly in enhancing the income of farmers. This is possible only once we are able to handle the issues of hygienic processing, value addition, modern preservation techniques, effect of climate change, quality & safety issues.

I am happy to note that the Department of Livestock Products Technology, Dr G C Negi, College of Veterinary & Animal Sciences ,Palampur , in association with Indian Meat Science Association is organizing International Symposium on **"Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved Health and Nutritional Security"** at DGCNCOVAS,CSKHPKV, Palampur on 6-8 November, 2019.

I am sure that the deliberations in the conference would generate new recommendations for further improvement in the meat production and processing industry.

I convey my best wishes for all the success of the conference.

Dr. Ram Lal Markanda

MESSAGE

Rural Development, Panchayati Raj
Animal Husbandry & Fisheries Minister
Himachal Pradesh

I am pleased to know that the Dr G C Negi College of Veterinary & Animal Sciences, Palampur, in co-ordination with Indian Meat Science Association is organizing International Symposium on **"Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved Health and Nutritional Security"** at DGCNCOVAS, CSKHPKV, Palampur on 6-8 November, 2019.

Animal husbandry forms an integral part of income, nutrition and livelihood security of rural masses of India and of the state of Himachal Pradesh. Production and value addition of livestock products is important segment, the benefits of which have not been accrued well .The production & processing of muscle foods is an emerging area that requires utmost attention from scientists, academicians, entrepreneurs & policymakers. Similarly there are growing concerns on the quality issues of muscle foods.

Therefore, the theme of the symposium "**Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved Health and Nutritional Security**" carries much relevance in the present time.

I wish all the success to the organizers and the participants for the successful organization of the workshop.

Virender Kanwar

MESSAGE

Vice-Chancellor
CSK HPKV, Palampur
Himachal Pradesh

India has the world's largest population of livestock. Livestock rearing offers income, employment & nutritional security to millions of people in India. Muscle food production has not received adequate attention from entrepreneurs, policy makers, scientists and various stakeholders though it is linked to socio-economic situation of poor livestock keepers of the country.

The consumption pattern of dietary products has seen a shift from cereal based to livestock based diet. Meat, fish and their products are important components of diet of a large majority of people. Their nutritive value and palatability are widely appreciated .

The consumption of meat and muscle foods has been increasing considerably which offers numerous opportunities in the sector. The production, value addition and processing of muscle foods have not been given due emphasis, inspite of immense potential. Further, muscle food products based on meat, poultry or fish behave similarly with regard to their microbial stability and safety since most of them belongs to categories of high moisture and low acid foods, so they need refrigeration for storage. Microbial instability of these foods under external influences can have serious consequences on food safety. Hence, quality assurance of these foods is also remains a vital aspect.

Considering this, the Department of Livestock Products Technology, DGCN College of Veterinary & Animal Sciences, Palampur, in association with Indian Meat Science Association is organizing International Symposium on **"Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved Health and Nutritional Security"** at DGCNCOVAS,CSKHPKV, Palampur w.e.f. 6-8 November, 2019.

It will be a great opportunity for students, academicians, researchers, developmental and regulatory agencies, domestic and export industry people to interact and exchange ideas and understand the perspectives of each others. I am sure that the deliberations by various stakeholders at conference will come up with definite solutions and good road map for shaping the development of meat sector in the coming years.

I am sure that the International Symposium and IX Conference of IMSA will be a grand success and I wish all the participants and organizers all the very best.

(Ashok Kumar Sarial)

MESSAGE

Dean, DGCN COVAS
CSK HPKV, Palampur

Adequate nutrition is a basic human need. Prolonged lack of food and nutrients leads to various physical and mental impairments of human being. Livestock products such as muscle foods are nutrient dense foods which offer high quality protein and essential micro-nutrients to human population. Therefore, production of livestock products in general & muscle foods in specific have potential to overcome the problem of Global hunger &nutrition .

Further, the challenge of supplying healthy diets to 9 billion people by 2050 will in part be met through increase in food production. However, reducing food losses throughout the supply chain from production to consumption and sustainable enhancements in preservation, nutrient content, safety and shelf life of foods, enabled by food processing will also be essential.

This is imperative for muscle foods such as meat, poultry & seafood which are among the highly perishable foods. These foods rapidly deteriorate unless properly processed, packaged and stored. The deteriorations and degradations are mainly because of the high contents of fat and moisture and are therefore vulnerable to biological reactions such as protein degradation, lipid oxidation, or putrefactions interceded by microbial and endogenous enzymes, resulting in a shorter life span . Also, food-borne diseases have risen as a menace in many parts of the world over the past few decades among all age groups. It has substantially influenced the environment and human health, and causes economic loss.

The food packaging technologies are improving consistently in response to the demands of modern society, as well as the industrial production trends toward fresh, mildly preserved, convenient, delicious, safe, wholesome and quality food products with a longer shelf life.

Under these situations, I am happy to note that the Department of Livestock Products Technology, Dr G C Negi, College of Veterinary & Animal Sciences , Palampur , in association with Indian Meat Science Association is organizing International Symposium on **"Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved Health and Nutritional Security"** at DGCNCOVAS, CSKHPKV, Palampur w.e.f. 6-8 November, 2019.

I am sure that the deliberations in the conference would generate new recommendations for further improvement in the meat production and processing industry.

I convey my best wishes for all the success of the conference.

(Prof. Mandeep Sharma)

MESSAGE

IMSA
President

Meat sector is the driving force for the sustainable livestock development and plays a key role in nutritional and livelihood security for millions of men and women from weaker sections. Accelerated growth of Indian meat sector and especially export component, requires greater emphasis on meat science teaching, training and research. The meat processing industry in India is still emerging and has much to offer to the prospective entrepreneurs and traditional processors. Indian Meat Science Association (IMSA), is playing significant role in since its inception establishing common platform for the exchange, discussion and dissemination of current research, knowledge and ideas in the field of Meat Science and Technology to the stakeholders. It has succeeded, in doing so by successfully organizing eight IMSA conferences. The IMSA conference has achieved international repute and number of participants from outside country have increased in the last few years.

As per recently published 20th Livestock Census, total livestock population in India is 535.78 million as compared to 512.06 million in 2012. Growth of 10.14 percent in Goat population, 14.13 percent in Sheep population, 1.06 percent in buffalo population and 16.81 percent in poultry population is a good a sign for meat industry. Poultry meat sector with highest growth rate indicates its potential to surpass 50 percent mark very soon, which is nearly 46 percent currently. Although, the total goat and buffalo population has increased, male buffalo and goat population has declined over previous census, indicating higher slaughter rate and more demand for meat of these animals. These figures indicates that an integrated approach is needed to exploit the potential of this colossal livestock population, encompassing quality animal production, processing, efficient traceability, meat value chain, marketing and meat industry collaboration with meat science research and academics. Strategic goals are required at governmental, institutional research and industry level to spur and sustain the growth of meat sector. There is an urgent requirement of need-based research in meat sector and the focused efforts by strong scientific work force can take the meat sector in India to new heights.

The 9th IMSACON and International symposium on " Advances in Production, Processing and Quality assurance of Muscle Foods for improved Health and Nutritional Security " going to be organized by CSKHPKV, Palampur, shall provide great opportunity for meat scientists, students, industry personnel and other stakeholders for exchanging their ideas, experiences and imbibing knowledge. I hope that besides sharing knowledge, IMSACON-IX with different sessions will identify the key research areas, where our research should be focused to improve the research output and its applicability in Indian scenario. I am sure that IMSACON- IX will be a great success and wish a pleasant, intellectually enriching and a lifetime experience to all of you.

I convey my best wishes to all the participants and sincere thanks to organizers.

(S. K. Mendiratta)

MESSAGE

IMSA
Secretary

The Indian Meat Science Association (IMSA) has always been in the forefront in addressing the requirements of Indian Meat Sector. IMSA is providing ideal platform to both academicians and industry personnel alike to work towards the betterment of the meat sector. National conference of IMSA provides a greater opportunities for exchange of information and ideas among the major agencies involved in meat animal production, processing and marketing. Since IMSACON VII 2016 organized at Ludhiana, the conferences are organized as an International event with wider International participation. The last IMSCAON was organized as International Symposium at Kolkata with participation of more than 300 delegates. I am glad to inform that IMSA also organised one day interactive session on “One health: Unprecedented opportunities and challenges” in association with Society for Research on Listeria on 17 December 2018. Journal of Meat Science has gone online, got funding from ICAR and has been listed in NAAS Journal list with impact factor of 4.22.

Meat sector is witnessing perceptible changes in terms of meat production and marketing. Several integrated chicken processing units are being established to meet the institutional as well as domestic requirements. Number of start-ups for online meat marketing are raising over the years. Inconsistent meat quality, social taboo for meat from certain meat animal species, different slaughter regulations in different states, inadequate infra structure in the value chain and untrained manpower are some of the major bottlenecks, these generation next entrepreneurs have to face before succeeding in their new ventures. The efforts of the country's regulatory authority - FSSAI in creating awareness among all the stakeholders to ensure the safe food in the country should also reach meat sector to provide wholesome meat.

I believe that the International symposium on, “Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved health and Nutritional security” organized by the Department of Livestock Products Technology, College of Veterinary and Animal Sciences, CSK HPKV, Palampur during 6-8, November 2019 will provide opportunities to deliberate various challenges and opportunities in meat value chain and will come up with concrete implementable recommendations for the development of meat sector in India.

I am sure that International symposium will be a grand success and wish all the success to the organizers and the participants.

(M. Muthukumar)

From the Desk of Organizing Secretaries

Dear Colleagues, Guests and Friends,

On behalf of the organizing committee, we are delighted to welcome you to participate in the Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved Health and Nutritional Security" at DGCN-COVAS, CSK-HPKV, Palampur on 6-8 November, 2019 in collaboration with Indian Meat Science Association (IMSA) at Palampur, Himachal Pradesh. This conference is aimed to carry out brainstorming discussions and presentations to design the future strategies related to Meat Animal Production-Climate Change, Livelihood & Food Security, Muscle Food Processing and Development, Muscle Food Safety and Quality Assurance, Functional and Traditional Foods, Nano-Biotechnology in Muscle Food Processing, Innovation in Food Packaging, Poultry Meat Production, Processing and Quality Assurance, Animal By-products and Waste Management.

We express our sincere thanks to IMSA family for providing us this opportunity. The organizing committee is highly indebted to the support and valuable guidance provided by our Honorable Vice-Chancellor and Chief Patron Professor Ashok Kumar Sariyal. We express our special and personal thanks to our Patrons Dr D. K.Vats, Dr Y P Thakur, Dr R. K. Agnihotri, Dr S. K. Choudhary and Organizing Chairman Dr Mandeep Sharma.

The financial assistance received from “Research and Development Fund” of National Bank for Agriculture and Rural Development (NABARD) towards publication of journal/ printing of proceedings of the conference and the sponsorship to meet partial expenditure incurred on Farmers'-Scientists interaction is gratefully acknowledged. We express our heartfelt gratitude to our sponsor, Allanasons Pvt. Ltd.

We are also thankful to all the members of the organizing committee, members of various committees, DGCN-COVAS faculty, staff members and post-graduate students of the Department for their strenuous hard work to organize this event. We extend my warm welcome to all the delegates from various parts of world and across India for participating in the conference and hope that all of them will enjoy the scientific congregation and hospitality here in the pristine town of Palampur. In the end, we pray to almighty for the blessings for the success of the event.

Dr. D. Krofa / Dr. B. G. Mane

Local Organising Committee

Chief Patron:	**Professor Ashok K. Sarial,** Hon'ble Vice-Chancellor, CSKHPKV, Palampur
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Organizing Secretaries:	Dr. Dinesh Krofa Department of LPT, DGCN COVAS, CSKHPKV, Palampur Dr. B. G. Mane Department of LPT, DGCN COVAS, CSKHPKV, Palampur
Joint Organizing Secretaries:	Dr. Sanjay Kumar Department of LPT, DGCN COVAS, CSKHPKV, Palampur Dr. Mahesh Gupta Food & Nutraceutical Division, CSIR IHBT, Palampur
Technical & Finance Secretary:	Dr. Devesh Thakur Deptt. of VAHE, DGCN COVAS, CSKHPKV, Palampur.

Introduction of the University

Himachal Pradesh Krishi Vishvavidyalaya (renamed as Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya in June,2001) was established on 1st November, 1978. The College of Agriculture (established in May, 1966) formed the nucleus of the new farm University. It is ICAR accredited and ISO 9001:2015 certified institution. The Indian Council of Agricultural Research has ranked this University at eleventh place among all farm universities of the country.

The University has been given the mandate for making provision for imparting education in agriculture and other allied branches of learning, furthering the advancement of learning and prosecution of research and undertaking extension of such sciences, especially to the rural people of Himachal Pradesh.

Over the years, this University has contributed significantly in transforming the farm scenario of Himachal Pradesh. Today, the State has earned its name for hill agricultural diversification and the farming community has imposed its faith in the University.

Academic Programmes

The University has four constituent colleges. The College of Agriculture has 13 departments, Dr. G. C. Negi College of Veterinary & Animal Sciences has 18 departments, the College of Home Science has five departments and the College of Basic Sciences has four departments. These colleges offer five Bachelor Degree programmes and the Dean, Post Graduate Studies offers 14 Masters Degree and 7 Doctoral Degree programmes.

At present 1643 students (943 girls & 700 boys) are on roll from six foreign countries and 14 Indian states. Around 7050 students have passed out from the University since its inception. In addition to world class academic, sports and co-curricular facilities, there are ten students' hostels, including one International Students' Hostel.

Research Activities

The Directorate of Research coordinates research in the field of agriculture, veterinary and animal sciences, home science and basic sciences. It has been giving priority to the location specific, need based and problem oriented research with multidisciplinary approach at main campus Palampur, 3 Regional Research Stations (Bajaura, Dhaulakuan & Kukumseri) and 10 Research Sub-stations (Kangra, Malan, Nagrota, Salooni, Akrot, Berthin Sundernagar, Sangla, Leo & Lari) situated in all the districts of the State (except Solan and Shimla).

The University has developed need-based technologies for the different regions of the State and has released one poultry variety (Himsamridhi) and 155 improved varieties of different crops (Wheat 24, Paddy 23, Maize 9, Barley 6, Pulses 24, Vegetables 29, Oilseeds 23, Buckwheat 2, Sugarcane 1, Fodder 12 and Tea 2). Around 800 quintal breeder seed and around 1000 quintal foundation seed of cereals, pulses, oilseeds, vegetable and fodder crops is produced and supplied to the State Department of Agriculture for further multiplication and making it available to the farming community. Around 100 farm technologies have been recommended to the farmers. To enhance crop and animal productivity, the University has developed suitable technologies in the areas of crop improvement, animal breeding, disease combating, natural resources management, etc. Besides continuing research on organic farming in hill agriculture, the University was first in the country to establish a zero budget natural farming centre and initiated research for safe farm produce, the concept adopted by the central government in its budget this year.

For doubling the farmers' income by 2022 as envisaged by the government, twenty farm based models have been formulated and shared with the agriculture and animal husbandry departments of the State government. Efforts have been made to educate and motivate the farmers to adopt the models as per the agro-climatic conditions of their area and their requirements.

Extension Education

The Directorate of Extension Education shares the responsibility for planning, implementation and coordination of various extension education programmes of all the departments of four constituent colleges and research stations in close collaboration with the State Departments of Agriculture, Animal Husbandry, Fisheries and other concerned departments and institutions. It conducts a large number of trainings for farmers, livestock keepers, farm ladies, rural youth, etc. at main campus and at its eight *Krishi Vigyan Kendras* (Farm Science Centres) at Bajaura, Dhaulakuan, Hamirpur, Una, Mandi, Kangra, Berthin and Kukumseri. During the last one year, Union Ministry of Agriculture and Farmers' Welfare has sanctioned Model Training Courses also. Various skill enhancement trainings sponsored by Agricultural Skill Council of India are also conducted. Natural Farming activities are being undertaken by all Krishi Vigyan Kendras (KVKs) and KVKs have adopted one village each for Natural Farming. The Agricultural Technology Information Center is serving as a single window service to the farmers.

The Media Cell projects and protects the image of the University among target clients and others by various Public Relations and Communication tools.

A massive infrastructure to fulfill the mandate and realize objectives has been created at main campus Palampur, all Research Stations and Krishi Vigyan Kendras. The main clients viz. the farmers and the students are provided quality facilities in the form of training halls, farmers' hostels, transportation, students' hostels, play ground & gymnasium, placement cell, etc.

Among the leading universities in the hill regions of the country, this University has emerged as torch bearer for all. It is considered most peaceful institution in the region with very conducive atmosphere to pursue academic and research activities.

Due to the sincere and arduous work during the past forty one years in the University, the State has achieved new standing in the area of agriculture. Despite constant decrease in area under farming, crop yields have increased. The State has earned name in commercial agriculture, especially off-season vegetable cultivation. Harvests have become bountiful and the socio-economic status of the farming community has improved significantly.

About the college

Late Dr. G.C. Negi, the then Vice Chancellor of CSK HPKV (1984-1989), fondly nurtured an ambition to start a College to provide best possible and affordable Veterinary education to the people from the hills. He finally translated his vision in reality by formerly starting the College of Veterinary and Animal Sciences in June, 1986 as one of the constituent college of CSK Himachal Pradesh Krishi Vishvavidyalya, Palampur (H.P.). Today, The same institution is known after his name as Dr. G.C. Negi College of Veterinary and Animal Sciences and has acquired the stature of being one of the premier educational institution in the hill states of India.

The motto of the college is "Caring and curing animals, creating new knowledge, therapies and learning opportunities and communicating with students, farmers, veterinarians, scientists and the public".

The mission of the college is to enhance animal and public health and well-being through excellent professional veterinary medical education, undergraduate, resident, and postgraduate education in the veterinary sciences, animal biotechnological and clinical research, and public service through clinical care and diagnostic services, life-long education, and outreach. The College of Veterinary and Animal science is unique within the state of Himachal Pradesh as the only College that is equipped for providing veterinary education.

The college has grown as one of the best among the hill Veterinary colleges of the country and has been rated in 10 top veterinary colleges of the country. The first batch of 25 students was admitted on merit in July, 1986. With the development of teaching and research facilities and as per the recommendation of the Veterinary Council of India, the minimum standards of veterinary education (MSVE, 1993) 17 departments and 2 services units were created.

The College is duly accredited with Indian Council of Agricultural Research and Veterinary Council of India and follows academic standards prescribed by Veterinary Council of India vide minimum standard of Veterinary education for BVSc. and AH programme w.e.f. session 1994-95, revised in 2016. So far the college has produced approximately 900 BVSc. & AH, 300 MSc/MVSc and 35 PhD graduates in Veterinary and Animal Sciences. All the graduates are gainfully employed. From the session 2010-11 the intake capacity of the college for UG programme has been increased to 58. As on today there are 264 students registered for BVSc. and AH, 42 for MVSc and 03 for PhD programmes, respectively

Project

Teaching Veterinary Clinical Complex provides facilities to the undergraduate and postgraduate students, teachers and interns for on hand clinical training in the field of Veterinary Medicine, Surgery and Gynaecology with reference to diagnosis and treatment of diseases on the standard recommended modern medical lines. Ambulatory services and emergency services including veterinary services at the farmer's door are also available. The clinic has OPD section, indoor wards and clinical diagnostic laboratory. Artificial Insemination unit, large animal operation theatre, obstetrical unit, semen laboratory, small animal operation theatre, recovery room, duty room for internees and staying facilities for owners of the animals are also available. Poultry farm is maintained for production of broilers and egg laying birds. Fishery farm is running a revolving fund, which has turned out to be a profitable venture. The researches on poly culture model have been adopted by the farmers of the state. The Metabolic stall is a field laboratory for the study of UG and PG students of Animal Nutrition. It has ancillary facilities of animal feed processing unit. The 1.5 hectare land serves as an experimental field for pasture and fodder research demonstration. Recently an "Advanced Multidisciplinary Veterinary Services and Farmer's Capacity Building Centre" has been sanctioned for the college under RKVY and the construction work is being taken.

MANDATE

The objective and the mandate of the college are as under:-

1. Human Resource Development to produce qualified veterinarians and postgraduates in different disciplines of Animal Health, Production and Products Technology besides updating the knowledge and skills of the field Veterinarians.

2. Enhancing Animal Production by genetic improvement of cattle, sheep and other livestock species from the health point of view, studies on fertility problems, development of viable and sustainable pastures/ grasslands and technology for improving feeds and herbages for optimum nutrition, development of hormonal and neuro-endocrinological and embryological and embryo transfer technology etc. For improvement of livestock production.

3. To provide animal health coverage to the livestock population of the State by giving specialized therapeutic service at the main campus, organizing animal health camps at the farmer's doors and attending disease outbreaks.

4. Strengthening Animal Products Technology for meat, milk, fur, wool and hair etc.

5. Transfer of technology to the farmers and to render referral health services for the livestock of the state.

Department of Livestock Products Technology- At a Glance

The independent Department of Livestock Products Technology was created in 1996 as per norms of Veterinary Council of India (VCI). Presently, the Department has three faculty members. The Department is in running undergraduate teaching as recommended by Veterinary Council of India. The Department is actively engaged in the teaching, research and extension activities. The Department is planning to start post-graduate education in Livestock Products Technology in near future to cater the need of scientific manpower and human resource development in livestock products processing sectors. The Department is planning to develop paid short-term certificate and diploma courses for field veterinarian for advances in Livestock Products Technology as well as unemployed youth of Himachal Pradesh.

The Department is involved in the following teaching, research and extension activities :

- Milk and Milk Products Technology
- Meat and Meat Products Technology
- Poultry Products Technology
- Animal By-Products Technology
- Quality Analysis of Livestock Products

The department is planning future extension activities in the following areas:

1. To establish training cum entrepreneurship development centre in clean milk production, processing and value addition
2. To establish training cum entrepreneurship development centre on processing and value addition of meat and poultry products
3. To establish training cum quality assurance centre for livestock products
4. To develop the liaison with livestock products and related industry, trade and regulatory bodies at the national level.

Research Projects

1. Department is running an ICAR sponsored experiential learning unit on dairy processing.
2. One research project is undergoing on milk quality control and laboratory establishment.

Faculty

1. **Dr. Dinesh Krofa**
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   Designation: Assistant Professor (In-charge)
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2. **Dr. B. G. Mane**
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3. **Dr. Sanjay Kumar**
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Committee for the conduct of 9th International Symposium on "Advances in Production, Processing and Quality Assurance of Muscle Foods for Improved Health and Nutritional Security" during November 6-8, 2019, Palampur, India

1. Conference Advising Committee

Dr. S. K. Upadhaya, Professor & Head
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Dr. Manoj Sharma, Asstt Professor

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INDIAN MEAT SCIENCE ASSOCIATION
(Reg. No. 307/001)

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Indian Meat Science Association (IMSA) with its head quarters located at National Research Centre on Meat, Hyderabad brings together meat animal/poultry producers, meat scientists, meat processors, meat exporters and all other involved in research, training and extension related to meat science and technology in India.

In order to realise the power of meat and meat products in 21st century, several Institutions and Industries are working with sizeable number of scientists, faculty members and students on various aspects of meat science viz, novel meat sources, meat sustainability, animal welfare and slaughter, muscle biology and biochemistry, microbiology and chemical hazards, advanced preservation techniques, by-products utilization, value addition, packaging, meat based functional foods and also on specific hot topics important to the industry. The IMSA which is strongly dedicated to research, training and extension in meat science, is still in its infancy but a lot of effort is being put in the direction of making this endeavour successful and useful.

The Association will work with the objectives of advancement of all aspects of science and technology relating to production, processing and marketing of meat and meat products to serve the humanity. In pursuit of these goals the IMSA will work with the following objectives:

- Stimulation of research, training and extension in the field of Meat Science and Technology.
- Provision of a forum for the exchange, discussion and dissemination of current knowledge in the field of Meat Science and Technology.
- Promotion of high standard of technical proficiency, professional expertise and personal integrity among its members.
- Elevation of the profession of Meat Science and Technology.
- Publication of the Journal of Meat Science.
-

We encourage individual scientists, technologists, faculty members, students, meat industry experts as well as corporate bodies to join as members and it is our desire to make the association most useful forum for techno-scientific and educational activities accessible to Master's and Ph. D students, scientists working in both academia and Industry.

The association invites all meat science researchers to join as members.

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(Key 01)

Indian Livestock- Production Potential and Trade Implications

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Introduction

Traditionally, livestock production in India and many developing countries has been a part of mixed farming systems, which had a high degree of environmental sustainability and considered the most efficient one. Indian livestock production is production by masses rather mass production by few. Mixed farming with value addition to crop sector is largely practiced and has been considered the most efficient one. Meat production is a by-product utility of livestock sector –an efficient resource utilization approach. But, in the recent years with changing land utilization pattern and socio-economic changes semi-intensive and intensive livestock production systems are emerging as entrepreneurial ventures to meet the increasing demand for livestock products including meat and by-products. In order to achieve better economics of these ventures and also sustaining traditional systems efficiency in the utilization of resources, livestock production, processing and marketing have become important requiring innovations and adoption of technologies. Approaches essentially required for sustaining prospects of livestock for livelihood, food and nutrition security and employment need to be given priority.

Sustainable animal production largely depends on feed supplies and costs, production efficiency and utilization of products. Modern technologies and policies need to support each one of these aspects of animal production to achieve maximum gain under a range of situations. Effective utilization of produce is important and depends on hygienic production, cost efficient processing technologies, creating demand for the product, innovative marketing approach, utilization and proper disposal of by-products and waste and providing a positive image.Complimentary efforts of dairy, meat, leather and feed sectors are demanded in solving the challenges faced in the sustained production and utilization of livestock species. Farmers need to be supported to face a range of situations developing on account of increased economic and social pressures that are compounding his constraints. Farmers interest cannot be compromised and scientific interventions need to favour the farmers. As meat,dairy and leather sectors are well developed and modernized, need to contribute in sustained production with appropriate production interventions and bringing increased awareness among the farmers towards realizing the maximum production potential of the livestock resources and other input items. All the co-sectors of livestock production need to implement model programs through adoption of villages for demonstrating realization of increased production potential and must work in tandem with other associated sectors for augmenting livestock prospects. Government programmes, policies and regulations need to be developed with active participation of stakeholders for implementation and contribute to sustaining livestock prospects.

In the recent years a number of conflicting factors are influencing livestock production activities. Animal production and utilisation need to be organised on modern and scientific lines (as compared to traditional approach where economics is not of a direct concern) to cope up in a range of situations with appropriate programmes. Decrease in land resources and socio-economic changes have adverse effect on livestock prospects. Hence measures for improved efficiency are necessary.

Production potentials of different livestock species:

Cattle: The resource is very large with 26 breeds and total population of 190 m (2012 census) and having great potential with relevant interventions and pragmatic approaches. Cattle have been developed for centuries for draught power and possess excellent meat production characteristics. Hence the important intervention for realizing greater production potential and sustainable prospects of cattle would be to have policies for milk and meat production from cattle which would be complimentary. While there are restrictions for cow slaughter in most states, but improved utility of males for meat including for exports would be a relevant approach. The menace of excessive cattle numbers and stray cattle issues would be prevented permitting cattle transport among the states in the country. Sustained efforts for cow prosperity rather than cow protection have to be important policy directives for sustained cattle production. It is well demonstrated that economic value of the species is the single major contributor of sustainability. Hence, cattle utility must be improved by implementing Article 48 of the Constitution in true spirit- by practicing *'organization of agriculture and animal husbandry on modern and scientific lines'*

Buffaloes: There seven breeds of buffaloes with a total population of 108.7 million (2012 census). Buffaloes proved successful species with increasing population census after census. The economic demand driven production contributed by milk and meat have sustained buffalo prospects. In particular buffalo meat exports have fuelled growth in sector. It has been demonstrated that as the utility increases farmers sustain their production with better returns. Thus, a range of interventions in terms of increased productive and reproductive performance for realization of production potential; value addition for increased demand at higher returns; natural resource and inputs utilization efficiency; policy and programme interventions are required.

Farmers have to be vigilant in retaining the best producers till the targets of lifetime production are achieved. Should take better care of all the superior replacement stock. Buffalo calf mortality is abnormally high as farmers do not leave adequate milk to calf and do not take adequate care of health (deworming etc.) and management of calf. Calf starter feeding is practically non-existing which is affecting buffalo potential. Early age feeding of low cost calf starters would have large benefits not only in reducing early age mortality but also contributing for whole life productivity.

Buffalo milk, meat and leather sectors growing prospects with modern processing plants and competitive marketing in domestic and export markets propelled buffalo prospects to make significant strides compared to other livestock species. Interventions to increase and realize the productivity potential of existing buffalo population is important in R&D programmes and policy efforts need to compliment.

Propelling effect of Buffalo meat exports: Buffalo meat exports facilitate profitable utilization of culled and surplus buffaloes to benefit the farmers with higher returns, providing employment and livelihood, providing much valuable foreign exchange to import essential items such as fertilizers, oil, heavy machinery etc. Also the multi benefits of meat exports propelled buffalo production and productivity by promoting effective culling of unproductive animals, optimum utilization of feed, fodder and other resources to the productive populations, increased income to farmers for livelihood and other investments. Male buffalo calf salvaging and rearing to optimum weights has a large potential for sustaining growth in buffalo meat exports.Importing countries have experienced the risk free status of Indian buffalo meat and patronized for about five decades due to natural rearing practices without hormone and antibiotic use and has no BSE implications.Export earnings –in dollar terms per kg over the decades – with modern processing plants/quality assurance and marketing efforts have contributed for sustained backward supply of buffaloes by the farmers due to increased returns year after year since 2001.

Table 1: Buffalo Meat Export- quantity and value (2001-2018)

Year	Quantity (MT)	Value		Unit value	
		Rupees- crore	US$-million	Rs/kg	US$/kg
2001	288002.84	1374.93	300.99	47.74	1.05
2005	337777.65	1774.52	395.48	52.53	1.17
2010	495057.91	5480.92	1156.31	110.72	2.34
2015	1475526.01	29282.58	4781.18	198.46	3.24
2018	1350563.48	26033.83	4036.89	192.76	2.99

Source: APEDA statistics.

Sheep and Goat: India hasrich resources of 40 breeds of sheep and 20 breeds of goats with a large population of 65m sheep and 135m goats.Intensive and semi-intensive production of sheep and goat have large prospects and in select agro-climatic zones crop production could be replaced with fodder,sheep and goat production. There is large acceptability for mutton and goat meat in the country and the demand is ever increasing resulting price increase. World sheep and lamb numbers are similar to those that existed in the 1960s. Some growth in sheep numbers has occurred in India, Pakistan, and North Africa. Although world inventory numbers have declined, productivity increases have increased world lamb and mutton production levels. Productivity has increased almost 60% since 1965. Australia and New Zealand are the world's principal lamb and mutton exporters. With decreasing numbers in these countries India would find better prospects in these species not only in the domestic market but also in the export market.Increase in sheep and goat productivity should be considered with introduction of twinning in prominent sheep breeds of the country and popularizing lamb milk replacer for better nutrition among lambs and kids. The technologies developed at ICAR-CSWRI should cover larger areas of the country for increased productivity among sheep and goat. Nutrition interventions for attaining optimum slaughter weights need to be promoted.

Pig: Pig population in the country was 10.29m comprising large number of indigenous breeds (78%) and exotic and cross-breeds (22%). Though a sizeable proportion of Indian communities have no objection to consume pork on religious ground the consumption is lower largely due to non-availability of good quality pork. The reasons attributed are: poor genetic stocks of pigs; lack of scientific feeding and rearing practices; poor slaughter practices; lack of processing and marketing facilities. If pig prospects are to be enhanced both in domestic and export markets it is necessary that concerted efforts and investments are made in private or joint sector mode in all these sectors of pig production, processing and marketing. The largest consumed meat among world countries is pork and India should not leave this species whose prospects aredeclining in the recent decades. Pork is a major meat in a number of countries such as China, Denmark, USA, UK etc.Hence, international trade prospects are large.

Pig production in India remained largely a nomadic (scavenging) activity with a very little or no input costs and primarily an activity of weaker section people. However, for these people it is not only a source of income and livelihood but also a choice of meat for consumption. Availability of quality pork for a variety of consumers would enhance the prospects.

Poultry production: Poultry prospects have increased over the decades with increasing potential realization following scientific production and genetic breed improvement.Any further increases in poultry numbers should be associated with processing. Poultry meat is the major meat of India today forming more than 50% of total meat and available at affordable prices. In meeting the animal protein requirement poultry meat and eggs deserve high priority due to the scientific adoption of poultry production with world comparable efficiencies and as a species poultry is one of the efficient species in converting feed to products.India's per capita consumption of poultry meat is estimated at around 3.6 kg per year, which is low compared to the world average of around 17 kg per year. It is expected, with rising middle class incomes, and more international exposure due to travel and expansion of fast food restaurant chains, consumption continues to rise for chicken meat in general and processed chicken meat in particular. The seasonal dips in market prices of chicken need to be exploited through processed products development.

Realization of livestock potential

The factors listed above that affect livestock production prospects also affect the realization of the potential of the species. The potential of any species are affected by the reproductive efficiency, nutrition efficiency in particular to able to utilize varied types of feed stuffs, utility of the species and their products in particular the economic demand for the produce, trade and utility implications as affected by the regulations etc. Hence the interventions have to be on all these aspects so that the maximum production potential could be realized under a range of situation and the sustainability of the species could be maintained. Important aspects include: improved milk production and composition, increased growth rate, improved feed usage, improved carcass composition, increased disease resistance, enhanced reproductive performance, and increased prolificacy'. Preventing early age mortality and growing meat animals to optimum slaughter weights has large prospects in the country.

Production and Trade implications

Trade implications of livestock and their produce include all aspects that contribute to animal production- rearing and feeding, management, health, transport, welfare etc that result quality animals and their product with optimum efficiency and at reasonable costs that lead to sustainability of animal production. Processing of the products- milk, meat, leather and other by products under hygienic and aesthetic conditions including waste disposal and environment

Travel, migration and trade will all continue to promote the spread of infections into new populations. Trade in exotic species and in bush meat are likely to be increasing causes of concern, along with large-scale industrial production systems, in which conditions may be highly suitable for enabling disease transmission between animals and over large distances (Otte et al. 2007).Other TADs are Anthrax, Brucellosis, bovine tuberculosis, BSE with which India is implicated in International trade.

Rinderpest: Rinderpest has been eradicated from the World but new diseases have emerged, such as avian influenza H5N1, which have caused considerable global concern about the potential for a change in host species from poultry to man and an emerging global pandemic of human influenza.

Bovine Tuberculosis (bTB): The disease is classified as TAD affecting trade prospects with many countries that are free from bTB. Prevalence of bTB has been estimated at 7.3% indicates an estimated 21.8m are infected cattle in India- a population greater than the total number of dairy cows in the United States of America. It has been suggested with the projected increase in intensification of dairy production and the subsequent increase in the likelihood of zoonotic transmission, the results of studies suggest that a attempts to eliminate tuberculosis from humans will require simultaneous consideration of bTB control in cattle populations in countries such as India.

OIE and Codex Standards for International trade

In the current trend of globalisation, animal health measures have increasing importance to facilitate safe international trade of animals and animal products while avoiding unnecessary impediments to trade. In light of this, the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) encourages the members of the World Trade Organization (WTO) to base their sanitary measures on international standards, guidelines and recommendations, where they exist. The OIE is the WTO reference organisation for standards relating to animal health and zoonoses. The Codex Alimentarius, or "Food Code" is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission. Codex standards ensure that food is safe and can be traded. The 188 Codex members have negotiated science based recommendations in all areas related to food safety and quality. Codex food safety texts are a reference in WTO trade disputes. WTO members that wish to apply stricter food safety measures than those set by Codex may be required to justify these measures scientifically. The Codex Alimentarius includes provisions in respect of food hygiene, food additives, residues of pesticides and veterinary drugs, contaminants, labelling and presentation, methods of analysis and sampling, and import and export inspection and certification.

Nutrition

Improving the efficiency of livestock production and meeting the expectations of consumers with desired quality of produce and practices of production and the demands of regulatory authorities are important requirements. Under nutrition or poor nutrition is one of the major production constraints in smallholder systems.The mixed crop–livestock smallholder systems in developing countries would be prospective with appropriate supplementation for better efficiency and minimize green house gas implications. Improved feeding practices (such as increased amounts of concentrates or improved pasture quality) can reduce methane emissions per kilogram of feed intake or per kilogram of product. It is more relevant in Indian situation due to lack of practice of feeding of concentrates to majority of the animals.

Public health issues will become increasingly important, such as concerns associated with the use of antibiotics in animal production, including microbiological hazards and residues in food (Vallat*et al*. 2005). The World Health Organization recommended that all sub therapeutic medical antibiotic use be stopped in livestock production in 1997, and proposed strict regulation and the phasing-out of other sub therapeutic treatments such as growth promoters; but appropriate surveillance and control programmes do not exist in many countries (Leakey *et al*. 2009). The globalization of the food supply chain will continue to raise consumer concerns for food safety and quality.Feeding ruminant origin meat meal to ruminants and swill feeding to pigs are other feeding practices that are regulated due to trade implications associated with BSE (in ruminants) and FMD/ ASF(pigs).

Regulations

Regulations in India have not been always promoting production and trade in a pragmatic way. Slaughter regulations implemented as per the State Animal Preservation Acts have not been pro-utility of the species and hence resulted adverse effect on economic demand driven production. Cattle in particular and buffaloes to some extent have been affected with the regulations most of which were of 1970s which have further made negative to cattle prospects with severe restrictions on the slaughter and utility aspects. Meat export policy has gone totally negative to cattle prospects. The success case of buffaloes with less severe slaughter restrictions and more favourable meat export policy have adequately demonstrated that the declining cattle prospects need consideration for better utility aspects as that of buffaloes.

Broadly the regulation pertaining to Meat animal transport and slaughter comes under the following categories:

A. Constitutional provisions- Directive Principles of State policy
B. Animal welfare regulations
C. Motor vehicle transport Act
D. State Animal Preservation Acts
E. Food Standards and Safety Act
F. Local bodies acts/Municipal acts/ Panchayat acts
G. Pollution control and environment protection acts
H. Meat export policy and regulations

Most important constitutional provisions of livestock sector are Article 48 & 47 which need to be pragmatically understood and interpreted for the larger good of the Nation.

ARTICLE 48: "Organisation of Agriculture & Animal Husbandry. The State shall endeavour to organise agriculture and animal husbandry on modern and scientific lines and shall, in particular, take steps for preserving and improving the breeds and prohibiting the slaughter, of cows and calves and other milch and draught cattle"

ARTICLE 47: "Duty of the State to raise the level of nutrition and the standards of living and to improve public health. The State shall regard the raising of the level of nutrition and the standard of living of its primary duties and, in particular, the State shall endeavour to bring about prohibition of the consumption except for medicinal purposes of intoxicating drinks and of drugs which are injurious to health"

State Animal Preservation Acts

Slaughter of animals is regulated as per State AnimalPreservation Acts and Rules made there under in different States (available in respective State web-site). Brief Details of State slaughter provisions of Animal Preservation acts are available at: http://www.dahd.nic.in/dahd/reports/report-of-the-national-commission-on-cattle/chapter-ii-executive-summary/annex-ii-8.aspx#

Unauthorized slaughter and meat quality implications: In the unauthorized slaughter in unrecognized slaughter places meat quality is bound to be affected as result of lack of basic facilities and lack of sanitary practices being followed. Local bodies have the responsibility for providing hygienic place for slaughter of animals and regulate the same. Thus, for the prevalence of unauthorized slaughter inthe country has been due to failure of the local bodies and the successive State Governments in performing their obligations to provide hygienic place for slaughter of animals and provide the consumers with quality meat.

Motor vehicle act (amendment regulations) 2015: A critical examination of the amendment rules indicatesa number of deficiencies/ difficulties for reconsideration and revision. In view of large variability in the types, breeds, sizes and condition of animals it is necessary that utmost care is necessary in proposing any interventions in the livestock related activities based on a thorough analysis of implications and assessing most appropriate intervention. A committee should be constituted by DAHD (GOI) with experts, officials, stakeholders, Transport Department officials, NGOs etc. for examining the issues and evolve a meaningful strategy for successful implementation of livestock transport regulations.

Indian Standard- Transport of Livestock — Code of practice (First Revision) *http://urban.bih.nic.in/Docs/Guidelines-Transport-of-Livestock.pdf*

This standard prescribes the conditions for the transport of livestock (cattle, sheep, goat and equines) by rail and road, of live domesticated animals (cattle, buffalo, deer, camelids, sheep, goats, pigs, equines and others) by sea, and of various species of animals by air. It is mandatory to follow this code as it has been in the Central Motor Vehicles transport (Amendment) Rules, 2015 effective from January 2016. The recommendations contained herein do not claim to be comprehensive for all circumstances but attempt to define high standards for livestock transportation on a species by species basis. ANNEX D- Space Allowances for road and rail transport of livestock have been listed.

Regulation of Livestock markets and Animal welfare

MOEF Notifications G.S.R. 494(E) Prevention of Cruelty to Animals (Regulation of Livestock Markets) Rules, 2017 and G.S.R.495 (E) Prevention of Cruelty to Animals (Care and Maintenance of Case Property Animals) Rules, 2017. These rules have come under severe criticism and cases filed against some of the provisions and revised rules are not yet notified under any of the Central Govt. websites. A number of provisions under these rules are detrimental to livestock trade and farmers interest. Establishing a task force to examine various issues and implications of livestock trade and utility is necessary so that the farmer's economic interest in livestock products gets sustained with the implementation of PCA act and the Rules made there under. With the recent transfer of Animal Welfare subject to the Department of Animal Husbandry and Dairying (newly formed Ministry if Fisheries, Animal Husbandry and dairying) it is hoped that relevant and prospective regulations in livestock sector shall be notified.

Other regulations that are related to Meat animals transport and slaughter are:

'

- The Prevention and Control of Infectious and Contagious Diseases in Animals Act, 2009'
- Drug and Cosmetic Act, 1940.
- Export (Quality Control and Inspection) Act 1963
- Agricultural and Processed Food Products Export Development Authority Act, 1985 -
- The Insecticides Act, 1968 and Rules, 1971
- The Environment (Protection) Act, 1986- *http://moef.gov.in/wp-content/uploads/2017/06/eprotect_act_1986.pdf*
- Hazardous Waste (Management & Handling) Rules, 1989
- Water (Prevention & Control of Pollution) Act, 1974
- Air (Prevention & Control of Pollution) Act, 1981

References

References can be made available upon request from the author.

(Key 02)

International & National Trends in Meat Sector and Policy Frame Work & Regulatory Issues Related to Meat Exports

Dr C K Thota, Director, Allana Group, Mumbai, INDIA

Introduction:

" Food Security is a National policy; while food safety is Regulatory & Statutory".

Food Security & Food Safety is a global subject for all nations who in today's era are interdependent. Food Commodities flow across the border from abundant place to demand/deficit places. It's an Urban & Rural economic driver of growth wherein nutrition has emerged as the right of the people similar to other fundamental rights.

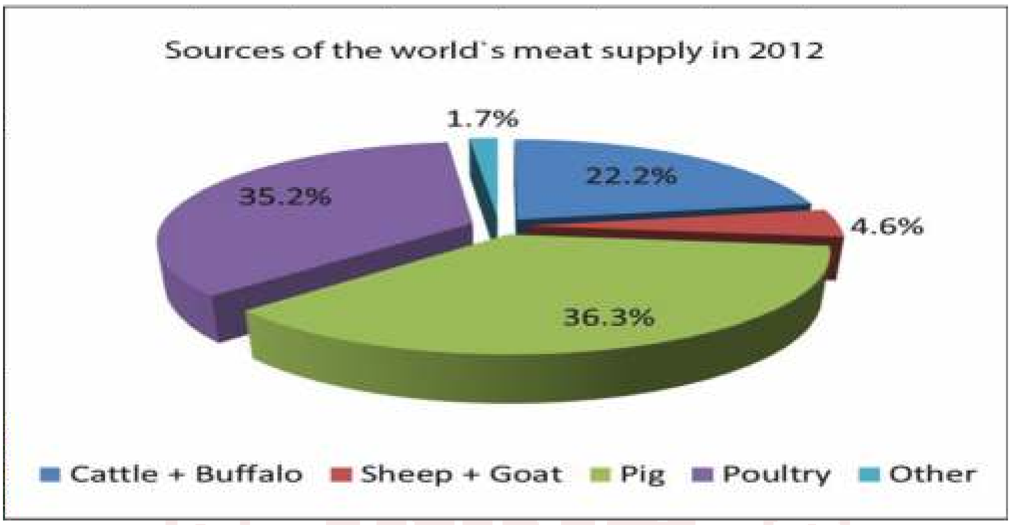
International Trends: Meat Sector :

The World Meat Trade has increased to USD 52 Billion since 2004 as per FAO data. The liberalisation across continents resulted in WTO reduction in trade barriers for International Food Trade to achieve individual national needs.

Globally, increasing population confirm the growth of the world meat and seafood market. Countries such as India, China, Brazil, and Russia are among the world's fastest growing economies; rise in per capita income is expected to shift dietary preferences toward protein-rich diets. There is also an increasing trend in developing countries' levels of income.

The highest growth of meat consumption is expected from the Asia-Pacific and Latin American regions, because of changing diet patterns, urbanization, population, and economic growth. (For example, China consumes around 28% of the world's meat, including half of its pork, and an average Chinese person consumes around 63 kg of meat a year.)

World Meat Consumption Pattern



Source :http://www.fao.org/ag/againfo/themes/en/meat/backgr_sources.html

However, economists at International Poultry Council meeting (2019) agree African swine fever outbreak will cause pork shortage, leading consumers to eat more poultry & Poultry is positioned to become the world's most consumed meat protein in 2019 as African swine fever (ASF) spreads in pig herds across China.

International Trends: Trade

Meat Exports- Trade at the global level, are projected to 20% increase by 2027. Global imports will increase, particularly for poultry and bovine meat which will account for the majority of the additional meat traded in 2027.Meat exports will become increasingly concentrated, with Brazil expected to capture more than one third of total trade expansion and the United States more than a quarter. Argentina, Brazil, Mexico and the United States are expected to increase their share of world meat exports somewhat benefiting from the depreciation of their currencies. The highest meat import demand in 2017 was from Japan, which saw a rapid expansion of beef imports that triggered special safeguard (SSG) for frozen beef imports from countries without free trade agreements. Import demand from Japan will slowly decrease as its population declines by nearly 4 million by 2027.

International Trends: Markets

Exports From India			
		Quantity in MT	**Value in Rs. Lacs**
		2018-19	
Sr No.	**Country**	**Qty**	**Value**
1	Vietnam Soc Rep	5,65,853.96	11,91,448.66
2	Malaysia	1,24,413.15	2,57,463.30
3	Indonesia	94,500.00	2,26,699.29
4	Iraq	67,514.62	1,19,279.04
5	Myanmar	45,745.38	88,346.22
6	Philippines	44,709.12	83,887.93
7	Egypt A Rp	47,128.00	82,162.67
8	Saudi Arab	33,232.31	78,589.75
9	U Arab Emts	37,852.20	75,602.68
10	Algeria	17,286.00	35,484.63
	Page Total	**10,78,234.74**	**22,38,964.17**

Source: DGCIS Annual Export

Asia will account for the greatest share of additional imports, with the greatest increases in the Philippines, Vietnam & Malaysia where consumption growth is outpacing domestic production expansion. Meat imports into Asia account for 56% of global trade, and poultry will constitute more than half of this additional import demand.

China's increase in meat production will not be enough to meet its increasing domestic demand, which implies the need to continue importing at current high levels. Vietnam and the Philippines are expected to capture a larger share of additional imports for all meat types, supported by favourable economic growth.

Africa is another fast-growing importing region, although many countries start from a low base. Rapid growth in imports from Africa is projected to increase the import share of the region by 2027.

In the **Russian Federation**, the long-term effects of the 2014 import ban on meat have permanently reduced the level of imports, which are projected to decline further as a result of the stimulus to domestic production.

It is anticipated **that Brazil and the United States** will benefit from strong poultry demand from the developing world where diets are diversifying towards higher animal protein consumption levels.

International Trends: Livestock Production

Australia and New Zealand will continue to supply global sheep meat markets as the middle class in China and the Middle East continues to expand. In New Zealand, export growth will be marginal as land use has shifted from sheep farming to dairy. Intensification of livestock production is taking place with regard to the use of most of the production inputs. In particular, the intensity of feed use has greatly increased over recent decades.

Feed stuffs particularly traditional fibrous and energy-rich are in relative decline, and protein-rich feeds together with sophisticated additives that enhance feed conversion are on the rise. Environmental regulations surrounding the global compound feed industry, and strict regulations on few feed additives, like antibiotics, are acting as challenges to the compound feed market, thereby affecting the livestock industry.

However the **labour cost** average is more in developed countries. But these countries have more places in world meat market. However, economics of scale can lower the cost of production. It can be said that capital intensive production has become more effective than labour intensive production in meat production. Limited availability of land and water resources for animal feed production is increasing the demand for animal feed in the global meat industry.Generation of **foreign exchange** through export of livestock and livestock products is one of the key objective of most countries in the promotion of livestock & livestock products production.

Increased Consumer Incomes & Food Safety Consciousness

Due to **increase in incomes,** especially in developing countries has increased demand for protein food. Growing number of people in the Developing world are moving up the Food chain, enjoying a richer and more diverse diet. Poultry has more volume in global meat trade.Chained outlets from branded fresh meat companies have become popular, since not only do they offer hygiene, they specialize in offering **high-quality products**, and have disease-free certification for their animals. Such factors instil trust amongst meat-eaters and simultaneously create demand for more branded fresh meat products.Methods of cutting and keeping the meat in good condition have become more sophisticated allowing a very high quality product to be traded and a large proportion of meat is now boned before export.

Indian Meat Sector

As per World Bank projection, worldwide demand for food will increase by 50% and for meat by 85% by 2030. Government's and industries must prepare for meeting demand of meat inthe country with long run policies and investments. Government of India has already recognized livestock and poultry as an important sectorfor the socio-economic development of the country.

(Source:http://www.fnbnews.com/Poultry/poultry-challenges-opportunities--climate-change-affects-productivity-47012)

Development of Meat Sector in India

Initially slaughtering was a backyard proposition. Independent butchers and abattoirs account for the majority of sales of meat in India; however, they often lack hygiene and quality. Governments considered "meat inspection" as one their obligations to the society.

Back yard slaughtering was banned and slaughter houses came into existence. Centralised premises were constructed for slaughter of food animals.

Up gradation of slaughter-houses for Scientific, humane & hygienic slaughter of meat animals to produce wholesome and safe meat for human consumption. Setting up abattoirs with the involvement of local bodies under government & will have flexibility of involvement of private investors on PPP basis. This has been a rising concern amongst consumers, especially in urban areas, which is motivating consumers to source their meat from branded fresh meat companies Awareness about the implications of meat on human health grew and realisation of the deleterious effects on the environment. (Source: http://www.fnbnews.com/Overview/Status-and-prospects-of-Indian-meat-industry)

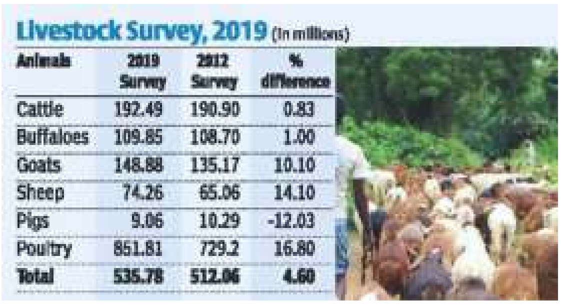
Indian Government Recent Initiative

Buffaloe shave been recognised as multipurpose animals (milk, meat, leather and draught). About 98% of total meat exports from India are contributed by buffaloes. Indian buffalo meat export is pioneered by Allana Group in 1969 among the world countries for reaching number one position in bovine meat export category from nowhere position about 50 years back (APEDA, 2018).

The World Organisation for Animal Health (OIE) has reported FMD outbreaks in India in 2016, 2017 and 2018. Older detailed data released by India's department of animal husbandry, dairies and Fisheries, said that, between January and October 2016, there were 120 outbreaks of FMD in cattle, leading to about 9,000 individual cases and 422 deaths. The prevalence of FMD in the country, for instance, has caused China to effectively ban Indian buffalo meat exports.

Understanding the importance of control of economically important diseases, Prime Minister Shri. Narendra Modi on 11 September 2019 launched a Rs 13,500-crore central scheme to control livestock diseases, especially foot and mouth disease (FMD) and brucellosis, from Mathura district in Uttar Pradesh. Announced by Prime Minister Narendra Modi himself, the National Animal Disease Control Programme (NADCP) will be implemented on a 'war footing', with all animals getting two shots of the vaccine, ear-tagged and followed up across all States.

(Source:https://economictimes.indiatimes.com/news/politics-and-nation/pm-narendra-modi-to-launch-rs-13500-crore-livestock-disease-control-scheme-next-week/articleshow/70982244.cms)



Livestock Survey, 2019 (In millions)

Animals	2019 Survey	2012 Survey	% difference
Cattle	192.49	190.90	0.83
Buffaloes	109.85	108.70	1.00
Goats	148.88	135.17	10.10
Sheep	74.26	65.06	14.10
Pigs	9.06	10.29	-12.03
Poultry	851.81	729.2	16.80
Total	**535.78**	**512.06**	**4.60**

Source : DAH&D 2019

Local Consumption Trends

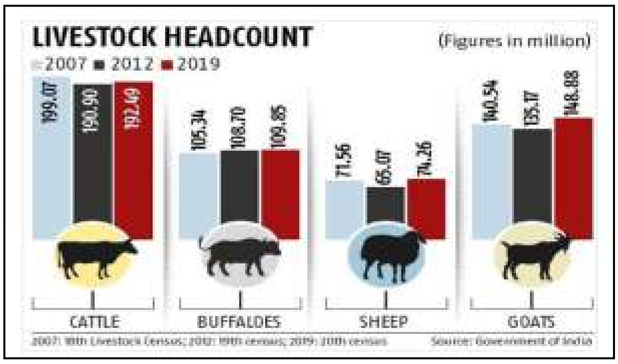
The production of meat in India has been doubled in last quarter century. This production increased both supply and demand conditions. While a growing number of people in the developing world are moving up the food chain, enjoying a richer and more diverse diet, so too protein-rich feeds together with sophisticated additives that enhance feed conversion are on the rise.

The per capita consumption of meat in India is fairly low compared to the developed markets suggesting that a significant share of the market still remains un penetrated. It is expected that a continuous growth in disposable incomes coupled with changing food habits to increase the consumption of meat in the coming years. Growth in the food services market such as restaurant and fast food joints are also creating a positive impact on the consumption of meat in the country. The share of restaurants and fast food joints serving non-vegetarian food is expected to increase in the coming years.

(Source:https://www.imarcgroup.com/india-poultry-fishery-animal-husbandry-industry)

Challenges Faced by National Meat Sector

- Animal markets to be modernised and to be regulated to comply traceability & animal welfare.
- Male buffalo calf rearing by farmers is highly economically viable & rural youth programme.
- Animal markets to be allowed & regulated around export abattoirs for direct farmer sale, no middle man.
- The subsidy on buffalo distribution should continue to promote meat exports & milk production.
- AMC cess on livestock for export to be abolished similar to Maharashtra, Uttar Pradesh & Odisha, Andhra Pradesh & Telangana.
- AH Department should have hi-tech regional labs for testing of meat for export purpose.
- The Department should also have adequate vegetarians as per law.
- Illegal slaughter should be vigilantly controlled by Task Force.
- All meat export units certification should be digitalised to avoid clandestine exports.
- Raw hides to be allowed for exports.



Policy frame work & Regulatory Issues: Meat Exports

Meat Export Policy

Only animals permitted under the Animals Preservation Acts are slaughtered for exports. According to the Prevention of Cruelty to Animal Slaughter house Rules (2001) no animals may be slaughtered which are pregnant, or have offspring less than three months old, have not been certified by a veterinarian that they are fit for slaughter. The item shave to be obtained/ sourced from an APEDA registered integrated abattoir or from APED A registered meat processing plant.

Legal Framework: Meat Industry

Starting from transporting animals to how and where to slaughter, to processing the meat for export, there is a plethora of laws being implemented at central, state and local governments. They can broadly be divided into two categories:

1. *Dealing with Animals:*

- The Prevention of Cruelty to Animals Act, 1960
- Prevention of Cruelty to Animals (Slaughter House) Rules, 2001:
- The Transport of Animals Rules, 1978

2. Dealing with infrastructure:

- Export Act (Quality Control and Inspection), Raw Meat (Chilled and Frozen), 1963
- Meat Food Products Order, 1973
- Food Safety and Standards Regulations, 2011 (FSSAI).
- Environment Protection Act, 1986
- The Ministry of Environment and Forests and Climate Change (MoEF&CC) Standards for effluent discharge (Slaughterhouses and meat-processing units)

Recent Curbs / Restrictions imposed by Govt.

- Government crackdown on illegal slaughterhouses since March 2017
- Criminalised cow slaughter and illegal transport of dairy animals under the National Security Act and Gangsters Act.
- In Gujarat, cow slaughter is now a non-bailable offence, punishable with life imprisonment, meaning that people who kill a cow will serve the same time as a murderer.
- Central Jharkhand and many other states ruled by BJP party have begun applying similar laws.
- The national government is also currently considering a petition to give cows an Indian identity card similar to those issued to its citizens.

National Policy on Food Security &Safety

The policy envisages evolving a 'National Livestock Breeding Strategy' to meet the requirement of milk, meat, egg and livestock products and to enhance the role of draught animals as a source of energy for farming operations.

Globally Food Safety has emerged as a challenge for growing population (7.7 Billion people

Worldwide / 1.36 Billion alone in India). Sharing of food by importing across borders has become a global inter-dependable phenomenon

Every importing county receives high quality meat only if they are compliant to their food safety standards & subject to audit inspections by technical teams. Importing countries Veterinary & Animal Husbandry Depts. expert doctors have to undertake and certify Ante mortem / Post mortem inspection that the meat is fit for human consumption. Each export consignment has to be passed the compulsory quality check before the dispatch with animal health status certificate duly from veterinarian.Foot & Mouth Disease (FMD) is a major economic barrier across continents and global disease control programme is being contemplated by countries that are effected on similar lines the way Rinderpest disease has been eradicated.

Food Safety Regulatory Authorities

In India Inspection of the meat processing plants is carried out by a committee of experts as per the standards laid down in the meat and meat products order (1973) of FSSAI, Govt. of India.Infrastructure facilities and the other parameters are inspected by expert members from the divers groups in meat industry and related fields.

- ***FSSAI : Central***

  Its functions are specified by the Government of India and the Ministry of Health & Family Welfare. They cover all stages such as manufacture, storage, distribution, packaging, sale, and import of food items

- ***FSSAI : State***

  FSSAI has been incorporated to ensure the safety of food at the State level under the Department of Medical & Public Health. The basic criteria for applying for a State Food License is that the annual turnover of business is falling somewhere between Rs. 12 lakh up to a maximum of Rs. 20 crores.

- ***Animal Husbandry Dept.***

  The Department is responsible for matters relating to livestock production, preservation, and protection from diseases and improvement of stocks and dairy development. The role of the Veterinary Services has traditionally extended from the farm to the abattoir, where veterinarians have a dual responsibility – epidemiological surveillance of animal diseases and ensuring the safety and suitability of meatmaking them uniquely equipped to play a central role in ensuring food safety, especially the safety of foods of animal origin. In many countries the role of the Veterinary Services has been extended to include subsequent stages of the food chain in aconcept popularised as “farm to fork”.

- ***Export Inspection Council :***

  With more than four decade experience in the field of inspection, testing and certification of food items as per importing country's requirements, EIC is the only organization in India having global acceptance.EIC provides mandatory certification for various Food items namely fish & fishery products, dairy product, honey, egg products, meat and meat products, poultry meat products, animal casing, Gelatine and crushed bones and feed additive and pre-mixtures while other food and non-food products are certified on voluntary basis.

Meat Exports Regulatory Authorities

- The Directorate General of Foreign Trade (DGFT), Ministry of Commerce & Industry, Govt. of India, makes it mandatory that export of meat and meat products can be only from APEDA registeredAbattoirs.
- Agricultural and Processed Food Products Export Development Authority (APEDA) Ministry of Commerce and Industry, Govt. of India, is an apex body under responsible forthe export promotion of agricultural products, Registration of Exporters of meat & its products.
- The Export Inspection Agency (EIA) is the official export – certification body of India which ensures quality and safety of products exported from India. The role of EIC is to ensure that products notified under the Export (Quality Control and Inspection) Act 1963 are meeting the requirements of the importing countries in respect of their quality and safety.

APEDA Recognised Meat Entities

- **Integrated abattoir cum meat processing plant:** A premises housing Lairage, Slaughter lie, Carcass dressing, Chilling, Deboning, Freezing, Packaging & Cold storages.
- **Meat processing plant:** A premise used for Chilling, Deboning, Freezing, Packaging & Cold storage of meat.
- **Abattoir:** A premise used for slaughter of animals for human consumption.
- **Manufacturer Exporter:** A company which exports goods manufactured by it or any other integrated abattoir cum meat processing plant or Meat processing plant or Slaughter House.
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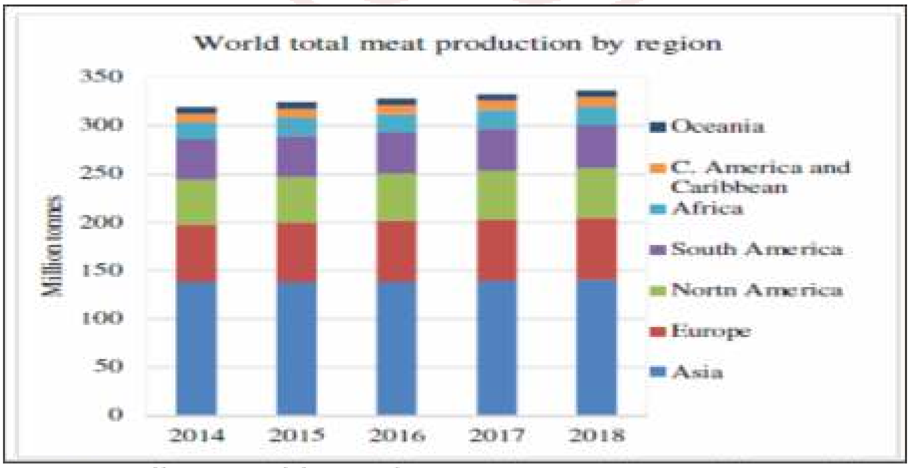
- **Merchant Exporter:** A company / person engaged in trading activities by sourcing meat from APEDA registered manufacturing unit.



Source :http://www.fao.org/3/ca3880en/ca3880en.pdf

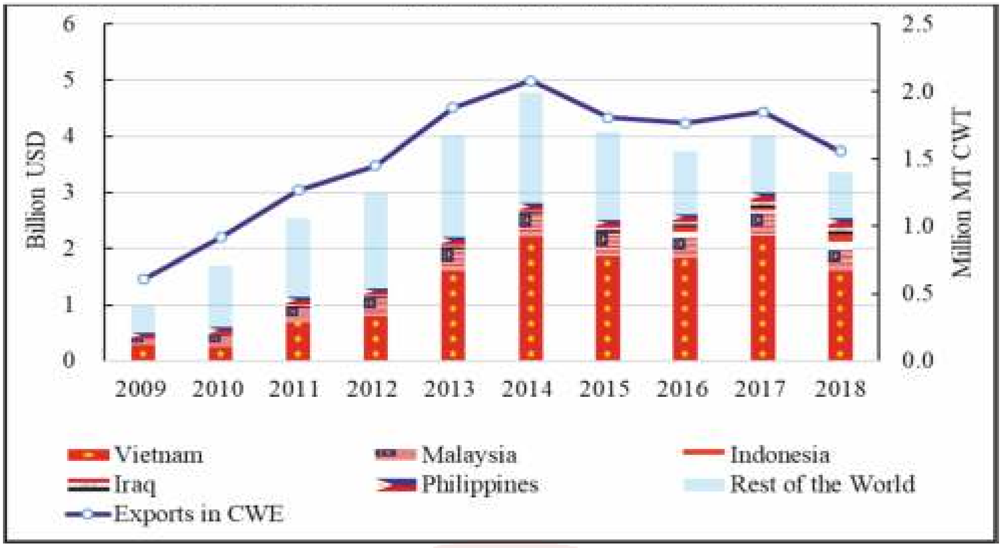
OIE / Importing Country Requirements

- The OIE Office (International des Epizooties) popularly known as “The World Organisation for Animal Health” stipulates the rules and regulations of international trade in livestock and livestock products.
- The OIE Animal Health code articles are authoritative referral documents.
- Article 8.8.22 specifically lists the conditions for safe importation from FMD prevalent countries or zones, where an official control programme exists like India.
- Although there are no OIE recognized FMD free zones in India, we do have special administrative zones / areas which are free from FMD are called Disease Free Zones (DFZ).
- There are systems in place to prevent movement of animals, which are in the form of state legislations and laws.
- Till date, no country including the OIE recognized FMD free countries/zones, which permit importation of Indian origin Deboned Deglanded Frozen Buffalo Meat (DDFBM).
- It's very important to note that till date no country ever recorded outbreaks of any form of livestock disease, including FMD due to the importation of DDFBM from India.
- Indian meat exporters strictly follow all the guidelines mentioned in the Terrestrial Animal Health Code directions; especially article number 8.8.22 like :

  - Compulsory ante-mortem &post-mortem of carcasses by Govt. Meat Veterinary Inspectors.
  - Microbiological testing by Government Veterinary Laboratories.
  - Maintenance of Records / inspections periodically audited by the Government.
  - Periodically inspection by APEDA and the importing countries.
  - A system of traceability is ensured in accordance with the Codex Alimentarius Standards, HACCP (safety & quality certification) and ISO accreditations.
  - Inspection by the accredited abattoirs Govt. Veterinary Doctors and Microbiologists.
  - Testing by State and Central Govt. Certification agencies.
  - Additional inspection by internationally accredited agencies like SGS, when mandated by importing countries.
  - Multiple agency inspection on arrival of the goods at destination (importing country)

Top 5 Markets for Carabeef&Beef worldwide

Source: Global Trade Atlas



Government of India Initiative: Livestock Mission to Increase India's GDP

Propelling livestock production into “mission mode” would be one of the keys for Prime Minister Narendra Modi in achieving his ambitious target of making India a $5 trillion economy by 2024. Accordingly efforts are being made to implement some of the biggest schemes (in the animal husbandry sector) in the world. "We are hopeful that it would lead to a fourfold increase in farmers' income by 2024.

Issues hindering the growth of livestock production in the country, identified 3 key problems were the biggest barriers for farmers for yielding less profit : Prevailing diseases in farm animals, poor nutrition value (of fodder provided to them) and low quality of breeding are the main reasons behind sluggish growth.

Despite being the world's largest milk producer, India could never break into the list of top 15 milk and dairy exporting countries. The main reason for this was that India's major bovine population was affected by several diseases including the Foot and Mouth Disease (FMD). The high sanitation norms and health parameters in western countries rejected import of Indian Livestock meat, milk and dairy products. The sector challenges are being addressed to meet Global & National demands.

Conclusion

Indian buffalo meat has successfully penetrated the global markets & acceptability of the consumers and has been witnessing the strong growing demand in international markets due to its lean character and near organic nature. India has a world largest population of livestock and it is world's 5th largest producer of meat.

- By the end of March 2019 India exported 1.2 million tonnes of Buffalo meat worth US 3.6 Billion and 22000 tonnes of Sheep & Goat meat worth US$125m as per APEDA.

- The World Organisation for Animal Health (OIE) has reported FMD outbreaks in India in 2016, 2017 and 2018.
- Older detailed data released by India's department of animal husbandry, dairies and Fisheries, said that, between January and October 2016, there were 120 outbreaks of FMD in cattle, leading to about 9,000 individual cases and 422 deaths.
- Indian Government initiative to eradicate Foot & Mouth Disease (FMD) from the country, costing INR13,343 Cores (US $ 133.43bn).
- Indian exports potential is around 5.7 billion US Dollar of meat every year according to the United States Department of Agriculture (USDA).
- The export of buffalo meat has been growing at a CAGR of about 8%. The country produces an estimated 1.5 million tonnes of buffalo meat annually.
- Indian livestock is free from some dreaded diseases such as Bovine Spongiform Encephalopathy (Mad cow disease), Rinderpest since 1995 and no Contagious Bovine Pleuro Pneumonia (CBPP) in India during the previous 17 years. Large states in India like Maharashtra and Uttar Pradesh are FMD-free since November 2003.
- World's biggest ever vaccination drive by injecting 1,056 million FMD doses every year mission has commenced to free Indian bovines from FMD, resulting in wide acceptance of Indian milk and dairy products across the world.

Source:economictimes.indiatimes.com/news/economy/indicators/modis-new-mission-propellivestock-production-to-increase-indias-gdp/articleshow/71636715.cms?from=mdr

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(Key 03)

Indian Meat Sector – Research Outputs and Expected Roles of Meat Scientists

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Introduction

Meat sector is the driving force for the sustainable livestock development and plays a key role in livelihood security for millions of men and women from weaker sections. As per 20th Livestock Census, total livestock population in India is 535.78 million with 109.85 million buffaloes, 74.26 million sheep, 148.88 million goats and 9.06 million pigs. Total poultry population in 2019 has been estimated to be 851.81 million. Share of different species in 20th census is, 35.94% Cattle, 20.45% Buffalo, 27.80% Goat, 13.87% Sheep and 1.69% pig. In terms of percentage increase, there is increase of 1.0, 14.1, 10.1and 16.8 per cent in buffalo, sheep, goat and poultry population, respectively over previous census. For pig, a decline of 12.03% population has been reported. Although, the total goat population has increased from 135.2 million in 2012 to 148.9 million in 2019, but male goat population has decreased from 37.6 to 32.1million during the same period. Similarly, female buffalo population increased by 8.6%, whereas male buffalo population has declined by 42% over previous census. These figures of growth rate in livestock sector would definitely be a revolutionary paradigm for meat industry. Further, decrease in male goats and male buffaloes indirectly indicate increase in slaughter rate. The colossal livestock population and efficient utilization of these resources including production and utilization of livestock products is important for nutritional security, increased returns, employment generation, upliftment of lower section of society and sustainable livestock production activities in India.

Meat industry is slowly yet steadily catching pace on the global front also as India exports both frozen and fresh chilled meat to more than 60 countries of the world. Meat production is largely an unorganized yet vital segment of the Indian agriculture. Traditional production systems, disorderly practices, unregulated meat markets, tropical climate, inadequate slaughterhouse hygiene measures, lack of surveillance of meat-borne diseases etc have flawed the image of Indian meat industry and enhanced the risk of meat-borne diseases and occupational hazards. It is necessary to establish modern slaughterhouses to bring improvements in meat-handling practices, recovery and proper utilization of by-products, waste treatments for pollution control to reorganize and strengthen the meat industry on scientific lines to provide wholesome and safe meat to the domestic consumers as well as to play a substantial role in international meat trade/market.

While India has an abundant supply of meat, the meat processing industry is still emerging and the budding Indian meat processing industry has much to offer to the innovative entrepreneurs and traditional processors, if backed by strong research. Meat processing covers a spectrum of products from sub-sectors comprising animal husbandry and poultry farms, to bulk frozen meat, chilled and deli meat, packaged meat, and ready-to-eat processed meat products. In the present scenario, there is large scope for meat processing in poultry as well as in red meat. In fact, the poultry industry has made a considerable progress by developing and marketing value added products.

Strategic goals for meat sector development includes—Increase of production, particularly related to high quality and safety of fresh meat—Adding value and quality orientation as an ultimate approach—Meat traceability and value chain management—Increase of export to capitalize on price competitiveness and quality competitiveness —Development of traditional and value added products as driver for sector development—Newer technologies for maintain quality during transportation and retailing. To meet these goals, the need of the hour is to develop and implement a strong strategic plan at governmental, institutional research and industry level to spur the growth of Indian meat Industry by improving and promoting the production of better quality meat animals, efficient value chain, hygienic processing of meat, suitable value addition and drive to sensitize and confide Indian consumers about quality meat processing and eating.

Indian meat researchers have to act proactively and generate data, processes, techniques or products, which can help in the growth of Indian meat industry and efficiently solve the pertaining problems. We have strong scientific and student work force to cater the research requirements of Indian Meat Industry. If we consider staff and facilities as compared to outcomes, our achievements are far below expectations. We need to introspect ourselves, what is our contribution to meat sector? What is the impact of our research on Indian meat industry? In this paper, we have made an effort to discuss about the current issues related to meat research in India and tried to explore the expected role of scientists, academicians, researchers and meat industry personnel in future to come.

Growth of LPT/ Meat Science Discipline in India

With creation of Veterinary Council of India (VCI) in 1984, establishment of Department of Livestock Products Technology was made mandatory and this Department was established in almost all existing colleges, where previously it was not there. In all those colleges established after VCI, this department was established as essential requirement for VCI recognition. At present, meat science and technology is an essential component of almost all 50 livestock products technology department of different veterinary colleges. The total number of staff in National Agricultural Research System (NARS) dedicated to teaching and/or research in the field of Livestock Products Technology and specifically Meat Science and Technology is above 150. The intake capacity per year is nearly 70 students for MVSc and 20 for PhD. Therefore, each year around 90 postgraduate theses are being published. Out of 90 theses, majority of the research (may be more than 75thesis) are dedicated to the field of meat science and technology and only a few research programs are there for dairy technology. This is a significant number and thus there is urgent need to consider the impact of research on meat sector in India.

Lessons from Developed Meat Industries

If we go through the history of the gradual but solid progress of meat science in USA (which started in 1900), one can conclude that meat science development in USA was blessed with strong leaders with great vision. The Federal Meat Inspection Act of 1906 (P.L. 59-242) and the Wholesome Meat Act of 1967 (P.L. 90-201) were designed and implemented to provide the public with a safe, wholesome meat supply. The establishment of National Livestock and Meat Board in 1922 was proved a major turning point for USA meat industry. Reciprocal meat conferences (first held in 1948) are also considered as major contributing factor for USA meat industry. The USDA has made many changes, as it has strived to fulfil its mandate during 84 years of meat inspection. The interesting fact about development of meat industry in USA is the bigger role played by nutritional scientist in collaboration with meat processing specialists. Meat extension techniques have been the major important part of all programmes of USA, since 1950. Like developed countries, we must focus on the importance of market dynamics and value chain analysis to draft the framework of development of Indian meat industry. In India, also many initiatives and schemes have been starting for development of meat sector. Closing of NMPPB may be considered as a temporary setback for Indian Meat sector but FSSAI in India is proving to be a turning point for Indian Meat sector.

Issues and Reasons for Low Research Productivity

High research activity and low research productivity is the right phrase to describe Indian meat science research. With around 150 Scientists/teaching cum research, staff and more than 90 theses per year research output is not as per expectations. In India, most of the animal science research has been directed towards milch animals. Any research related to meat animals is considered as responsibility of meat scientists and he/she has to lead/coordinate research projects related to meat science. Thus, the role of meat scientists becomes more important.

Insufficient faculty and staff in most of the LPT Departments, extra teaching load/, overburdened with administrative duties, lack of sufficient funds/financial support, research skills etc are important issues that are greatly hindering the research productivity. Lack of industry exposure for both faculty members and students is an issue that needs immediate addressing to improve the quality of teaching and research in meat science in India. Lack of basic knowledge of statistics, necessary skills for writing good research papers, demotivation after rejection of research papers, poor interpersonal relationships, and less participation in conference/seminars are some of the other issues that can be easily addressed.

Many times, we are submitting projects for external funding as per the thrust area given by funding agencies, even if we are not convinced but to grab the opportunity we try to justify. Funding agency also may invite proposals for "Pressure group" research area to satisfy political activities (e.g. cultured meat, functional meat products, A2 milk etc). I suspect that funding agency may sponsor research, even if they do not consider that area as high priority for India or high probability of success. Further, for externally funded research projects, there is more accountability and less freedom to modify technical programme in between and thus researchers has no option, but try to complete project without worrying about adoptability of results/findings.

Generally, we select such research topics, which are of more interest for developed countries, so that research papers can be easily accepted for publication in high impact factor journals published from developed countries. If we analyse the research carried out in India in last 15-20 years, majority of the research revolves around topics related to meat processing that are of more interest for developed countries. Many areas that required serious research backup for Indian conditions like fresh meat, meat packaging, by-product utilization, meat production etc. have not received required attention of researchers. FSSAI has formulated most of the standards based on studies conducted in other countries because in India we do not have sufficient data/information, whatsoever information is available that is also not on the required scientific lines.

There shall be no inhibition in admitting that the research of most of investigators has been determined individually. It will not be wrong to say that we are exploiting the freedom to select research topics. We always want to excel in first attempt and generally choose well beaten path and re-do the things to ensure that it will work.

Lack of funds or insufficient research allocation is one of the important reasons for low productivity. The global rate of growth of scientific publications is 4 per cent, whereas ours is 10 per cent. We are at sixth position in the world in terms of publications. However, in terms of scientific output per dollar spent, our position is not so bad. The cost of producing one PhD in India is one tenth of other developed countries like USA. India's R & D intensity (R&D spends as share of GDP) fell from 0.83 percent in 2008-09 to 0.69 percent in 2016-17.

Habit of conveniences, piecemeal approach, and duplication of work, eager to try new areas/fields and less emphasis on meat extension/field work are also hampering our research outputs. In addition, more emphasis on number of analytical parameters (without caring about relevance), less emphasis on repetition/number of samples/sensory scores/statistical analysis, lack of Industry exposure are other reasons for lower research output.

Lack of inter-disciplinary approach i.e. projects in collaboration with animal nutrition, economics, management, public health scientists is also not as per requirement. Identification of optimum slaughter age in Indian conditions is the best example for Interdisciplinary research. Although, number of studies has been carried out to find out the slaughter age of different breeds, age, sex etc. but still we are not able to identify optimum age and weight for slaughter of animals of different species/breeds. We have not given required emphasis on economics and nutritional requirements. It is not possible to identify optimum age and weight unless meat scientists, animal nutritionists, economists and management people come together and follow interdisciplinary and even inter-institutional approach to solve problems more efficiently.

Moreover, plagiarism, fear of idea stealing and lack of raw data recording/ management/perseverance etc are also lowering our research productivity. Further, the attitudes of some of the senior researchers to rely entirely on students or research fellows or junior colleagues for the research work are affecting our outputs.

Reasons for low research output also include hesitation between several study choices (multiple objectives), project not properly thought at and lack of motivation, commitment or self-confidence. Moreover, focus on research papers, urge to learn too much (so many irrelevant parameters), always under pressure to defend novelty of proposed research, expecting perfection from students. PhD students—aiming too low (researcher look towards weakest student/scientist of the department or institute) or aiming too high (advisor and students shall also keep in the mind that within 2-3 years miracles cannot be expected) and ignoring suggestions/advise of advisory committee members are some of the other reasons. Generally, the attitude has been seen that after working over one topic we switch over to entirely new topic. Habit of justifying whatever we are doing is also affecting our outputs. More emphasis on theory and less practical exposure along with mostly foreign books with missing Indian perspective are also hindering effective learning and research output of postgraduate students.

In many developed countries, PhD scholars are considered like regular employees. In India, also, most of the PhD scholars get one or other fellowship but instead of problem solving mode, they are mainly focusing on publication of research papers in high impact factor journals. Though their perspective is also right, we need to think about the other aspect too. Many a time students hesitate to tell advisor, if he is getting unexpected results (lack of trust). We shall always keep in mind that negative results are also the research outputs and publish the same, so that the results can give base to other scientists to avoid picking up the research topic on the same lines or to think on the other side of the coin.

Expectations from Meat Industry

Although, industry personnel are always complaining about not conducting need based research, but there are no serious attempts from industry to have collaborations with research institutes. Proper direction from industry is missing. I request industry personnel to clearly spell their requirements and communicate to higher officials of DAHD, ICAR, APEDA, FSSAI etc. so that they can pressurize scientists to take up only suggested areas. The other way is to have contact research project or sign MOUs with research institutes, discuss your needs with meat scientists and formulate the research plan accordingly. In addition, many times industry is not permitting access to scientists on data recorded by them. Authentication of data collected by industry is another issue. The ultimate goal of Industry and meat scientists should be to look after the interest of farmers, consumers, processors, traders and other stakeholders. Like AMUL, Indian Meat co-operatives may also be encouraged by private players or govt to ensure proper revenue returns to animal keepers, butchers and retailers, and to provide safe quality meat to consumers.

How to Choose Research Topics?

First criteria to choose research topic should be "Feasibility" (e.g. Facilities, funds, skill of worker etc.). If these criteria are not considered then just to complete research on time, many a time incomplete data is generated or replications are reduced that do not fulfil the actual objectives of intended research. Interest of industry/farmers/processors/consumers shall be given top priority. Only academic or personal interest shall be avoided. Brainstorm for ideas, in depth reading and understanding literature is very important for formulating good research plan. Setting clear objectives before beginning journey towards focussed goal is very important (why it is necessary? why you should be allowed to work, use resources, workforce etc.?). Formulation of research questions (questions that you are going to answer), problem statement (associated problem, how to get rid of) and thesis/project statement (what will be informed to stakeholders at the end of study) can greatly help in improving research outputs. Preliminary experiments are essential, before submitting research proposal. Rethinking/detour about technical programme after preliminary trials is also essential. Flexibility should be there in technical programme not in goals. Temptation to start work immediately shall be avoided. It is always advisable to avoid easy research goals but not of any interest for any of the stakeholders, research topics that are interesting but impractical, new areas, which are of little practical use for our country, but just chosen to be first in India.

How to Improve Research Outputs?

As discussed above serous thinking is required on all aspects starting from conception of idea until transfer of technology by meat scientists, students and industry to ensure effective utilization of resources and improve research outputs. Some other suggestions are listed below, that can help in improving research outputs.

- Only problem solving /need based research shall be undertaken and research for academic interest, getting degree, or guiding students should be avoided.
- Raw data management - printed data books/registers shall be issued to each scientist/faculty member. The properly recorded data book/register shall be maintained like permanent inventory of the laboratory.
- Research should be carried out as a legacy so that depth of the topic can be explored. The lead of one project should be taken as the basis of the new proposal.
- Inter-laboratory or inter-institutional validation shall be made mandatory before transfer of technology/process or making big claims.
- It shall be mandatory to give thesis topic related to research project of major advisor only, so that habit of piecemeal research can be checked.
- Multidisciplinary holistic approach should be followed to carry out impactful research.
- All thesis topics may be uploaded on IMSA website and repository/details of all papers published by Indian authors could be created to reduce duplication of research work.
- A database of research work held in last two to three decades may be prepared to avoid duplication as well as to execute the research outcomes from lab to land.
- Expectations from Industry shall be clearly spelled out and meeting of all the stakeholders shall be regularly convened to address concerns, requirements and to monitor progress.

- A Linking programme may be initiated to bridge the gap between producers, processors, butchers, retailers, consumers and scientists to streamline the vision of Indian meat industry and strengthen meat value chain.

Thus, complete revamping of how the meat research is carried out in country is needed to create an impact of our research on meat sector. Efficient utilization of research workforce including students and staff involved in meat science research shall be ensured for impactful research that could be commercialized or transferred to intended stakeholders. I hope in this IMSACON-9 with different sessions, we will come out with clear description of research requirement for meat sector in India and motivate researchers to focus on only need-based research.

References

References can be made available upon request from the author.

Lead Lectures

(Lead 01)

Organic goat production by Gaddi nomads in Himachal Pradesh: Opportunities and Challenges

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In the hilly areas of Himachal Pradesh, crop production alone is not sufficient enough to meet the household requirements owing to small land holdings (that too fragmented) and unhostile climate not so productive for viable agriculture. Therefore, animal husbandry is the main occupation especially for the tribal farmers. The extensive production system with small ruminants plays an important socio-economic role in the arid and semi-arid regions of the country. Goat is a source of meat, milk and manure for the shepherds. Moreover, it requires very less input or negligible investment. Pastoralists and their animals often act as custodians to grasslands and biodiverse landscapes, preserving soils capable of sequestering carbon, properly regulating water cycles, regenerating natural vegetation, and preventing natural hazards (e.g. fires) (IUCN, 20011; Reuff *et al.*, 2004). Grazing animals return nutrients to soils and even disperse seeds through their dung (Cheminitz, 2015).

India possesses about 135 million (17.93% of the total world population) heads of goats (BAHFS, 2013; Livestock census, 2012). The growth rate varied from -0.75 to 5.10 % with overall average of 3.05% during the period 1951-2012. This increase in goat population is higher than any other livestock species, indicating their economic importance and adaptation to ecologies where they are predominant. The same trend in the goat population of Himachal Pradeshhas also been observed. It has been analyzed that the decrease in CAGR (compound annual growth rate) of goats from 1997-2012 was 6.55 times slower as compared to the sheep and 1.68 times slower as compare to total livestock of the state, which indicates that goat rearing is still a preferable occupation for the people of this state(Dogra *et al.*, 2018). Total livestock wealth of Himachal Pradesh is 48 lakh, of which 11 lakh are goats. Migratory sheep and goat population in the state is approximately 70% of the total population of sheep and goat (Misri, 1998). Goats are traditionally raised either stationary or under migratory production system. The migration may be temporary or permanent were the flocks spend most of the time on migration, usually long distances (Kaul *et al.*, 2004).

Pastoralism is a part of local heritage and contributes to the local and regional identity. The contribution of pastoralists in maintaining livestock is very significant in India. More than 200 tribes, comprising 6 per cent of the country's population, are engaged in pastoralism (Khurana, 1999). Pastoralists are described as the "members of caste or ethnic groups with a strong traditional association with livestock-keeping, where a substantial proportion of the group derive over 50 percent of household consumption from livestock products or their sale, and where over 90 percent of animal consumption is from natural pasture or browse, and where households are responsible for the full cycle of livestock breeding" (Sharma *et al.*, 2003).

There is a big knowledge gap in majority of the goat rearers practicing nomadic production system. Productivity of goats is low and mortality is high.With the availability of diverse occupations, there is a decline in a number of pastoral nomads. Decline in pastoralism is due to switching over to the alternative source of income which needs less manpower and migration to the urban areas. However, it is still a main occupation of a large population especially of economically weaker sections of society in tribal hilly areas. Understanding of goat production from economic, ecological and animal welfare perspectives will increase the likelihood of the success of the organic goat production (Lu *et al*, 2010). There is a lack of awareness among the farmers, stakeholders and customers towards the taste and health benefits of their livestock products and they are still marketing their products at nominal price.

Organic agriculture could actually contribute to global food security but its potential to do so depend greatly on political will (FAO, 2007). Organic agriculture could lessen new challenges such as climate changes throughsoil carbon sequestration, improve drinking water quality and security through decreased irrigation needs in organic soils. It increases agro biodiversity, enhance nutritional adequacy with more diverse and micronutrient rich organic foods, and achieves rural development by generating income and employment in areas where people have no alternative other than using labor, local resources and indigenous knowledge. Badgley *et al.* (2007) suggested that organic agriculture could sustain the food supply of the current population without increasing the land base and contribute to the alleviation of the detrimental environmental impact caused by traditional agriculture. The focus of organic production systems is not on maximizing production, but rather on optimizing the production in the context of resources and management options available.

Organic animal husbandry

Organic animal husbandry is defined as a system of livestock production that promotes the use of organic and biodegradable inputs from the ecosystem deliberately avoiding the use of synthetic inputs such as drugs, feed additives and genetically engineered breeding inputs while ensuring the welfare of animals. Organic livestock production is productive and sustainable (Reganold *et al*., 1993; Letourneau and Goldstein, 2001; Mader *et al*., 2002). Livestock organic production entails production of highly nutritive quality foods free from all kinds of impurities for sound human health, in which ethological characteristics of animals are respected. Organic live- stock producers commit to respect a list of specifications governing animal care, welfare and feeding, obliging them to give their livestock access to pasture (Leroux *et al.*, 2009) which is nutritionally favorable.

Animal health and welfare (AHW) have become an important component of consumer motivation to purchase organic products of animal origin. Values in animal welfare, environmental preservation and product quality have been increasingly viewed by consumers and producers as important consideration for producing and consuming the livestock products. The organically produced animal is not same as naturally raised under free-range grass feeding regimens (Lu and Gangyi, 2008). Increasing demand of consumers for such products is a driving force behind the promotion of organic goat production both in domestic and export markets. The organic production plays a dual societal role, where on the one hand, it provides a specific market responding to a consumer demand for organic products, and on the other hand, delivers public goods contributing to the protection of the environment and animal welfare, as well as to rural development (Council Regulation (EC) No 834/2007; EC, 2007).

Organic standards

Standards contain several guidelines and rules regarding husbandry and housing of livestock, with aim of establishing livestock systems that are appropriate to each species physiological characteristics and natural behavior. These are meant to assure both an organic product to the consumer and living conditions for farm animals which limit stress and promote good health. Currently there are no universal standards for the organic food production worldwide. As a result many countries have established national standards for organic production.

- IFOAM (International Federation of Organic Agriculture Movement) is the leading federation in international organic farming. IFOAM standards focus more on management, physiological and ethological needs (IFOAM, 2012)
- The National Programme for Organic Production (NPOP) provides for Standards for organic production, systems, criteria and procedure for accreditation of Certification Bodies, the National (India Organic) Logo and the regulations governing its use.
- Codex Alimentarious (FAO/WHO) Standards
- European Union Organic (EU Organic) Standards- Regulations EEC. EU regulations provide more attention to the animals ethological needs as compared to international standards (Schmid, 2000)
- USDA National Organic Program Standards (NOP)

Organic goat production

Organic goat production can be a rewarding livelihood and is gaining popularity (Lu *et al*, 2010).Total area under organic certification in India is 5.71 million hectares (2015-16). This includes 1.49 million hectare (26%) cultivable area and rest 74% forest area for collection of minor forest produces. Extensive pastoral production used about 25% of the world's land and produces about 10% of themeat intended for human consumption, while supporting about 20 million pastoral households (Blench, 2000).

Opportunities and Challenges for organic goat production

Breeds

Breeding programmes for the organic goat production are mainly focused on selection for disease or parasite resistance rather than increased milk or meat production. 100% of the breeds reared by the nomads are indigenous in origin. Nomadic breeds are ideal for organic goat production. Gaddi goats are very well adapted for grazing and browsing in different hilly terrains and topographies. They are less disease prone and hence require less allopathic medicines. Moreover, the indigenous breeds are more resilient to adverse climatic conditions as comparison to cross-bred and exotic breeds. These breeds often have higher reproductive rates and better disease resistance than “high-yield” imported breeds. Therefore, the need of allopathic medicines and antibiotic will be lower for them. These breeds can face draught and hunger in a better way and can well survive in the areas where other crops could never be grown.

Housing

The ethological needs of the organically farmed animals should be respected in order to allow the expression of their natural behavior (Braghieri and Napolitni, 2009). Animal must be able to express their natural, species specific behavior which implies loose housing system and going outdoors, or giving them access to an outdoor run or pasturing them. The Gaddi goats are not tethered and are neither kept in sheds. They are free to move in open grazing areas and are not confined as the goats of stall-fed. They are moved and grazed freely in extensive open areas. Nomadic pastoralist tribes migrated vertically, ascending into higher seasonal pastures during the warmest months and to lower altitudes in the coolest months. Goat flocks migrate from foothills of the Himalayas to high altitude alpine ranges during the summer months and to foothills and plains during the winter season (CSWRI, 2001; Pandey et al., 2002). Goat flocks start migrating to lower hills during October- November. The flocks return to village to manure the agricultural fields during April. Thereafter the shepherds start migrating to the high altitude areas for summer grazing.

Feeding

Instead of using externalagricultural inputs, the organic production system mainlyrely on what the local or regional ecosystem can provide – namely the grass, shrub, or stubble on which their animals graze andforage. Organic livestock production is pasture based feeding i.e. higher forage-to- concentrate ratio. For organic goat production the pastures should be organically maintained without use of pesticides, herbicides and chemical fertilizers. In organic farming, sheep and goats have to be fed with 100 % organic feedstuff (EEC Regulation 2007). For an implementation period to be set by the competent authority, livestock products will maintain their organic status providing feed, consisting of at least 85% for ruminants and 80% for non-ruminants and calculated on a dry matter basis, is from organic sources produced in compliance with the guidelines.

- The main source of nutrition for Gaddi goat is rangeland, natural pastures and common property resources (CPR). The rangelands is covered with a variety of vegetation mainly grasses, bushes, shrubs and trees. THP (Transhumant pastoralism) is seen as an adaptation strategy, because it uses pasture resources at different elevations depending on seasonal variability (Agrawal 2010). This is a kind of adaptive grazing management, which takes good advantages of annual climate variations (temperature and rainfall variations) along the elevation gradients for securing the feed supply. Organic animals should be born and raised under continuous organic management form last third of gestation.
- Organic system doesn't use synthetic amino acids, antibiotic and growth promoters. The Gaddi nomads give no mineral, vitamins and GMOs in the animal feed. Gaddi nomads claim that the superiority of the goat health and product is due to consumption of diversity of forage species consumed by the goats. The pastures at high altitude provide excellent grazing facilities during summer months and in winter the flocks move to low hills which are relatively warmer areas.
- Gaddi goats gets its nutritional requirement through rotational grazing of the pasturelands. In each type of pasturelands at different climatic zone, the grazing animals are moved from one plot to another in a time interval (every 10–15 days in the most cases) depending on the herders' estimates of grass cover, and the same plots can

be repeatedly grazed during the same grazing season if the coverage and height of grasses have recovered.

- Tree fodders have similar nutritive value as that of leguminous fodders (Akram *et al.*, 1990). Pastoralist preferred tree-cover grazing areas, which include oak trees, as the nutritive value of leaves are rich in iron, Sulphur and copper. Feeding of oak leaves having condensed tannins upto1.6% in diet improved the microbial nitrogen supply, immunoglobulin status andantioxidant status of growing kids (Chaurasiya, 2018).
- Salt hunger phenomenon is observed in alpine pastures, hence the flock should be give supplementation of salt.
- Plant secondary metabolites (e.g. tannin) have positive effect on some ofthe body functions when ingested in right quantity. These leads to decrease in the fecal egg count, hence reducing the parasitic load which is the one of the greatest disease problems in the extensive system
- In intensive production system early weaning system is practiced while nomads follow natural suckling method same as the organic standard. Kids receive colostrum and milk form the mother's udder. Weaning age of the Gaddi kid is may vary from 3-6 months.
- During winters the nutritional quality of fodder is very poor. Supplementary feeding is being rarely done by the pastoralist. Poor pasture will lead to poor breeding and reproductive performance of flock. Proper pasture management is necessary to save the valuable pastures from the excessive weed growth.
- Herd splitting – Splitting the herd into smaller groups andmoving them to different areas is used to prevent overgrazing and maintain the long-term productivity of therange.

Breeding

Animal in organic production system must be able to reproduce independently i.e. animals reproduce natural to express their natural, species specific behavior. Reproduction technologies with exception to Artificial Insemination (AI) are not allowed in organic system. Natural breeding is practiced in the nomadic goat production system. Artificial insemination, embryo transfer and oestrus synchronization is unpopular among nomads.

- Farmers owned flock was the primary source (68.4%) of breeding buck followed by buck purchased from middleman (20.4%) and only in limited cases (10.2%) the buck was purchased from fellow farmer's flock (Dogra et al., 2019).
- Some nomads use aprons/ genital covers which hang perpendicularly in front of the genital organs. This prevent the copulation during the period when mating is not desired (restricted breeding). Selective breeding is practiced by all the flocks.
- Artificially insemination is totally absent in the Gaddi pastoral system.
- Irrespective of the size of flock, the number of breeding bucks used at a given time in the flock usually ranged between 1- 3 while majority of the flocks maintained 2 bucks only. These breeding bucks were found to be used continuously for 4-5 breeding seasons before their replacement.
- Kidding takes place most exclusively in late winter or early spring due to controlled breeding.

Health management practices

Organic goat production system mainly relies upon the prevention rather than curing/treating the animals.All the natural materials are allowed in organic agriculture, unless specifically prohibited, while all the synthetic materials are prohibited unless allowed specifically (Karreman, 2006). The focus is on preventing the health problems through better management practices. The animals intended for slaughter cannot be treated with antibiotics, anthelmintic, growth implants or other restricted materials. Vaccinations are acceptable in organic goat production, but use of antibiotics and anthelmintic is prohibited

- Mortality rates of kids in nomadic production system are higher than in semi-nomadic and sedentary system, especially during harsh winters. It may also be due to poor mothering ability and migratory nature of flocks. The mortality show inverse relationship with the size of the flocks. To reduce the mortality of kids, they were kept together in tents and are taken care of until they were old enough to go with the flock. They are also kept in the bamboo baskets to prevent them from drafts. Weak kids are transported in basket bound to horses.
- The main challenge of this production system is to control the internal parasites. Nomadic herders believed that the risk of animal'sloss due to illness or extreme environmental conditions can be reduced if the flock is buffered with the different species e.g. raising of sheep and goats together by gaddies. Raising of different types of livestock gives an opportunity for using different niches.
- Management of disease is done by the Gaddi nomads through adoption of preventative measures such as avoidance of areas known to be particularly susceptible to disease.
- Application of appropriate rotational grazing may contribute to effective reduction of the endo-parasitism.
- Traditional knowledge of Gaddi farmers for endo and ectoparasitism in goat need to be validated on efficacy and dosage. For ectoparasites, government has provided dipping facilities.
- Livestock diseases such as Peste des petits ruminants (PPR), Foot and Mouth disease (FMD) has been controlled through vaccination.

Animal Welfare

Farm animals under organic regimens are entitled to the right to express their natural behavior. Organic goat production should provide more welfare for the animals and provide them stress relieving environment. The nomadic goat production system does not substantially compromise the welfare of the animals as compared to the intensive or conventional production system. Mutilation is prohibited is organic goat productions. These are restricted to waivers that require a separate permission by certifying agencies. Procedures that cause pain, such as tail docking, disbudding/dehorning are restricted under organic certification.

- Pastoralism take care of social behavior of goats
- Close confinement of farm animals has raised welfare concerns into both physical and behavioral issues. Physical concerns arise from the consequences of lack of exercise, such as leg weakness, skin lesions, and lameness. Major behavioral issues are the

restrictions in the execution of locomotion and comfort behavior. Organic livestock are not allowed to be kept tethered or in individual confinement housing. Tethering is not practiced under the nomadic system and animal can perform it's all behaviors with freedom.

- Marking of goats is done by cutting its one ear in a distinctive way to guarantee unambiguous identification when herds are mixed. It is done by cutting pieces out of ear with a knife or by marking with fire-heated metal on ears. These practices need to be discouraged and farmers should be motivated for other alternatives (Ear tagging) that do not compromise the animal welfare.
- No disbudding is practices by the Gaddi pastoralist
- No tail docking is performed in the Gaddi goats.
- The breeding management will be difficult in mixed flock of males and females, without male castration. Castration of bucks is done by nomads to make them fattier to get more return and to make them less aggressive, hence easy to handle. Unwanted breeding males are made infertile by crushing the spermatic chords. The method of castration includes crushing with the pieces of wood or stone or with knife. The burdizoo castrator is also used by some Gaddi nomads. The castration is practiced without use of Local anesthetic and NSAID.
- Handling, transport, slaughtering, injury, diseases, consumption of poisonous grass during grazing, starvation and veterinary treatment are the major considerations for organic goat producers to address the consumers concern for animal welfare. Disease and accidents (during migration through steep rocks) are the also the causes of death in goats.
- Nomads are mostly being affected by the climate change. Alert warning system/ mapping about climate extremities and resources need to be developed which could be accessed by them through mobile phones.

The farmers need to be made more aware to improve welfare of the goats. Management solution to prevent undesirable mating may be more humane than castration (Hosie *et al.*, 1996).

Ethno-veterinary practices

In organic farming, phytotherapeutic essences and homeopathic products shall be used inpreference to chemically synthesized allopathic medicinal products or antibiotics, providedthat their therapeutic action is effective for the species of animal, and the condition for whichthe treatment is intended.Use of chemicals is prohibited in organic goat production hence alternative and Indigenous technical knowledge can be used to prevent, control and treat disease.

Pastoralists are usually highly knowledgeable about the behavior and physiology of the animals. They practice their traditional remedies prior to accessing the modern medicines. Nomads are enriched with the native technical and health management knowledge which are replacement of allopathic medicines.This can be an effective substitute for allopathic medicines, and will give an edge over other areas or countries in matter of organic production system. In addition, following these practices, animal products will be residue free.

Traditional goat health management practices by Gaddi goat rearers (Singh and Misri, 2006)

Ailment	Indigenous Technical Knowledge
Lanatana Poisoning	Roots of *Lantana camara Linn.* are removed and crushed to make a bolus and given to goat to counteract the effect of poisoning caused due to consumption of *Lantana camara Linn.* (Local name: bara phulnoo)
	Mix sour lassi with mustard oil and Amla (*Emblica officinalis Gaertn.*) water and drench the animal during morning and evening. Mustard oil causes purgation and sour lassi and Amla water help in counteracting the effect of lantana poisoning. In case of Lantana poisoning in sheep and goats flock, the Gaddis chop off the apical portion of the ear of poisoned animal and allow bleeding for some time. After sometime when toxic blood drains out, they apply mud on the wound for stopping the blood and healing.
Urea toxicity	Turpentine oil (15 ml) mixed with mustard oil (300 ml) is given to urea poisoned animals and is repeated every 4 hrs till the animal recovers.
Mouth ulcers	Black pepper, ajwain (*Trachy spermum ammi [L.] Sprague*), black salt and turmeric are mixed and rubbed in the mouth. Turmeric acts as antiseptic; balck pepper irritates the ulcers and salt increases the saliva secretion.
Diarrhoea	Leaves of Sapdotri (Berginia species) are crushed and given to the animals. Decoction (Juice) of *Acacia catechu* (Wild Khair) stem/ bark is given to the suffering animal. Leaves of *Dalbergiasissoo Roxb.* are also fed with barley flour for this purpose.
Wound, ticks and lice	*Cedrus deodara Loud.* (Deodar) oil is applied to the foul ulcers and wounds.

Certification and labelling

- Product certification is an essential part for the viability of the organic producers. Purpose of certification is to address a growing worldwide demand for organic food, to assure quality, to prevent fraud and to promote commerce. Subsidies may be provided to the farmers to aid in the conversion to the organic farm.
- Labeling food as being "organic" identifies the products as deriving from a production method defined by guidelines and minimum standards.The organic label is therefore a process claim rather than product claim.
- Conversion period is not required for the transhumant pastoralism to organic as they are organic by default. The Gaddi Shepherds need to be mademore aware about organic goat production.
- Development of labelling and certification for organic products can help in improving sustainability of this production system

Marketing

- Growing demand of organic products will act as a catalyst for the nomadic livestock systems for domestic and export markets.
- There is no organized market for sale and purchase of goat and goat products in the state. Gaddis are mainly dependent on the middleman for the sale of the livestock.Development of the niche organic marketing channels in the state for pastoral products will help in promoting the organic goat production. The organic products are 20-30% higher than the conventional products. The premium price of the organic livestock products is high due to higher production cost and the tendency for demand to exceed the supply.
- Besides being residue free the organic goat products form the pastoralist are

appreciated for high nutritional value.

- A grass- fed organic goat will likely be leaner, have less saturated fat, more omega-3 fatty acids, more conjugated lineolic acid, and higher beta- carotene and antioxidants (vitamin E). Organic livestock products are not allowed to be contaminated by chemicals. No synthetic materials like preservatives and flavoring agents can be used in processing. These are all attractive quality indicators for consumers and can be emphasized in marketing. The fat present in goat milk was found to be a rich source of medium chain fatty acids. The occurrence of palmitic acid in higher amount might be responsible for intense flavour in local and Gaddi goat milk.
- The advantages of the basic standards is mainly lined to environmental friendly production and to animal welfare issue while the animal health and productivity are more influenced by specific farm management rather than a particular production method (Sundrum, 2001). Quality assurance programs and controlling systems should be improved to ensure the high demand of consumers.

Epilogue

There is an increase demand of organic products worldwide due to increasing interest among consumers over past few years. Organic livestock farming is a way of producing food, with provisionsof high animal welfare standards, environment care, and limited use of medicine and production of residue free livestock products. The ideology of organic goat production is not new to the nomads of the Himachal Pradesh as they were rearing goats under natural husbandry practices since time immemorial. The pastoral goat farming may be considered organic by default.Being a low input system it can be an alternative to the factory production system, but its opportunities and strength need to be strengthened. Moreover, there is close similarity between nomadic and organic production system. There is a great scope of conversion of nomadic to organic production system with some modification and certification. Organic standards need to developed for the nomadic production system. Nomad farmers need to be oriented and educated to the organic standards. The organic production system is sustainable, with being environment friendly it also takes care of the welfare parameters of the goat. Gaddi goat breed is ideal for promotion of organic production system in this region. The welfare of the goats in pastoral system is not much compromised as compared to factory style production system and more studies need to be done in this aspect. ITK will provide an effective option for veterinary care through proper validation. Farmer needs to be made aware about the detrimental practices to animal welfare.If the premium price of the organic goat products could be achieved, it will help in converting the extensive; range based nomadic system to organic goat production system. The products form the Gaddi goats can be labelled organic after making further extensive studies, surveillance, regulation and certification.

References

References can be made available upon request from the author.

(Lead 02)

Recent Developments in Major Animal Genes for Consistent Meat Quality and Technologies for Improvement

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Livestock production is expected to grow tremendously in line with the projected demand for animal products. Therefore, the methods of livestock production must be changed to allow for efficiency and improvement in productivity. Substantial improvements in production efficiency and quality of animal products have been made possible through manipulation of animal genetics. Meat quality covers inherent properties decisive for the suitability of the meat for consumption, further processing and storage including retail display. The earlier work on genetic effect on meat quality focused on breed differences and those differences are still very relevant for improvement of meat quality through molecular means. Technological quality is a complex and multivariate property of meat, which is influenced by multiple interacting factors. The quality attributes like fat content, composition, uniformity and oxidation stability are mainly affected by genotype and feeding strategy. The WHC, tenderness and color are major affected by all the above factors. Genetic influences on meat quality comprise difference among breeds as well as difference among animals within in the same breed. Differences can be caused by a large number of genes with small effects - polygenic effects. Some meat quality attributes can also be associated with large monogenic effects – Major genes. In this present paper, more emphasis has been given on the genes identified for various meat quality traits and how markers can be used for improvement in meat quality traits in farm animal selection for consistent meat quality.

Consistent and uniform meat quality

Meat quality is defined by those traits the consumer perceives as desirable which includes both visual and sensory traits and credence traits of safety, health and more intangible traits such as clean and green or welfare status of the productive system. In order for livestock industries to consistent produce of high quality meat, there must be a understanding of the factors that cause quality to vary and implementation of management systems to minimize quality. Important visual traits include: colour and texture of meat, fat colour, amount and distribution of fat, decrease of excess water (purge) in the tray. Consumers of lamb in Australia usually place the highest weighting on flavour/odour, followed by tenderness and juiciness. This is contrast to consumers of beef who generally rate tenderness as the most important palpability trait. Meat standards Australia indicate that flavor has increased in importance to beef consumers, most likely a result of reducing the variation in tenderness. Meeting the increasing demands for high-quality pork protein requires not only improved diets but also biotechnology-based breeding to generate swine with desired production traits.

Major genes for meat quality

Advances in molecular genetics have led to the identification of genes that affect meat quality trait. Currently several genes with major effect on commercial animal production especially on carcass and meat quality traits are known. Some of the candidate genes identified and their association with meat quality traits are elaborated as follows:

Halothane gene

This gene is mapped to pig chromosome 6. A recessive mutation of this gene causes susceptibility to malignant hyperthermia. It is also referred to as the PSS (Porcine stress syndrome) gene, causes malignant hyperthermia, which can be triggered by stress or exposure to the anesthetic gas halothane. As the name porcine SS gene indicates, carrier of this gene is highly susceptible to stress. The effects of the gene have been closely associated to development of PSE meat. This was initially described as muscle degeneration. The development of PSE meat is caused by an extensive protein denaturation due to the combination of the pH and simultaneous high temperature early post mortem. Certain breeds (Pietran, Poland China) or certain strains within breeds (Landrace) contained a large proportion of PSE-prone animals whereas other breeds or strain were practically free of this defect. The causative mutation (RYR_1) for the halothane gene is the gene encoding for a ryanodine receptors isoform. Some countries eliminated the presence of halothane gene from their selection lines several years ago, eg: Denmark, Netherland, Sweden and Switzerland.

The RN^- gene

RN gene was mapped to chromosome SSC15 (*Sus scrofa*). The RN^- gene identified in the Hampshire breed is associated with reduced technological yield (Napole yield or in French Rendement Napole, from which the gene has its name) during processing of ham and bacon. The effects of the gene have been associated with high muscle glycogen stores in the scarcoplasmic as well as lysosomal components and an extended pH decline postmortem. Meat from carriers of the RN^- gene is often referred to as "acid meat" due to the low pH. The causative mutation (R200 Q) for the RN^- gene is in the $PRKAG_3$ gene encoding for a muscle specific isoform of the regulatory Y subunit of adenosine monophosphate – activated protein kinase. The RN^- gene has no effect on early postmortem pH value, but results in a lower pH_{24h} value, which again is associated with a higher reflectance (light meat) and inferior WHC. Carriers of the RN^- allele have been shown to produce more tender meat with a lower WB-Shear force. In developed countries, approximately 20-35 % of pork is consumed fresh and 65-80% in further processed. Hence with the low processing yield of meat from carriers of the RN^- gene the processing industry has a strong interest to be able to discriminate better pork from the two genotypes.

Callipyge sheep

The callipyge sheep phenotype results from a mutation on chromosome 18 present in a heterozygous offspring that inherit the mutation from their sire, they have extreme muscling, particularly in the hindquarters, reduced fatness and improved feed efficiency, but have extreme tough meat. In callipyge sheep, increased myofibre size is due to a greater proportion and size of type 2X/2B (fast glycolytic) muscle fibres and a reduction in the % of the IIa myofibre. The muscle of callipyge sheep has increased calpastatin, reduced breaks in the I-band region during post-mortem ageing and no change in collagen cross linking compared to normal sheep.

Carwell or rib eye muscling (REM) gene in sheep

It has emerged that certain Australian Poll Dorset sires produce off spring with increased *longissimus* cross-sectional area and mass at equivalent live or carcass weights. This is apparently due to segregation at a locus on 18 known as the rib eye muscling (REM) or Carwell locus. In contrast to callipyge, the effect of carwell is limited to the *longissimus* muscle, with no effect on fat depth, live weight or hindquarter weight. Carwell increases the rib eye area and weight approximately 11% and 7% respectively which translates into a 15% boost in yield for high priced cuts. The carwell allele does not alter meat tenderness, intramuscular fat deposition and acts as a completely dominant mutation.

Myostatin

The Myostatin gene (also known as GDF-8) regulates development of muscle and inactivation of this gene products results in extended muscular development. The double muscled body type of Belgian Blue and Piedmontese cattle has been linked to a inactive myostatin gene. The loss of myostatin activity causes these cattle to be extremely muscular and lean. In the case of Belgian Blue, the mutation is an 11-bp deletion in the third exon, while the Piedmontese carriers a point mutation in the same exon. Myostatin is a negative growth factor that inhibits both the terminal differentiation of myoblasts and the proliferation of myogenic cells. Alleles associated with increased muscling have also been associated with variation in other traits including collagen content, meat colour, energy metabolism and hormonal levels. Although there have been conflicting reports on the effects of double muscling on meat tenderness.

Calpain and Calpastatin (CAST) system gene

The markers for tenderness have been identified and these markers are known to influence the expression of the calpain-calpastatin enzyme complex that regulates the rate of protein degradation in the live animal and post-mortem muscle. Meat tenderness is an important issue in beef cattle production because it has a major impact on consumer satisfaction. Among the factors that have been identified as responsible for this process are μ-calpain and m-calpain which are encoded by the $CAPN_1$ and $CAPN_2$ genes and its inhibition, calpastatin (CAST), which is encoded by the CAST gene. The calpain proteolytic system is also involved in the regulation of myoblast migration and fusion and cell proliferation and muscle growth.

Melanocortin receptor gene

In animals, the melanocortin receptor gene (MC4R) is known as a factor maintaining body homeostasis by regulating the energy balance. MC4R is involved in appetite regulating mechanism. In pigs, it has been the effect of MC4R polymorphism on feed intake and carcass fatness traits. It can be used as a genetic marker for these traits in animal selection.

Insulin like Growth Factor 2

Insulin –like growth factor 2 (IGF2) gene plays an important role in mammalian growth, influencing foetal cell division and differentiation, and post natal muscle growth. It is paternally expressed i.e. on the allele from father is expressed in progeny. IGF2 is one of the intermediates in the GH endocrine pathology. Based on its physiological function, IGF2 is considered as a candidate gene for a QTL in pigs affecting muscularity. IGF2 is involved in myogenesis and is supposed to the responsible for 15-30 % of the phenotypic variation in muscle mass and 10-20% in back fat thickness of pigs.

Fatty acid binding protein

Intramuscular fat content has a major influence on meat quality. Amount of intramuscular fat decides the marbling of the animals. It was determined that pork loin should have at least 2% fat in the lean meat, otherwise it is too dry after cooking. Fatty acid binding proteins (FABPs) are members of the super family of lipid binding protein. The heart fatty acid binding protein (FABP3) is involved in fatty acid transport from cell membrane to the intracellular sites of fatty acid utilization and is mainly expressed in cardiac and skeletal muscle. FABP3 has been mapped to the QTL region on SSC6 (*Sus scrofa*).

Exploitation of major genes for meat quality

Improving meat quality is not just about changing levels of traits like tenderness or marbling, but it is also about increasing uniformity. The existence of major genes provides excellent opportunities for improving meat quality, since it allows large steps to be made in the desired direction. Secondly, it will help to reduce variation, since we can fix relevant genes in our products. For a proper exploitation of major genes it is critically important to know what type of meat we want to select for. This is not a trivial issue, as meat is processed and used in many different ways.

Marker genes

Most quantitative traits such as growth rate are controlled by many hundreds of genes, each with a small effect. A gene with a large effect such as the halothane gene is very much the exception. Nevertheless much research is now under way to identify possible genes with useful effects on performance. They may however be situated on the chromosome close to a gene that does affect performance, for example growth rate, but for which no DNA test exists. Due to genetic linkage the gene that can be detected will then show an association with growth rate, which is actually caused by its neighbor that cannot be detected. In this case the DNA tested gene is known as a marker, because it marks a section of chromosome affecting performance. The gene whose presence it detects is known as a quantitative trait locus (QTL), with linkage between the marker and the QTL. Possible markers have been reported for all the important traits, and many have been mapped.

Marker assisted selection

The development of the field of genomics has stimulated interest in 'molecular breeding for meat quality' as this 'trait' constitutes the classic case where DNA marker-based selection is at its most efficient, where the trait cannot be measured on the selection candidate and can only be measured at high cost on its relatives post-mortem; e.g., meat ultimate pH. In the process of *marker assisted selection*, DNA testing for the marker can be used to increase the frequency of the QTL and lead to an improvement in the trait. The main benefit would be in traits such as meat quality or disease resistance which are difficult or expensive to measure in the live animal, or reproduction which occurs late in life. The phenotypic meat quality data will not only enable the detection of relevant DNA markers, but will also be used to validate markers from experimental populations or to test candidate genes. Significant markers or genes will be included straight away in the selection process. An advantage of the molecular information is that we can obtain it already at very young age, which means that animals can be preselected based on DNA markers before the growing performance test. This is a great advantage for the overall testing and selection system.

Candidate genes

The most straightforward approach for identifying the genes controlling a particular trait is to use knowledge of the physiology of the trait to identify the biochemical pathways involved. This will then suggest genes that may be important for controlling key processing in the development of the phenotype. These genes are "*candidate*" genes that can be tested by identifying polymorphisms within the genes and observing whether the occurrence of the polymorphisms can account for some or all of the variation observed in the trait. Candidate genes to control boar taint from skatole and androstenone are being investigated by several groups. Other markers which have been generated for meat quality based on the candidate gene approach include myogenin (increased muscle fibre number, which may impact overall meat quality). A shortcoming of the candidate gene approach can be that the number of candidates is increasing substantially as more and more genes are being identified.

Conclusions

The modern molecular technology provides excellent opportunities to improve meat quality in selection schemes within lines. Selection on major genes will not only increase average levels of quality but also decrease variability (i.e. increase uniformity). On the other hand, major genes can be exploited for differentiation for specific markets. New horizons may be explored using biotechnology for preparing nutritive food products with longer shelf life, superior quality as well as more acceptability in consumer market. Although progress is being made, much more needs to be accomplished. Eating quality and safety must not be sacrificed as leaner animals are developed. We are still a long way from fully understanding the integrated mechanisms resulting from manipulation of growth and carcass composition and possible effects on meat quality (either positive or negative) as a result of the biotechnological techniques.

References

References can be made available upon request from the author.

(Lead 03)

Developments in Sheep Meat Production, Processing and Marketing

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In the country, 33.57 millions of households' rear sheep and goat across the country and nearly 70% of goats/sheep are reared by small and marginal farmers and landless labourers

(CSWRI, Vision 2050). Sheep are boon to the developing country particularly for resource poor, landless, small and marginal farmers for their contribution for nutritional and livelihood security. Sheep could beconsidered as 'five-star' animals/ ATMs/ movable bank as every product (meat, wool, milk, skin and manure) from sheep is of economic value. Sheep are projected as a future animal for rural prosperity under the scenario of deteriorating agro-geo-climatic conditions and grazing resources.

Majority of sheep flocks are maintained on a common property resource by employing family members with little capital, resources and traditional knowledge. India is a rich depository of sheep genetic resource with 43 well-defined breeds and non-descript animals, well adapted to different agro-climatic conditions of the country.Nowadays, new momentum is gaining among large progressive farmers, entrepreneurs. In the recent past, commercial sheep farms have been established in the southern part of the country. More and more farmers are joining to take up the commercial sheep farming for producing mutton. There is a growing demand for mutton in the country that shall continue to escalate in future with a growing population. On the other hand, grazing resources which are major sources of forage to sheep are declining. The rearing on sheep on semi-stall with scientific principles is imperative to make the sheep farming more remunerative and economical for farmers where male lambs are raised on stall feeding up to 6 months of age and adult and hogget are maintained on the semi-intensive system. In this system, animals are grazed on available pasture and supplemented at stall after grazing for optimum economical production.

Most of the meat is sold in the market as fresh meat, a very little amount of meat is being sold as processed meat into different products. Now the demand for functional and diversified meat products in big cities are coming up. Healthy, functional ready to eat, heat and servemeat products are well in demand in the country. Marketing of live animal is unorganised in the country, as results are getting only 60-70% of their animal price in the market. Long-chain of intermediaries are involved from production to marketing of live animals. There is a need to organise the sheep and meat production sector to increase meat production at an economical cost to consumers with diversified meat products.

Sheep resources in India

As per 19th livestock Census of India, the country has 65.07 million sheep, which account for 12.71% of total Indian livestock population. Top states with higher sheep population are: Andhra Pradesh (26.39 million), Karnataka (9.58million), and Rajasthan (9.07 million). The sheep produced 41.5 million kg of wool (BAH&FS, 2018). As per the National Bureau of Animal Genetic Resources (NBGAR), Karnal, India has diverse sheep germplasm with 43 breeds. In the country, there are 41.08% nondescript sheep. Major sheep breeds are Nellore, Deccani, Marwari, Bellari, Jaisalmeri, Mecheri, Hassan, Ramnad White, Patanwadi and Kenguri which contributes 19.17, 10.15, 6.70, 3.79, 2.92, 2.33, 1.40, 1.39, 1.25, 1.10 %, respectively of the total sheep population and remaining sheep breeds contribute < 1% (DHADF, 2016). 65% of sheep found in southern regions and mostly produce meat, 20% of sheep found in Rajasthan, Gujarat and Uttar Pradesh produce carpet type wool and meat and only 6% of sheep found in Jammu & Kashmir, Himachal Pradesh and Uttrakhand produce fine wool and meat.

Meat production

The meat of sheep is known as mutton; further, these meats don't have any religious taboo, unlike other meats. Maximum portion of meat produced in the country is consumed as hot/fresh meat with very little export. Sheep meat is relished in the Andhra Pradesh, Telangana, Karnataka and Jammu & Kashmir states of the country. Sheep contributed 602.82 million kg (7.94%) of total meat production (7.7 million tonnes) in 2017-18. In the country, 46.21 million sheep have been slaughtered annually (DAHDF, 2018). During 2007-12 there was a decline in sheep population by 9.07. The decline in sheep population might be attributed to increased meat demand, increased slaughter rate, a reduction in grazing resources, reluctance of young generation to go for migration *etc*. Most of the southern sheep breeds have meaty confirmation with coarse wool. The wool produced by them has little utility in textile. Southern states have a major share in mutton production in the country and produce 432.38 million kg (72 %) with Andhra Pradesh and Telangana leading mutton producer (Fig.1) These two states contribute 183.39 and 158.39 million kg of mutton, respectively (DAHDF, 2018).

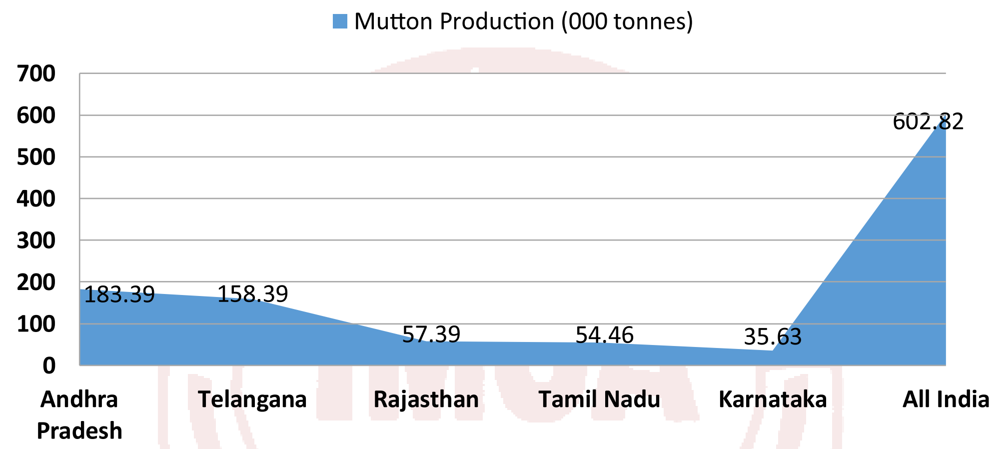

Fig. 1 Top five mutton producing states (BAH&FS, 2018).

Demand for meat

The mutton production in the country is showing an increasing trend, but still, it is far below than the requirement current as well as future demand in the country. The estimated mutton requirement in India will be 813, 986 and 1408 million kg by 2020, 2030 and 2050 respectively (CSWRI Vision 2050). To meet out the demand of the domestic market, it is necessary to increase production per animal without much increase in population as the feed and grazing resources are limiting with declining grazing lands. Sheep rearing will have to improve its resource use efficiency and productivity to sustain meat production and consumption. In India, sheep and goat meat availability India was 0.58kg/person during the year 2014 (FAOSTAT, 2019).

Export of meat

The United Arab Emirates, Saudi Arab, Qatar, Kuwait and Oman are top importers of sheep and goat meat (Fig. 2). Indian meat hasa number of advantages on contrary to meat from other countries *viz.*Genuine halal meat, leaner meat, nearly organic system of production. Out of India's total export of sheep and goat meat, more than half (63.37%) of the meat is exported to the United Arab Emirates in the year 2018-19 (APEDA, 2019). Indian domestic market demand is increasing, further,the export growth trend in India's sheep and goat meat declined from 19% in 2014-15 to -12% in 2018-19. Last year, India exported 18,425 metric tons of sheep and goat meat worth of Rs79,064 lakh.

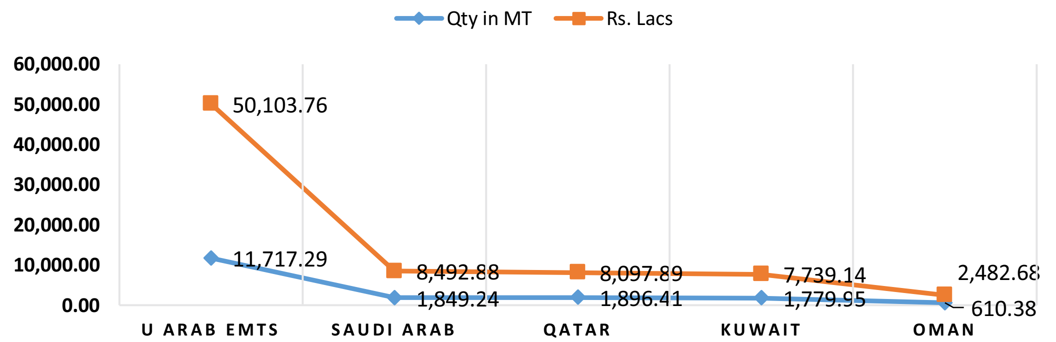

Fig. 2 Top five destinations of sheep and goat meat export during 2018-19.

Strategies for increasing mutton production in the country

1. Sheep Genetic Resource and Improvement: There are 43 sheep breeds found across the country which are well adapted to the specific agro-climatic region. The animals with better growth rate, feed efficiency, bigger size, better adaptability to climate, resistance to diseases and market demand should be propagated for mutton production. Selective breeding should be restricted to the native sheep, and low producing sheep within the tract should be upgraded with the defined, pre-dominant breed of high genetic merit. Progenies of elite bucks/ram add to the higher premium price in the market.Theanimals with extraordinary growth should be introduced in specific pockets where environmental conditions and feed resources are optimum for enhancing rapid growth in meat production in the country (Naqvi et al. 2016).

Table 1. Carcass traits of Indian sheep breeds at variable age .

Parameters	Mutton sheep				Wool sheep			Prolific sheep		
	Malpura	Bandur/ Mandya	Fat tailed	Nellore	Deccani	Chokla	Avikalin	Avishaan	Garole	Kendrapada
Age	6 months	6 months	15 months	7 months	12 months	12 months	12 months	15 months	10 months	24 months
Slaughter wt. (kg)	21.63±0.59	13.49± 0.26	62	22.05	20.50	27.8±0.85	28.2±0.84	41.13±1.87	9.10±0.90	11.42±1.43
Dressing yield (%)	55.61±0.33	47.77± 0.70*	54.18	47.55±0.78	49.37	50.2±0.59	53.3±0.71	54.03±0.46	46.31±1.0	49.42±2.41
Prime cuts (%)										
Leg (%)	30.97±0.20	25.06	33.32	36.87±0.72	31.94	33.6± 0.44	33.3± 0.44	31.28±0.65	32.66±0.3	32.09±0.60
Loin (%)	13.37±0.21	7.44	8.27	7.96±0.26	13.16	12.8± 0.29	12.1± 0.19	11.77±0.58	12.21±0.4	13.29±0.95
Rack (%)	13.91±0.18	10.04	14.46	5.65±0.14	12.14	12.5± 0.49	14.2± 0.53	13.95±0.26	12.83±0.21	14.63±0.24
Neck & shoulder (%)	24.16±0.23	31.61	25.25	32.95±0.72	23.50	25.4± 0.35	25.4± 0.37	25.09±0.37	25.56±1.77	24.67±0.75
Breast & fore shank (%)	17.59±0.22	9.33	18.70	16.30±0.48	14.73	16.0 ±0.43	15.0 ±0.29	17.91±0.49	16.99±1.46	15.33±0.51
Edible contents (%)	7.63±0.56	8.42± 0.19	4.57	-	-	3.91 ±0.08	3.81 ±0.07	-		7.9±0.22
Inedible content (%)	24.78±0.65	22.68± 0.51	17.10	-	-	-	-	-		24.83±1.78
Carcass composition (%)										
Lean (%)	58.17±0.78	-	56.98	-	55.89	-	-	56.87±2.43	71.39±2.11	56.12±0.97
Fat (%)	14.4±1.27	-	20.96	-	5.97	-	-	9.04±1.41	5.73±0.98	11.30±1.99
Bone (%)	23.99±0.42	-	20.68	-	24.97	-	-	29.59±0.99	23.02±.1.3	29.72±2.37
Fat tail (%)	-	-	9.74	-	-	-	-	-		-
Reference	Shinde et al. 2018	Naveen Kumar et al. 2018	CSWRI	Girish et al. 2012	Nagi et al. 2006	Sureshkumar& Karim 2009	Sureshkumar& Karim 2009	Gadekar et al. 2012	Sen & Karim 2010	Gadekar et al. 2018

*pre slaughter weight basis

Fat-tailed sheep constitutes 25% of the global sheep population. In India, fat-tailed sheep are found in small number. Fat-tailed lambs attained bodyweight of 28.50 kg and 43.20 kg at three and six months of age. Fat-tailed sheep produced 72 litres of milk in a lactation period of three months. The milk contained 8.63% fat, 3.50% protein, 3.93% lactose and 16.09% total solids (Annual Report, ICAR-CSWRI 2018-19). There is a huge demand for fat-tailed sheep and also fetches a premium price in the Indian market. The carcass traits of different sheep breeds to be studied and suitable weight and age for slaughtered should be determined. The carcass traits of some of the well-defined sheep breeds are given in table 1.

2. Improving Prolificacy in sheep for faster multiplication: Majority of Indian sheep breeds produce single lamb per lambing except few prolific sheep breeds like Garole, Kendrapada and Edka, which produce twins/triplets. The major constraint is their low adult body weight (<15-20 kg). In order to have sheep with higher prolificacy, faster growth and higher body weight, ICAR-CSWRI, Avikanagar has developed a new genotype '*Avishaan*' (GMMXP), which produce twins/triplets and also have higher body weights, better survivability and milk yield. Avishaan sheep produces 72% more lambs than native single bearing Malpura sheep and provide 46% more weight than Malpura at three months of age with the survivability of >96%. They attained slaughter weight of 24.36 kg at six months of age and produced a carcass of lean, fat and bone contents of 57.51, 15.66 and 24.45%, respectively (Annual Report, ICAR-CSWRI 2016-17).

3. Improve the reproductive efficiency of sheep for more profit*:* The demand for meat in the market is rising, especially during the festive seasons. Majority of sheep in the country are bred during breeding season with a very few ewes bred all over the year. To overcome the issue of seasonal breeding in sheep, ICAR-CSWRI, developed a cost-effective 'progesterone' impregnated intra-vaginal sponges 'Avikasil-S' for oestrus synchronization and Artificial insemination (AI) with chilled semen. These sponges bring the ewes in estrus simultaneously with success rate of 83-85%. Majority of the ewes gives birth to a single lamb in a year under the existing system of rearing. Three lambs in 2 years can be achieved by breeding at a regular interval of 8 months either naturally or by synchronizing with the use of sponges. The accelerated lambing system produced 50% more lambs in comparison to a conventional system. Besides, nine lambs can be harvested from a ewe life against six lambs under the conventional system.

In natural mating, one ram covers 30-35 ewes in a season, but with one ejaculate, 30-35 ewes can be inseminated using AI technique. This would further help for multiplying elite animals in a flock at a faster rate, reduce the requirement of the number of rams and avoid the possibilities of transmitting contagious diseases within the flock. Advances made in the development of new semen diluents and insemination procedures opened a new avenue for achieving an accelerated genetic gain in sheep through AI. The success rate of AI with chilled semen in sheep is around 60-65%.

4. Nutrition and feeding of lambs to attain desirable slaughter weights at an early age*:* Major portion (90%) of the income from sheep rearing comes from the sale of lambs for meat purpose. The prime objective of the sheep keeper is to achieve slaughter weights of lambs at an early age. In the majority of sheep dominating states, it has been observed that lambs are sold for meat purpose at an early age of 3-4 months when they hardly attain a slaughter weight of 12-14 kg. The study conducted at ICAR-CSWRI, Avikanagar indicated that lambs maintained on suckling with *ad-lib* creep ration and tree leaves achieved 14.6 kg body weight at three months of age with ADG of 134 g and FCR of 2.00 (Tripathi et al. 2011). There is ample scope of increasing pre-weaning weights by nutritional inputs at economical cost. Lambs on grazing system alone on community lands attained 17-18 kg body weight at six months (Table 2). The study conducted at the ICAR - CSWRI indicated that Malpura lambs could reach> 30 kg body weight at six months with ADG of 170-180 g and feed efficiency of 5.0-5.5. Carcasses of these lambs contained 57-58% lean, 22-24% fat and 23-24% bone and suitable for the domestic market.

Table 2.Characteristics of carcasses of Malpura lambs maintained on different system

Parameters	Intensive	Semi-intensive	Extensive
Initial body weights (kg)	16.3	16.6	16.8
Final body weights (kg)	33.0	31.0	23.3
Total gain (kg)	16.7	14.5	6.5
Average daily gain (g)	185	161	73
Feed efficiency (%)	14.23	12.63	11.54
Carcass weights (kg)	16.8	14.5	10.3
Dressing yield (%)	50.9	48.8	44.9
Lean content (%)	60.44	61.10	65.11
Fat content (%)	18.56	17.70	10.89
Bone content (%)	21.00	21.20	24.00

Source: Shinde et al. 2008

Milk yield of Indian sheep is low and not adequate to support higher growth and weaning weights of lambs. Moreover, the prolific sheep when gives multiple births could not meet out the milk requirement of lambs due to low milk yield. Feeding of milk replacer (*Memnaprash*) to lambs improved growth and also survivability. A new technology based on early weaning and artificial rearing of lambs on milk replacer increased flock productivity. Milk replacer feeding in Malpura lambs during the pre-weaning stage from 0-3 month of age improved weaning weight (17.2 kg), ADG (154 g) and feed efficiency (3.73) (Bhatt et al. 2009). In Malpura lambs, suckling from a dam with additional gelatinized milk replacer during pre-weaning and supplemental crushed linseed as an energy supplement during post-weaning resulted in ADG of 187 and was a useful strategy for achieving higher body weight with better carcass quality (Bhatt et al. 2018).

Table 3.Effect ofchallenge feeding on carcass traits of Malpura lambs at six months of age

Parameters	*Ad-lib* 50:50 roughage: conc.
Slaughter wt. (kg)	26.5±0.80
Dressing yield (%)	55.5±0.66
Loin eye area (cm2)	12.5±0.73
Leg (%)	33.76±0.37
Loin (%)	12.83±0.51
Rack (%)	12.62±0.36
Neck & shoulder (%)	24.98±0.32
Breast & foreshank (%)	15.81±0.552
Edible contents (%)	4.99±0.21
Inedible content (%)	34.30±0.80
Lean %	65.46±0.966
Fat %	8.94±1.312
Bone %	24.87±0.818

Source: Karim et al 2007

5. Effective and planned health management: Sheep diseases are major constraint affecting production efficiency and apparent financial losses. Mortality in lambs during the pre-weaning stage is a major problem; effective strategies and health interventions are required to reduce mortality. Sheep diseases adversely affect mutton production in the country; most importantly, PPR and Bluetongue cause substantial mortality and morbidity losses. Farmers incur around 18-20% production losses due to diseases and mortality. A prophylaxiscalendar has been developed based on the epidemiology of sheep diseases, which contains timely vaccination, drenching, dipping and tactical health care. Animals should be regularly vaccinated against enterotoxaemia (ET), Sheep pox, *Peste des petits ruminants* (PPR) and Foot and mouth disease (FMD). Annual health management calendar that includes timely vaccination, drenching and dipping when effectively implemented in a flock to reduced morbidity and mortality losses. Sheep need to be regularly vaccinated against ET, PPR and Sheep pox vaccine. Deworming should be practised for controlling internal parasites during pre-monsoon. Dipping in spring season is required to manage ectoparasites. Besides this, foot bath with copper sulphate is essential during monsoon season. The annual cost comes to around Rs 70-75 per sheep and reduced mortality losses to < 5.00 % and save 10% animals.

6. Pasture establishment*:* There is a huge gap between demand and supply of fodder in India.As per the estimate of ICAR-National Institute of Animal Nutrition and Physiology Adugodi, Bangalore, in India fodder (green and dry) requirement of 1410 and 1550 million tons/annum by 2020 and 2025 while estimated availability would be 1004 and 1033 million tons/annum indicating 40.44% and 50.05% deficit. Degrading grazing resources, encroachment in common property resources, climate change, urbanization are major factors affecting fodder production. There is a challenge of maximizing fodder production with limited land availability. Drought resistant improved high yielding fodder varieties for cultivation to meet out the ever-rising demand is need of the hour.

Value addition to mutton

Worldwide, India, with a CAGR of 22% is the second-fastest emergent processed meat and poultry market. Processed meat markets are growing at a faster pace, and many of them are from the Asia Pacific region, especially India (www.icfa.org.in). Value-added meat products can be developed from meat for increasing convenience to the consumer by reducing preparation time and steps and making it, ready-to-eat and more appealing. Non-meat ingredients along with low-value meat cuts, edible meat by-products can be incorporated for improving quality and economy.

Additionally, processing can also promote export of meat products, entrepreneurship development and employment generation. Using novel ingredients, healthier, meat products like low fat, low sodium/salt, fibre rich and natural antioxidants fortified meat products could be developed. ICAR –CSWRI, Avikangar have developed numerous (nuggets, patties, kabab, sausages, loaf, salami, kofta, cookies, pickles *etc.*) ready to eat and heat and serve sheep meat products for the consumers.

Marketing of small ruminants: In India, the marketing system of small ruminants is highly unorganised (Fig.3), and the number of intermediaries is involved. This reduces profit margin to the sheep keepers. Ideally, sheep and goatmarketing should offer remunerative price to sheep/goat owners (Shinde, 2018). Similarly, consumers should get the meat at a reasonable price and also in good quality and sufficient in quantity.

Majority of sheep/goats are sold in the market on the basis of physical appearance by visual observation

Rarely, animals are sold on the basis of actual weight and body conformation in the markets. This leads to poor realization of animal prize to farmers

Large channels of intermediaries (Commission agents, butchers, traders) are involved in marketing of goats/sheep

Farmers get only 60-70% of price of animal in the market under normal situation

In drought and other calamities, due to scarcity of fodder and water, farmers have no option but to sell their animals at throwaway price

Fig 3.Marketing pattern of sheep /goats

In India, still, consumers prefer fresh/hot meat rather than frozen or processed meat. A minimal amount of meat (1-2% of total production) is processed and sold in the market outlets. Because of the involvement of a long chain of intermediaries, the price of live animals and meat rises at each level of marketing from producers to end-users. The price fluctuates with the seasons, and it increases up to 25-30% during festive season.

Majority of sheep and goat keepers are from the downtrodden section of society. Credit support from a financial institution is required to them for establishing sheep farming or introducing new breeding stock and also meeting contingency expenses (Fig. 4).

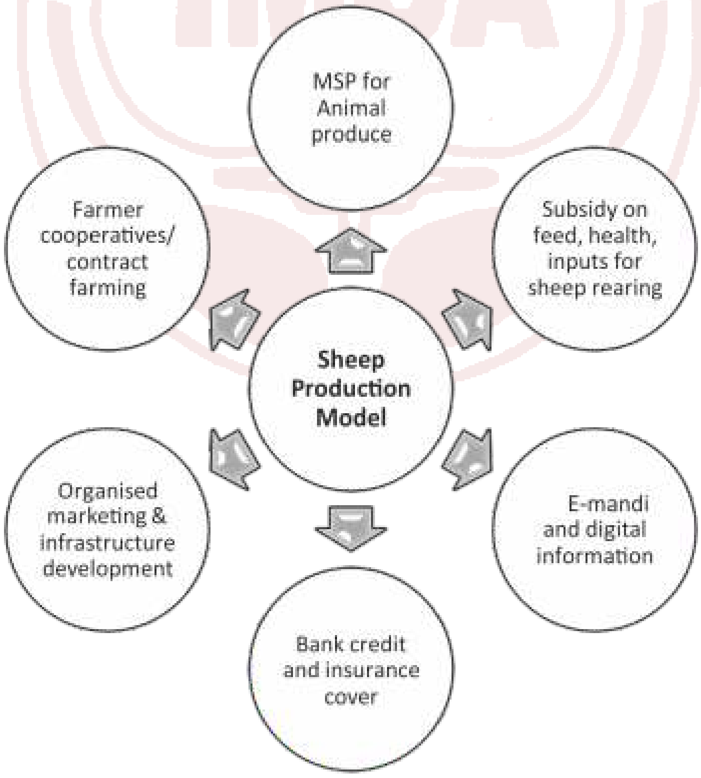

Fig 4. Sheep production model

Skill development and capacity building of entrepreneurs in the mutton sector: The focus should on enhancing skills and capacity building through improving and upgrading small-scale meat production and processing techniques. The skill development of stakeholders at each stage right from the farm to fork is need of an hour. Sheep farmers should be trained in scientific rearing for the production of healthier livestock by adopting improved technologies. Similarly, the personnel involved in the processing sector should be trained for hygienic, safe meat and products manufacturing.

The increasing demand for meat and value-added products can be fulfilled by improving per animal productivity, scientific feeding and management practices and their adoption at sheep farm. Because of declining grazing lands, the traditional system of sheep management under extensive grazing system should be substituted by semi-intensive/commercial system. There is a need to establish direct tie-up of farmers with processors and consumers to get remunerative prices for their produce. Smart marketing would further increase the profit margin and get remunerative prices. Further, consumers would also get a safe, hygienic and quality product as per their convenience.

Reform areas for sheep meat production, processing and marketing

Production

Standardization of body weight and age for slaughter in different breeds: Ideal weights and age for different breeds of sheep should be standardized for producing quality carcass and reducing cost of feeding.

Lamb rearing centre in production areas or near to market place: stall feeding of lambs near to production areas should be established for production of carcass of desirable weights and quality for domestic and international markets.

Protection of elite rams lambs from slaughter: It has been observed elite germplasm are put to slaughter for meat purposes. These germplasm should be protected for breeding purposes to improve meat production.

Fattening of lambs: Lambs on grazing alone attain 12-14kg at 3 months and 16-18kg at 6 months. They may be stall fed on roughage and concentrate to attain desirable carcass weight and quality.

Training of farmers in commercial lamb production: Skill development and capacity building of farmers in recent improved package of practices for increasing meat production from lambs should be given on priority.

Processing

Establish state of art slaughterhouse in production areas: This would avoid middlemen and would facilitate remunerative prices to the sheep keepers.

Cold chain facility for meat transport: Cold chain in transport of carcass of animals should be maintained for quality measures and healthy meat to consumers.

Modernization of retail meat shop: The retail meat shop need to be modernized with infrastructures in form of storage, prime cuts, display, packaging and accessibility to consumers

Diversified functional and healthy meat products: More and more diversified and healthy meat products be developed and popularized in the market for consumers to increase entrepreneurship and demand in the market.

Food safety measures: Food safety measure shall be strictly followed to ensure health of consumers and shelf life, cold chain and packaging etc. shall be strengthened.

Meat identification to check adulteration: Simple and affordable method for identification of adulteration of meat of different species should be developed to prevent malpractices.

Training of butchers for hygienic meat productio*n*: Butchers and traders involved in trading, slaughtering and selling of meat should be trained for hygienic meat production and environmental protection.

Slaughterhouse waste management and pollution control: Waste management of slaughterhouses should be improved to produce clean and hygienic meat and also protecting environment.

Utilization of aged and tough meat: Meat of cull ewes/rams after completing productive life should be utilized in development of meat products to improve its utilization and ensuring quality products for consumers and to get better price to farmers.

Marketing

Payment of animal by weight basis: Sheep and goats are sold in the market as a lot without considering individual weights and body conditions simply on basis of physical appearance. Pricing of individual animals shall be made on weight basis to give remunerative price to producers.

Display of live weight rates in Mandies: In present scenario of marketing, e-marketing, similar to broiler chicken rates, rates of sheep and goats should be declared on a day to day basis.

Introduce selling of prime cut: In the country entire carcass is sold at same price without considering the prime cuts. Selling of cuts at prime price should be introduced to provide higher return to producers.

The sheep is wonderful animal with multiple utility. In view of climate change and depleting grazing resources, sheep could be considered as future food animal. They have ability to thrive on sparse vegetation, ability to adopt extremes of weather conditions. Small size, easy to handle, less feed requirement makes them more suitable animal to rear for resource poor, landless and marginal farmers. In view of rising demand for mutton in the country, scientific approaches for sheep rearing, processing and marketing of sheep and their produce is need of an hour.

References

References can be made available upon request from the author.

(Lead 04)

Effect of Processing on the Bio-Availability of Nutrients and the Health Concerns Therein

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Introduction

Meat is a significant source of protein, which is of high biological value. It provides about 60% of protein intake in developed countries as compared to only 15% in developing (Higgs and Pratt, 200). The nutritive value of a protein depends on the physiological availability of its constituent amino acids. Studies on the relation between food intake and health are based on data from raw food without consideration cooking and other processes that cause considerable alterations. Cooking of foods prior to consumption is important for healthy nutrition. Cooking methods and temperatures have important role on keeping nutrients. Methods for preparation and cooking of foods cause some changes in structures of food components. Foods such as meat and fish become edible and more digestible when they are subjected to cooking.

Heat treatment and interaction

Any reactions occurring during heat treatment, which lead to an impaired digestion, absorption or utilization of any amino acid which is likely to be limiting in the diet, could therefore reduce the nutritive value of the protein. In practical diet the amino acids most likely to be limiting are the sulphur amino acids (methionine and cystine), lysine and tryptophan. The foodstuff manufacturer therefore needs to know what reactions can take place during heat processing and storage and what their nutritional consequences are. Most of the protein we eat has been heat-treated in some way before consumption.

However, heat treatment can lead to undesirable modifications, such as the loss of the nutritional value of foods due mainly to lipid oxidation, and changes in some components of the protein fraction (Uran and Gokoglu, 2014) Cooking also reduces the biological value of protein. Beuk et al (1949) observed that rats fed a raw meat diet showed the largest average weight gain and protein efficiency, followed in order by rats fed diets containing meat which had been autoclaved for 5 minutes, 2 hours, and 24 hours. The addition of cystine to the diet containing meat which had been autoclaved for 24 hours resulted in only a slightly higher gain in weight and protein efficiency. Maillard reaction which occurs under mild conditions of heating or storage in the presence of reducing sugars affects mainly lysine. It seems that cross-linkages are formed in the severely heated protein or protein-sugar mixes and that these reduce the rate of protein digestion. When freeze-dried chicken muscle (15% H20 content) was severely heated its protein showed a great fall in digestibility but its value for supporting growth in the rat had fallen even more. Aspartyl-lysine and glutamyl-lysine cross-linkages, which had been formed during heating, appeared to be as digestible as the total N component and it seems that once they are released from the protein chain they can be absorbed and utilized (Friedman, 1977). Protein–protein cross links play an important role in deter- mining the functional properties of food proteins. Manipulation of the number and nature of such protein cross links during food processing offers a means by which the food industry can manipulate the functional properties of food, often without damaging the nutritional quality. Although protein cross linking is often considered to be detrimental to the quality of food, it is increasingly clear that it can also be used as a tool to improve food properties (Gerrard 2002).

Heat treatment and carcinogens formation

In January, 2017 FSSAI has issued a code of practice for the reduction of contamination of food with polycyclic aromatic hydrocarbons (PAH) from smoking and direct drying processes. Possible mechanism for formation of PAH compound is by pyrolysis of organic matter such as fat, carbohydrate and proteins at higher temperature (2000C), lipid dripping in direct contact over flame at intense heat and incomplete combustion of charcoal which can generate PAH which intern is adhered to the surface of the food (Hamamidi et al., 2016).There is a general consensus that human exposure to potent genotoxic heterocyclic amine carcinogens produced in meat during cooking is widespread. Mutagens/carcinogens produced during cooking of meat and fish has been published by Takashi Sugimura et al. (2004). They concluded that HCAs are readily produced by cooking meat. Traore et al. (2012) studied the effect of heat treatment on protein oxidation (estimation of carbonyl content) in pig meat, they stated that the heat treatment appeared to promote conformational changes, and protein aggregates could impact the nutritional value of meat proteins by decreasing the ability of digestive tract enzymes to recognize proteolysis sites. Understanding the parameters affecting their formation also shows us ways to avoid their formation. The demonstrated mutagenicity of these compounds in bacteria, cells in culture and in mice support the many studies of carcinogenicity in mice and rats. Mechanistic data show that, even at low 10 doses, heterocyclic amines form DNA adducts in rodents, primates, and humans. The majority of epidemiological studies generally support the hypothesis that meat cooking doneness increases risk for human cancers (Knize and Felton, 2004), Formation and Human Risk of Carcinogenic Heterocyclic Amines Formed from Natural Precursors in Meat, Nutrition reviews, UCRL-JRNL-208240). Processing of food (such as drying and smoking) and cooking of foods at high temperatures (grilling, roasting, frying) are major sources generating PAH (Guillen et al., 1997; Phillips, 1999). Levels as high as 200 µg /kg food have been found for individual PAH in smoked fish and meat. In barbecued meat, 130 µg/kg has been reported whereas the average background values are usually in the range of 0.01-1 µg/kg in uncooked foods. Contamination of vegetable oils (including olive residue oils) with PAH usually occurs during technological processes like direct fire drying, where combustion products may come into contact with the oil seeds or oil (Speer et al., 1990 , Abu Abdallah , 2013)

Risk assessment

Risk assessment is a term used to describe the overall process or method includes Identification of hazards and risk factors that have the potential to cause harm (hazard identification), analyze and evaluate the risk associated with that hazard (risk analysis, and risk evaluation) and determine appropriate ways to eliminate the hazard, or control the risk when the hazard cannot be eliminated (risk control). The risk analysis studies in India for the meat consumption and health issues has not been conducted , however in 2011 a comparative study on risk assessment of pork value chain in Nagaland was conducted by Deka et al. (2011). They reported high levels of important food-borne hazards, many reported for the first time in Nagaland.

Meat consumption and health

The role of red meat consumption in colorectal cancer (CRC) risk has been widely contested among the scientific community. Several postulated mechanisms have been proposed by which red meat may increase CRC risk, such as the content of the meat (e.g., heme iron), mutagenic compounds produced by cooking practices (e.g., heterocyclic amines), and gut microbiota composition. However, data from epidemiologic studies of red meat intake and CRC have not supported clearly the notion that there is an underlying biological mechanism of action. International agency for research on cancer after detailed investigations and discussion has issued a caution on red meat and processed meat consumption as limit the processed meat consumption to less than 500 g per week (70 g per day i.e. 25.5 kg per year). In India the overall per capita meat consumption is about 5 kg per year and the processed meat consumption is about 20% i.e. 1 kg per year. Hence without proper risk assessment studies it is not advisable to create a fear in the minds of people in blaming meat consumption for cancer development.

Cooking methods and nutrient retention

Cooking has major effects on the connective tissue of meat. Firstly, cooking causes collagen fibres to contract. Contraction starts before gelatinization, and both are somewhere between 60 and 70ºC. Secondly, further cooking causes the gelatinization of collagen fibres. Cuts of meat with high connective tissue content must be cooked with moist heat for an extended time - for example, stewed or casseroled. This takes time and effort - so the meat is less expensive than cuts with a low connective tissue content which can be barbecued. However, cuts of meat with high connective tissue content usually have an excellent taste. If they are put through a meat grinder the connective tissue toughness is reduced. Cooking makes myofibrils stronger. The longer we cook myofibrils, the tougher they get. Cooking cross-links the proteins. If sarcomere length is short, there is more cross-linking and cooked sarcomeres are very strong. Cooking makes all the myofibrils tougher, but reduces the strength of connective tissue. Thus, the overall effect is - the longer the cooking, the more tender the meat.

Cooking food improves digestion and increases absorption of many nutrients For example, protein in cooked eggs is 180% more digestible than in raw eggs. However, several key nutrients are reduced with some cooking methods. The following nutrients are often reduced during cooking viz Water-soluble vitamins: Vitamin C and the B vitamins - thiamin (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), folic acid (B7) and cobalamin (B8),Fat-soluble vitamins: Vitamins A, D, E and K and Minerals: Primarily potassium, magnesium, sodium and calcium. While water-based cooking methods like boiling, simmering and poaching cause the greatest losses of water-soluble vitamins, they have very little effect on omega-3 fats. Grilling and broiling provide great flavour but also reduce B vitamins. Grilling generates potentially cancer-causing substances like PAH. Up to 40% of B vitamins and minerals may be lost during grilling or broiling when the nutrient-rich juice drips from the meat. There are also concerns about polycyclic aromatic hydrocarbons (PAHs), which are potentially cancer-causing substances that form when meat is grilled and fat drips onto a hot surface. It was observed that PAHs can be decreased by 41–89% if drippings are removed and smoke is minimized.

Silva et al. (2016) studied the effect of the cooking methods (grilling, roasting, frying and sous-vide) on the oxidation of thiols, tryptophan, alkaline amino acids and protein cross-linking in jerky chicken and found that sous-vide technique was the most advantageous cooking method to obtain high-quality ready-to-eat chicken charqui. Microwaving is a safe cooking method that preserves most nutrients due to short cooking times. About 20–30% of vitamin C in green vegetables is lost during microwaving, which is less than most cooking methods. Studies have found that microwaving is the best method for retaining the antioxidant activity in garlic and mushrooms. Roasting or baking does not have a significant effect on most vitamins and minerals, with the exception of B vitamins. Most vitamin losses are minimal with this cooking method, including vitamin C. However, due to long cooking times at high temperatures, B vitamins in roasted meat may decline by as much as 40%. Sautéing and stir-frying improve the absorption of fat-soluble vitamins and some plant compounds, but they decrease the amount of vitamin C in vegetables. With sautéing and stir-frying, food is cooked in a saucepan over medium to high heat in a small amount of oil or butter. In general, this is a healthy way to prepare food. Cooking for a short time without water prevents loss of B vitamins, and the addition of fat improves the absorption of plant compounds and antioxidants. One study found that absorption of beta-carotene was 6.5 times greater in stir-fried carrotsthan in raw. Frying makes food taste delicious, and it can provide some benefits when healthy oils are used. It's best to avoid frying fatty meat or fish and minimize frying time for other foods. Frying tuna has been shown to degrade its omega-3 content by up to 70–85%, while baking caused only minimal losses. In contrast, frying preserves vitamin C and B vitamins, and it may also increase the amount of fiber in potatoes by converting their starch into resistant starch. When oil is heated to a high temperature for a long period of time, toxic substances called aldehydes are formed. Aldehydes have been linked to an increased risk of cancer and other diseases. The type of oil, temperature and length of cooking time affect the amounts of aldehydes produced. Reheating oil also increases aldehyde formation. If you're going to fry food, don't overcook it, and use one of the healthiest oils for frying. Steaming is one of the best cooking methods for preserving nutrients, including water-soluble vitamins that are sensitive to heat and water. Researchers have found that steaming broccoli, spinach and lettuce reduces their vitamin C content by only 9–15%.

Conclusion

Processing techniques does have an effect on the nutrient retention and their bio availability and also formation of undesirable compounds. However, epidemiological evidences on red meat consumption and ill health are very weak and should be considered in conjunction with other dietary and lifestyle factors, lack of a clear dose-response effect, Further, detailed studies on the Indian styled cooking methods needs to be investigated, especially with reference to traditional meat products vis-à-vis cooking methods.

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References can be made available upon request from the author.

(Lead 05)

Essential Oils in Meat Food System: Its Comprehension and Potential as Natural Additive

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Introduction

Meat and meat products are exceedingly prone to microbial and oxidative deterioration since they are rich in essential nutrients and perishable in nature and if they are not properly preserved, public health problems may arise. Producers and manufacturers have been challenged by the escalating demand for safe and high quality meat and meat products over the past few decades. Particularly, the recent demand for minimally processed, easily prepared, and ready-to-eat meat products combined with the novel concepts of all-natural and clean-label has rapidly augmented. These products may contain natural or organic ingredients without artificial preservatives that do not elicit common food allergies or sensitivities to consumer (Mariutti et al., 2011).

In order to ameliorate the antioxidative and microbial quality of meat and meat products, novel ingredient systems that are associated with natural and organic foods, are applied. Many studies have demonstrated the antimicrobial and antioxidative activity of plant-origin natural ingredients in meat and meat products. However, advanced technologies can improve the antioxidative, microbial stability and the sensory quality of meat products containing natural extracts and essential oils through different techniques. Nowadays EOs is far and wide used in the food industry because of their ability in retarding the food spoilage, improvement of organoleptic quality, and pathogen growth inhibition (Hashemi et al., 2016). These compounds are classified as "Generally recognized as safe" (GRAS) food additives for human consumption with antimicrobial, antioxidant and pharmaceutical, properties by the Food and Drug Administration (FDA).

Meat spoilage

High nutrient matrix of meat and meat products initiate microbial spoilage and is further accelerated by some intrinsic factors including pH and water activity of fresh meat making it perishable (Dave & Ghaly, 2011). Pre-slaughter handling of livestock and post slaughter handling of meat play an imperative part in deterioration of meat quality. Three sensory quality characteristics appearance / color, texture, and flavor are the main quality attributes that affect consumer's acceptance of meat, and lipid per-oxidation and microbial spoilage are the primary cause of these quality deteriorations in meat and meat products.

Consequences of Lipid Oxidation on Meat and Meat Products quality

Substantial factors can affect lipid oxidation in meat and meat products including high ratio of polyunsaturated fatty acids (PUFAs) as components of membrane phospholipids, lack of antioxidants, high concentrations of pro-oxidants and reactive radical species, presence of high amounts of salt (NaCl) and free molecular oxygen that is typically entered into meat mixture during processing. Oxidative deterioration of meat and meat products domino in the development of off-flavor, discoloration, formation of toxic compounds, loss of nutrients, drip losses and thus shorten the shelf life (Contini et al., 2014). Under normal physiologic conditions, the molecular oxygen exposes a series of reactions that causes generation of free radicals. In general imbalance between the production of ROS and antioxidant leads to oxidative stress, which often causes functional and structural damages to muscle organelles, cells and tissues. Myofibril protein can be affected by ROS during the storage which affects meat quality and damage cellular structure. ROS can reduce collagen synthesis in the muscle, which increases meat toughness and decrease solubility of collagen fibers (Falowo et al., 2014).

Microbial spoilage

Meat and meat products offer excellent growth media for a diversity of microflora (bacteria, yeasts and molds) some of which are pathogens (Jay et al., 2005). The intestinal tract and the skin of the animal are the main sources of these microorganisms. A significant level of spoilage of meat and meat products takes place every year at different levels of the production chain including the preparation, storage, and distribution (Dave & Ghaly, 2011). Microorganisms associated with the spoilage and deterioration of meat and meat products includes bacteria such as Pseudomonas, Acinetobacter, Brochothrix thermosphacta, Lactobacillus spp., Enterobacter etc., and yeast and mold cause quality defects such as off-flavor, off-odor etc. Additionally, foodborne diseases have emerged as important and growing public health and economic problems in many countries over the last few decades.

Synthetic additives have been accused for some carcinogenic and toxic properties. This increased the consumer concerns toward functional meat and meat products and the demand for natural food additives over the years, which led researchers to examine natural alternatives to synthetic food additives (Mariutti et al., 2011). These natural additives ought to improve meat quality without leaving residues in the product or in the environment (Simitzis et al., 2008).

Essential oil

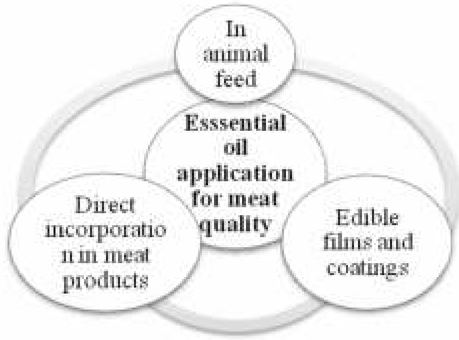
Essential oils (Eos), which are aromatic and volatile oily extracts obtained from aromatic and medicinal plant materials, including flowers, buds, roots, bark, and leaves (Hyldgaard er al., 2012; Viuda-Martos, 2010) by means of expression, fermentation, extraction or steam distillation (Burt, 2004), are one of the best such alternatives, given their strong antimicrobial activities (Bozin et al., 2006). Essential oils have received increasing consideration as natural additives for the shelf-life extension of food products due to the possible risk in using synthetic food preservatives. Essential oils are a excellent source of several bioactive compounds, which possess antioxidative and antimicrobial properties, which can be very useful to extend shelf-life in variety food products.

Potential Essential Oils for Manufacturing Meat and Meat Products

In total, approximately three thousand essential oils are known, and approximately three hundred of them are considered to be commercially important, in particular for the pharmaceutical, agronomic, food, sanitary, cosmetic, and perfume industries. Simultaneously, the replacement of crude spices with isolated essential oils and oleoresins has increased in the meat industry. This may be associated with some advantages that essential oils have compared with dried spice materials, including better stability during storage, higher concentrations of flavor components, reduced need for storage space, ease of handling, no seasonal variation, microbial safety, and standardization. Various researchers have recently worked on the effects of essential oils from oregano, rosemary, thyme, sage, basil, turmeric, ginger, garlic, nutmeg, clove, mace, savory, fennel, etc., when used alone or in combination with other essential oils and/or preservation methods to improve the sensory qualities and extend the shelf life of meat and meat products (Jayasena & Cheorun, 2014).

Mode of action of Eos

A number of reports have indicated that the antimicrobial activity of a given EO can be attributed to its major constituents as well as their interaction with minor constituents present in oils (Hyldgaard et al., 2012). Nevertheless, the antimicrobial activity of EOs has been consistently associated to phenolic constituents such as carvacrol, thymol and eugenol (Barbosa et al., 2009). The hydroxyl groups of phenolic compounds are very vital for their antimicrobial activity. The antimicrobial activity of EOs is not attributable to one specific mechanism (Burt, 2004). There are several sites or mechanisms in the microbial cells that supposed to be the sites of action for EO constituents for their action. In brief, EOs can degrade the cell wall, disturb the phospholipid bilayer of the cytoplasmic membrane, and damage the membrane proteins leading to increased permeability of the cell membrane and loss of cellular constituents. They can further disrupt the proton motive force, electron flow and active transport, and coagulate the cell contents (Burt, 2004). Additionally, these oils can impair a variety of enzyme systems including the enzymes involved in the energy regulation and synthesis of structural components (Burt, 2004) and inactivate or destroy genetic material (Solomakos et al., 2008), strengthening their antimicrobial activities. The effectiveness of a wide range of essential oils against antimicrobial and lipid oxidation has been repeatedly demonstrated via three main routes in the meat industry: the addition of essential oils to (1) animal feed and fodder, (2) during meat products manufacturing and processing, and (3) edible films and coatings.



Essential oil in feed to improve meat quality

Essential oil may contain variable mixtures of terpenoids that primarily include monoterpenes (C10) and sesquiterpenes (C15), and diterpenes (C20). They also include a variety of low molecular weight aliphatic hydrocarbons, acids, alcohols, aldehydes, acyclic esters or lactones and N- and S-containing compounds, such as coumarins, and homologs of phenylpropanoids (Dorman & Deans, 2000). These products act as antimicrobials (oils of clove, rosemary, thyme and vanillin are some of the most effective due to the presence of phenolic compounds) and antioxidants, benefiting the immune and digestive system of animals, which is reflected in their performance indices (Benchaar et al., 2008, Jayasena and Jo, 2013). Moreover, when a blend is used, essential oils may have a synergistic effect, influencing their mode of action in animal metabolism and affecting beef quality (Prado et al., 2016, Valero et al., 2014).

Direct incorporation in meat products

Cinnamon (*Cinnamomum Zeylanicum*) contains phenolic and polyphenolic compounds and act as a good inhibitor of primary and secondary oxidation products in Lyoner-type sausage (Aminzare et al., 2015). Thymol, p-cymene, linalool, and carvacrol available in Satureja Montana L. EO could reduce the use of sodium nitrite of mortadella-type sausages (Coutinho de Oliveira et al., 2012). Petrovskáklobása is a traditional dry fermented sausage that has been manufactured for over 250 years. It is produced from pork meat, spices and fat. Ballester-Costa et al. (2017) have focused their study in EOs from four Thymus species from organic growth, to its antioxidant and antibacterial properties with the objective of its use for the meat industry. The main novelty of this work is the application, as culture medium for the antibacterial activity evaluation, and of several meat homogenates (minced beef, cooked ham, or dry-cured sausage). This type of findings favors the potential effect of these meat matrices on bacterial survival and would be included in the general antibacterial activity that has been evaluated. Anita (2015) developed spent hen meat jam with six essential oils; Oregano, cassia, cinnamon, thyme, clove and holy basil at different concentration separately. Hurdle treated and fibre enriched meat jam had shelf life of approximately 35 days that increased by approximately 15-16 days with incorporation of combination of chitosan with individual essential oil/blends without negatively affecting the sensory and microbial quality of product. Karuna (2017) developed low salt fiber enriched functional chevon sausages with incorporation of thyme, caraway and cinnamon essential oil. The incorporation extended the shelf life of sausages upto 24 days under refrigeration with well acceptable microbial and sensory properties. Tanveer (2017) optimized anise, oregano and clove essential oil and found appreciable effect on the Microbial and Sensory Attributes in chicken meat spread.

Incorporation or coating over edible packaging

EOs have also been used as additives in biodegrabable films and coatings for active food packaging. EOs can be a active component of the films and coatings with antioxidant and/or antimicrobial properties, depending both on their composition and on the interactions with the polymer matrix. The antioxidant activity depends not only on the specific antioxidant activity of the oil compounds but also on the film's oxygen permeability. EOs' controlled release from edible films is another aspect that positively affects their efficiency. In addition, consumers' apprehension regarding possible negative health effects of applying synthetic preservatives to food products together with the boom of organic culture that promotes the consumption of organic foods (in whose processing synthetic additives are not authorized) have also contribute to boost the interest in organic EOs properties. Bharti (2019) develop biodegradable edible film from sweet potato, arrowroot and tapioca starch using casting technique for preserving chicken nuggets. Three essential oils (EOs) viz. anise, caraway and nutmeg were selected and optimized at 0.5%, 1%, 2% and 3% on the basis of minimum inhibitory concentration by tube dilution method. Chicken nuggets wrapped with EOs incorporated film was found well acceptable upto 15th day of storage under refrigeration which provides an interesting alternative to protect and extend the shelf life of meat and meat products.

Industrial Application

It can be clearly declared, based on the literature cited above, that essential oils can be used as effective antioxidant agents in meat and meat products. These antioxidants can be primarily incorporated into meat by supplementation of feed of livestock animals, including beef, swine, chicken, turkey, rabbit, and sheep, with these essential oils. In addition, they can be directly added to different types of meat and meat products, including raw meat, sausages, patties, liver, ground meat, and pates. However, these oils should be used without compromising the sensory properties of the end products. This can be particularly achieved through lowering the concentration of essential oils and combining with other antioxidative compounds and/or other hurdle techniques including vacuum packing and MAP.

Limitations and Future Perspectives

Although good antioxidative and antimicrobial activities are exhibited by many essential oils, a few limitations have also been identified in their applications in meat and meat products.

Some essential oils interact with food ingredients and structures, which may reduce their effectiveness.

Low water solubility, high volatility, and strong odor are the main properties that make it difficult for food applications.

The actions of essential oils in food systems, including meat and meat products, may be markedly reduced owing to the presence of fats, carbohydrates, proteins, and salts, when compared with the actions observed in vitro. For example, mint and cilantro essential oils are not effective in products with high levels of fat, such as pate, and a coating for ham that contains canola oil.

Compared with synthetic antioxidants, most essential oils are less effective and more expensive. The compositions and antioxidant levels of essential oils can be affected by several factors, including the time of harvest and the variety. Some essential oils negatively affect the sensory quality of food. This can be resulted in primarily due to the intense aroma of these essential oils even at low levels of incorporation that exceeds the threshold acceptable for consumers.

Researchers are now seeking solutions for these problems through advanced technology. For instance, the encapsulation of essential oils in polymers of edible and biodegradable coatings or sachets, or into nano-emulsions, and the incorporation of volatile components of essential oils into films or edible coatings, provides better results. In addition, a synergistic effect can be achieved through the combination of lower concentrations of essential oils with other antioxidative compounds and/or other preservative technologies without compromising their antioxidative activities.

Conclusion

Being perishable food items, meat and meat products are highly prone to lipid oxidation and microbial spoilage, which ultimately leads to safety and quality issues. Among the assorted types of natural substances that are used to replace synthetic food additives owing to some health issues, EOs from aromatic and medicinal plants have been proved to be the finest types of alternative preservatives in meat and meat products, in particular as effective antioxidant and antimicrobial agents. Besides traditional methods of adding essential oils either directly into the diets of meat animals or as additives during the manufacture of meat products, these oils are now being used effectively, which improves the sensory quality of meat and meat products in addition to their antioxidative properties. Thus, Application of essential oils in meat food systems is an attractive and promising area for researchers whose results could end up having a great use for meat industries. It is a extensive field of research where different aspects can be further addressed.

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References can be made available upon request from the author.

(Lead 06)

Post Harvest Technology of Meat for Nutritional Security

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Introduction

The agricultural and animal husbandry sector plays a key role in the overall development of the national economy.About 20.5 million people (ie, two-third of rural community) depend upon livestock for their livelihood. It also provides employment to about 8.8% of the population in India. Livestock sector contributes 4.11% GDP and 25.6% of total Agriculture GDP.The livestock provides food items such as milk, meat and eggs for human consumption. India is number one milk producer in the world. It is producing about 137.7 million tons of milk in a year. Itis also the main source of food accessibility at the national level, and a prime source of food andincome for most households.India is the world's 2nd largest producer of food next to China, and has the potential of being the largest with the potential of being the largest with the food and agricultural sector.

There has been an increasing pressure on the livestock sector to meet the growing demand for high-value animal protein. The world's livestock sector is growing at an unprecedented rate and the driving force behind this enormous surge is a combination of population growth, rising incomes and urbanization. Annual meat production is projected to increase from 218 million tonnes in 1997-1999 to 376 million tonnes by 2030.There is an opportunity for large investments in food and food processing technologies, skills and infrastructure, especially in areas of canning, dairy packaging, frozen food / refrigeration and thermo processing.

Food Security

Achieving food security, however, can be said to be based on the efforts and technology used to transport, store, process and valueaddto harvested crops and livestock products. Crops and livestock products can deteriorate and become unfit for sale or human consumptionunless preserved, processed and stored under suitable conditions. Poor transport facilitiescan also result in spoilage and subsequent food-borne illnesses.The term meat refers to muscle of warm blooded four legged animals. The chief one being cattle, sheep and pigs. Meat foods play a very imperative role in human health by providing all essential nutrients needed for growth and maintenance.Meat also includes the glands and organs of these animals. Meat products include many of the by-products from animal slaughter such as animal gut used for sausage casings, the fat in the manufacture of lard, gelatin and others.Being fifth largest meat producer in the country, India holds tremendous potential in meat production, processing and marketing. India produces about 7.4 million tonnes of meat annually from all species comprising buffalo meat (1.45 million tonnes), beef (0.34million tonnes), chicken (3.46 million tonnes), goat meat (1.04 million tonnes), sheep meat (0.56 million tonnes), and pork (0.47 million tonnes). The meat production estimate was 0.6 million metric tonnes.

Post-Harvest Technology- Importance and Role

Post-harvest loss reduction technology encompasses the usage of optimum harvest factors, reduction of losses in handling, packaging, transportation and storage with modern infrastructure machinery, processing into a wide variety of products, home scale preservation with low cost technology. Use of thermal processing, low temperature, drying, chemical and biological reactions coupled with other preservation techniques are applied to enhance the storability. Containers and packaging materials confer portability as well as extend the shelf-life. Adoption of these techniques could make available a large quantity of food by avoiding losses and provide better quality food and nutrition, more raw materials for processing, thus ensuring better returns to the farmers.

Further processing and value addition

At present further processing and value addition of meat in Indiaremains less than 2.0% with the exception of poultry where ~7.2% of meatundergoes processing. The Indian market is witnessing a revolutionarychange and several multinational companies are introducing globallyknown products in the Indian markets. There has been an increase in both, the number of players in the frozen products segment and the availability ofconvenience and ready to eat meat products.

Compared to broiler industry, which is growing at 12-15% per annum, the ready to eat meat productssegment is growing at more than 20% in India. Even though, culturalpatterns rather than income dominate meat consumption in India, the readyto-eat meat sector is growing with consumer affluence. Large meatprocessing companies like METRO, SPAR Hypermarket, Walmart, etc. have already entered into retail sectorand catering to the demands of urban population. KFC, Suguna Daily Fresh, Venky's Xprs, Godrej-Tyson have created the infrastructure to marketpoultry products in most of the western and southern cities in India.

Classes of Meat

Veal is the meat from cattle slaughtered 3 to 4 weeks after birth. Calves Less than 3 to 8 months.Mutton is the flesh of young lambs of both sexes whose age is 12 months or under. Yearling mutton is the Carcasses of young sheep usually from 12 to 20 months old one termed yearling mutton.Mature mutton is the Flesh of both male and female. Chevon is the meat harvested from Goats.

Meat production, processing and value addition

The second major segment deals with slaughter of meat animals and poultry for harvesting of meat and edible offal and aspects pertaining to post-harvest handling, processing, by-products utilization and value added meat products. The primary objective of this segment is supply ofclean and safe meat and meat products to the consumers. Value addition to meat products has assumed vital importance in our country due to diversity in socio-economic conditions, industrial growth, urbanization and globalization. It is not merely to satisfy producers and processors by way of higher monitory return but also with better taste and nutrition. Value is added by changing their form, colour and other such methods to increase the shelf life of perishables.

Nutritive Value of Animal Foods

	Energy (KCals)	Moisture (g)	Protein (g)	Fat (g)	Minerals (g)	Fibre (g)	Carbohydrates (g)	Calcium (mg)	Phosphrous (mg)	Iron (mg)
Beef meat	410	8	79	10	2	0	0	68	324	19
Buffalo meat	86	79	19	1	1	-	-	3	189	-
Duck	130	72	22	5	1	-	0	4	235	-
Egg hen	173	74	13	13	1	-	-	60	220	2
Goat meat	118	74	21	4	1	-	-	12	193	-
Fowl	109	72	26	1	1	-	-	25	245	-
Quail	103	75	22	2	1	-	-	22	282	-
Mutton	294	71	18	13	1	-	-	150	150	2
Pork	114	77	19	4	1	-	-	30	200	2
Venison	97	75	21	1	1	-	2	3	233	-
Liver sheep	150	70	19	7	1	-	1	10	380	6
Liver goat	107	76	20	3	1	-	-	17	279	-

Source: Nutritive value of Indian Foods, NIN (ICMR), Hyderabad

Traditional meat products

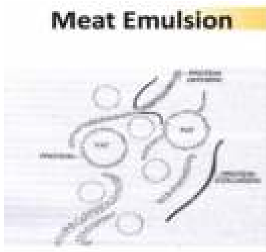
Traditional meat products have tremendous mass appeal with unique sensory attributes. Large varieties of traditional food products of indigenous taste profile are being prepared and consumed in Hyderabad. Biryani, haleem, kebabs, koftas, tandoori items and meat curries are few to name. Even the multinational companies like Subway, KFC, and McDonald etc. have realized the importance of traditional meat products for Indian customers and started blending western products with traditional meat products or introducing new ethnic products with their brand. Considering this, traditional meat products will have huge demand among quick service restaurant chains if organized on more scientific lines. Process optimization, large scale production, safety management and better packaging will further boost their acceptability. Retort processing is a promising technology for increasing the shelf life, which will ensure their availability throughout the year. Hence shelf-stable traditional meat products could be produced in large scale and find export potential in different geographical areas.

Scope for value added meat products processing in India

National Food Processing Policy aims to increase the level of food processing from 10% in 2010 to 25% in 2025. Urbanization and fast changing socio-economic and cultural aspects have increased the demand for value added and convenience products. Ready to eat (RTE) foods symbolize processed foods; consequently no further processing is required. They are more convenient option as they are easily available, have a long shelf life, store the nutrients and reduce risk of food poisoning. The RTE meat foods contributed 40% revenue share to the Indian RTE food market in 2017 (RNCOS 2017). According to Associated Chambers of Commerce and Industry of India (ASSOCHAM), the quick service restaurants (QSR) sector in India is likely to grow from current 8,500 crore to Rs. 25,000 crore by 2020 at a compounded annual growth rate (CAGR) of 25%. Because of huge anticipated growth, leading manufacturers are focusing on expansion of their respective meat processing business across India and setting up new manufacturing plants to ramp up production capacities and broaden overall product line.

Processing- Emulsion

Meat emulsion is a two-phase system, with the dispersed phase consisting of either solid or liquid fat particles or the continuous phase being the water containing salts and dissolved, gelled and suspended proteins. Thus they can be classified as oil in-water emulsion.



Dry Heat

Roasting: Roasting in pan over temperature of 163^{0}Censures the adequate browning of meat for good flavours and good appearance.

Broiling: It consists of cooking meat by direct radiant heat such as the open fire of a gas flame, live coals or electric oven. Broiling is applied to tender cuts that are at least 2.5 cm thick. Thinner cuts will be too dry if broiled. Broiling is carried out at a temperature of 176^{0}Cuntil the top side is down. Broiling is a faster method of cooking meat by dry heat than roasting.

Pan Broiling: Meat is placed in a cold girdle and heated so that meat cooks slowly. Any fat that accumulates the pan is removed so that the meat will continue to pan broil rather than pan fry.

Frying: Two methods of frying are pan frying and deep at frying. Too high temperature results in inside uncooked and too low temperature results in greasier product.

Moist heat: This method is used for less tender cuts, meat become tender owing to the conversion of connective tissue to gelatin.
Braising: In this method meat is cooked with or without the addition of water, the meat is first carefully browned on all sides by broiling, pan broiling or frying. Tomatoes and fruit juices may be added as liquids.

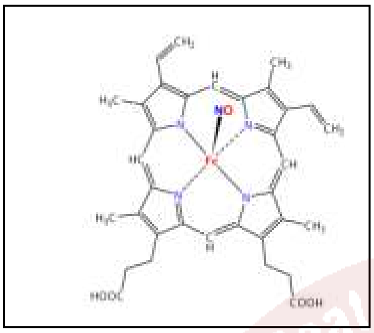
Stewing: Large pieces of tough meat are cooked in sufficient water until tender.

Pressure-cooking: This method takes less time. Pressure-cooked meats are less juicy and cooking losses are great.

Irridation

Curing

Refers to modifications of the meat that affects preservation, flavour, colour and tenderness due to added curing ingredients.Ageing still leaves the meat recognizable as a fresh cut. Curing grossly alters the nature of meat and produces distinct products such as smoked and salted bacon ham corned beef highly flavoured sausages (frankfurters and Bologna). Principle ingredients used Sodium chloride – mild preservative and adds flavor Sodium nitrate and /or sodium nitrite –help cure meat develop the unique flavor -acts as preservative -anti botulinum activity -fix the red colour of the cured meat Sugar ---stabilizes colour and adds flavor Spices ---mainly for flavor

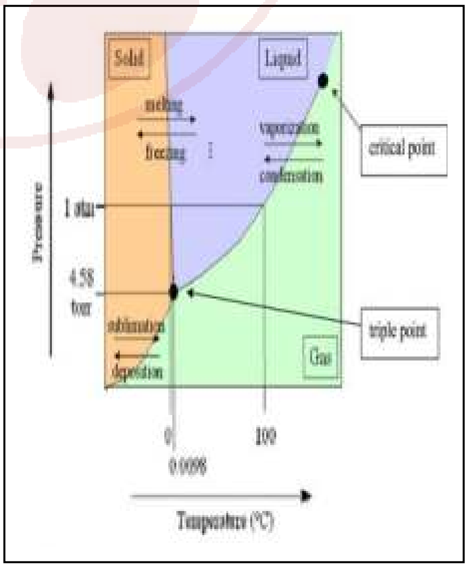


Smoking of Meat

Curing and smoking of meat are closely interrelated and are often practiced together. Smoking like curing has a preservative effect on meat.

- Development of aroma and flavor
- Creation of new products
- Development of color
- Formation of protective skin on emulsion type sausages
- Protection from oxidation

Freeze drying



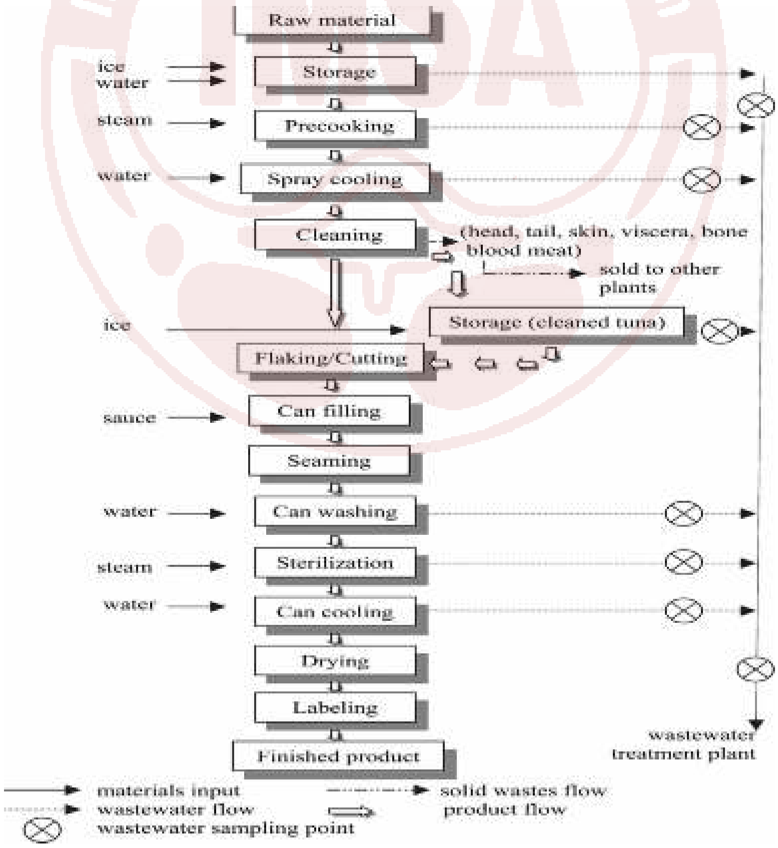
Branding in meat/poultry Industry

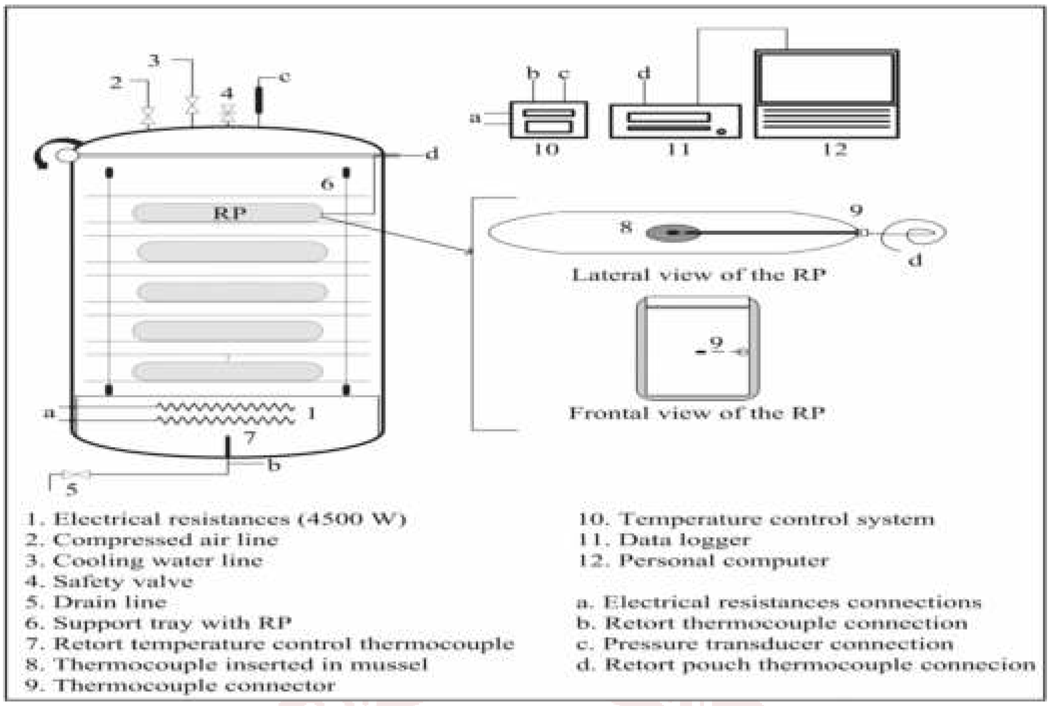
The evolution of modern retail outlets with better packaging, labeling, chilling and cold chain facilities will hopefully address the drawbacks of the existing situation. Branding is a tool for improving marketability of meat/poultry produce. Many commodities like wheat flour, edible oil and milk are now transformed into the brands. The milk is a classic example of commodity which came over the challenge of perishability, sourcing, storage, supply chain and has produced various brands of dairy products. The branding made the milk business profitable. Chilled or frozen chicken has slowly started entering into consumer's refrigerator even though the availability is limited to some cities/location. Consumers in some cities are now witnessing few branded chicken shops and even the supermarkets have started to allocate a corner for the meat and fish. The 100 per cent FDI in marketing of food products and in food product e-commerce and a new platform for selling agricultural produce (e-RaKam) are some of the initiatives.

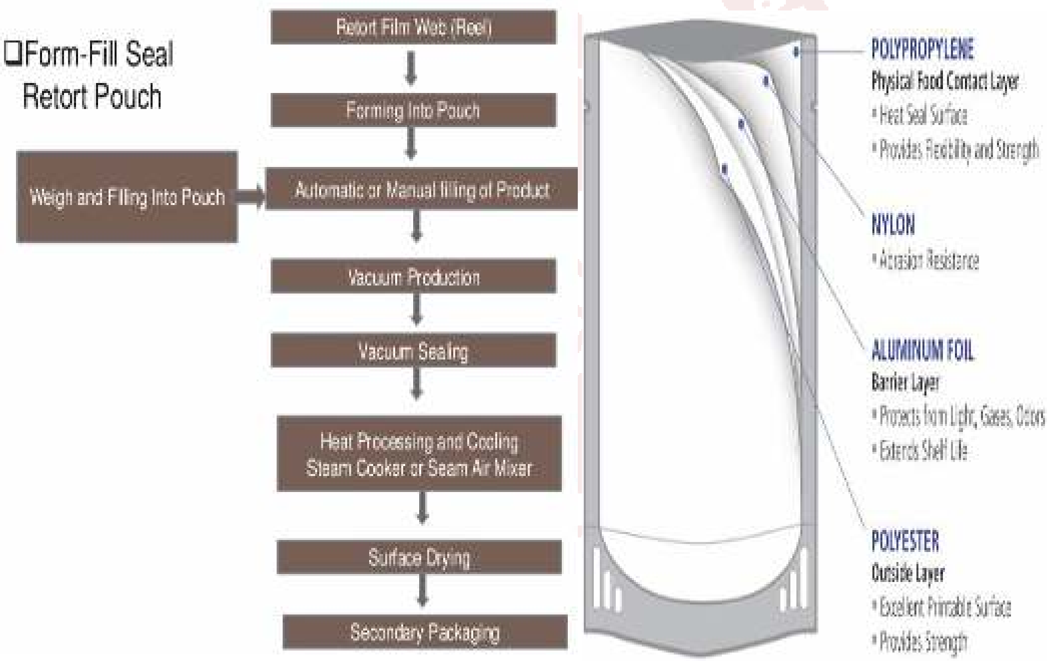
Canning of Meat

Retort processing

Retort processing represents unique combination of package, process and product technology with potential, economic benefits. The meat product is first prepared, and then sealed into the container. The most common form of pouch consists of Polyester/Aluminium foil/cast polypropylene.







Smart packaging

- Capable of detecting, sensing, recording, tracing, or communicating information about quality or state of the product during the whole food chain
- Indicators with application to muscle food packaging are
- Time temperature indicators,
- Oxygen and integrity indicators,
- Freshness indicator.

Marketing of meat and meat products

Though retail meat outlets of supermarkets in metropolitan cities catering to high end markets with all kinds of meat and meat products are at par with standards in developed countries, vast majority of meat retail shops lack minimum facilities like portable water supply, knife sterilizers, fly proofing, fly killers, air curtains for hygienic handling of meat. Lack of hygiene in the traditional meat markets have given rise to online meat selling market, which has better supply chain management and technological intervention than the offline options.

- Weaknesses
- Highly unorganised market
- Stringent quality standards of importing countries
- Lack of disease free zones for rearing animals
- Popularity of value added meat products developing at a slow rate
- Latest technological advancements still awaited to make their way to Indian meat processing industry
- Lack of appropriate support infrastructure for processing
- Vegetarianism, religious reservations, regional preferences and preference for fresh and hot meat
- Lack of centralised slaughter facility

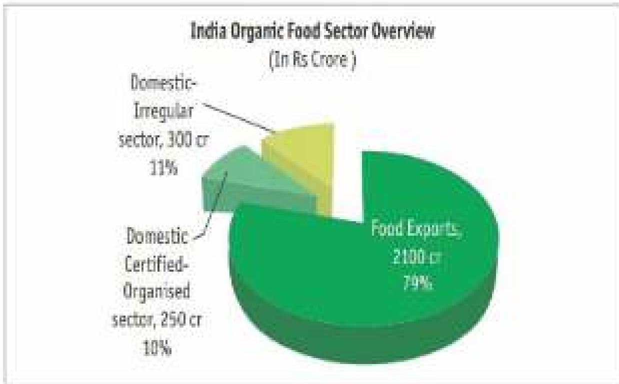
Harnessing E-commerce

Roping the services of logistic agencies including post departments, couriers services, logistical service providers, which have a wider network could be engaged to supply immediately upon order (offline as well as online) even forth away place in major cities through air transport. Ordering groceries online is in its infancy in India and consumers still prefer to see the product before they buy it. E-commerce in India is projected by big players like Tata and Reliance have already ventured into the sector to tap the potential, but the grocery category makes up only a small share of the market. The groceries category makes up just 4.2% of the e-commerce market, according to are port from Entailing India, compared to almost 30% in China. Tata's site my247market.com, offers fresh and chilled chicken, mutton, fish and prawn in certain areas of Mumbai. Consumers can buy specialty chicken products and orders are delivered in temperature controlled vans. There are a number of other start-ups, including Lucious, Big Basket, Aaram Shop, Local Banya, Grofers and Ekstop, offering services to local areas. Prices are 10-15% higher than in-store prices.

Growing demand for natural and organic meat

A growing worldwide trend towards consumption of meat from animals/birds reared under free-range condition is evident. The demand for such produce is steadily on increase in response to the concerns of animal welfare and move away from the widespread use of antibiotics and feed additives. Organic animal production system, which follows natural process of animal production with utmost regards for food safety and food security, is emerging as an effective alternative to address all these issues.

India's organic food sector is estimated at Rs. 2700 crores (approximately USD 415 million) which stands at lesser than even one percent of the global organic food market estimated at about USD 90 Billion in 2015.



All the products and services in the organic food value chain are likely to fetch premium price in the market as they are targeted for niche consumers who are quality conscious and would be willing to pay premium price for quality products.

Integrated and intensive meat animal production

Except chicken, this segment has notmade significant strides in our country although sheep, goats and pigs are reared by the countrymen for meat production using extensive and semi-intensivemethods. India has a world's lowest yield for goats and sheep (< 10.0 Kg) due to inadequate feeding and complete dependence on free grazing,lack of awareness about superior quality breeds/animals for breeding, poor access to preventive and curative health care (Singh et al., 2018). Technological interventions have resulted in transformation of unorganized and unscientific chicken farming practice in India to a highly successful commercial production system. Similar to organized poultry production system in India, sheep and goat farming need to be taken-up on intensive/semi-intensive concept in larger scale with complete integration. The integrated production will also suffice mandatory requirement of traceability of food products as per the Food Safety & Standards (Food Recall Procedure) Regulations, 2017.

Summary

Post-harvest technology has potential to create rural industries. India, where 80 percent people live in the villages and 70 percent of them depend on agriculture has experienced that the process of industrialization has shifted the food, feed and fibre industries to urban areas. Importance of Post-harvest technology lies in the fact that it has the capability to meet food requirement of growing population by eliminating losses making more nutritive food items from raw commodities by proper processing and fortification.

References

References can be made available upon request from the author.

(Lead 07)

Future Prospects and Scope of Herbs and Spices In Meat Industry

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Meat contains higher amount of proteins, fats and unsaturated fatty acids, it is susceptible to rancidity due to the oxidation of nutrients causing quality deterioration during storage. Quality loss in preserved foods can be minimized by imparting conventional synthetic antioxidants such as Butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) etc. However, the use of synthetic antioxidants is questionable on the grounds of their ill health effects. Different kinds of herbs and spices are used in preparation of meat products have a tremendous Antioxidative and antimicrobial potential. They have great role in increasing the shelf life, sensory quality, oxidative stability and overall acceptability of the products.

Herbs and Spices contain variable amounts of protein, fat, carbohydrate, small quantities of vitamins (e.g., carotene, thiamine, riboflavin and niacin) and inorganic elements (calcium, magnesium, manganese, phosphorous, potassium, chlorine, copper, iron, sodium and zinc). Some spices also contain fatty acids, starch, sugars, cholesterol and fiber (Hung and Foster 1996). Many species have been recognized to have medicinal properties and health benefits, e.g. antioxidant activity, digestive stimulation action, anti-inflammatory, antimicrobial, hypolipidemic, antimutagenic effects and anticarcinogenic potential (Aaby et al., 2004,). Components in spices also possess colorant, bioactive (i.e., antioxidant and antimicrobial), acidulant and sweetener effects (Wang et al., 2000). Common herbs and spices contain an impressive list of phytochemicals, essential oils, minerals, and vitamins that create unique sensual qualities and have cancers, Alzheimer's and metabolic syndrome–preventing properties (Dini, 2018). They are also used as preservatives and fumigants (Perseglove et al., 1981). Spices are generally used in food as flavouring and tenderizing agents (Ayres et al., 1980). The Spices are famous for various kind of function as:

- Serves as vital ingredients of recipes and add taste and aroma to the food.
- It is the raw components in preparation of different kind of "curry powder".
- It transforms insipid food palatable.
- It is the ingredients of perfume, cosmetics and medicines.
- The essential oil of spices are widely used in food, confectionary, beverage, pharmaceutical, perfume industries etc.

It imports attractive colour, flavour and taste to dishes and make them more palatable (Singh 2007). Storage stability of the processed meat products is the main concern of meat processing industry today. Retaining the prime quality during storage is depends upon the hygienic production, processing, packaging and storage of the product. Among the quality deterioration of muscle foods during the storage period microbial growth and oxidative rancidity are most prevalent. As meat is a good concentrated source of nutrients and can make a valuable concentration for the growth of microorganisms and oxidation of these nutrients may develop rancidity. Unsaturated fatty acids which in turn get oxidized in presence of oxygen and cause deterioration of quality of meat and meat products leading to development of off-flavor, discoloration, loss of texture, increased drip loss, decreased nutritive value and production of toxic compounds (Gray et al 1996). The free radicals produced due to oxidative rancidity of fatty acids cause deterioration, the loss of nutritional values, and undesirable changes of many important food parameters like aroma, taste, texture, consistency, appearance and tenderness. Food technology uses two strategies to fight these problems, a passive one based on the avoidance of oxidation causing factors and an active strategy based on addition of antioxidants (Sim and Fioriti 1991). To overcome the oxidative rancidity different synthetic antioxidants can be used, but due to its unhealthy residual effect it suffers from a negative consumer image. This has lead to the commercialization of natural antioxidants. Different spice ingredients as antioxidants play very important role in improving the quality of meat and meat products (Raj et al 2005, Ahn et al 2002, El-Alim et al 1999, McCarthy et al 2001, Rhee 1987).

Spices

Spices defined as "a strong flavored or aromatic substance of vegetable origin, obtained from tropical plants, commonly used as condiments", it is a dried seed, fruits, root, rhizome, bark or vegetative substance or flower bud used in nutritionally insignificant quantities as a food additive for the purpose of flavoring. Spices and herbs have played a dramatic role in civilization and in the history of nations. The delightful flavor and pungency of spices make then indispensible in the preparation of palatable dishes. In addition they are reputed to possess several medicinal and pharmacological properties and hence find position in preparation in a no of medicine (Parthasarathy et al 2008). India is not only the home of spice but also having supreme position as producer, consumer, and exporter of spice and spice products in the world. Spice constitutes an important part of agricultural commodities which are virtually indispensible in culinary enhance the taste and flavor of food. Some spices possess antioxidant properties while others are used as preservatives in some food like pickles, *chutneys* etc. (Singh 2007). The principle use of spices in flavoring food and drinks, and all aromatic vegetable products used for this purpose are sometime included as spices, these are of considerable importance as ingredients of processed products. And used to season insipid food, such as those mainly of carbohydrate origin of many parts of the tropics, and add zest to an otherwise monotonous diet. They are used as preservatives and fumigants (Perseglove et al 1981).

Physical and chemical aspects

Spices are dry parts of plants as roots, leaves, seeds, flower etc which impart to food a certain flavor and stimuli. Spices impart aroma, color and taste to food preparations and sometime musk undesirable odor. Aroma compounds play a significant role in production of flavourants, which are used in the food industry to flavor, to improve and increase the appeal of their products. Spices contains not more than 7.0% total ash,1.0% acid insoluble ash, 12% moisture, 42% starch and 1.5 ml volatile oil/100 g (Raj et al 2005). Different spices vary in their biological and physiochemical characters, as they contains different active principles/functional groups in them as alcohols, aldehydes, amine, esters, ethers, ketones, terpenes, thiols and other miscellaneous compounds. In spices, the volatile oil constitutes these components (Zachariah 1995, Menon 2000).

Spices are generally used in food as flavoring and tenderizing agents (Ayres et al 1980). The antimicrobial properties of various spices on foods have been reviewed by Davidson et al (1983). The phenolic compounds found in spices do not have any known nutritional function, but they may be important to health, because of their antioxidant potency (Hortog et al 1995). Flavonoids may defend cell against toxicants via their ability to increase the pump-mediated efflux of carcinogens from cell (Phang et al 1993) or via induction of detoxifying enzymes. Anti microbial activity of spices has been demonstrated (Buchat 1976). Many spices have been found to contain natural antioxidants such as ascorbic acid, flavonoids, phenolic compounds like ferulic acid and catechins and contribute significantly in scavenging free radicals if taken regularly in diet (Long et al 2002). Spices are famous for various kind of function as, 1) Serves as vital ingredients of recipes and add taste and aroma to the food. 2) It is the raw components in preparation of different kind of "curry powder". 3) It transforms insipid food palatable. 4) It is the ingredients of perfume, cosmetics and medicines. 5) The essential oil of spices are widely used in food, confectionary, beverage, pharmaceutical, perfume industries etc. 6) it imports attractive color, flavor and taste to dishes and make them more palatable (Singh 2007).

Effect of cooking on spice

On cooking antioxidant activity was reduced to 7 and 2% in white and black mustard respectively. The maximum loss of AOA on cooking was in drumstick leaves (53%) and minimum in almond seeds (1%). The AOA increased on cooking in Malabar cardamom (101%), jeera (95%), and vanilla (93%). Te total phenolic content was decreased to a maximum amount on cooking in tulsi (green 47%) and minimum in vanilla (0.2%). The phenols in clove were increased by 7.8% on cooking whereas horseradish showed the minimum loss (Anilakumar et al 2007). The increase in total phenolics on cooking may be due to the release of total phenolics, flavonoids and other bounded phenolics from the cell matrix with thermal processing (Stewart et al 2000). Eberhardt et al (2000) reported that flavonoids increased the AOA of phenolics and act like synergists. The decreased AOC after cooking may be attributed to the decreased phenolics as reported by Friedman (1997).

Antimicrobial effect of spices in meat products

Effects on Physico-chemical quality of meat products

Spices play important roles in sausage production besides their obvious function as flavor components. Since ancient times spices have been regarded as food preservatives. Antioxidant properties of spices have been reported, and a number of spices have been found to be effective in retarding rancidity during frozen storage of ground pork and beef (Dubois and Tressler 1943), ground pork (Chipault et al 1956), and pork sausage (Atkinson et al 1947).

The antioxidant and antibacterial effect of rosemary, orange and lemon extract was investigated in cooked Swedish-style meat-balls. Activity in lard system was established for all the extracts and further determination of the development of rancidity as thioberbituric acid reactive substances consistently showed that about 50% of the rancidity can be controlled by citrus preparation. Rosemary extract (water and oil soluble) were more effective with practically complete elimination of rancidity (TBA values) after a period of 12 days. Rosemary extract against lactic acid bacteria and listeria but not *Brochothrix thermosphacta* was demonstrated in an agar diffusion test, but in the product only lactic acid bacteria counts were slightly reduced. Sensory analysis results, particularly aroma and acceptability scores, indicated the significant advantages in using rosemary and citrus extracts in rancidity susceptible meat products (Fernandez-Lopez et al 2005).

Spices added to sausage mixture shown to affect to affect the course of fermentation during manufacture of Lebanon bologna. A mixture of nine spices used in Lebanon bologna formulation enhanced fermentation of this sausage. Similar stimulatory effects of spices were observed when sausages were prepared by natural flora fermentation or by addition of starter culture (Zaika et al 1978). Ethanol extracts of white poney, red poney, sappanwood, Moutan poney, rehmania or angelica were individually added to ground goat meat at 0.5-2.0% (g dry extract/100 g final meat sample), and raw and cooked samples were aerobically refrigerated for 0, 3, or 6 days. These extracts and rosemary extracts were also individually added to salted or unsalted ground beef at 0.01-0.25% and refrigerated as raw or cooked patties. White poney, red poney, sappanwood, Moutan poney markedly reduced lipid oxidation in cooked stored goat meat. With 0.25% above all ingredients in beef, lipid oxidation during storage was minimal in raw and cooked patties; raw patties redness values at day 6 were higher for sappanwood, white poney, red poney or Moutan poney than rosemary extract treatment or control. At 0.01%, sappanwood was more antioxidative the other extracts (Han and Rhee 2005).

Sodium chloride (5%) and some antioxidants (rosemary extract 400 ppm, acerola extract 2000 ppm, ethylenediamine tetraacetic acid 50 ppm) were added to minced chicken by Beltran et al (2004), samples were pasteurized under pressure or cooked. Rosemary extract showed potent antioxidative capacity for pressure treated samples than cooked samples.

Dutch style fermented sausage were prepared by using *Geranium microrrhizum* and *Potentilla fruticosa* extract by Miliauskas et al (2007) a high antioxidant capacity was found by the extract of spice mix in the sausage. It was significantly higher than that of commercial rosemary extract with its well known antioxidant properties. The pH changes for all samples during fermentation and maturation were negligible. It was concluded that antioxidant activity of the tested extracts from *Potentilla* and *Geranium* in lipophilic media is poor. The extracts are rich in polyphenols, and showed remarkable radical scavenging (antioxidative) activity in teste with lipophilic media is low or absent.

Effects on sensory quality of meat products

Meat cuts (beef, mutton) and chicken carcass, when sprayed with acetic acid, lactic acids and extracts of ginger, garlic and onion, singly or combination with sodium chloride, extended the shelf life of meat at ambient temperature (28±20C). The shelf life of beef cuts was higher than that of mutton cuts and chicken carcass. Color and odor and other sensory properties of treated meats were acceptable to test panelists. Beef *masala*, mutton *masala* and chicken *masala* prepared from the meats, treated with lactic acids and ginger extract, were superior with regard to sensory quality (Ziauddun et al 1996).

Antioxidative efficiency of rosemary along with other natural ingredients in precooked pork patties was investigated during storage under retail condition (10 days, 4℃, atmospheric air), using descriptive sensory profiling following reheating and quantitative measurement of hexanal, thioberbituric acid reactive substances (TBARS) and vitamin E in patties with extract incorporated, indicating that the extract related lipid oxidation during processing of the meat. Rosemary extract in a sensory acceptable level was found to yield efficient protection was demonstrated both by sensory evaluation and chemical analysis and thus displayed potential for maintaining sensory eating quality in processed pork products. (Nissen et al 2004).

According to Labell (1987), addition of ginger powder at 2% weight of meat helped to omprove flavor and texture of microwaved meat and poultry. Ziauddin et al reported that ginger treated meat was tenderer according to taste panelists.

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(Lead 08)

Recent Developments in Meat and Meat Products Processing

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Meat and meat products are an important part of diet globally. They have even occupied their space in the fast food sector. Fast food sector and ready to eat and ready to cook meals have boosted the meat processing sector. The processed meat market value is expected to increase upto 1.5 trillion dollars by 2022 from 714 billion dollars in 2016 (Statista, 2019). The major driving forces for increased production and processing are urbanisation, busy-lifestyle, dual income and convenience. Nowadays utilisation and consumption pattern of meat has gone to a higher level than just nourishing, relishing and preserving. Today's fast moving and busy life has shrunken the cooking time and efforts. Ready-to-eat meat or ready-to-cook meat with in convenient one or two diet meal packs has overtaken longer home cooking processes. Consumer demands have also shifted from normal diet to nutritious and healthy diet with increased functionality. Efforts are being made for developing and enhancing the functionality of meat products. Such products require a better and sophisticated processing so as to prevent undesirable effects on functional components. The processing techniques earlier were more time, energy and labour intensive which sometimes becomes inefficient during large scale production. The processing process should be economical with minimum waste., microbiologically safe with minimum chances of contamination and recontamination as well as should retain and maintain the nutritional value of meat. Thus, the processing industry must embrace novel and advanced processing equipments, tools and methods

1. Advances in low temperature processing

I. Super-chilling

Super chilling is defined as the process where the temperature of meat and/or meat products is lowered by 1-2 °C below the initial freezing point, such that some portion of water present in the product is frozen (Kaale et al., 2011; Zhou et al., 2010), later by equilibration of ice distribution a uniform temperature is maintained within the product (Magnussen, et al., 2008). It has been reported that super chilling of fish and meat restricts microbial proliferation. The process is cost effective as it decreases energy losses, labour cost and weight loss and protects product from the freezing/thawing changes in fluctuating cold chains. Magnussen et al., (2008) observed 1.4-4 times higher shelf life of super-chilled meat products than those stored under conventional system. Fish and pork have also been superchilled to extend their storage life (Duun et al., 2008; Duun and Rustad, 2007, 2008). Super-chilling is widely used in New Zealand for chilled beef and lamb shipments (Farouk, et al., 2013).

ii. Immersion vacuum cooling (IVC)

IVC is a based on heat removal by evaporation, conduction and convection methods. It ensures higher cooling rate and lesser losses. IVC process is mainly alienated into three phases: violent, strong, and simmering boiling phases. At the violent stage, the water evaporation occurs in both meat cores and the surrounding water. When water evaporates, it absorbs the necessary latent heat from its surrounding for phase change and so cooling is achieved. At the later stage of IVC, the rate of evaporation greatly recedes and heat conduction within the meat and convection from the surface are then increasingly relevant and may even control the entire later stage of IVC processes. To this point, enhancing the heat transfer, especially at the bottom of the container, is an important approach to increase the cooling rate. Cheng and Sun (2006) studied influence of IVC on large pork cuts (2.260.2 kg) and observed 7.0% reduction in cooling loss and improvement in meat tenderness. Moreover, smaller meat cuts show comparatively faster rate of cooling and are associated with increased product throughput and reduced cold room occupation. Houska et al. (2005) investigated the effect of small cooked beef samples of different sizes (0.1–0.6 kg) and observed rapid cooling rates without adversely affecting the meat quality.

iii. Hydrofluidization freezing

Hydrofluidization freezing (HFF) is a modified form of immersion freezing which involves a circulation system that pump refrigerating liquid in a cooling vessel through nozzles, in thereby creating agitating jets which forms a fluidized bed having turbulent liquid and moving products. HFF offers high heat transfer coefficients that provides paced freezing (Fikiin, 2003). However, a limited literature is available to highlight the use of HFF for meat-based products. Nevertheless, it is stated that HFF provides quick freezing rates to fish and other related products (James et al., 2015).

iv. Impingement freezing

The use of impingement technology is one of the latest techniques that are commercially introduced for the preservation of meat and other food products. The main advantage of this method is higher heat transfer rate through coupling impingement technology with cryogenic freezing system (Winney, 2012). This technique involves directing high speed (50 ms21) jets of fluid to the surface of a solid product that breaks up the static layer of gas surrounding the food surface (Newman, 2001). This process enhances the efficiency of heat transfer which results in rapid freezing compared to conventional blast freezing systems

(Sarkar and Singh, 2004). Reports have shown that impingement freezing is more effective for those foods having high surface area to weight ratio, that is, meat cuts and fish fillets. However, further investigation is needed to explore its potential to elaborate the effect of this freezing technology on quality attributes of muscle foods (Newman, 2001).

v. Pressure-shift freezing

Freezing foods using high pressure (200–400 MPa) has attracted researchers in recent years with special reference to pressure-shift freezing (PSF) (Otero and Sanz, 2012). In PSF, high pressure is applied while cooling the food to subzero temperatures which prevents the phase change and then food is frozen after releasing this pressure. When the pressure of the system is released, uniform and small ice crystals are formed in food due to rapid nucleation. Picart et al. (2004) verified that by applying PSF at 207 MPa and 221 8C, significant microbial reduction can be achieved in smoked meat products. Similarly, Alizadeh et al. (2009) postulated that thawing loss was reduced in salmon subjected to PSF (200 MPa, 2188C).

2. Advances in processing technologies

I. High Pressure Processing

High pressure processing is a non-thermal processing technique that involves use of high pressure to destroy microorganisms in food without affecting the sensorial or nutritional characteristics of meat or meat products and causes no physico-chemical alterations in them. It is a safe and consumer friendly, potential preservation method used for inactivation of pathogenic and spoilage microbes. Today's consumer is looking for nutritional, healthy, minimally processed and chemical free foods and is also willing to pay higher prices for it. Thus, the meat industry has employed high pressure processing to develop meat products with good eating and keeping properties. Commercial application of HPP requires standardization of conditions to inactivate selected microbes for every product, novel packaging, innovative processing combinations as well as proper marketing.

ii. Ultrasonic wave processing

Ultrasound waves are sound waves with frequencies greater than 20kHz or above the audible range of human ear. It is a form of energy which when passes through a medium; it induces high compression and depression of particles imparting energy. Acoustic cavitation is the characteristic of ultrasound waves which depends on wave frequency, intensity, products characteristics, temperature and pressure (Dolatowski et al., 2007). Application of ultrasonics in food industry can be classified on the basis of energy generated (sound power (W), intensity (W/m2) and sound/energy density (Ws/m3)) into low-energy and high -energy or power-ultrasound (Knorr et al. 2004). Low energy (Intensity< 1 W/cm2 or frequency 10-100 kHz) ultrasounds are used for non-invasive applications in food such as analytical observations, physicochemical evaluation, composition etc (Jayasooriya et al. 2004). Simal et al. (2003) evaluated composition of fish tissues, chicken and raw meat mixtures using ultrasonic waves and semi-empirical equations. High energy (Intensity > 1 W/cm2) ultrasound waves in the range of 10-1000W/cm2 Intensity with frequency in the range of 20-100 KHZ are used for causing structural, physical or chemical changes. Application of ultrasound waves is a recent advancement in food technology. It is considered a sustainable, energy efficient technique. In meat industry ultrasound waves have been applied for meat tenderization, curing and marination.

iii. Hydrodynamic Pressure Processing or Hydrodyne or Shock wave processing

Hydrodynamic pressure processing is a novel technique for tenderization of meat which involves generation of shock waves that causes physical disruption of muscle structure as well as intracellular organelles membrane damage inducing enzymatic degradation. Mechanical pressure pulses propagating through meat causes instantaneous tearing of muscle structure (Bolumar et al., 2014; Bolumar et al., 2013). The tenderizing effect is dependent on the condition (fresh, frozen) and type of sample (size, shape, species, age, toughness of cut,) and treatment conditions (number of detonations, amount of explosive, voltage) (Zuckerman et al., 2013; Solomon et al., 2011).

3. Accelerated conditioning technologies

i. Electrical stimulation

Electrical stimulation is a process of passing electrical current through the carcass for accelerating the bio-chemical processes and thus reaching a desired pH level in relatively less time. It is the process of hastening rigor mortis before chilling. It is widely used for preventing cold shortening and increasing the tenderness of meat. Efficient electrical stimulation lowers the muscle pH below 6 before the carcass temperature decreases below 10°C thus prevents cold shortening and reduces carcass processing time (from slaughter to chilling). It also improves muscle texture by increasing proteolytic degradation and some physical disruption of muscle structure (Lang et al., 2016).

ii. Pulsed Electric field

Pulsed electric field (PEF) processing is a non-thermal food processing technology that applies brief (µs) electrical pulses of high voltage to food products placed between two electrodes. Depending on the process intensity, the process affects cell membrane permeability due to localized structural changes. PEF is an emerging technology based on the application of electrical currents between two electrodes thus inducing electroporation phenomena and enabling a non-invasive modification of the tissues' structure.

4. Modernization of equipments

i. Vacuum tumblers

Vacuum tumbling is an extension of conventional tumbling where vacuum tumblers are used to remove air and thus prevent frothing of protein exudate. Vacuum also facilitates rapid and consistent brine uptake, as the air is gradually removed, meat tissues are exposed causing cellular absorption of brine into meat. Later when vacuum is released meat regains its original state locking marinade into the structure. The expansion and pounding of meat during tumbling improves the texture of meat making it more tender and juicier. The whole process of marination is accelerated. Vacuum tumbling also reduces bacterial load as high salt concentration in brine along with vacuum causes bacterial cells to rupture. It has been established that intermittent tumbling is more efficient and beneficial than continuous tumbling. The amount of vacuum required depends on the age, sex, species, type and size of meat. Tougher meat, beef, lamb and pork require higher vacuum and longer time to achieve desired texture while poultry meat requires lower vacuum and lesser time.

ii. Grinders

Comminution is the subdivision of meat into smaller size. Various forms of comminution of meat are grinding, chopping, flaking, slicing, homogenization etc. Meat grinders are used for particle reduction of meat for further processing and depending on the particle size these grinders can be classified as coarse meat grinders and fine meat grinders (better known as homogenisers). These can also be classified according to the type of meat handled i.e. normal grinders, mixture grinders and frozen meat grinders. The holes are generally made at 90o to the plate but recent advanced plates have holes at less than 90o to the plates. It has been suggested these changes have increased the efficiency and functionality of grinders (Weiss et al., 2010).

In a continuous meat processing plant pumping grinders are used. Pump grinders consists of a vacuum pumping machine attached to meat grinders. Vacuum causes a pumping action and pushes meat through the grinders. Vacuum pumping has enabled grinding of meat as small as 0.25 mm with a continuous and consistent supply (Haack and Schnäckel, 2008). It has been shown in various studies that keeping quality of pump grinder meat is better than conventional grinding owing to lesser air pockets and damaging effect of vacuum on microbial load (Honikel, 2004).

iii. Slicers

Meat slicers are widely used for portioning of meat and meat products. With increased urbanization, commercialization of convenience foods, ready to eat meat etc. slicing is becoming integral part of meat processing. Continuous slicing lines are increasingly been installed in meat processing plants (Holac, 2009). Traditional slicers have been used to accurately portion meat and meat products of specific desired dimensions. Nowadays slicers with varying designs are available. Spiral slicers have become quite popular for preparing thin sheet of meat for gourmet dressing. Automated slicer lines are now equipped with processors for feeding instructions to produce decorative designs while slicing. Heavy duty meat slicers can handle large volume of meat with high efficiency and continuous supply. An essential requirement for slicing is that the product must be frozen for even finishing, accurate and consistent weight and structure but recent advance in knives design and structure has eliminated the need of freezing surfaces of soft products (Weiss, 2010).

5. Modern tools for quality evaluation

i. Near-infrared reflection (NIR) spectroscopy

Near infrared reflectance (NIR) spectroscopy is a rapid, sensitive and non-destructive analytical technique that allows simultaneous evaluation of many samples, requires no prior sample preparation, and is suitable for in and on-line applications. It can be used for quality assessment and process monitoring of large scale meat processing plants. It can be utilised for quantitative analysis of meat samples, determining proximate composition, differentiating frozen and unfrozen meat, for identifying adulteration of high value meat with poor quality meat.

ii. Nuclear magnetic resonance (NMR) Spectroscopy

NMR is another highly sensitive and useful spectroscopic technique for assessment of meat quality. The widely studied NMR techniques are time-domain proton NMR relaxometry (TDNMR) and high-resolution proton NMR spectroscopy. NMR spectroscopy can be used to study muscle metabolism, qualitative and quantitative assessment of meat. Intramuscular fat evaluation has been successfully done by NMR spectroscopy using the fat–water chemical shift in the NMR spectrum. The water holding capacity of meat can be determined by proton NMR relaxometry. The different NMR techniques can provide valuable information about the biophysical and biochemical changes, factors governing these changes and effect of these changes on meat quality.

iii. Computer Vision system

Recently a process analytical technique, computer vision system has been used to analyse meat quality. A conventional method for colour evaluation was based on point evaluation of sample. This system allows estimation of overall colour evaluation by analysing the entire surface of sample as it provides superior spatial information. Such image analyses have been used for food quality and safety evaluation, quality control, presence of foreign objects, etc (Acevedo et al., 2009; Borah and Bhuyan, 2005; Medina et al., 2013; Torrence et al., 2004). It is considered as the most potential technique for the objective grading of beef marbling due to its best match to human eyes and a combination of nondestructiveness, speediness, and simplicity in sample preparation. Digital images were used to investigate quality and compositional attributes of pork ham (Valous et al., 2009).

References

References can be made available upon request from the author.

(Lead 09)

Nutritional strategies for Enhancing Conjugated Linoleic Acid: A Multifunctional Nutraceutical in Animal Products

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Nutritional quality is becoming a major issue in food choices because of increasing consumer awareness of the link between diet and health. As a result there is increasing consumer acceptability of the concept of functional foods. Animal products especially meat and meat products have a negative image because of saturated fatty acid which have been associated with heart diseases. Conjugated linoleic acid (CLA) is one of these functional food components, a fatty acid found in milk fat and ruminant meat. Even though animal foods such as meat and dairy products naturally have CLA, but the CLA concentration is low therefore different nutritional intervention required which increases these functional food components in animal products, which ultimately improve human health. In ruminants microbial conversions prior to the small intestine result in the production and accumulation of intermediates, among which CLA are relatively unique to ruminant products. To fulfil the consumer demands, there is a large interest in the animal industry to improve the composition and health value of products of animal origin. Animal products contribute significantly to the total nutrients in our food supply.

Conjugated Linoleic Acid

CLA refers to mixture of positional and geometric isomers of linoleic acid (LA; *cis*-9, *cis*-12 octa-deca-dienoic acid) with a conjugated double bond system, instead of the usual methylene-separation. Each double bond can be of *cis or trans* configuration giving rise to possible CLA isomers. Parodi (1977) was the first to identify *cis*-9, *trans*-11 octadecadienoic acid as a fatty acid in milk fat that contained the conjugated double bond pair. The discovery of "role of CLA as a functional food" occurs decade ago when ground beef contained anti-carcinogen factor that consisted of a series of conjugated dienoic isomers of LA (Ha *et al.*, 1987).

Isomers of CLA

Numerous isomers of CLA have been identified and these differ by position or geometric orientation of the double bond pair. Although many isomers occur in ruminants but *cis*-9, *trans*-11 CLA accounts for about 75-90% of total (Fritsche and Fritsche, 1998). Other isomer of CLA are present at low concentration, generally representing less than 0.5 percent of the total CLA in ruminant fat. The trivial name "Rumenic Acid" (RA) has been proposed for *cis*-9, *trans*-11 CLA due to its unique relationship to ruminants (Kramer *et al.,* 1998).

Sources of CLA

Food products from ruminants (Table 1) are the major dietary sources of CLA for humans. The highest CLA concentration was found in adipose tissue (38 mg/g fatty acid) of kangaroo (Engelke *et al.*, 2004).

Table 1. CLA content of common foods (mg/g of fat)

Dairy products	Total CLA	Meats	Total CLA
Homogenized milk	4.5	Ground beef	4.3
Condensed milk	7.0	Lamb	5.6
Butter milk	6.1	Pork	0.6
Mozzarella cheese	4.9	Chicken	0.9
Plain yogurt	4.8	Salmon	0.3
Ice-cream	3.6	Ground turkey	2.5

Source: Chin *et al.* (1992)

Enhancement of CLA in meat and meat products

Milk, meat and meat products are an important source of nutrient. The demand for milk, meat and other animal products is increasing at a substantial rate driven by a combination of population growth, urbanisation and rising income. For large parts of many societies, meat and animal products represent a source of high quality protein, although high intakes of some animal products can lead to excessive fat intakes especially saturated fatty acid. So there is a need of nutritional management for enhancement of CLA and polyunsaturated fatty acid (PUFA) in meat.

Potential health benefits of CLA:

- Anticarcinogenic
- Antiatherogenic
- Altered nutrient partitioning and lipid metabolism
- Antidiabetic (type II diabetes)
- Immunity enhancement
- Improved bone mineralization
- Biosynthesis of CLA:

The CLA found in milk and meat fat of ruminants originated from two sources (Griinari and Bauman, 1999). One source is CLA formed during ruminal biohydrogenation of LA and other source is CLA synthesized in the animal's tissues from Vaccenic Acid (VA; *trans*-11 C18:1), another intermediate in the biohydrogenation of the unsaturated fatty acids.

Ruminal biohydrogenation:

The diet of lactating dairy cows typically contains 4 to 5 percent fat, with the major PUFA being LA and LNA that are supplied mainly from dietary concentrate and forages, respectively. When dietary material enters the rumen, it enters a large fermentation vat, where it undergoes a wide range of chemical changes performed by the microbial population (Harfoot, 1978). Lipids are extensively altered in the rumen, resulting in marked differences between the fatty acid profile of lipids in the diet (mostly UFA) and lipids leaving the rumen (mostly SFA). Ruminal microbes transform lipids entering the rumen via two major processes, lipolysis and biohydrogenation. The extent of hydrolysis of dietary lipids in the rumen is generally more than 85 percent. (Bauman and Lock, 2006). After lipolysis, UFA undergoes biohydrogenation by ruminal microbes. This process converts the UFA to SFA via isomerization to *trans* fatty acid intermediates, followed by hydrogenation of the double bonds (Harfoot and Hazlewood, 1988).

Role of different ruminal microbes in regard to biohydrogenation:

Ruminal bacteria play major role in ruminal biohydrogenaion. Kemp and Lander (1984) classified rumen bacteria involved in biohydrogenation into two groups based on their metabolic pathways. Group A bacteria hydrogenate 18 carbon PUFAs to *trans* 18:1 fatty acids e.g. *Butyrivibrio fibrisolvens, Micrococcus spp, Ruminococcus albus* etc. whereas only a few species characterized as Group B, could hydrogenate VA to Stearic Acid (C18:0; SA) e.g.

Fusocillus spp. And *C. proteoclasticum* etc. (Harfoot and Hazlewood, 1997). Thus, complete biohydrogenation of UFAs generally requires bacteria from both groups. However a small contribution is made by protozoa and fungi (Nam and Garnsworthy, 2007).

Endogenous synthesis:

An active pathway for endogenous synthesis of CLA existed in the mammary gland, indicated that contribution of endogenous synthesis to the overall CLA content in milk fat is around 64 percent making it the primary source (Griinari *et al.*, 2000). Adipose tissue seems to be a major site of endogenous synthesis of *cis*-9, *trans*-11 in growing ruminants. Vasta *et al.* (2009) found that, Δ^9-desaturse expression was higher ($P \leq 0.05$) for the lambs receiving herbage with tannins as compared to the lambs receiving herbage without tannins. Δ^9- desaturase expression was influenced by the presence of polyphenolic compounds (Suman *et al.*,2012). So by modification of expression of Δ^9-desaturse expression with the supplementation of plant secondary metabolites the CLA concentration can be increased.

Factors influencing CLA synthesis in rumen:

Any change in the process of lipolysis or biohydrogenation will influence the supply of their intermediate and end products, including CLA to the small intestine and ultimately their contents in the meat and milk.

Effect on lipolysis and biohydrogenation:

Replacement of forages with grain in the diet reduced the rates of lipolysis and biohydrogenation (Gerson *et al.*, 1985). Increased proportion of nitrogen in the diet resulted in increased rates of lipolysis and biohydrogenation by rumen contents *in vitro* (Gerson *et al.*, 1985). Biohydrogenation of fatty acids averaged 47 percent in the rumen of cows fed diets containing calcium salts of palm oil and 71 percent with diets containing fat from animal vegetable sources (Wu and Palmquist, 1991). Factors affecting ruminal fermentation and microbial population are undoubtedly the keys to control the regulation of biohydrogenation and CLA synthesis.

Effect of substrate on CLA concentration:

It is evident that high LA concentration in diet reduces biohydrogenation and increase post ruminal flow of CLA (Qiu *et al.*, 2004).

Pasture and conserved forages:

Grazing animal on pasture, feeding fresh forages or increasing the amount of forage in the diet will elevate the percentage of CLA as a proportion of total fatty acid in meat from ruminants. Many studies indicated that fresh pasture results in a 2 to 3-fold increase in CLA content of milk fat. In addition to precursor for CLA these pasture also have high concentration of soluble fibre and fermentable sugar which may create an environment in the rumen (without lowering the ruminal pH) that is favourable for the growth of the microbes responsible for CLA and VA production (Bauman and Lock, 2006). CLA content was increased by 300 percent in milk when the green fodder in diet increased from 33 to 100 percent (Tyagi *et al.*, 2007). Fresh grasses provide C18 fatty acid substrate for ruminal biohydrogenation. The increase in CLA content of beef varies with the quality and quantity of forage in the animal diet.

Feeding of oilseed:

Addition of oilseed to the diet has been proven to be an efficient method to increase the CLA content in muscle lipid. However, not all oilseeds exert the same effect.

Feeding of vegetable oil:

Vegetable oils are equivalent to oilseed show similar effect to CLA. In beef cattle addition of 3 and 6 percent sunflower oil to a barley based finishing diet resulted increase CLA content in *longissimus* muscle (Mir *et al*., 2003). Vegetable oil influence CLA content in meat by supplying PUFA which are substrates for bacterial isomerisation and biohydrogenation.

Feeding of fish oil:

Feeding fish oil increase the *n-3* long chain PUFA concentration in the intramuscular fat due to the high Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA) content in fish oil. Ruminal biohydrogenation of EPA and DHA is limited and therefore considerable amounts of this fatty acid are available for incorporation in to adipose tissue (Raes *et al*., 2004).

Effect of rumen pH on CLA production:

Rumen pH has an important role in maintaining a viable rumen environment suitable for *Butyrivibrio fibrisolvens* . Ruminal pH of 6.0 or above has a positive effect on VA and CLA content in rumen cultures (Troegeler-Meynadir *et al.,* 2003).

Effect of supplementation of plant secondary metabolites:

Plant secondary metabolites a have antimicrobial effect, so these are useful natural alternative to antibiotics. Durmic *et al*. (2008) examined 91 Australian plant extracts against pure cultures of the two representative bacterial species involved in rumen biohydrogenation, followed by *in vitro* batch culture assay with mixed ruminal bacteria. Out of 91 plants, 37 plants group selectively inhibited *C. proteoclasticum* P18, which effectively metabolizes VA, the main precursor of CLA in ruminant tissues and meanwhile did not affect *B. fibrisolvens* JW11, at concentrations that were inhibitory to *C. proteoclasticum* and some of the plant alter LA metabolism *in vitro.* After supplementation of polyphenol rich *Terminalia chebula* plant extract at different concentrations in the goat kid there is increase in content of CLA in rumen fluid, plasma, intramuscular fat might be effect on type B bacteria and effect on desaturase enzyme expression (Suman *et al*.,2012)..

Conclusion

Enhancement of CLA, PUFA content and decreasing the level of SFA content in animals products is useful strategy in human health point of view, moreover dietary CLA are currently attracting considerable interest because of its health benefits to humans like anticarcinogenic, antiatherogenic, antidiabetic and immunomodulatory properties. Now days, people are more concerned about foods, which possess specific health attributes beyond its organoleptic and nutritional properties. There is a need of different nutritional intervention researches in ruminants to increase the functional food components in their products which is going to affect the animal product quality. The nutritional manipulation are able to enhance the nutraceutical and therapeutic value of the meat and meat products then producers gets remunerative price for what they produce and the consumers gets satisfaction for what they eat.

References

References can be made available upon request from the author.

(Lead 10)

Recent Development in Meat Tenderization

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Introduction

Tenderness is one of or the most discussed features in meat. It is real challenge for the scientific community and for the meat industry to achieve products with standardized and guaranteed tenderness, since these characteristics are exactly what consumers want in meat product. (Koohmaraie, 1995). Flavor, juiciness, and tenderness are the three main attributes which influence the sensory enjoyment of meat (Aaslyng & Meinert, 2017; Grunert, Bredahl, & Brunsø, 2004; Picard and Gagaoua 2017). Defined as "the ease, perceived by the consumer, with which meat structure is disorganized during mastication (Lepetit & Culioli, 1992), tenderness has been shown to have the largest role in consumer purchasing decisions (Mennecke, Townsend, Hayes, & Lonergan, 2007; Morton, Bhat, & Bekhit, 2018) and in particular repeat buying (Miller, Carr, Ramsey, Crockett, & Hoover, 2001)." It is also the most variable of all meat palatability traits. The critical component of processing meat is to ensure that meat reaches the optimum level of tenderness before consumption. Meat is 'aged' up to five days in chillers to improve tenderness before being released to the market for consumption, which constitutes significant cost to the industry. Tenderization can be accelerated by electrical stimulation, whereby currents are used to trigger muscle contractions and accelerate the depletion of muscle energy. Rigor mortis, the point at which all muscle energy is depleted, can be accelerated from 12-24 hours post mortem to as little as 2 hours. Achieve rigor mortis sooner while the muscles are still warm after slaughter means that the tenderization process is significantly accelerated. Tenderness is actually a quality of meat gauging how easily it is chewed or cut. Tenderness is a desirable quality, as tender meat is softer, easier to chew, and generally more palatable than harder meat. Conversely, tender pieces of meat generally acquire higher price than harder ones. The tenderness depends on a number of factors including the meat grain, the amount of connective tissue, and the amount of fat. The factors responsible for meat tenderness are the length of sarcomere, the intramuscular connective tissue and proteolytic effect of the muscle. After the death of an animal, proteolysis of occurs due to endogenous enzymes which have been found to be responsible for tenderization of meat (Mane *et al.,* 2014). According to recent studies, Caspase is a proteolytic system which may be considered to be highly responsible for proteolysis (Nowak, 2011). Tenderness plays a very important role in deciding the quality of meat by consumers

(Mendiratta *et al.,* 2010).

Recent Advancements in Methods adopted for meat tenderization

There are various methods available for meat tenderization. Some newer methods of meat tenderization have been employed which resulted in better efficiency and high quality meat products. Various newer methods employed in meat tenderization are –

Traditional aging

It has long been known that holding carcasses for days or weeks after slaughter improves both the texture and the flavor of meat. Also known as "ripening" or "conditioning," aging involves holding carcasses, primals, or subprimals for a specific period under controlled refrigerated conditions to avoid microbial spoilage. Several biochemical processes including lipolysis and oxidation are involved during postmortem aging of meat but the most important process for tenderness is proteolysis of the myofibrils. There is strong evidence supporting the central role of the calcium-dependent protease, calpain 1, in aging although other proteases are also involved (Geesink, Kuchay, Chishti, & Koohmaraie, 2006; Morton, Bickerstaffe, Kent, Dransfield, & Keeley, 1999). Although aging is a common method of tenderization and is very effective in improving the palatability of meat cuts that have relatively small amounts of connective tissue.

Electrical stimulation

The development of electrical stimulation dates back to the 1950s (Troy & Kerry, 2010) and it was commercially introduced in New Zealand in the 1970s to manage toughening due to cold shortening by the rapid freezing of lamb carcasses (Strydom & Frylinck, 2014). Electrical stimulation is now widely used in many meat-producing countries including New Zealand, Australia, the USA, South Africa, India, and some European countries. The meat industry often demarcates the range of application of voltage into two types, high voltage (300 to 1,000 V) and low (50 to 120 V) voltage (Troy & Kerry, 2010). High-voltage stimulation produces a greater rate of pH decline, which is more consistent and less variable (Simmons et al., 2008), but it is more expensive and requires greater safety precautions. Several studies have demonstrated equal efficacy of low-voltage stimulation on pH drop and improvement in tenderness Electrical stimulation leads to accelerated postmortem glycolysis with the production of lactic acid, which ensures that the pH of the meat falls to below 6.0 before the muscle temperature reaches 10 °C. This reduces the risk of cold shortening during rapid chilling of carcasses, but electrical stimulation also accelerates meat tenderization by increasing the rate of proteolysis and by physically disrupting the muscle fibers (Lang et al., 2016). It may also improve the tenderness of meat by disrupting the membranes of lysosomes and releasing the cathepsins at low pH and high temperature (Dutson, Smith, & Carpenter, 1980). The physical disruption of muscle fibers by severe contractions and reduction in cross-linking of the collagen molecules may also contribute to tenderness (Judge, Reeves, & Aberle, 1980).

Pulsed electric field

PEF is a novel technology that was first applied commercially to sterilize fruit juice (Clark, 2006). During PEF processing, food is passed through or placed between two electrodes and exposed to electric field pulses of short duration in the range of several nanoseconds to several milliseconds with an electric field strength of 0.1 to 80 kV/cm (Barba and others 2018; Bhat, Morton, Mason, & Bekhit, 2018; Puértolas & Barba, 2016). PEF has attracted the attention of meat scientists due to its ability to alter membrane properties (Barba, Grimi, & Vorobiev, 2014; Bhat et al., 2018; Deng et al., 2014) and potentially affect the activity of calpains and thus influence the rate and extent of tenderization during aging. It is also able to modify several quality characteristics of meat (such as color, texture, and water-holding capacity) and enhance mass transfer processes (such as brining and curing) due to its potential for cell membrane permeabilization (Gudmundsson & Hafsteinsson, 2001; O'Dowd, Arimi, Noci, Cronin, & Lyng, 2013; McDonnell, Allen, Chardonnereau, Arimi, & Lyng, 2014). Several studies have confirmed the potential of PEF for improving the tenderness of muscles during aging (Bekhit, Suwandy, Carne, van de Ven, & Hopkins, 2016; Faridnia et al., 2015; Khan et al., 2017; Ma et al., 2016; Suwandy, Carne, van de Ven, Bekhit, & Hopkins, 2015a, 2015b, 2015c, 2015d).

Enzymatic interventions

Tenderness of the meat can be improved by degradation of muscle proteins mediated by enzymes that are exogenous and purposely added like enzymes of plant and microbial origin. Although intrinsic enzymes are mostly active against myofibrillar proteins, exogenous enzymes can degrade both myofibrillar and connective tissue proteins. The problem with exogenous enzymes is regulating their activity as they can result in an over-tenderized meat and the production of undesirable flavors. The use of exogenous proteases to improve meat tenderness has recently become an increasing focus of interest. Some enzymes have the potential to reduce the amount of detectable connective tissues with minimum degradation of muscle fibers by controlled proteolysis of targeted proteins. Plant as well as bacterial and fungal enzymes could be employed for the purpose. The exogenous proteases have the capability of digesting connective tissues as well as muscle proteins Plant enzymes, like cysteine proteases of the papain family, such as papain from papaya latex, bromelain from pineapple fruit and stem, actinidin from kiwi fruit, and the bacterial collagenase are most widely used and studied exogenous enzymes. Exogenous proteases isolated from ginger rhizome (zingibain), fruits of *Cucumis trigonus* Roxb plant, and *Asparagus officinalis* have also been characterized. Bromelain, ficin, and papain from plants and the protease from *Bacillis subtilis* have been currently approved by USDA's Food Safety Inspection Service as “generally recognized as safe” (GRAS) for improving tenderness.

High Hydrostatic Pressure (HHP)

Hydrostatics is the study of characteristics of liquids at rest or the force that a liquid imposes on a submerged object. High hydrostatic pressure (HHP) treatment can influence meat protein conformation and induce protein denaturation, aggregation, or gelation. The means whereby HHP treatment exerts effects on meat protein structure change are due to the rupture of non-covalent interactions within protein molecules, and to the subsequent re-formation of intra- and inter-molecular bonds within or among protein molecules. Depending upon the meat protein system, the pressure, the temperature, and the duration of the pressure treatment, meat can be either tenderized or toughened. Muscle texture variation induced by heat treatment is due to breakage of hydrogen bonds, whereas changes from high pressure treatment are due to the rupture of hydrophobic and electrostatic interactions. Pressure treatment has little effect on the toughness of connective tissue. Juiciness, springiness, and chewiness are increased upon HHP treatment. The use of high pressure processing (HPP) to tenderize meat has a potential to revolutionize red meat industry since tenderization effects are highly variable between meat carcasses.

Ultrasound

Ultrasound is one of the new clean technologies applied to meat. In science and technology of meat, is mainly studied for its ability to improve meat tenderness by cavitation mechanisms. Some acoustic parameters such as frequency, intensity and exposure time influence the treatment of meat tenderization. The intensity in which the ultrasound reaches the meat matrix is also important, and when applied below 10W cm-2 or much above this value does not realize the effect. The exposure time is dependent on the frequency and the used intensity directly influences the softness. The use of ultrasound technology to improve meat tenderness shows itself as a promising technology with the potential to be exploited (Alves *et al.,* 1991). It has been suggested that ultrasonic techniques cause lysosomal rupture and disruption of myofibrillar protein and connective tissue which result in tenderization of meat. The lysosomal rupture is due to the cavitation process. There exists two types of cavitation of interest. The first one is reffered to as stable cavitation in which the bubble or cavity grows to a resonant size and oscillates due to ultrasound. Within a biological media (steaks), the bubble is suspected to produce hydrodynamic forces which affect the integrity of muscle structure. The second and more severe form of cavitataion is called collapse or transient cavitation. The violent hydrodynamic forces due to a collapsing bubble or transient cavitation can cause severe damage within biological media such as meat specimen in this case, thereby damaging the fiber structure of the muscles (Solomon MB *et al.,* 1997).

Hydrodyne process

The Hydrodyne process uses a small amount of explosive to generate a shock wave in water. The shock wave passes through (in fractions of a millisecond) objects in the water that are an acoustic match with water. As much as a 72% reduction in shear force was observed for the longissimus muscle using 100 g of explosives. Hydrodynamic pressure wave generated in a steel chamber is less effective as compared to disposable/plastic container for tenderizing meat. Even, the composition and configuration of the explosive containers influence the magnitude of performance of this Hydrodynamic process on meat tenderization. Regardless of the type of meat cut and level of initial toughness, hydrodynamic pressure technology has been successful at increasing the value of these meat products by improving tenderness instantaneously (Solomon *et al.,* 1997).

Vitamin D

The first evidence that associated the involvement of calcium with the process of meat tenderization during postmortem aging was noted over 30 years ago (Davey and Gilbert, 1969). They indicated that weakening and disappearance of muscle structure during postmortem aging was inhibited by ethylene diamine tetraacetiz acid (EDTA). They also speculated that EDTA might exert its effect by chelating calcium ions. It appears that VIT-D supplementation accelerates the aging process by shifting calcium to inner areas within muscle cells. In normal muscle, calcium is primarily housed in compartmentalized structures. If VIT-D can solicit calcium from these areas and into a closer proximity to muscle cells, calcium mediated enzymes can more readily tenderize meat during postmortem aging.

Infusion of ionic compounds for tenderization of meat

Pre-rigor ionic compound injection to change the rate of glycolysis, rate and state of contraction, and rate of proteolysis appears to be a feasible method of postmortem meat tenderization. Infusion refers to an introduction of solution via vein and perfusion should refer to the introduction of a solution via an artery. Infusion of bovine carcasses with salt solutions caused a considerable improvement in tenderness. Salts generally influence the functional properties of meat products and are believed to affect contraction and shortening, protein-protein interactions, protein solubility, proteolytic enzyme activity and lattice swelling (Polidori and Francesco, 2003).

Chemical interventions

Salts, organic acids, and phosphates, various salts including calcium salts, sodium chloride, ammonium hydroxide (Naveena et al., 2011) can be incorporated in meats through immersion, injection, or marination and have well-established effects on tenderness (Berge et al., 2001). These chemicals improve the tenderness of meat by affecting the structure of the muscle by modifying the protein solubility or mediating it through the action of proteases. Processes like vascular infusion have become the commercial reality and several infusion mixes have come up with promising results. Traditional marinades contain oil, seasonings, sugar, and acidic constituents, including vinegar, wine, or fruit juices (Oreskovich, Bechtel, McKeith, Novakofski, & Basgall, 1992).

Thermal treatment method

Thermal treatment is one of the most important ways to change the components of muscle that control toughness. The cooking at a high temperature can denature the protein that results in structural changes in the meat such as the destruction of cell membranes, shrinkage of meat fibers, shrinkage and solubilization of the connective tissue, aggregation and gel formation of myofibrillar and sarcoplasmic proteins (Tornberg, 2005).

Smart Stretch and Pi-Vac Elasto-Pack system

Two novel approaches have been developed using packaging to improve tenderness. SmartStretch™/Smartshape™ / Pi-Vac Elasto-Pack™ are designed to reduce the contraction of hot-boned primal during rigor or by stretching these muscles. The system has been adopted commercially in Australia (Hopkins, 2014) and uses external air pressure to stretch and reform hot-boned primal into a uniform size and retain the stretch during rigor by using restraining packaging.

Conclusions

Technological interventions like electrical stimulation, suspension methods, blade tenderization, use of exogenous enzymes, and aging which are currently applied in the meat industry are effective in improving tenderness. However, there are some limitations and disadvantages of using these methods. Emerging tenderization techniques like hydrodynamic-pressure processing, HPP, PEF, ultrasound, Smart Stretch and Pi-Vac Elasto-Pack system provide some advantages over the applied methods, however, would require initial capital investments and changes in the meat plant design. Further, more research is required to optimize the process parameters for different muscles and cuts before some of these novel methods could find commercial application in the meat industry.

References

References can be made available upon request from the author.

(Lead 11)

Implementation of GFSI accredited food safety management system for meat processing plant

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Food safety is a public health priority and requires holistic approach from farm to fork. It is a concept that food will not cause harm to the consumer when it is prepared and/or eaten according to its intended use. Many aspects of animal production and animal products processing including meat and meat products are at risk from biological, chemical and physical agents. These agents may enter food-producing animals or animal products through a wide variety of exposure points in the food chain, with consequent potential risks for consumers. Therefore, building production model in-line with Global Good Agricultural Practices (GAP) to provide stable supply of food animals and poultry for ensuring healthy animal protein supply. Hence, establishing *"safe and traceable meat and poultry value chain"* will help towards "building sustainable livestock production chain".

A contemporary risk-based approach to meat hygiene requires that hygiene measures should be applied at those points in the food chain where they will be of greatest value in reducing food-borne risks to consumers. This should be reflected in application of specific measures based on science and risk assessment, with a greater emphasis on prevention and control of contamination during all aspects of production of meat and its further processing. Application of HACCP principles is an essential element. The measure of success of contemporary programmes is an objective demonstration of levels of hazard control in food that are correlated with required levels of consumer protection, rather than by concentrating on detailed and prescriptive measures that give an unknown outcome. This paper will cover information about requirements of global food safety assurance programmes, food safety management system, different food safety certifications and regulatory agencies.

Global Food Safety Initiative (GFSI) benchmarked food safety audits

In recent years customers are increasingly demanding that their suppliers receive an "Accredited Third Party Audit". During the 90s, there had been a series of high-profile international food safety crises including BSE, dioxin poisoning and listeria outbreaks. The brand owners and retailers realized that reliance on food safety regulations alone is not sufficient to achieve a level of food safety and consistency they desire from food suppliers. Therefore, retailers and brand owners introduced their own food safety standards with more stringent documentation and food safety requirements. Food companies were forced to follow these newly developed standards along with pre-existing government regulations. According to a leading food safety trade publication, there were approximately 135 different standards used by different customers in 2002. Within the food industry, there was growing audit fatigue as retailers and brand manufacturers audited factories against their countless in-house standards, each developed in isolation and with no consideration of convergence.

In order to reduce audit burden, the CEOs of the world's food retailers, working through their independent network- Consumer Goods Forum (CGF), agreed to take collaborative action. With a vision of *safe food for consumers everywhere*, food industry leaders created Global Food Safety Initiative (GFSI) in 2000 to find collaborative solutions to collective concerns, notably to reduce food safety risks, audit duplication and costs while building trust throughout the supply chain. The GFSI community works on a volunteer basis and is composed of the world's leading food safety experts from retail, manufacturing, and food service companies, as well as international organizations, governments, academia and service providers to the global food industry.

The main goal of GFSI was laid out at the very beginning and remains a compelling message: once certified, recognized everywhere. Originally, GFSI wanted to create a single global standard which is accepted by all participating suppliers to eliminate redundancies associated with multiple supplier audits. But, GFSI quickly realized that by creating a single standard, it is going to create more competition among already existing food safety standard. Therefore, GFSI chose the benchmarking approach.

Food safety management: ISO 22000 Certification

- Specifies requirements for a food safety management system.
- It is one of the means of providing assurance that the certified organization has implemented a system for the food safety management of its processes, activities, products and services in line with the organization's food safety policy and the requirements of ISO 22000.
- It specifies the requirements for a comprehensive food safety management systems as well as incorporating the elements of Good Manufacturing Practices (GMP) and Hazard Analysis Critical Control Points (HACCP).
- ISO 22000:2005 specifies requirements for a food safety management system where an organization in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption.

Prerequisites for certification

In order to achieve successful certification, a quality management system for food safety must be established by the producers/processors or within the company, with the requirements of Good Manufacturing Practice (GMP) and Hazard Analysis and Critical Control Point (HACCP) also fulfilled. These requirements particularly relate to quality assurance of the production processes and the production environment, as well as the analysis of possible risks to food safety. Food and Drug Administration-Food Safety Modernization Act (FDA-FSMA) was signed into law in 2011 in USA for shifting the focus from responding to food-borne illness to preventing it. The FSMA require food establishments/facilities to have a food safety plan that has been prepared by a "Preventive Controls Qualified Individual (PCQI). Under FDA-Foreign Supplier Verification Programme (FSVP), the importer will verify the Food Safety Plan and the Third Party Audit.

GMP's and SOP's

Good Manufacturing Practices (GMP) and Standard Operating Procedures (SOP) are two tools for a meat processing facility that help for the production of high quality and safe meat products. The programs established for GMP's and SOP's will provide the basis for other programs the help to assure the level of product quality such as standards for ISO 9000 and for product safety in the HACCP system. GMP's and SOP's are not clearly separated as one may overlap the other. GMP's are usually referred to as practices and procedures performed by a food processor which can affect the safety of the meat or food product. GMP's may refer to the people, equipment, process and the environment in the production process. SOP's may be thought of as one person's job or one task that is performed in the production process.

HACCP

Implementing Hazard Analysis and Critical Control Point (HACCP) is crucial for any food manufacturing process. A HACCP plan covers the total supply chain, from inbound logistics, through storage, processing, sanitation and maintenance to the final use by the consumer. Across the operations, it must be ensured that procedures are available for internal logistics, processing specifications, working instructions, hygiene procedures and preventive maintenance plans. These procedures must cover start-ups, shutdown and unexpected stoppages during processing. The HACCP is essential to carry out to identify the weakness of the production line and to suggest critical limits in compliance with legislation and therefore the preventive and corrective measures.

Though HACCP system was designed to aim zero defect products, yet it is not feasible to achieve 100% defect free products. However, it sets a goal to minimize the associated risks during production and subsequently reduce unacceptable unsafe products. During implementation of HACCP, it is imperative to set controls at each point of the production line at which safety problems (physical, chemical and biological) are likely to occur.

Food Safety Management System

Food Safety Management System (FSMS) are intended to provide organisations with systems and controls for their processes to achieve the best practice in food safety, minimize risk for the safety of their products and to maintain economic and business goals. The requirements for the development, implementation and maintenance of the FSMS are laid down in the standard ISO 22000 “Food Safety Management System's – Requirements for any organization in the food chain”. The ISO 22000: 2018 provides requirements for a FSMS to enable an organisation to establish, implement, operate, monitor, review, maintain and improve a documented FSMS within the context of the organisation's overall business risks. It is applicable to any organization within the food chain, regardless of size, from feed producers, primary producers through food manufacturer's, transport and storage operators and subcontractors to retail and food outlets. The standard may be applied to inter-related organisations such as producers of equipment, packaging material, cleaning agents, additives and ingredients manufacturers and also service providers.

The ISO 22000: 2018 is a FSMS which is internationally recognized and it brings together recognized food safety concepts (HACCP) to ensure food safety of the products or services of the organization in whichever sector of the food chain it is involved. The adoption of FSMS is a strategic decision for an organization that can help to improve its overall performance in food safety. The potential benefits to an organization of implementing a FSMS are:

- The ability to consistently provide safe foods and relevant products and services that meet customer and applicable statutory and regulatory requirements;
- Addressing food safety associated risks
- The ability to demonstrate conformity to specified FSMS requirements.

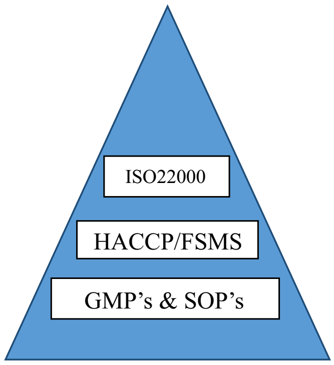
The ISO 22000: 2018 employs the process approach which incorporates the Plan-Do-Check-Act (PDCA) (cycle and risk based thinking). This process approach enables an organization to plan its processes and their interactions. An important prerequisite for ensuring food safety is that organisations in the food chain maintain the conditions for hygienic environment and production. ISO 22000 requires in clause 8.2 that organisations shall select and implement specific “prerequisite programmes” (PRPs) for these basic hygiene conditions. As mentioned in clause 8.2 of ISO 22000 on PRPs did not fulfil the GFSI's benchmarking requirements and therefore the technical specifications (ISO/TS 22002-1) were developed and are used in addition to ISO 22000 to provide an agreed set of requirements recognized globally.

Prerequisite Programs (PRP)

Procedures, including Good Manufacturing Practices (GMPs) that provide the basic environmental and operating conditions necessary to support the Food Safety Plan. It is the foundation of food safety management system, developed implemented and documented before implementing the HACCP system. Some of the PRP's in food sector are:

- Construction and layout of buildings
- Layout of premises and workspace
- Utilities-air, water, energy
- Waste disposal
- Equipment suitability, cleaning and maintenance
- Management of purchased materials
- Measures for prevention of cross contamination
- Cleaning and sanitizing
- Pest control
- Personal hygiene and employee facilities
- Rework

- Product recall procedures
- Warehousing
- Product information/consumer awareness
- Food defence, biovigilance and bioterrorism



Additional requirements

To meet the needs of the key stakeholders and to ensure an adequate control of food safety, specific requirements for the FSMS are included in FSSC scheme. These may be elaborations of the clauses in ISO 22000 and technical specifications for sector PRPs or additional requirements as outlined below:

- Management of services
- Product labelling
- Food defense
- Food fraud prevention
- Logo use
- Management of allergens
- Environmental monitoring
- Formulation of products
- Management of natural resources

Benefits of implementing FSMS

- Reduced food safety investigation time
- Reduced process training and new staff training
- Reduced litigation and legal fees
- Increase in commercial and public image
- Protection of assets
- Increased confidence with customers and other interested parties
- Improved profile and credibility
- Competitive advantage in the market place
- Employee pride and motivation
- Meets the future anticipated demands of customers

References

References can be made available upon request from the author.

(Lead 12)

Use of Smartphone for Rapid Monitoring of Muscle Food Safety

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Introduction

Mobile analysis is gaining attention in food sector, allowing rapid and on-site analysis. The aim is to bypass the expensive instrument, cost and time efficiency. Recently a Horizon Prize regarding the challenge of developing a rapid non-invasive food scanning device has been launched (Mandal and Biswas, 2019). This could have a huge effect on food analysis in both developed and developing countries, since mobile phone users spread globally (Ozcan, 2014). The current methods for ensuring food safety rely on costly laboratory-based examination of chemicals and/or food-borne pathogens. In remote areas, sending specimens to a laboratory can be difficult.

A new generation of mobile sensing approaches offers significant advantages over traditional platforms in terms of test speed, control, low cost, ease-of-operation, and data management, and requires minimal equipment and user involvement (Rateni et al., 2017). The marriage of novel sensing technologies with smartphones enables the development of powerful lab-on-smartphone for food safety analysis. These devices typically comprise multiple components such as detectors, sample processors, disposable chips, batteries and software, which are integrated with a commercial smartphone. One of the most important aspects of developing these systems is the integration of these components onto a compact and lightweight platform that requires minimal power. In recent years, many external sensor modules have been designed and integrated with smartphones for extracting more-sophisticated information. These portable, low-cost devices have the potential to run routine tests, which are currently performed by trained personnel using laboratory instrumentation, rapidly and on-site (Mandal, 2018).

Application Of Smartphone

Smartphone-based food analysis can be divided into two categories: lab-on-smartphone biosensors and smartphone optical and spectroscopy. An explanation is provided of the technique employed and the added value the integration of a smartphone in the loop provides to the approach.

Lab-On-Smartphone Biosensors

Biosensors are analytical devices that integrate abio-receptors with an appropriate transducing method to detect analytes of interest. The specific interaction between the target analyte and the receptor produces an output measurable signal, which highlights the presence of the sought element. Thus, this approach has high selectivity, since direct detection of the target analyte is achieved. However it always includes an invasive sample pre-treatment phase to give rise to transduction. Biosensors allow low-cost, and fast analysis, with results in a few minutes, and show perspectives for miniaturization and portability. Taking advantage of the combined use of smartphone and adapted biochemical assay, biosensor-based analytical systems are promising tools for on-site detection of analytes including contaminants, drugs, pesticide residues, and foodborne pathogens (Mandal, 2018).

Fluorescence Imaging Using Smartphone

Fluorescence imaging is the visualization of fluorescent dyes as labels for biological or chemical molecules of interest. It enables a wide range of experimental observations including the location of gene expression, protein expression and molecular interactions in cells and tissues. To label a biological molecule of interest, a fluorescent marker, which is able to bind the target molecule, has to be introduced. The setups found in the revised works, which perform fluorescence imaging, also include a mono-chromatic light source, typically a UV LED, to generate the dye excitation and a smartphone camera used as detector to collect and measure the fluorescence intensity. The presented systems, proposed for a specific detection application, have the advantage of being applicable to other targets of interest through the use of different specific molecular dyes (Zhu et al., 2012).

Smartphone-Based Colorimetric Readers

Colorimetric assay is widely used in biochemistry to test for the presence of several analytes interest, such as enzymes, antibodies, and peptides. It works by measuring the amount of light absorbed by a chromogenic reagent or a reaction product at a characteristic wavelength. This light absorbed by a chromogenic reagent or a reaction product at a characteristic wavelength is specific to the reagent being measured. The amount of absorbed light is proportional to the concentration of reagent present in the assay well. Different solutions must be made, including to the concentration of reagent present in the assay well. Different solutions must be made, including a a control solution for reference. In this section, the most used architecture is a smartphone camera control solution for reference. In this section, the most used architecture is a smartphone camera used used to detect the read-out from assay reactions to detect the read-out from assay reactions.

Finally, DuVall et al. (2015) presented a rapid detection of foodborne pathogens using a cell phone and custom-written app, in which the physical identification was made by pathogen DNA transduction, mediated by magnetic bead aggregation with pathogenic DNA fragments. The smart phone was used to acquire picture of the assay reaction and analyse the image to perform a qualitative Yes or No detection of pathogen presence. The proposed detection modality was fully portable for point-of-care detection of food-borne pathogens Escherichia coli O157:H7 and Salmonella enterica.

Smartphone-Based Electro-Analytical Platforms

Electroanalytical methods use electrodes to make electrical contact with the analyte solution, in conjunction with electric or electronic devices to which they are attached, to measure an electrical parameter of the solution. The measured parameter is related to the quantity of an analyte in solution. According to the electric parameters that are measured, electroanalytical methods include potentiometry, amperometry, conductometry, electrogravimetry, voltammetry and coulometry. The names of the methods reflect the measured electric property or its units. Electroanalytical methods are particularly interesting for the development of smartphone-based platforms for on-site food diagnostics, as they combine high-performance detection with great simplicity, low-cost, portability, autonomy, cable-free operation, and capacity to conduct in real-time the entire analytical measurement at remote places (Dou et al., 2016).

Smartphone Spectroscopy

The works reviewed in this section belong to the optical diagnostics macro-category. Unlike approach based on biosensors, in which it is necessary a reagent to trigger the transduction, in this case the analysis is performed in a non-invasive manner. In particular, spectroscopy has powerful tool in research and industrial applications. It is extensively and successfully used in applications including diagnostics, assessment of food quality, environmental sensing, analysis testing. This technique is intrinsically rapid and non-destructive Liang et al. (2014).

However, most spectrometer setups used in industrial or laboratory-based applications are expensive and bulky limiting them to controlled laboratory settings. Recently, due to advancements in electronics fabrication methods, more portable spectrometers have been realized. Technological progress has allowed the release of micro-spectrometers which take advantage of new micro-technologies such as micro-electromechanical systems (MEMS), micro-opto-electromechanical systems (MOEMS), mirror arrays, etc. These improvements reduce cost and size while allowing good performance high-volume manufacturability. Compared to lab-based instruments, miniaturized systems must become a black-box, providing expected results with high reliability and without intervention technicians specialized in spectroscopy measurements. The ultimate goal, in the future, is the integration of a spectrometer into a smart phone, taking advantage of the highly efficient processing abilities in the compact configuration, to offer spectroscopic information on the fly (Oh et al., 2016)

Emerging Market

Many start-ups that are proposing the use of mobile devices able to test the quality of food and to determine its constituents are emerging. These smart systems represent a mobile and miniaturized labs, optimized for the detection of a specific target, which are offered in combination with dedicated smartphone applications that provide friendly user interfaces for handling and displaying the test results, received through BLE (Bluetooth low energy) connection (Mandal, 2018)

Limitations

The proposed sensing strategies, which used a phone as the read-out tool (e.g., colorimetric fluorescence imaging), are optimized for the phone models used for carried out the analysis. Calibration of each phone necessary because there is significant variation in color between different phones, due to hardware differences. Indeed, cameras may have different spectral responsivities, lamps may have different spectral emittances, and digitizer elements may be different. Moreover, the above mentioned mentioned properties may change over time. Another point to be addressed when dealing with properties may change over time.

Another point to be addressed when dealing with pictures and pictures and colors is the image format. As smart phone cameras have become more and more powerful, the camera does its own processing to convert into a JPEG. The white balance and colour space are applied to the image by default. Drawback of this built-in processing is that it is clearly camera-dependent (Mandal and Biswas, 2019).

Sample preparation is still a bottleneck for the field of food mobile diagnostics, which aim is to bypass the use of expensive and bulky instrumentation-based tests, operated by trained personnel bypass the use of expensive and bulky instrumentation-based tests, operated by trained personnel. Sampling performed by non-expert user may lead to unwanted contamination, resulting in defiled measurements. For example, in colorimetric assay, if unwanted solutes in the sample buffers positively or negatively affect light absorbance, it results respectively in false positives or negatives.

Conclusions

In this paper, we have presented the recent developments in smart phone-based food diagnostics within the past 5 years. Results show that this novel field of research represents a promising area that has high scientific and commercial impact. In particular, advancements in biomedical science, chemistry, biotechnology, optics, and engineering have led to new diagnostic platforms which are more portable, economical and easier to use than conventional lab-based assays. Furthermore, the universal presence of mobile phones in our society makes it possible to leverage these devices for on-site testing. Nevertheless, these systems raise questions about use protocols and reliability of measurements. The repeatability of a measure, intrinsically guaranteed by a laboratory apparatus, becomes a delicate condition to be met in case of portable modules for on-site analysis.

References

References can be made available upon request from the author.

(Lead 13)

The One Health Perspective of Fighting Antimicrobial Resistance

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Antimicrobial resistance (AMR) is a global threat with far-reaching consequences on human and animal health, environment and economy. It has been estimated that AMR, if left unaddressed, could claim as many as 10 million lives annually by 2050 (O' Neill, 2016). With the emergence and spread of AMR, once-treatable infections are increasingly becoming dreadful, resulting in high mortality and additional healthcare costs. Considering the gravity of the situation, WHO has listed AMR as one of the top ten threats to human health in 2019. Though antibiotic resistance, to some extent, is a natural phenomenon, misuse and overuse of antibiotics can greatly escalate this process. The greater the consumption of antibiotics, the higher the chances that resistant bacterial subpopulation will emerge in the competition for survival of the fittest. AMR had long been regarded an issue of human health alone, but in recent years more attention has been paid to drivers of antimicrobial resistance in food animals, agriculture, aquaculture, environment etc. The interconnectedness between these sectors underpins the need for a 'one health' approach to tackle the issue of antimicrobial resistance. One health envisages multi-sectoral initiatives to design, implement and co-ordinate various activities to ensure better health for humans, animals and the environment. Antimicrobial resistance is perhaps the most important 'one health problem' the globe is facing. As far as important human and animal infections are concerned, drug resistance genes are widely disseminated in common pathogens such as *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus aureus*.

The role of antibiotic has now expanded from treating complicated infections to preventing infections in hospitalized or immunocompromised patients, and stimulating growth in food animals and poultry and preventing disease outbreaks in settings of aquaculture or livestock. The ever-increasing demand for animal proteins prompts farmers to opt for intensive farming where antibiotics are often used irrationally to optimize production. It is interesting to note that more antibiotics are used in animal agriculture as prophylactic measures or as growth promoters than are used in human medicine. There can be multiple ways by which antibiotic use in livestock impact human health: direct transmission of resistant bacteria from animals to humans, particularly in the context of occupational exposure; animal food to human transmission by consumption; and food-borne outbreaks of drug-resistant pathogens. Many cross-sectional studies have proved identical strains of drug-resistant bacteria in farm animals and animal handlers and/or family members. Transmission of *E. coli* strains carrying the potential carbapenemase gene New Delhi metallo beta-lactamase (NDM-5) between dogs and family members has been reported (Gronthal et al., 2018). Commensal *E. coli* is a major reservoir of extended- spectrum beta-lactamases (ESBL), which mediate resistance to 3rd generation cephalosporins, an important class of beta-lactam drugs. On account of its ability to colonize guts of humans and animals alike, *E. coli* can easily get transmitted through contaminated food and can promote dissemination of resistance genes. Moreover, the fact that the major ESBL-gene families such as $bla_{CTX\text{-}M}$, bla_{SHV} and bla_{CMY} reside on mobile genetic elements (MGEs) such as plasmids and transposons, their spread to susceptible population or other pathogenic bacteria is way easier. Studies based on whole genome analyses have identified in animal isolates, the presence of important $bla_{CTX\text{-}M}$ variants which are usually implicated in the spread of CTX-M gene among human clinical isolates (Cormier et al., 2019). This suggests the possible clonal or horizontal spread of *bla*-genes between different settings. Global dissemination of $bla_{CTX\text{-}M}$ can be attributed in large part to many 'epidemic plasmids' (identical plasmids found in genetically diverse strains of bacteria) harboring this gene. Since CTX-M enzymes were originated from the rhizosphere bacterium Kluyvera, environmental sources are believed to play an important role in the dissemination of $bla_{CTX\text{-}M}$. ESBLs have been reported from a wide variety of environments such as sewage, fresh water, marine environments, farms etc. Poor sanitation and contamination of drinking water resources in low and middle income countries greatly accelerates the cycling of CTX-M-carrying *E. coli* between humans and environment. This is exemplified by the significant upsurge in the community-carriage of ESBL in developing countries in the Asia-Pacific region (Chen et al., 2011). A recent study by Hedman et al., 2019 showed high prevalence of CTX-M in *E. coli* isolates from chicken in small-scale poultry farms in a rural setting and also in children living on the farms. The study site had historically low prevalence of resistance to 3^{rd} generation cephalosporins. CTX-M mediated resistance was observed in bacteria both in the commercially-bred chicken which were exposed to high doses of antibiotics and in free-grazing birds with no direct exposure to antibiotics. Moreover, the chicken and human isolates showed identical bla_{CTX-M}sequence, pointing towards a spillover event. The study highlights the complex dynamics of AMR transmission between humans and animals sharing the same environment and also the role of small-scale meat production activities in the selection and spread of resistance genes in underdeveloped settings. Widespread occurrence of ESBL has prompted in extensive use of colistin, a former antibiotic employed in veterinary medicine in clinical practice. This has now resulted in the emergence of the *mcr-1* gene (mobilized colistin resistance) in various human and animal settings, challenging this 'last drug of resort' in the treatment of serious gram-negative infections.

As far as ESBLs and carbapenemase are concerned, another important pathogen of interest is *K. pneumoniae.* Important carbapenem resistance genes such as KPC, OXA-48 and NDM-1 and the quinolone resistance genes *qnrA* and *qnrB* were first discovered in *K. pneumoniae.* More than 400 aquired resistance genes have been identified in the *K. pneumoniae*, suggesting the high plasticity of the genome. In what concerns ecological niche of this pathogen, many studies have shown that isolates of human, animal or environmental origin do not represent discrete subpopulations. For example, clinically relevant sequence types such as ST15, ST23, and ST25. have been isolated from non-human sources also. This flexibility facilitates the strains to move between various niches and provides opportunity for genetic exchange with a wide variety of bacterial species (Wyres et al., 2018). On account of its broader ecological niche and high burden of plasmids, *K. pneumoniae* serves as a major transmitter of resistance from environment to various human or animal pathogens.

As in human, livestock or agriculture, aquaculture is an important sector where indiscriminate use of antibiotics is believed to have happened over the years. The situation in aquaculture is more complex compared to terrestrial ecosystems owing to many reasons. There are large numbers of species being cultured (including shrimp, finfish, crustaceans, molluscs, aquatic plants, amphibians etc.). Aquatic environments receive effluents containing antibiotic residues and/or resistance pathogens from various settings such as hospitals, industries, agricultural feed, animal farms etc. Thus, detection of AMR pathogens in aquaculture need not always have direct link with the imprudent use of antibiotics in this sector alone. However, a wide range of clinically relevant antibiotics are used in aquaculture, especially in intensive shrimp farm settings and hatcheries where management of hygiene is crucial and disease outbreak is a major issue. Apart from affecting the target pathogen, application of antibiotics results in selection of AMR strains in many environmental bacteria entailing a risk of transmitting the trait to pathogenic human bacteria. This has been demonstrated in a study from Chile where quinolone-resistant aquatic bacteria became more prevalent in a Salmon farming area with a history of heavy usage of quinolones. Later, quinolone-resistant *E. coli* were isolated from cases of urinary tract infections in people in the surrounding region, clearly indicating events of horizontal gene transfer in the shared environment (Quinones et al., 2019). The issue of AMR in aquaculture is becoming rampant in low and middle income countries on account of poor farming practices, high disease burden, limited access of the farmer for proper diagnostics and absence of regulations on the use of antibiotics in this sector.

As far as AMR is concerned, *Staphylococcus aureus* is perhaps the best example of a pathogen that has evolved spectacularly in the post antibiotic era and acquired resistance to virtually all drugs available in clinical practice. In particular, methicillin resistance has gained much attention in scientific and public arena. Methicillin-resistant *Staphylococcus aureus* is an established pathogen in both healthcare and community settings. In addition to being a human pathogen, MRSA has gained much attention in recent years as an important source of infection in livestock, especially in pigs, poultry, cows etc. Animal reservoirs of MRSA pose a hidden threat to public health since many lineages of LA-MRSA are successful colonizers of humans too (Butaye et al., 2016). Though the transmission and persistence of LA-MRSA among humans is still a subject of debate, human infections/carriage by LA-MRSA clones have been reported in people with occupational contact (farmers, raw-meat handlers etc.) to animals and also in individuals who lacked exposure to livestock (Benito et al., 2014).Geographical distribution of LA-MRSA is diverse with clonal complex (CC) 398 accounting for the majority of LA-MRSA infections in European countries and CC9 being the most prevalent clone in Asian countries.CC398 is basically a human-associated lineage of methicillin susceptible *S. aureus* (MSSA) which later exhibited a host jump and emerged as MRSA in livestock (Price et al., 2012). Indiscriminate use of antibiotics in animal agriculture is a major driver of resistance. As far as India is concerened, no regulatory provisions exist for the use of antibiotics in livestock sector, except for certain restrictions on antibiotic use in export meat and poultry products (Laxminarayanan and Chaudhary, 2016).The prevalence and epidemiology of LA-MRSA in India and its impact on public health is largely unknown. Considering the poor healthcare and socio-economic background of people from farming sector, there is a potential risk involved in the transmission of LA-MRSA to larger sections of the community and also to nosocomial settings. Impact of LA-MRSA on public health is a relatively new challenge and has not been given its due importance.

Combating AMR in every sector requires an equal and complementary effort from other sectors owing to the multifactorial and complex nature of the transmission of resistance. Reducing antibiotic selection pressure is of prime importance to disrupt the transmission cycle. This can be achieved only by reducing the need for antibiotics through better sanitation, improved water quality, immunization, nation-wide surveillances, easy access to rapid diagnostics, superior farming practices etc. Another effective strategy would be to create awareness among public through massive campaigns on the misuse of antibiotics. More importantly, a strong political commitment to bring in legislations, draft policies and to channel more funding to research related to AMR is warranted.

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(Lead 14)

Bioactive Peptides: A New Vista for Neutraceuticals

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Nutraceuticals are chemicals found as natural components of foods or other ingestible forms that have been determined to be beneficial to the human body in preventing or treating one or more diseases or improving physiological performance. Thus, recent development in the field of proteomics has conferred new range of nutraceuticals in the form of bioactive peptides which can provide solution to the abovementioned major health problems. Bioactive peptides are basically protein fragments consisting of 2-20 amino acid residues; with various biological activities including antioxidant, antimicrobial, antihypertensive, immunodulatory, anticarcinogenic, anticoagulant effect. These peptides also ply an essential role in the enhancement of mineral absorption & prove to the beneficial in the field of nutraceuticals & therapeutics too.Peptides within the sequence of their parent proteins are usually inactive, but can be liberated during enzymatic digestion or fermentation. Applying enzymes to modify protein is an efficient way to recover potential bioactive peptides. Once bioactive peptides are liberated they act as regulatory compounds with hormone like activity. Bioactive peptides are considered the new generation of biologically active regulators that not only prevent the mechanism of oxidation and microbial degradation in foods but also enhanced the treatment of various diseases and disorders, thus increasing quality of life.

Livestock products (milk, meat and eggs) are important component in human diet due to its known nutritive value. These are a rich source of proteins, conjugated linoleic acid, antioxidants, vitamins such as riboflavin, niacin, vitamin B_6, pantothenic and folic acid and numbers of minerals including iron, zinc, selenium and phosphorus.The proteins of animal productsis of high quality and contain all the essential amino acids and high biological value. These high quality proteins are a source of multifunctional bioactive peptides.

Peptides from different animal sources

Blood: Blood disposal is a severe problem for meat processors, serum albumin, and the main blood protein has received little attention. Blood is a valuable source of proteins (circa 20%) and represents a promising source of BP. Peptides derived from animal proteins have been attributed to different health effects. In our laboratory, Goat and Pig Serum albumin were hydrolyzed using different concentrations of alkaline phosphatases and trypsin. The peptide sequences in the hydrolysates presented the following activities: angiotensin-converting enzyme (ACE) inhibition (antihypertensive activity), DPP-IV inhibition (glucose regulation), and antioxidant.

Meat Industry Byproducts: Bioactive peptides isolated from meat products have the potential for incorporation into functional foods and nutraceuticals. However, a limited number of food products containing meat derived bioactive peptide are commercially available. Verma et al., 2018observed that bioactive peptide derived from meat shown to exhibit anti hypertensive effects in vivo, along with antioxidant capabilities and other bioactivities such as antimicrobial and anti-proliferative activities in vitro. Pork meat constitutes a source of bioactive compounds that could be utilized in functional foods or nutraceuticals.

Methods of Extraction: Various methods have been employed for the extraction of bioactive peptides from animal proteins and enzymatic hydrolysis of protein is the most widely used technique. The acid hydrolysis of proteins is economical, relatively simple to perform, but at the same time difficult to control and can damage certain amino acids. Methods based on enzymatic hydrolysis have an advantage because they are more predictable with respect to the end products, and the process conditions can be controlled. Microbial fermentation process is another method for the isolation of bioactive peptides from milk proteins. Ultrafiltration membrane system is used to fractionate hydrolysates based on peptide size. For the same purpose, ion exchange, gel filtration technologies, liquid chromatography (HPLC), reversed-phase liquid chromatography (RP-HPLC), and gel permeation chromatography could be used. Individual peptide fractions are identified using the combined techniques of mass spectrometry and protein sequencing.

On, hydrolytic digestion by pepsin, trypsin, chymotrypsin & pancreatin, active fragments are liberated from the degradable protein substrates. Being active compound these peptides interact with preferred transporter agent based on affinity parameter such as size, stereochemical structure, functional groups and charges. The bio peptides are produced, isolated, purified & then characterized

The peptides are isolated from natural food sources and purified by Reverse phase chromatography, Ion exchange chromatography, Exclusion liquid chromatography, Affinity chromatography and Capillary electrophoresis.

Health Benefits of Bioactive Peptides :

Cardiovascular System	Nervous System	Immune System	Gastrointestinal System
Antithrombotic Activity Antioxidative Activity Antihypertensive Activity Antihyperlipidemic	Opioid Agonist Opioid Antagonist	Immunomodulatory Antimicrobial Cytomodulatory	Antimicrobial Mineral Binding Anti-Appetizing

Method of Use of bioactive peptides

The developed and identified biopeptides need to be incorporated in the diet system. It is incorporated either as suspended, dispersed or encapsulated into different from like that of Emulsion, Liposomes, Neutraceuticals, Edible Biolymers

The methods of incorporation help them to achieve the optimum functionality, bioavailability, stability, target effectiveness and strategies help to protect the bio functionality during transportation from the enterocyte domain (stomach and small intestine) into the portal circulation (blood domain) from any kind of denaturation.

Commercial applications of bioactive peptides

Bioactive peptides have attracted increasing interest as prominent candidates for various health-promoting functional foods. At present, milk proteins are the best known source of such ingredients but until recently the commercial production of milk derived bioactive peptides has been limited by a lack of suitable large-scale technologies. Membrane separation techniques seem to provide the best technology available for the enrichment of peptides with a specific molecular weight range. Nanofiltration and ultrafiltration techniques are now employed industrially to produce ingredients which contain specific bioactive peptides based on casein or whey protein hydrolysates. Such preparations are commercially available and are being introduced into different consumer products, such as dairy and fruitbased drinks, confectionery, chewing gum, pastilles and capsules. Currently marketed products contain peptides with anticariogenic, antihypertensive, mineral-binding, stress relieving and satiety inducing properties.

Challenges to commercialization

Complications in methodology for quality assurance: Compared to synthetic small-molecule drugs, which are single identifiable entities, in most cases, the target end product for bioactive peptides derived from food is not usually a single peptide with 99% purity not only due to the unacceptable high cost and low yield that would be involved, but also because products containing only single peptide entities would ignore any additive, synergistic or antagonistic effects among peptides. Moreover, peptides possessing bioactivity are often hydrophobic in nature and exhibit poor aqueous solubility at high concentrations. Formulating products with several peptides each at lower concentration can ameliorate the solubility problem while conferring the same level of bioactivity. Thus, the minimum level of information for quality assurance should include not only verification of specific peptide sequences in the complex matrix that are associated with the activity but also the bioactivity of peptide mixtures under standard conditions

Sparse data on bioavailability and metabolic fate: Most studies on food-derived bioactive sequences paying little attention to the susceptibility of the peptides to degradation by gastric, pancreatic and small intestinal brush border membrane enzymes, and the likelihood that only nano-molar or even pico-molar concentrations of the original peptide may pass into the systemic circulation. The majority of therapeutic peptides exert their bioactivity via the systemic circulation. Therefore, information on in vivo stability, availability and accessibility of identified bioactive peptide sequences as well as their absorption, distribution, metabolism and excretion is critical.

Inadequate clinical evidence of bio-efficacy: To date, ACE-inhibitory and/or antihypertensive peptides are probably the most intensively studied class of bioactive peptides derived from food. Despite this vast body of literature, the European Food Safety Authority (EFSA) has rejected health claims proposedfor bonito protein peptide, the C12-peptide (FFVAPFPDVFGK), as well as the milk tri-peptides IPP and VPP, citing inadequate human studies and/ or 'major methodological limitations' in the reported studies, and a lack of convincing evidence for the mechanism responsible for the claimed effect at the proposed dose.

The bitter taste of peptides: The taste of peptides is seldom one of the most relevant issues when one considers the many important biological functions of this class of peptides. Unfortunately, protein hydrolysates and peptides are notorious in exhibiting bitterness, necessitating suitable formulation of the bitter peptides with other ingredients such as cocoa powder and aspartame or fructose, pectin, natural and artificial flavors and colors. There is currently a dearth of information on the taste attributes of bioactive protein hydrolysates or peptides. Research applying sensomics mapping, instrumental taste sensing or cell-based systems to the study of bioactive peptides could accelerate the acquisition of important knowledge in this field.

Future outlook:

Novel technologies, such as chromatographic and membrane separation techniques seem to be appropriate means to enrich active peptide fractions from the hydrolysates of various food proteins. Production of bioactive peptides from protein-rich raw materials may be scaled up to industrial level using controlled fermentation in bioreactors with known LAB. Recombined enzyme technology and specific production strains or peptidases isolated from suitable microorganisms are likely to be employed industrially in the future. In addition to enzymatic hydrolysis, microbial fermentation provides a natural technology applicable for the production of bioactive peptides either from animal or plant proteins. The stability of chemical structures and biological activity of peptides in different food matrices and subsequent fate during the digestion process are to be taken into account in formulation of products containing bioactive peptides. Again, new emerging technologies, such as micro and nano-encapsulation may offer feasible solutions for improving stability of peptides in various food products and during digestion. Molecular studies are needed to assess the mechanisms by which bioactive peptides exert their activities. For this approach, it is necessary to employ new nutrigenomics techniques, for example proteomics and metabolomics.

Conclusions:

Being unique in their characteristic and due to their biophysical and biochemical properties these bioactive peptides are valued a lot among the potential ingredients which regulate oxidative stress and food intake, reduce the risk of diseases in living organism. Although, there is still a small number of studies, especially *in vivo* studies, which should be conducted in order to confirm safety and beneficial effects of bioactive peptides, scientific, technological and consumer interest for these peptides and their potential use in controlling and promoting health increases, and results remains to be seen. The important step for new bioactive products is in providing consumers with accurate, not misleading information about the health benefits of these products. The vast potential for such product will not be achieved without extensive scientific research to ensure the safety and efficacy.

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(Lead 15)

Systems of Food Preservation: A paradigm Shift Towards Natural Preservatives for Enhancing Safety and Quality Assurance of Meat and Meat Products.

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Introduction:

The importance of food for Homo sapiens is indisputable; there is still no way of living without eating food, therefore, this commodity is of utmost importance for the well-being of everybody across the world. Although the need to feed has maintained itself binding across the ages, the way the global populace consume produce has seen profound changes. From the local gatherers in the stone age to the domestications of animals and vegetables, there was a huge leap, surpassed by the commercial trading of spices and other goods in the fifteenth century. Today, globally the food is produced in specific facilities and then transported to markets within the same country or even in far-away nations. Supplying food in hygienic conditions from the production site to the consumer requires a great consignment of energy, either by refrigeration, controlled packaging or the use of additives to avoid spoilage and reduce food alteration. While cooking, sun drying, fermentation preservative methods were in use during prehistoric period, salting and curing (3600BC), smoking (3500BC), refrigeration(1784A.D),Canning(1809AD), pasteurization (1871AD),Vacuum packing (1945AD), chemical preservation (1950+AD) had been well-documented, though there was no organized form of food preservation system before 4000 BC. In a competitive global market, the least expensive method of food preservation is through food additives over the other options. Besides, food preservatives /additives are indispensable to facilitate the meat industry to make food meets the increasingly challenging market and legal demands.

In the 80's food additives were considered dangerous to be consumed due to the generalized scares hence colorants were removed from processed food. Since then, the relation between additive and consumer has improved, although some mistrust still lingers. Today, some authors report health issues on the consumption of food additives, even though the authorities periodically review the data supporting the safety and corresponding acceptable daily intake (ADI).The most widely used antimicrobials are benzoates, sorbates, propionates, nitrites and parabens. But some potential dangerous effects towards health are still found on account of use of them. Sodium benzoate, although regarded as safe, has yet to prove that it is not hazardous on long term exposure. Depending on the dose used, sodium sorbate proves to be genotoxic on in vitro blood lymphocytes; parabens have been proved to induce migratory and invasive activity in human breast cancer cells in vitro, while their dermic exposure has been overlooked, proving that this type of exposure can be added to the oral exposure, therefore increasing the overall intake. Some studies describe sorbates as genotoxic and mutagenic, while others refer to this not being relevant. While sodium sorbate is not allowed in the US, but legal to be used in food. Nitrates (E240-E259) and nitrites (E249-E250) are other antimicrobials that are used in foodstuffs,been restricted within the EU, and can now only be added to meat for slow curing. Nitrites are used in meat for color formation, flavor enhancement and antimicrobial activity, being the only food additive to inhibit the botulinum toxin, can take part in the formation of nitrosamines, cause carcinogenic effects in humans besides oxidation of oxyhemoglobin to ferrihemoglobin. Sulphites or sulphiting agents are used in food are known to have cytotoxic and carcinogenic effects in rats and humans. The synthetic antioxidants, butylated hydroxyanisole, butylated hydroxytoluene, ethoxyquin, tert-butylhydroquinone and propyl gallate are known to cause toxicity and carcinogenic effects. Colorings like indigocarmine are found to be dangerous by producing superoxide dismutase during metabolisation in mice (doses between 1 mM and 100 mM). Safflower yellow and Kokum red shown to have clastogenic effects in mice bone marrow. Tartrazine, a widespread food colorant has been linked to irritability, restlessness and sleep disturbance in children. Nuclear radiation when used for food preservation may cause changes in food color or texture.Ingeneral, infants and children are more vulnerable to chemicals such as Bisphenols and Phthalates which cause endocrine disruption, obesogenic activity, neurodevelopmental disruption. Exposure to Perfluroalkyl chemicals (PFCs) and perchlorate cause oxidative stress, cardiotoxicity, immunosuppressant, endocrine disruption, decreased birth weight and Thyroid hormone disruption.

Major Food Preservation Methods /Techniques:

Based on the mode of action, the major food preservation techniques can be categorized as (1) slowing down or inhibiting chemical deterioration and microbial growth, (2) directly inactivating bacteria, yeasts, molds, or enzymes, and (3) avoiding recontamination before and after processing [8,9]. A number of techniques or methods from the above categories are shown in Figure 1.3. While the currently used traditional preservation procedures continue in one or more of these three ways, there have recently been great efforts to improve the quality of food products principally to meet the requirements of consumers through the avoidance of extreme use of any single technique.

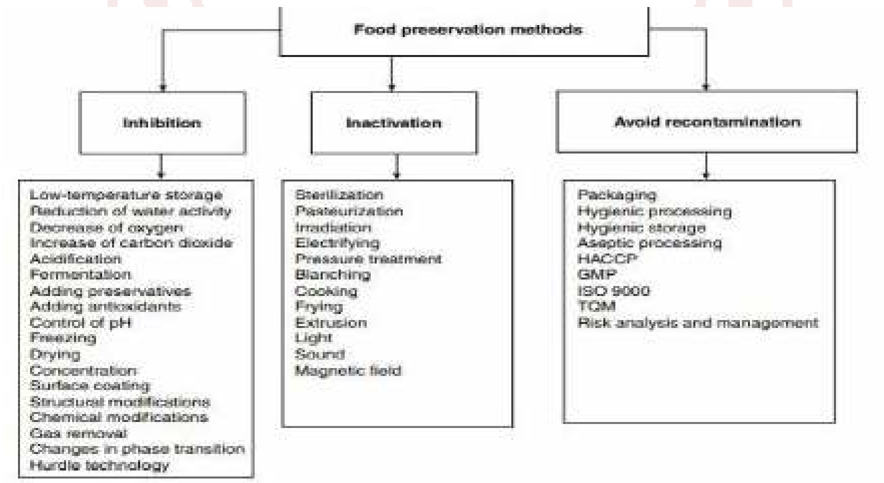

FIGURE 1.3 Major food preservation techniques. (From Gould, G. W. 1989. In: *Mechanisms of Action of Food Preservation Procedures*. Gould, G. W., Ed. Elsevier Applied Science, London; Gould, G. W. 1995. In: *New Methods of Food Preservation*. Gould, G. W., Ed. Blackie Academic and Professional, Glasgow.)

The traditional preservation methods/ techniques include control of pH; control of water activity; developments in conventional heat treatment; combination of heat treatment, control of water activity and pressure to preserve food; combination of traditional and new preservation techniques to control pathogens and developments in freezing whereas the emerging food preservation technologies include 1. High Pressure Processing (HPP), 2. Pulsed Electric Field), 3.

Ultrasonic Food Processing, 4. Ohmic Heating of Foods, 5. Intense Pulse Light, 6. Plasma Light, 7. Oscillating Magnetic Fields (OMF). The combination of novel methods of food preservation include common Hurdle Technology with more than 60 potential hurdles for food. Biotechnology in preservation includes (a) Biopreservation (b) Antimicrobial metaboloites of Lactic Acid Bacteria (c) Organic Acids (d) H2O2 (e) Cabon Dioxide (f) Reuterin (g) Bacteriocins (h) Fermentates of selected organisms (i) Biopreservation by protective lactic cultures

For some decades now, natural food additives/preservatives have been gaining more interest from the public and food manufacturers. In general, the public will choose a food with no additives, but if these are not available, the same consumer will chose a food containing natural additives or no additives over synthetic ones and there has been a trend towards natural e-numbers and clean label food products because for them natural is the same as safe.

Consumer studies have shown that consumers have recently become more informed about food additives and they always tend to choose the additives of natural origin than their synthetic analogues. However, there is no definition of natural additives or preservatives, antioxidants, colors or sweeteners but only natural flavorings have legislation both in the EU and the USA, and this is then transposed to the other classes of additives, leading to wrong interpretations and the confusion of what is natural or synthetic. There is a growing need for transparent legislation regarding the natural additives, as they are of growing interest in developed countries; now in developing countries like India too.

There are no defined categories for natural additives; in the EU, they are incorporated into the same "E" classification as all the other counterparts (Council Regulation (EC) 1129/2011) and the most researched natural additives are antioxidants, antimicrobials, colorings, and sweeteners.

Nanoencapsulation-based natural preservative system for food preservation:

Trend towards nanoencpasulated natural preservatives have been in use for meat products safety and quality assurance globally. Encapsulated acidulants are in use in United States of America and it's use is increasing in Europe. Lack of binding and discoloration can be overcome by encapsulation of natural preservatives. Control of emerging pathogens can be controlled by encapsulation of natural preservatives for meat products also. This nanoencapsulation technology is widely used because of availability of equipment, feasibility of large scale production of desired products, simple continuous operation, ease of manipulation and low process cost. Oil in water nano emulsion has gained widespread application for foods of various kinds. These materials are used as carriers of lipophilic and amphiphilic antimicrobial agents improving their dispersion and sustained concentration of entrapped natural preservatives. Oregano essential oil nano emulsions at 0.1% reduced the growth of *Salmonella Typhimurium*, *L. monocytogenes, E.Coli* 0157:H7 over 3 logs per gram for fresh lettuce at refrigeration temperature for 72 hrs. Cinnamaldehyde nanoemulsions at 0.8% used to inhibit the growth of *S. aureus*, *Salmonella typhimurium* in water melon juice. A d-limonene and Nisin based nanoemulsions used in chicken broth, tryptic soya broth and vegetable cream reduced *L. monocytogenes* up to 3 logs per gram. Insitu nanoemulsions of biopolymer based edible coating has been effectively used to place antimicrobial agents on the surface of the solid foods which not only improve adhesion but also increases potential synergies between incorporated nanoemulsions and coated solid products reducing the deterioration.

Natural antioxidants

These are used in food to prevent off-flavors by oxidation of fats, halting their per oxidation in the initiation or propagation phases, which are of 5 types; the primary antioxidants known as radical scavengers or chain breaking antioxidants; chelators, that bind to metals and prevent them from initiating radical formation; quenchers, which deactivate high-energy oxidant species; oxygen scavengers, that remove oxygen from systems, avoiding their destabilization; and the antioxidant regenerators, that regenerate other antioxidants when these become radicalized. The antioxidants are used in meats, oils, fried foods, dressings, dairy products, baked goods and extruded snacks. Polyphenols have strong antioxidant capacity against cancer, osteoporosis, cataracts, cardiovascular dysfunctions, brain diseases, and immunological conditions. All the classes of polyphenols (phenolic acids-hydroxybenzoic or hydroxycinnamic acids, flavonoids including anthocyanins, tannins, lignans, stilbenes, and coumarins) can be added as plant extracts, taking advantage of the synergistic effects between compounds, or by further purification to individual molecules, adding the most bioactive ones to the foodstuff. Polyphenolic extracts like rosemary and other extracts used as a food additive in the Council Regulation (EC) 1129/2011, with the E number 392. Although the synergistic effect between the compounds are important for the extracts antioxidant activity, some industries seek specific molecules to carry out these effects. Carnosic acid, a hydroxybenzoic acid derivative, is a known constituent of rosemary extract and is believed to have the most important antioxidant effect in it. It is used in oils, animal fats, sauces, bakery wares, meat patties (between 22.5 and 130 ppm for the meat patties) and fish, among others. Ferulic acid, a hydroxycinnamic acid, is also used in the food industry as an antioxidant and a precursor of other preservatives, as well as taking part in food gels and edible. Catechin, a widely known flavon-3-ol, is also known for its antioxidant activity. It can be directly added to food, joined with other natural substances and even encapsulated to promote and extend its effects. Ascorbic acid, also known as vitamin C, is a high oxygen scavenger used in various foodstuffs, regenerates phenolic oxidants and tocopherols that have suffered oxidation, due to its higher oxidation potential, as explained in Fig. 2.

Ascorbic acid (E-300) is particularly important to stabilize lipids and oils, but can be used in other matrices. As per the EFSA there is no risk in its consumption, not defining an ADI. Carotenoids are also known for their antioxidant potential as food additives, although their use is always limited by being very susceptibility to oxidation by light. Lycopene (E-160d) is the most abundant carotenoid, being found mainly in tomatoes, although it is not widely used as a food antioxidant. On the other hand, b-carotene is used in baked goods, eggs, and dairy products, among others, as a singlet oxygen quencher. In many foodstuffs that use carotenes, ascorbic acid or vitamin E (tocopherols) are used to benefit from synergies. Carotene mixes and b-carotene have been reviewed by the EFSA's scientific panel and ruled out any toxicity arising from its consumption, whether from synthetic provenance or extraction from plants and fruits.

Tocopherols, which are the building blocks of vitamin E, are also known as very strong antioxidants. They can act isolated or in synergy with ascorbic acid, by regenerating it. Apart from this, their main antioxidant function is by terminating free radicals in autoxidation reactions. In some cases tocopherols are used in films and coatings, although they can be used as an additive as well (E-306 to E-309). Tocopheral compounds have been used in bacon (300 mg/kg), meats, dairy products and oils, among others.

Natural antimicrobials

Natural antimicrobials are very important for food processing which guarantee the food safety; these are derived from microorganisms, animals and plants, should have a broad spectrum action, heat stable, unaffected by pH, impart no flavor or color, have no toxicity, easily assayable, have no pharmaceutical application, not susceptible to resistance from contaminants, label friendly, cost effective.

Antimicrobials derived from microorganisms are bacteriocins; to date, there are about 300 bacteriocins, some of them having the potential to inhibit the growth of other proteins. The first class 1 bacteriocins contains lanthionine, the second class is non-containing and the third are non-bacteriocins lytic proteins. The main limitation of bacteriocins is the limited microbial species that are affected by them, which tend to be species very closely related to each other.

Nisin

Nisin, one of the most used bacteriocins, has a broad spectrum of action in terms of the species it is able to inhibit. It is used both as a food additive (E-234) and as a constituent of coatings and films. It is applied to dairy products (from 100 to 4000 IU/mL), beverages, eggs, meat (from 400 to 1000 IU/mL), among others. It has synergistic action with other bacteriocins.

Pediocin

It is used as an antimicrobial against *Listeria* species. It can be used as a film to coat sliced ham, and dairy products. These two proteins, nisin and pediocin, are commercially used bacteriocins, although others like sakacin, which is rather a group of bacteriocins, are used in cooked ham and cold cuts (from 12 to 35 mg g1). The application of bacteriocins has been gaining interest in the food industries due to their natural origin and the benefits that can be achieved with their incorporation into foodstuffs, although pediocin and sakacin are not considered a food additive in the EU. Natamycin is also a widely used natural preservative, is a polyene macrolide with antifungal activity, active against yeasts and moulds and virtually without effect on bacteria, protozoa and viruses. It has been used in a variety of foodstuffs, both as a free additive (E-235), encapsulated and as a constituent of films. It has been used to control the growth of yeasts in cheese (from 2.31 to 9.25 mg/dm2 film, as a constituent of chitosan based films in Saloio cheese (from 0.0625 to 2 mg mL1).Besides, beverages are also included in the application of this macrolide.

Natamycin as a food additive has very poor absorption in the human body and has no risk in its use. Reuterin is an antimicrobial compound produced by the Gram positive lactic bacteria, effective against *Listeria* species. Reuterin has application in food by adding the Lactobacillus into the foodstuff as starter cultures with glycerol, in cheese, sausages and cold-smoked salmon in cottage cheese.

Poly-L-Lysine is a homopolimer of the amino-acid lysin that has a GRAS status is allowed as a natural food additive in Japan, where it is used in staple foods for many years. Large amounts may confer a bitter taste to food, but due to its high antimicrobial effect, very low quantities are required. It has synergistic effects with other natural antimicrobials .

Lysozyme

Lysozyme, is an antimicrobial derived from eggs used in US and the EU (E-1105). This enzyme's antimicrobial activity relies on the hydrolysis of the b-1,4 linkage site of the peptidoglycan in the bacterial walls, therefore yielding very high activity against Gram negative bacteria (which is constituted of 90% of peptidoglycan) and moderately effective against Gram positive bacteria (with much less peptidoglycan), but with no action against yeasts or fungi. The main commercial use of this natural biocide is in the cheese industry, where it is added to avoid “late blowing” of cheese, although studies have been carried out in eggs, milk (2 mg/mL in 25 mL milk) and beef (200 mg/90 mg beef). Lysozyme has also been assayed to take part in biofilms and edible coatings while synergistic effects with other natural antimicrobials.

Another natural antimicrobial compound is the enzyme lactoperoxidase, which belong to the peroxidase-cyclooxygenase superfamily, abundant in bovine milk. The antioxidant activity is carried out through the lactoperoxidase system, consisting of lactoperoxidase, thiocyanate and hydrogen peroxide. The antimicrobial activity relies on the oxidation of thiocyanate, in which the intermediate compounds formed have antimicrobial activity. The main use of lactoperoxidase is to maintain raw milk, especially in places where refrigeration is not readily available. By adding thiocyanate to the milk, the lactoperoxidase system will start, displaying its antimicrobial activity. This addition is necessary, due to amount of thiocyanate present in the milk not being enough to trigger the antimicrobial activity. Newer applications have been suggested for this enzyme, such as preservation of fruit juices, and also as coating of foodstuffs. Lactoferrin, a GRAS, iron binding glycoprotein abundant in milk displays antimicrobial activity. It is potentially a molecule that can be used to control microbes in food, it is used in baby formulas and as a spray on meat to prevent contamination.

Antimicrobials derived from plants are usually compounds belonging to their secondary metabolism, that confer protection from predators, code for signalling molecules and help the plant resist stress. Examples are terpenes, steroids, alkaloids and polyphenols. The polyphenols group encompasses various classes of molecules, and although they are attributed to have many biological effects on health, there are only few reports of some polyphenols with application in coatings and films showing antimicrobial. Another very important group of molecules with antimicrobial activity are the essential oils derive from the mevalonate, methyl-erithrytol and the shikimic pathways, out of the 300 known essential oils of different plants of which oregano oil, thymol, carvacrol, clove oil, cinnamon oil and clove oil have GRAS status in US, which are applied in meat, fish, dairy products, vegetables, rice and fruit and also impregnated with carvacrol and thymol.

Natural colorants

Natural colorants are used in food to make it feel more appealing and appetising, used to enhance existing colors that can be lost either during the manufacture or over the shelf life, or even to attribute new colours to it. Food colors are classified into three groups; natural food colorants, which refer to ones that are synthesized naturally; nature-identical colorants, which although synthesized in industries, imitate the natural ones and finally the artificial/synthetic colorants. Other colorants include annatto, is extracted from the *Bixa Orellana* L. tree, with the E number E160b. The main constituents of the annatto mixture are the carotenoids bixin and norbixin, which display a yellow to orange coloration is used in cakes (from 250 to 1000 mg/kg of dough), biscuits, rice, dairy products, flour, fish, soft drinks, snacks and meat products. Paprika is mixture of two carotenoids, capsanthin and capsorubin, approved in the EU (E160c) and displays an orange to red color.Other carotenoids used in food are bcarotene, lutein, violaxanthin, neoxanthin, b-cryptoxanthin, fucoxanthin,lycopene and astaxanthin extracted from plants, algae, insects used in sauces, marinades, spice blends, coatings, beverages, milk, among others.

Anthocyanins (E 163) are responsible for pigments in nature, namely red, purple, violet and blue and this can be transposed to food when they are used as colorants. The main anthocyanins are cyaniding, delphinidin, malvinidin, pelargonidin, peonidin, petunidin, have applications in soft drinks, confectionary products and fruit preparations. Others are betalains, which display colors ranging from red-violet (betacyanins) to yellow-orange (betaxanthins) have some applicability in the food industry as natural colors due to having three times more coloring strength than anthocyanins. The only betalain legislated for use is derived from beetroot (E 162-betanin), and has application in dairy products, meat products and many others.

Regulation of Natural Preservatives in Meat Products:

The permitted preservatives in livestock foods are sodium acetate, natamycin, pimamycin, nisin, nitrites (potassium nitrite and sodium nitrite), nitrates (potassium nitrate and sodium nitrate), sorbates (sorbic acid, sodium sorbate, potassium sorbate, and calcium sorbate), and sulphites (sulfur dioxide, sodium sulfite, sodium bisulfite, sodium metabisulfite, potassium metabisulfite, potassium sulfite, and potassium bisulfite). Natural food preservatives are regulated by maximum permitted levels for food safety and health .The only natural preservatives regulated by legislation are natamycin and nisin. Natamycin (E235) is permitted for use in over 150 countries in the surface treatment of hard, semi-hard and semi soft cheeses and dried, cured sausages with a maximum permitted level of 6-40 mg/kg. Nisin (E234) is permitted for use in over 80 countries worldwide, including the United States and European Union, and has been in use as a food preservative for over 50 years. The maximum permitted levels in meat, poultry, game products are 5.5-7 mg/kg. Natural preservatives are considered safer than synthetic preservatives because of their existence in nature and long history of use. However, the use of natural preservatives in food is not powerful enough when considering added amounts in food system. Therefore, effective use levels of conventional and plant extracts/oils against microorganisms are less than 0.1% and 10-20%, respectively. Therefore, the regulation of these natural preservatives as food additives is necessary regarding their safety, toxicity, and effectiveness.

Summary and Conclusion

Chemical preservatives have side effects related to the emergence of drug-resistant strains and chronic toxicity. Traditional methods of preservation including refrigeration, pasteurization, and low pH are not completely effective in controlling food pathogens. Therefore, the efficacy of combining natural preservatives with traditional methods has been tested. Combination with other substances or different food preservation systems, coatings, or microand nano-capsulation should be tested to assure safety and nontoxicity of natural preservatives.

Natural additives have come a long way as ancient additives for conserving food. The storm and indistinctness among the chemical additives associated to the sporadic scares have paved the way for natural additives. Today, most consumers prefer natural additives rather than synthetic ones in producing minimally processed foods. The benefits of natural additives are infinite, their synergy and potency is a great jump from synthetic additives that carry out, in most cases, only one effect over the food. While preferring natural additives for food safety and quality, their toxicity must not be ignored, focus research on toxicological, carcinogenic and other facets to ensure their safety. Limitations still remain when it comes to natural additives, while some are the same as with synthetic ones, others are specific to their natural derivation. Natural additives must be reasonably cheap to be used for food in the context of competitive globalized market. Another great limitation is the real effectiveness of natural additives; this is important due to the quantity that is added to food. If the effectiveness is weak and a large quantity is needed, this might alter the meat foods in terms of appearance, taste or texture, consequently, the effectiveness vs successful outcome must be properly attained. In some cases it is not profitable or advisable to use additives or preservatives. Legislation poses great challenges to natural additives due to the lack of separate legislation for natural additives, which are legislated in the same manner as synthetic ones, sometimes not being clear how they are produced or where their source lies (synthetic or natural), causing more entropy from the consumers perception point of view. The delay on new additives approval is transversal to both natural and synthetic additives, and does not favour the introduction of new compounds in the market. This can be in part explained by the exhaustive assays that have to be carried out to determine a safe dosage, rule out interactions, allergens or hypersensitivity and an ADI. Besides, the legislation regarding additives is not transversal across countries, and the labels of products has to change to be in agreement to the local legislation, which fosters controversy and lacks simplicity, which is desirable when it comes to choosing food from the shelves. A specific problem with certain natural additives is the difficulty to find sources of the plants or microorganisms that produce them, causing in some cases an over harvesting which can lead to harm for the ecosystems they are inserted in. The synergistic effects and the capacity to carry out many functions at the same time is quite normal in natural additives, but some are not compatible with other natural or synthetic ones, as well as with ingredients in the food itself, which in some cases excludes them from being used. Notwithstanding these limitations, natural food additives are the future of food preservation due to the health benefits and synergies, and will gain even more interest in the future with the limitations being solved. The consumption of natural additives has been encouraged over the past years, with new products displaying labels of “all natural additives” or “no synthetic additives”. An increasing amount of funding is being channelled globally to find better, safer and more efficient natural additives.

Finding ultimate natural food additives that are safe, cheap, does not interfere with food is the challenge of the food industry for future. Until then, the consumers of today's world must rely on advances of science, that are hand in hands with legislators and not in conflict with them, leading to healthier and safer natural food for global consumers including India.

References

References can be made available upon request from the author.

(Lead 16)

Natural Antioxidatives in Goat Meat Products

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Goat Meat products with prolonged stability

The conditions encountered while development of goat meat products make them susceptible to chemical spoilage in the form of oxidative rancidity. Moreover, ingredients such as salt have been found to act as pro-oxidant. Attempts have been made to mitigate such oxidative changes in the meat products through incorporation of synthetic and natural antioxidants in the formulation, though later is most preferred both by processors and consumers. Nath et al. (2016) evaluated the quality and refrigerated storage stability of chevon patties treated with green tea extract (GTE) and rosemary extract (RE). Green tea extract was found to have better capability in reducing product oxidation than rosemary extract. However, the overall acceptability and flavour of RE treated samples products were the highest as compared to control and GTE treated sample. Nassu et al. (2003) determined the oxidative stability of the fermented goat meat sausage with rosemary, at room temperature for 90 days. Formulations containing 0.05% rosemary showed the best characteristics with respect to oxidative stability, sensory quality and colour parameters when compared with the sample containing 0.025% rosemary.

While working on marinated pre-rigor Osmanabadi chevon with different concentration of ginger rhizome extract Pawar et al. (2007) observed that marination of chevon resulted in increased water holding capacity, protein degradation, and collagen solubility thus tenderness. The chevon patties with ginger rhizome extract received a higher score for colour, tenderness, flavour, juiciness, springiness and overall acceptability. The result indicated that ginger rhizome extract in comminuted goat meat product exhibits antioxidant, proteolytic and antimicrobial properties, and has the potential to be used as an alternative to other plant proteolytic enzymes.

The effective utilisation of *Moringa oleiferia* leaves (MOL) extract as an antioxidant in cooked goat meat patties during 15 day refrigerated storage was investigated (Das et al., 2012). It was observed that the MOL extract at a level of 100 mg/ 100 g meat protected goat meat patties against oxidative rancidity better than the most commonly used synthetic antioxidant like BHT.

In an effort to replace synthetic antioxidants in meat products, Devatkal et al. (2010a) investigated the antioxidant effect of extracts of kinnow rind powder (KRP), pomegranate rind powder (PRP) and pomegranate seed powder (PSP) in goat meat patties. These extracts were found to have good antioxidant potential and their incorporation in products lowered lightness value and TBARS number during storage. These workers also reported the colour and oxidative stability of raw ground goat meat as a function of added salt, kinnow and pomegranate fruit byproduct under refrigerated storage (Devatkal et al., 2010b). Meat colour parameters were found to be influenced by added ingredients and storage. The added salt in ground meat acted as a pro-oxidant while fruit byproducts nullified this effect. Further, in another work, the effect of vacuum packaging and pomegranate peel extract on the quality of ground goat meat and cooked nuggets during refrigerated storage was evaluated (Devatkal et al., 2014). A significant increase in hardness and gumminess of nuggets was observed during the storage. However, vacuum packaged nuggets showed the least changes in textural parameters. Vacuum packaging and combination of vacuum packing and pomegranate peel extract significantly decreased TBARS number compared to aerobically packed nuggets. These workers also found synergistic antioxidant effect between vacuum packing and extract during refrigerated storage of products.

The application of curry leaf powder (CLP) as an antioxidant in raw ground and cooked goat meat patties during refrigerated storage was investigated (Das et al., 2011). The results showed that CLP at 0.2% level was very effective inhibitor of primary and secondary oxidation products in raw ground and cooked goat meat product. The antioxidant potential of broccoli powder extract (BPE) was evaluated in goat meat nuggets against control and butylated hydroxyl toluene (100 ppm). Broccoli powder extract decreased pH and chroma values of the products. Thiobarbituric acid reactive substances number of extract added nuggets was lower than control throughout the storage and 2% incorporation level of extract was found optimal (Banerjee et al., 2012). In restructured goat meat products Gadekar et al. (2014) used sodium ascorbate and alpha tocopherol acetate as a natural antioxidant and evaluated their quality and stability. The antioxidants improved the colour attributes of restructured goat meat product and significantly reduced the lipid oxidation and free fatty acid value. A study was conducted to assess the storage stability of chevon rolls prepared by incorporating aloe vera and cinnamon extracts during aerobic refrigerated storage. Chevon rolls with extracts showed lower peroxide value, TBARS number and free fatty acid value as well as microbial counts (Rathour et al., 2017).

Baelpulp residue (BR), a by-product of bael fruit after extraction of juice has been reported to have antioxidant potential and used in goat meat nuggets (Das et al., 2014).BR has been observed to be a potential source of phenolic compounds and estimated to have total phenolics of 15.16 mg GAE/g dry weight. While addition of BR (0.25, 0.5%) in goat meat nuggets improved the lightness and redness values, whereas yellowness value remained unaffected. It has been reported that the lighter and redder goat meat nuggets looked very much appealing and could be helpful in attracting the consumers. Lower thiobarbituric acid reactive substances (TBARS) value was recorded in BR treated nuggets; lowest value was observed in 0.5%treatment. Incorporation of BR may enrich meat products with dietary fiber and antioxidants, and can be helpful in enhancing their physiological and functional values as well as oxidative stability.

Aloe vera gel (AVG) is a potential therapeutic agent and rich in antiaging factors. It has antioxidant polyphenols, indoles and alkaloids and therefore, AVG shows strong antioxidant capacity. AVG has been added in goat meat nuggets at 2.5 % and 5.0 % level (Rajkumar et al., 2016). It has been observed that AVG has reduced the lipid peroxidation values (TBARS) significantly during storage.

It can be concluded that, though there are reports of using potential antioxidants in goat meat products, still the scope addition exists. Commercial products are yet to come in the market with added antioxidants. There is a need of screening the active principals of natural antixodants in order to have more specific information and to try at nano levels. Future of natural antioxidants depends on the above aspects of research.

References

References can be made available upon request from the author.

(Lead 17)

Functional Meat Products in Special Reference to Kadaknath: A Requirement, Health Impact and Legislation

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Kadaknath is only Black Meat Chicken (B.M.C.) Breed of India. It is a native bird of Madhya Pradesh, reared mainly by the tribal communities of Jhabua which is adjacent to Indore (Malwa region). The bird is very popular locally mainly due to its adaptability to the local environment, disease resistance, tasty meat quality, texture and flavour. Though the flesh of this breed is black, it is considered not only a delicacy of distinctive taste, but also of medicinal value. Meat is an important source of protein and essential nutrients including iron, zinc, vitamin B_{12} and folic acid (Schonfeldt and Gibson, 2008). Some studies have shown the benefits of meat consumption (McAfee *et al.,* 2010). However, a sector of the population perceives meat as a food that is detrimental to their health because it contains high levels of saturated fat and little or no fiber. Epidemiological studies have also associated meat consumption with cardiovascular diseases (CVD) and colon cancer (Chan and Giovannucci, 2010; Goldhaber, 2010).

Most researches into meat-based functional foods are confined to animal production or technological strategies for increasing the presence of healthy compounds (Brian *et al.*, 2012; Jiménez- Colmenero, 2007b; Muguerza, *et al.*, 2004). The functional food should "contain a component with a selective effect on one or various functions of the organism whose positive effects can be justified as functional (physiological) or even healthy".

The term functional food in use today conveys health benefits that extend far beyond mere survival (Clydesdale, 2004). There are mainly two types of functional foods, modified and fortified (Buisson, 1999). Functional foods are similar in appearance to conventional foods. These are consumed as part of a usual diet and are known to improve health status beyond basic nutritional function expected from the conventional foods (Shahidi, 2004). They also provide biologically active components that impart health benefits. Such foods must possess characteristics like modified composition, limit the presence of certain potentially harmful components and incorporate certain desirable ingredients (Jimenez-Colmenero et al., 2001). There are three basic requirements for a food to be regarded as functional: (i) it should be a food derived from naturally occurring ingredients; (ii) it should be consumed as a part of the daily diet; and (iii) once ingested, it must regulate specific processes such as enhancing biological defence mechanisms, preventing and treating specific diseases, controlling physical and mental conditions, delaying the ageing process etc. (Goldberg, 1994).

A diet high in fibre usually advocates a healthier life-style (Kritchevsky, 2000) and fibre intake can be viewed as a marker of healthy diet. On the other hand, meat as such does not contain any dietary fibre. Lipid oxidation is of great concern to the consumer because it causes physical and chemical deterioration of food quality, such as undesirable changes in taste, texture, appearance and development of rancidity, losses of important nutritional values and formation of potentially harmful components including free radicals and reactive aldehydes (Alamed *et al.,* 2009; Conde *et al.,* 2011). Antioxidants are substances that at low concentrations retard the oxidation of easily oxidizable biomolecules, such as lipids and proteins in meat products, thus improving shelf life of the products by protecting them against deterioration caused by oxidation. Although there are many compounds that have been proposed to possess antioxidant properties to inhibit oxidative deterioration, only a few can be used in food products.

Current Need to Develop Functional Food:

Over the last several decades, meat products have come under increasing scrutiny by medical, nutritional and consumer groups because of the associations established between their consumption (Low fat and high fibre) and the risk of some of the major degenerative and chronic diseases (heart disease, hypertension and obesity, colon cancer). Meat products contribute a significant amount of salt in the diet and eating habit estimates suggest that approximately 20-30% of common salt intake comes from meat and meat derivatives in western countries (Wirth, 1991). It has been postulated that high salt intake is related with arterial hypertension (Law et al., 1991a, b). Consumption of too much meat and meat products without dietary fibre is also being associated with various health disorders such as colon cancer, obesity and cardiovascular diseases.

Fat content is essential to meat product characteristics such as flavor, juiciness and texture and therefore fat content cannot be reduced simply by using less fat or direct replacement with another type of fat (Jimenez-Colmenero, 2000). Reduction of fat in comminuted meat products results in rubbery and dry textured products (Keeton 1994) and poses difficulties in terms of flavor and texture. Hence, there is a need for using suitable ingredient which is able to replace fat without affecting quality. Fat replacers are generally categorized into two groups: fat substitutes and fat mimetics. Fat substitutes are ingredients that have a chemical structure somewhat close to fats and have similar physiochemical properties (Lipp and Anklam, 1998; Kosmark, 1996; Peters *et al.*, 1997). They are usually either indigestible or contribute lower calories on a per gram basis. Fat mimetics are ingredients that have distinctly different chemical structures from fat. They are usually carbohydrate and/or protein-based. They have diverse functional properties that mimic some of the characteristic physiochemical attributes and desirable eating qualities of fat: viscosity, mouth feel and appearance (Duflot, 1996; Harrigan and Breene, 1989). An alternative is to use functional ingredients that mimic or substitute the properties of fat in emulsified cooked meat products.

Salt (sodium chloride) is the oldest food seasoning, which provides one of the important basic human tastes (saltiness) and preserves foods to extend the shelf-life. Salt is one of the required components by body for performance of normal physiological activity. Salt mainly consists of two elements: sodium and chloride. There are various types of salts available in the market depending on the size and refining process. Although salt has various unique functions for the human body as well as in food processing, high amounts of sodium consumption is a rising social problem because it is increasing the risk of heart attack and high blood pressure (Doyle, 2008). The reduction of sodium to develop healthier products is particularly challenging because it necessarily implies removing or partially replacing sodium chloride levels in the formulations in meat products (Weiss *et al*., 2010). Sodium chloride in meat products is an essential ingredient providing simultaneously a number of different functionalities. Salt is being used as a preservative, lowering the of water activity, produce characteristic flavour, desired texture and help in the shelf life extension of processed meat. Thus, when the salt content in meat products is reduced below typically used levels, the product has a shorter shelf life. (Madril and Sofos, 1985). Despite these key functionalities that are essential for the manufacturing of many meat products, there is increasing pressure from a large number of organizations to reduce both salt and sodium content in meats. The consumption of meat and meat products contributes about 16– 25% to the total daily intake of sodium chloride and thus is second only to bread with respect to salt levels (WHO, 2003).

For adults, the recommended acceptable intakes of dietary fiber are 28–36 g/day must be insoluble fibre. Apart from acting as an integral fraction of diet, dietary fibre performs many functions in meat products, viz., improvement in yield, desirable processing attributes, fat reduction and texture modification etc. Thus, the inclusion of fibre in meat products helps in improving processing and technological functionality with proven health benefits for consumers (Mehta *et al*., 2017). Black gram belongs to the leguminosae family and widely used in different parts of the world. Protein content in black gram and its fractions ranged from 12 to 42%, while fat content ranged from 0.9 to 3.4%. Seed coat had the highest (78.5%) dietary fibre content (Girish *et al*., 2012).

Natural antioxidants constitute a broad range of compounds including phenolic or nitrogen species and carotenoids (Aehle *et al.*, 2004). These compounds are particularly rich in higher plants (vegetables, fruits and tea) where they may function as reducing agents, free radical or active oxygen scavengers or complexents of pro-oxidant transition metals. They suppress the levels of reactive oxygen intermediates and thus play an important role in the defense mechanisms of plants (Gulcin *et al.*, 2003; Aehle *et al.*, 2004). Most natural antioxidants are obtained from plant resources including culinary herbs, fruits, vegetables, and oilseed products (Shahidi and Zhong, 2010). Natural antioxidants can also protect the human body from free radicals and retard the progress of many chronic diseases as well as lipid oxidation in foods. Vitamin C is ubiquitous in fresh fruits and vegetables and as a bioactive constituent; it is involved in wound healing, resistance to infections, and cellular respiration. In addition, vitamin C is also a strong antioxidant due to its preventative effect on the oxidation of other compounds upon donation of its electrons (Suntornsuk *et al*., 2002).

Approaches To Develop Functional Meat Products:

Various approaches are being followed for the development of functional meat products including production practices, post harvest techniques and reformulation techniques (Kinsella, 1987). Among these this reformulation is most commonly used method to develop functional meat products as it can help to avoid undesirable component and obtain most desirable composition with optimum palatability (Jimenez-Colmenero et al., 2001; Kinsella, 1987).

Fibre enriched meat products:

Dietary fibres consist of the plant polysaccharides and lignin, which are resistant to hydrolysis by digestive enzymes of human being. Recent epidemiological data show that a diet high in fibre generally promotes a healthier life style (Kritchevsky, 2000) and fibre intake can be viewed as a marker of healthy diet. Increased proportions of fibres in foods are known to reduce the risk of colon cancer, obesity, cardiovascular diseases and several other disorders (National Cancer Institute, 1984). Now a day there is an increasing trend of fibre addition in meat products due for technological reasons and benefits to human health (Vendrell-Pascuas et al., 2000). Several dietary fibres have been used in meat products as potential fat substitutes also (Mansour and Khalil, 1997). Soy hulls have been incorporated for the preparation of high fibre camel meat patties (Al-Khalifa and Atia 1997). Patties containing soybean hulls were high in fibre and low in fat and calorific content.

Incorporation of black gram hull and bengal gram hull may be added in kadaknath meat products to increase the fibre content in kadaknath chicken patties. Moisture content decreased gradually and showed a significant ($P<0.05$) difference at 6 % and 9 % incorporation of black gram hull. The fibre content in kadaknath chicken patties was increased significantly ($P<0.05$) with the increasing level of black gram hull. Moisture retention of black gram hull incorporated kadaknath chicken patties also differ significantly ($P<0.05$). Hardness value was increased gradually with the increasing level of gram hull and become significant ($P<0.05$) at. There was a non–significant ($P>0.05$) lower gumminess value was recorded for the product prepared with 3% black gram hull as compared to control. Further, gumminess value in the treatment increased as the level of gram hull in the product is increased. Patties with 9% gram hull indicated significantly ($P<0.05$) lower flavor and texture scores compared to control (Subham and Nayak, 2018).

Low/ reduced fat meat products

Low fat kadaknath chicken patties were prepared by guar gum by replacing added fat.

There was a significant ($P<0.05$) difference in the cooking yield of kadaknath chicken patties between control and treatments. Guar gum added low fat kadaknath chicken patties had significantly ($P<0.05$) lower fat content compared to control. Moisture retention was significantly ($P<0.05$) lower in control as compared to guar gum incorporated kadaknath chicken patties. Fat retention was significantly ($P<0.05$) increased with the increasing level of guar gum. Sensory attributes of guar gum incorporated low fat kadaknath chicken patties indicated that there were non-significant ($P>0.05$) difference in the mean scores of general appearance, mouth coating, saltiness and juiciness. Overall acceptability revealed that there was significant ($P<0.05$) variations among different guar gum incorporated low fat kadaknath chicken patties. Hence, patties 1% guar gum was found superior and most acceptable by the sensory panelists (Sunil and Nayak, 2019).

The carrageenan used as to develop low fat chevon patties. Emulsion stability and cooking yield increased with the increasing levels of carrageenan. The moisture contents of patties containing carrageenan was significantly ($P<0.05$) higher than control. However, significantly ($P<0.05$) lower fat and cholesterol contents were observed in formulation with carrageenan. Moisture and fat retention was significantly ($P<0.05$) lower in control compared to carrageenan incorporated chevon patties. Incorporation of carrageenan in chevon patties demonstrated significant ($P<0.05$) effect on the textural parameter except adhesiveness. Lightness (L*) value was significantly ($P<0.05$) increased on addition of carrageenan. Poppy seed was also considered as a good fat replacer. Emulsion stability and cooking yield was found to increase significantly ($P<0.05$) with the addition of poppy seed. Moisture and fat retention was significantly ($P<0.05$) lower in control patties as compared to poppy seed incorporated chevon patties. Fat and cholesterol contents was significantly ($P<0.05$) reduced in treatments as compared to control. Patties with 5 percent poppy seed had significantly ($P<0.05$) higher potassium, calcium, iron, manganese and zinc content. Hardness, springiness and cohesiveness values were significantly ($P<0.05$) higher in control compared to poppy seed incorporated chevon patties. Lightness (L*) and redness (a*) values differed significantly ($P<0.05$) between treatments. A significantly ($P<0.05$) higher flavor and texture score for control as compared to poppy seed incorporated chevon patties was recorded (Nayak and Pathak, 2015)

Low/reduced sodium meat products:

Reduction and substitution of sodium chloride in meat products Common salt or table salt or sodium chloride is an important additive in processing of many foods including meat products. Raw meat itself is relatively poor source of sodium, containing only 50-90 mg of sodium per 100 g (Romans et al., 1994). It has been established that the consumption of more than 6 g NaCl/day/person is associated with an age-increase in blood pressure and it had been recommended that the total amount of dietary salt be maintained at about 5-6 g/day (Aho et al., 1980; WHO, 1990). As various reports have linked excessive sodium intake with the incidence of hypertension (Dahl, 1972; Fries, 1976; Law et al., 1991a; 1991b; Tuomilehto et al., 2001), there is an urgent need to curtail the salt content in the food including meat and meat products. Meat industry is searching for ways to reduce salt content of some of the processed meat products (Pasin et al., 1989).

Different combination of salt blends was used to develop low sodium chevon patties. Mean value of emulsion pH and product pH value were significantly (P<0.05) higher for LS_1(NaCl and KCl) and significantly (P<0.05) lower for LS_2 (NaCl, KCl and $CaCl_2$), LS_3 (NaCl, KCl, $CaCl_2$ and ME) and LS_4 (NaCl, KCl, $CaCl_2$ and ME) compared to control (Nacl). Significantly (P<0.05) lower sodium and higher potassium content was observed in chevon patties substituted with different salt blends compared to control. Sodium content was reduced from 35.86% to 38.07% in the salt substituted chevon patties. Calcium content was significantly (P<0.05) higher in LS_2, LS_3 and LS_4 salt substituted chevon patties. Hardness, gumminess and chewiness values were significantly (P<0.05) higher and springiness value was significantly (P<0.05) lower in control chevon patties compared to treatments. Mean score for flavour and saltiness were reduced significantly (P<0.05) in LS_1, LS_3 and LS_4 compared to control. However, flavor, juiciness and saltiness as well overall acceptability scores for LS_2 were comparable to control.

Meat products enriched with natural antioxidants.

Different natural antioxidants viz; noni juice, plum puree and pomegranate rind extract were studied. Significantly (P<0.05) lower pH value and higher cooking yield was observed in noni juice incorporated chevon patties compared to control. The springiness and cohesiveness value deferred significantly (P<0.05) at 5% added level of noni juices. Lightness (L*) value was significantly (P<0.05) lower at noni incorporated compared to control. Mean scores of general appearance, texture and saltiness were also differed significantly. Lightness (L*) value decreased significantly (P<0.05) with plum puree addition. The redness (a*) and yellowness (b*) values increased significantly (P<0.05) with addition of plum puree in chevon patties.

With the addition of pomegranate rind extract potassium and iron content increased significantly (P<0.05) with the increasing. Hardness value differed significantly (P<0.05). Cohesiveness, gumminess and chewiness value increased and springiness and adhesiveness decreased gradually with the addition of pomegranate rind extract. Lightness (L*) value decreased and yellowness (b*) value increased significantly (P<0.05) in pomegranate rind extract incorporated chevon patties (Nayak and Pathak, 2015).

Food Safety Standards (Advertising And Claims) Regulation 2018 (Enforced: 1 July 2019)

SN	Nutrient and component	Claim	Condition
1	Cholesterol	Low	Not >20 mg cholesterol/100g and 1.5 saturated fat /100g for solids Not >10 mg cholesterol/100g and 0.75 saturated fat /100g for solids Must not provide > 10% energy from saturated fat
		Free	Not >5 mg cholesterol/100g solid or 100 ml liquid Additionally no >1.5 saturated fat /100g for solids and 0.75 saturated fat /100 ml for liquid. Must not provide > 10% energy from saturated fat
2	Unsaturated fat	High	Not < 70% of the fatty acid present are unsaturated
3	Trans fat	Free	Not >0.2g trans fat per 100 ml or 100gm of food
4	Energy/calorie	Low	Not> 40 kcal/100g for solid
		Free	Not> 20 kcal/100g for liquid
5	Fat	Low	Not > 3 g of fat /100g (solids) Not > 1.5 g of fat /100g (Liquids)
		Free	Not > 0.5 g of fat /100g (solids) Not > 0.5 g of fat /100g (Liquids)
6	Saturated fat	Low	Not > 1.5 g of fat /100g (solids) Not > 0.75 g of fat /100g (Liquids) Must not provide > 10% energy from saturated fat FFA (saturated) not > 0.1g/100g or 100ml.
7	Sodium	Low	Not> 0.12g of sodium /100g for solid or liquids
		Very low	Not> 0.04g of sodium /100g for solid or liquids
		Free	Not> 0.005g of sodium /100g for solid or liquids
8	Dietary fibre	Source	Not<3.0g of fibre /100g solids Not<1.5g of fibre /100 Kcal
		High/Rich	Not<6.0g of fibre /100g solids

References

References can be made available upon request from the author.

(Lead 18)

Species, Sex and Tissue Level Authentication of Meat and Meat Products: Current Status and Future Developments

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Introduction

Mislabeling of food products is done to cover up the food fraud committed while making food preparations in the form of ingredient substitution and has been observed globally (Amaral et al., 2017).One of the worst outcomes of meat authenticity issue can be elucidated from the “Horse meat scandal” of Ireland in January, 15, 2013 (Walker et al., 2013). The issue had its origin when the press release from the Food Safety Authority of Ireland (FSSAI), declared the presence of horse and pig DNA in beef burgers. It begins with merely two meat processing plants, but on a two month laboratory investigations, it evolved on to a pan-European food fraud incident. This fraud exposed mainly in the cheaper end of frozen beef market and as on consumer confidence in processed meat products in the European Union has been significantly damaged. This is a lesson for the meat food industry that, any such incidence may leads to sharp decline in trade of ready meal sector. Anecdotal evidence of such meat admixture episode can also be traced from the "great meat substitution scandal" unfolded in 1981 in Australia (Grabosky and Sutton, 1989). In this case, horse meat was detected in beef shipped from Australia to a plant in San Diego in US. Another devastating picture of meat fraudulency can be read out from the article of Walker et al., (2013). In his own words it is explained as "Considerable quantities of pet food were illegally diverted into the human food chain. The pet food included the flesh of donkeys, (feral) goats, kangaroos, buffaloes and horses, killed in the field without regard to hygiene".

Being a country with diverse geography and religiously and seasonally adaptable food habits, the possibilities of adulterations are various. The high price of animal derived proteins in market makes this commodity (meat) highly vulnerable to adulteration. The driving force behind any adulteration is the revenue maximization, either by using a low cost ingredient to substitute a more expensive one, or to remove the valued component (Ioannis and Nikolaos 2005).Food authenticity issues in the form of adulteration and improper description have been around for a long time and probably for as long as food has been offered for sale (Ioanniset al. 2005). Many consumers are concerned about the meat they eat, and accurate labelling is important to inform consumer choice (Ballinet al., 2010). Authentication methods can be categorized into the areas where fraud is most likely to occur and lot of researches were already carried out using various biomarkers (like DNA, proteins) to detect the species and sex origin of meat. Analytical methods used in authentication are as diverse as the authentication problems, and include a diverse range of equipment and techniques.

Various PCR based approaches for meat species identification

DNA- based molecular techniques developed over the last few decades have improved the hopes of developing authentic and reliable methods for species & sex determination, due to its presence as basic cellular component, the stability of DNA at high temperatures, and the fact that its structure is conserved within all tissues of an individual.

Singleplex or duplex PCR platforms

In conventional singleplex PCR, a single target sequence is amplified in a single reaction tube. This can be achieved through use of a universal primer set to amplify a conserved region across the species or using species specific primers one at a time. Singleplex PCR is used for detection of a single target sequence and does not require specific probes. Therefore, it's not surprising that singleplex PCR is inherently simpler in its design, implementation and optimization. It can be fast and easy to perform with little optimization required. Universal primers like mtcyt b, mt 12s rRNA, mt 16s rRNA, mt D-loop will amplify a target sequence and the PCR product could be further sequenced to exactly detect the meat species. Another extension of universal primer technology is the application of by restriction fragment length polymorphism (RFLP) with AluI and/or HhaI for species identification of cattle and buffalo. The application of this technology, both universal and species specific primers, is further explained in next sessions. In duplex PCR, two different target sequences were simultaneously amplified in the same reaction tube with two sets of specific primers, and this technology were applied to detect the presence of buffalo tallow in cow ghee using mtcyt b gene specific primers.

Real time- Quantitative PCR (qRT-PCR) platforms

The most popular PCR technique to measure the presence and concentration of aDNA sequence, is real-time quantitative PCR (qRT-PCR, or qPCR). In qPCR, DNA is copied until it produces a certain level of signal; the number of amplification cycles needed to reach this point is then used to calculate how many DNA molecules with the particular sequence were originally present relative to other DNA molecules in the sample. RT PCR platforms, like Taqman, SYBR green can be utilized to accurately measure the limit of detection (LOD) and to further quantify specific DNA, using standard curve method. Application of this technology in meat science and a comparison with digital PCR is explained further in detail.

Digital PCR platforms

The latest PCR based platform getting familiarity in the field of meat science as well, is the digital PCR (dPCR). The strategy for digital PCR (dPCR) has been summarized as 'divide and conquer': a sample is diluted and partitioned into hundreds or even millions of separate reaction chambers so that each contains one or no copies of the sequence of interest. By counting the number of 'positive' partitions (in which the sequence is detected) versus 'negative' partitions (in which it is not), scientists can determine exactly how many copies of a DNA molecule were in the original sample (Baker, 2012). A droplet digital PCR (dd PCR) platform working based on the principle of microfluidics (Bio-Rad's QX200 droplet digital PCR System), is already acquired by the meat biotechnology lab of ICAR-NRC on Meat. Digital PCR uses the same primers and probes as qPCR but is capable of higher sensitivity and precision. The possible uses of dd PCR in meat science research will be covered in the next session.

d. Recombinase Polymerase Amplification (RPA)

The present area of interest in nucleic acid amplification that breaks the traditional concept is the isothermal amplification of the target DNA. Among the various isothermal amplifications, the one that attains fastest development and wide acceptance amongst researchers is the recombinase polymerase amplification (RPA). Specifically, RPA technology potentiates highly accessible and sensitive nucleic acid amplification outside of laboratory (Jia et al., 2019). As explained by the authors, RPA helps in reduces equipment requirements due to single temperature incubation and engage new avenues in performing the amplifications in low resource set ups and field conditions. RPA also aids in low-resource implementation, through reduced amplification times through elimination of repeated heating and cooling steps also provides a second advantage for. Faster reactions occur not only because of a reduction in heating and cooling times, but also because multiple molecular reactions can proceed asynchronously rather than being forced to operate sequentially within an artificial heating and cooling cycle (Jia et al., 2019).

“The fundamental reaction mechanism of RPA relies on a synthetically engineered adaptation of a natural cellular process called homologous recombination, a key process in DNA metabolism. The standard RPA reaction reagents comprise three key proteins (recombinase, recombinase loading factor and single-stranded binding protein), which subsequently co-ordinate with ancillary components such as deoxyribonucleic acid (DNA) polymerase, crowding agent, energy/fuel components (*e.g.* adenosine triphosphate, ATP) and salt molecules to perform the RPA reaction mechanism" (adapted from Jia et al. 2019).

Field applications

The standard protocol of operations followed after receiving a sample in meat biotechnology lab, ICAR-NRC on Meat, is given below. After sample review, the DNA is extracted using spin column method. Further the DNA will be amplifying using universal primer that targets 12s rRNA. The amplified product will be analysing through both sequencing and restriction fragment length polymorphism (RFLP), using AluI and/or HhaI. For further confirmation of the results, a species specific PCR will also be carried out. All the samples received suspected as cattle will be going through one more PCR for identifying the sex of origin of meat.

Universal primer based PCR platforms

One of the most widely used PCR platforms for species identification of samples collected/suspected from wild animals is the use of universal primers to amplify the target DNA and further sequencing of the PCR product. Mitochondrial genes were widely utilized for the designing of universal primers due to its conserved nature. A primer set that targets mitochondrial 12s rRNA to give an amplicon of size 456 were utilized in meat biotechnology lab, ICAR-NRC on Meat for species identification of suspected samples. A total of 80 samples out of 81, were analysed for species identification through forensically informative nucleotide sequencing (FINS) based methods using the amplicon sequence of universal mt 12S rRNA gene primer and the alignments were made in NCBI BLAST. The sequences were found to be of high quality, with an average consensus length of 449 ± 8 bp, with a gap of 0-1%. All the samples showed genetic matches > 96% to species-level entries in nucleotide BLAST analysis, for cattle, buffalo, sheep, goat and chicken. Further, the results were confirmed using species specific mt D loop PCR assay and the RFLP analysis. However, the product with both cattle and buffalo could not be done through this method, and which might be due to the sequence ambiguities aroused due to simultaneous amplification of both cattle and buffalo DNA.

Species specific PCR platforms

Mt D-loop with common forward primer and species specific reverse primers were utilized to differentiate meat from cattle and buffalo, based on amplicon size, i.e. 126 bp for cattle and 226 bp for buffalo. A similar PCR platform targeting mtCyt b gene were also utilized to differentiate sheep and goat, where 254 bp amplicon identifies sheep and 453 bp identifies goat. One sample received allegedly as dog meat form municipal local authority, which was collected from some restaurants were analysed using species specific primers for dog. Amtcyt b based primers were used to find out the presence of dog meat with an amplicon size of 100 bp. But, the results were negative for the presence of dog meat and later it is confirmed as sheep meat using species specific primers of cattle, buffalo, sheep, goat, pork, chicken and dog. Out of 28 samples analysed to differentiate between cattle or buffalo using species specific techniques, 19 were cattle male (67.8%), 4 were buffalo (14.3 %), 2 were cattle female (7.14%), 2 were sheep (7.14%) and 1 was chicken (3.57 %).

Sex specific PCR platforms

Primer designed against SRY (Sex determining region Y) region were utilized to determine meat samples from male animals, because this gene is male specific. The product size is 182 bp in males and female sample doesn't show any amplification. Since it is amplifying only in male samples, the results may misleadingly read as female once the PCR conditions fails. So, to differentiate exactly between cattle male and female, another primer set designed against amelogenin gene were utilized in the lab. This gene is located in X chromosome, so both male and female shows amplification but of varying size. 313 bp size product is present in male and female, but 250 bp present only in female. TK_S4 (Genebank accession no: D16357) and Sat-1 (Genebank accession no: V00125) are the other two primer sets for sex differentiation. TK_S4 is a highly repetitive sequence conserved in Y- chromosome, and the product sizes specific to male is 300 bp and 538 bp. During the past years, 45 samples received by the meat biotechnology lab of ICAR-NRC on Meat suspecting as female cattle, were analysed by sex specific and species specific PCR platforms. The results were confirming only 4 female cattle samples out of 45 suspected samples. The rest samples (36/45) were identified as male cattle and 5/45 as buffalo. Interestingly, one sample submitted was in the form of product of mixed type with both cattle and buffalo. In this particular case the confirmation of these results of species identification were made possible through three specific tests viz. FINS test, species specificmt D loop PCR assay and RFLP analysis to differentiate the cattle and buffalo. Subsequently, the sex identification of meat sample was performed only for cattle meat through SRY/Amelogenin/TS-K4 &Sat1 analysis.

Quantitative or real time PCR platforms

A quantitative real time PCR (qRT PCR), using Taqman probe were successfully developed to efficiently quantify DNA from cattle and buffalo tallow from known samples. And the researchers succeeded in quantifying DNA from cattle and buffalo tallow at 1% level. Moreover, the validity of this test can be emphasized by the linear relationship (R2>0.96) observed between DNA content and tallow percentage in known binary mixtures of tallow and ghee. The PCR efficiencies observed were 116 and 128% respectively for cattle and buffalo DNA when one diluted into the other with R2>0.95 which indicated excellent linearity. So, further this Taqman real time PCR assay were utilized to detect cattle/buffalo DNA in the unknown tallow samples.

LCD array based techniques

DNA macro-array, and more specifically a meat Low Cost and Density (LCD) Array, is a specific, reliable and fast method and fit-for-purpose of simultaneous detection of 32 species of meat samples. This meat LCD array approach is based on classical PCR followed by a LCD array hybridization. The first PCR step amplifies a fragment of DNA ranging from 115 to 125 bp from the vertebrates' 16S rRNA mitochondrial gene and further the amplicons are hybridized on a macro-array spotted with capture probes specific to 32 different meat species with a high screening capability. The meat biotechnology lab utilized its LCD meat array facility to detect the presence of undeclared species of meat in one of the most traditional and only one geographically indicated meat product of India, Hyderabadi Haleem. Haleem samples were obtained during the Ramzanmonth of 2016. DNA extracted by spin column method and PCR assay and hybridization was done as prescribed in the LCD meat array kit. Fifty samples of

Haleem,sold either as mutton or buffalo were analysed and misrepresentation of species were detected in as many as 21 samples. Presence of buffalo meat, beef and chicken either alone or in combinations were detected in 12 samples of Haleem sold as Mutton from 40 samples analysed. From another 10 samples analysed as buffalo Haleem misrepresents the species in as many as 9 samples, mainly due to the presence of beef or chicken. But, interestingly camel meat was detected in one sample sold as buffalo meat Haleem.

Digital PCR platforms

One of the classical use of dd PCR in meat science, apart from species identification is the quantification of adulteration or detection of level of incorporation of various meat species in an admixture. A complete picture of this technique in quantification can be read out from the article of Ren et al., (2017). Different proportions of chicken and sheep were prepared covering from 1 to 80 % and quantification were made both by dd PCR and qRT PCR. Quantification was done by use of a multiplication factor to convert copy numbers of DNA in the sample analysed to real meat quantity present in the admixture.

PCR techniques to detect rendered animal fat (tallow) in ghee

Efforts were made to develop PCR based platforms to detect the presence of rendered animal body fat (buffalo tallow) in cow ghee and to quantify the level of incorporation. The experiments were initially carried out using known samples and further extended to unknown samples. DNA isolation methods from milk fat, rendered animal fat and vegetable fat was standardized for the new PCR platform to perform. The DNA isolated from milk fat/animal body fat/vegetable fat was not good quality in terms of A260/A280 ratio. However, the isolated DNA quality was sufficient enough to get amplified. Using known samples with linear proportion of buffalo tallow and ghee and by use of species specific primers targeting mt D loop and mtCyt b in an end point PCR platform, addition of buffalo tallow above 5% in the milk fat (cow ghee) were detected. Another PCR platform based on Ribulose-1,5-Bisphosphate Carboxylase/Oxygenase (rbcl) is also in development to detect the presence of vegetable fat.

miRNA based method for tissue level authentication of meat and meat products

Only muscle tissue is considered as meat and other tissues are mainly offal component. The value addition to the meat is done through various means including the processed meat products. One of the processed meat products is the comminuted meat products which are made of meat, fat and a small quantity of offal ingredient. The production of comminuted meat products allows itself to various forms of adulteration. The addition of low priced meat replacing normal meat during the production of quality meat products is among the most frequent way of adulterating such products. But the importance in detecting non-muscle tissue in processed meat products is driven by new European legislation that specifically excludes offal (liver, kidney and heart) from the definition of meat (Food Labelling Regulations, England, 2003). And also due to the concern about neurologically transmittable diseases when collagen containing head meat, neuronal tissue and spinal cord were used in comminuted meat and meat products. Labels must declare the identity and content of non-muscle tissue and not conceal it within the heading 'meat'. At present scenario, there is no robust genomic tool is available to assess the quality of meat and meat products 'true to its labelling', especially when it is adulterated with low quality offal/by-products.

Micro (mi) RNA as based methods for tissue authentication

MicroRNAs (miRNAs) are a large class of endogenous noncoding RNAs of about 21 nucleotides long. Because of their size, abundance, tissue specificity, miRNAs hold promise as unique accessible biomarkers to monitor tissue (offal) incorporation in comminuted meat and meat products. At present, hundreds of miRNAs have been cloned or predicted in various organisms, including humans, mice, zebra fish, viruses, flies, worms and plants (Xu et al., 2006). Because of differential expression of genes in different tissues, levels of mRNA and miRNA species can be indicative of tissue source and represent better target molecules that can potentially overcome some of the limitations associated with protein-based assays (Haas et al., 2009).

MicroRNAs are one of the largest gene families and account for ~1% of the genome (Bartel, 2004). They are 21–25 nucleotide small, non-coding RNAs that post-transcriptionally repress the expression of protein-coding genes through binding to the 3' untranslated regions (UTR) of the target mRNAs (Ambros, 2004). Accumulated evidence indicates that miRNAs are important in the regulation of many biological processes, such as developmental timing, cell metabolism, cell differentiation, cell death, cell proliferation, hematopoiesis and patterning of the nervous system (He and Hannon, 2004). Recent studies have uncovered tissue specific miRNAs that regulate diverse aspects of muscle function, including myoblast proliferation, differentiation, and contractility and stress responsiveness. Variations in the expression profiles of common and differentially expressed miRNAs among various tissues of meat animals could be used to detect the tissue specific origin of the samples.

In our own study (unpublished), global expression of miRNA in all the tissue samples studied were initially evaluated using whole genome screening through massive parallel sequencing, as the relative abundance of sequences representing miRNAs can recapitulate miRNA expression levels in the source tissue. Further, qPCR is used to validate quantitatively the genome wide profiling of miRNA expression of tissues studied. Moreover, the sequencing results were further validated with droplet digital PCR too for better accuracy.

References

References can be made available upon request from the author.

(Lead 19)

Cultured Meat: An Indian Perspective

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Introduction

Meat sector is an integral and important component of Indian agro-food industry which contributes immensely for rural income, nutritional security, employment generation and earning much required foreign exchange. However, challenges in the sector are numerous:

environmental cost of producing meat, welfare issues linked to meat production in slaughterhouses, meat borne diseases and meat animals competing with human food continue to be challenge which need urgent attention. In this context, need for development of alternative methods for meat production has been felt across the world. Cultured meat or lab grown meat or in vitro meat is the meat produced without rearing and slaughtering the meat animals. Large scale culturing muscle stem cells using appropriate medium under controlled environment can produce meat for consumers. Cultured meat, if produced sustainably in large scale, will alleviate the pain, the animals undergo, in the process of slaughter, which is a serious welfare issue. Major breakthrough in *invitro* meat production happened in 2013 when first *invitro* burger prepared from cultured stem cells by Mark Post, Dutch Scientist was tasted by experts in London. This event created immense interest across the world and several companies in different countries have started working to achieve large scale meat production from cultured cells. Recently, several research Institutes in India have initiated research projects in this direction. This article tries to understand the cultured meat in the background of current Indian meat industry scenario and what it means to different stakeholders like farmers, meat handlers, processors, consumers, food industry players, policy makers etc. Prospects of cultured meat in different meat animal species has also been discussed.

Concept of cultured meat

Winston Churchill, a British politician, in an article in *Strand Magazine* shared his thoughts on "Fifty years hence" expressed that "With a greater knowledge of what are called hormones, *i.e.* the chemical messengers in our blood, it will be possible to control growth. We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium". However, scientifically first idea of growing meat in laboratory was coined in 1930 by Birkenhead & Smith who predicted the possibility of growing beef steak in the lab rather than growing the full cattle. Since then several researchers have standardized the methods for large scale multiplication of muscle cells. These techniques are basically based on two principles: (a) Scaffold based and (b) Self organizing based. Self-organizing technique, known as *in vitro* muscle protein production system (MPPS), involves use of explant from the muscle of a donor animal, proliferated in a culture medium (Benjaminson et al., 2002). Second method is based on scaffold based technique (Shruti et al., 2015), in which, embryonic myoblasts or adult skeletal muscle satellite cells are proliferated, attached to a scaffold in a bioreactor containing culture medium. Among these, scaffold based method is the commonly pursued method for lab grown meat production by researchers.

Table-1: Merits and demerits of the conventional and cultured meat

Demerits of conventional meat	Merits of the cultured meat	Demerits of the cultured meat
Resources: Require resources like water, land etc whose availability is slowly reducing. Environment: Contribution to deforestation, global warming and pollution Animal welfare: Process of slaughtering which often compromises it. Nutrient conversion: Inefficient. Health: Food borne diseases due to presence of microbes in the meat. Religious: Religious restrictions and social taboos. Scarcity: Demand of meat is increasing day by day but the production is not in line with it.	Resources: Require lesser resources (nutrients, land, water etc.) Environment: Environmental friendly. Helps reduce emission of greenhouse gases. Animal welfare: Animal friendly as it does not require slaughtering of the animal. Only one time biopsy collection will serve the purpose. Nutrient conversion: Highly efficient. Health: Hygiene meat produced in sterile and aseptic conditions. Religious: May help overcome religious concerns Scarcity: To meet raising demand cultured meat can be one of the solutions. Possible to produce designer/ customized meat (adjusting the meat composition fats, protein etc)	Unnaturalness of the product Expensive price Yuck factor Concerns with reference to job loss at farming and processing levels

Merits and demerits of cultured meat vis-à-vis conventional meat is given in Table 1. Raising of the animals is time consuming, utilizes natural resources and it may lead to deforestation and the consequences are global warming and pollution. Cardiovascular diseases and animal food-borne diseases are associated with meat consumption and 22% of the food-borne pathogens (Salmonella, Campylobacter and Escherichia coli) arise from meat products (Bonny et al., 2015). The epidemics like chicken flu, swine flu and bird flu are also associated with conventional meat. Also, the animals will undergo pain while performing the slaughtering.

The cultured meat having the advantages of rapid production, less usage of natural resources, animal friendly, environmental friendly and also there is support from scientific, environmental and animal rights agencies. The cultured meat is tailored product where we can adjust the protein, fat and also we can add desired compounds in this way it can be used as a personalized medicine. The aseptic conditions maintained while producing cultured meat will avoid the chance of food borne diseases. The main problems associated with the cultured meat are unnaturalness of the meat and expensive price of the product. The price of cultured meat will decrease if the production increases.

Process of cultured meat production

The cultured meat production involves the selection of cells, culture medium, scaffolds for culturing the cells and finally the scale up of the process in the bioreactors. The steps involved in the production of cultured meat are shown in Fig 1.

Cells for the cultured meat: The ideal cells for cultured meat are able to divide infinitely, differentiate into muscle cells, able to grow on scaffolds for 3D culture and conditioned to get mature and form muscle fibers. There are different cells which having the potential to divide for multiple times they are induced pluripotent stem cells (Holde and Vogel 2008), embryonic stem cells (Pandurangan et al, 2015), adult stem cells (Roobrouck et al, 2008) and muscle satellite stem cells (Asakura et al, 2001). The native muscle tissue will contain fat cells, vascular tissue and nervous tissue. We can co-culture the muscle cells with the above mentioned cells to provide the natural environmental and in 3D culture.

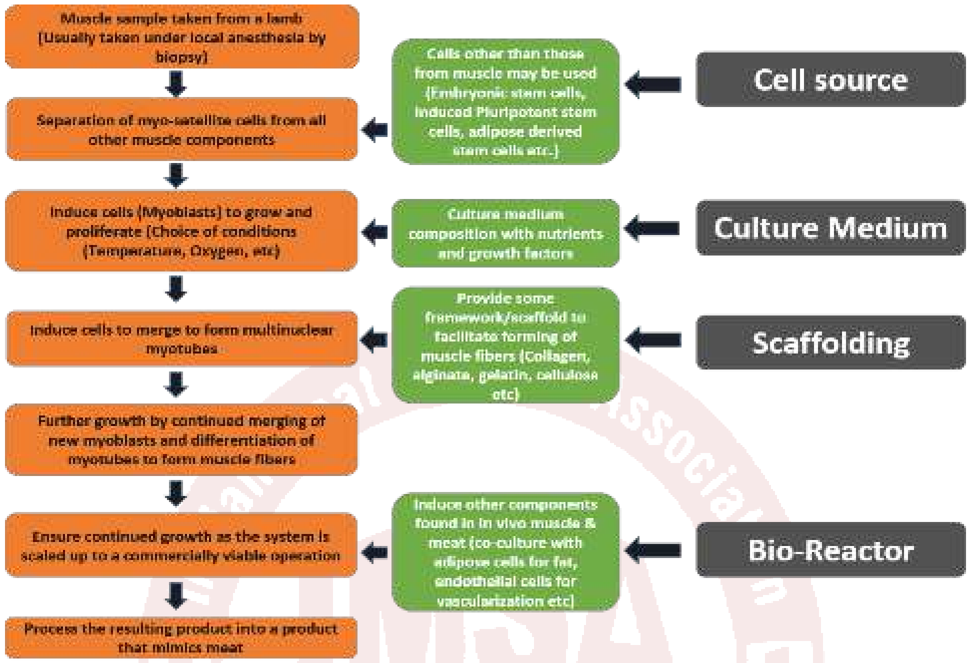

Fig-1: Flow diagram showing some of the steps involved in the production of cultured meat

Culture Medium: The ideal culture medium should be free of endotoxin compounds and support the muscle cells proliferation and differentiation. Commonly used cell culture medium for muscle cells contains basal media along with fetal bovine/calf serum or horse serum. The different basal media include DMEM, Hams F12 etc. The problem with serum is that it is costly, animal dependent and may be presence of endotoxins.The culture medium for cultured meat the media should be optimized for the growth and differentiation of myoblast cells. The different serum free media available in market are costly again this is a constraint. The available different serum free media supports growth of muscle cells include L15, Ultroser G and AIM-V (Fujitha et al., 2010). Mushroom extract, Cyanobacteria and different combinations of growth factors like basic fibroblast growth factor (bFGF), vitreonectin, glial cell derived neurotrophic factor (GDNF), brain cell derived neurotrophic factor (BDNF), cardiotrophin 1(CT1), neurotrophin3 and 4(NT 3&4)are used to compensate usage of serum in muscle cell culture (Das et al.,2009).Different factors which helps in the differentiation into myotubes and myofibers includes mechanical, electromagnetic, gravitational and fluid flow methods (Kosnik et al.,2003, De Deyne.,2000), horse serum (2% to 10%), biochemically by inducing/stopping signaling pathways like TGFß1,Pax7, Notch and Wnt and repetitive contraction and relaxation can enhance the length of skeletal muscle by at least 10% (Powell et al, 2002).

Scaffolds: The ideal scaffold should possess the qualities of biocompatibility, easily separable or edible, possess mechanical strengths to withhold muscle contraction and relaxations, maximize the medium diffusion and suitable for bioreactor culture. The literature available reports that the muscle cells were cultured on different scaffolds includes chitosan (mushroom), Alginate (sea weed), gelatin(salmon), fibrin hydrogel, cellulose, silicone with wavy micro patterned surface and collagen in different forms like beads, spheres, meshwork (Edelman et al, 2005). Recently, there are reports on using decellularized iceberg lettuce, spinach plant leafs apple hypanthium and leek as scaffold for muscle cell culture (Daniel and Cory et al, 2014). The major challenge with scaffolds is the removal of the scaffolds system after the culture. Generally, the cells are detached from the scaffold using mechanical or enzymatic methods which destructs the extra cellular matrix and damage the cells also. There is reports on thermo responsive coating which by cooling change from hydrophobic to hydrophilic and releases the intact cell sheets of cultured cells and extracellular matrix (Da Silva et al, 2007). The degradation/digestion of the attachment protein laminin also helps in the removal of cells as a confluent sheet from a non-adhesive micro patterned surface (Lam et al, 2009).

Bioreactors: Bioreactors are required for the large production of the cultured meat. The ideal bioreactor should support the cells with the scaffold and maintained all the parameters like mass transfer, oxygen level, shear stress and flow of the medium at optimum level to produce high output. There are different bioreactors with specific functions. The different bioreactors studied for cultured meat are rotating wall vessel bioreactors, direct perfusion bioreactors and micro carrier based bioreactor. In direct perfusion reactors the scaffolds with porosity will be used and media will flow through the scaffold and gas exchange will happen in an external fluid loop (Carrier et al,2002). Direct perfusion bioreactors support scaffold based culture with high mass transfer and significant shear stress. Rotating wall vessel bioreactors maintain invivo conditions by adjusting rotating speed which in turn balances the centrifugal force, drag force and gravitational force and finally allows the 3D culture to be submerged in the medium (Vander Weele and Tramper, 2014). These bioreactors provide high mass transfer with less shear stress. In some cases they have tried to co-culture myoblasts, embryonic fibroblasts and endothelial cells to get the cultured meat. In some cases to mimic in vivo conditions myoblasts are cultured with fat cells. .

Micro carrier based reactors: Micro carriers are used to support the cells in 3D environment there are two types are there in this one is suspension of the micro carriers and the other is packed bed rector. In packed bed reactors the medium can be oxygenated before entering into the reactor and the flow of the medium also continuous but the available literature restricting its use up to 30litre. Micro carriers in suspension help cells to grown on them, the seeding density of the cells have different effects on the characteristics of the cells in this type of rectors. The problem with micro carriers based bioreactors are formation of aggregates and shear stress due to agitation (Mortiz et al, 2015).

International status in cultured meat production

There are lot of companies invested in the cultured meat sector. The companies with a goal to serve the cultured meat to the society within the next 5 years are Memphis meat (San Francisco, California), Super meat(Israel) and Mosa Meat (The Netherlands, Supported by

Mark post) (Devitt et al,2017). The price of the lab –grown burger had dropped from $ 3,25,000 to $11.36 per kilogram of culture meat announced in 2015 by the makers of the lab-grown burger (Crew et al, 2016). The price had dropped heavily within two years which is a good sign for the commercialization of cultured meat.

Indian status in cultured meat production

Meat consumption in India is increasing day by day. Over 70% of India is non-vegetarian (TIFAC, 2018). Centre for Cellular and Molecular Biology, Hyderabad and ICAR – National Research Centre on Meat, Hyderabad have initiated one of the first research projects in this direction with funding from Department of Biotechnology, New Delhi. Recently, production of lab grown chicken meat by 3D cell culture technology was reported by Dr. Biman Mandal, IIT-Guwahati, where they claimed that they produced the lab grown chicken meat which is going to be patented. In India ahimsa food is the first company to enter into "Mock meat" production. At IIT Delhi an event was organized 10th Feb, 2018 by TIFAC to discuss various aspects of cellular agriculture which brought scientists, businessman, policymakers, politicians and religious leaders on a common platform. Further, on 24th August 2018, 'Future of protein summit' was organized by Good Food Institute (GFI) in collaboration with Centre for Cellular and Molecular Biology (CCMB) at Hyderabad wherein experts from different related areas, NGOs and policy makers participated and mulled upon developing lab grown meat for meeting the raising animal protein requirement in the country.

Prospects of cultured meat in different meat animal species

As per Department of Animal Husbandry, Dairying & Fisheries (DAHD&F) data poultry is the highest consumed meat in India with total contribution of 49.64 % to the total meat production (2017-18). It is followed by buffalo (18.85 %), goat (13.74 %), sheep (7.94 %), pig (5.22 %) and cattle (4.61 %). Brief information regarding meat from different species and their prospects for cultured meat production is given below:

Bovine meat: India possess 191 million cattle and 109 million buffaloes which are reared mainly for milk purpose. India is the number one milk producer in the world with total milk production of 165.4 million tonnes in 2016-17. About 70 % of the milk in the country is contributed by cattle and buffalo. Meat from these species are byproducts of dairy industry. There are no exclusive meat purpose breeds for cattle and buffaloes. Slaughter of cattle is restricted in most states of India due to taboo attached to beef. On the other hand, more than 80 % of the buffalo meat produced is exported. Milk group contributes about 67 % of the total value of output from livestock sector while meat group contributes about 20 % of the total value of output from livestock sector. Milk is an extremely important commodity for ensuring nutritional security while dairying contributes immensely in employment generation and utilization of crop residues in rural India. Also, demand for bovine meat in domestic market is minimal. In addition, bovines are reared mainly on crop residues and very little supplementation is done with concentrates (prepared using food grains) in milking animals. In view of the above, there is not much scope for production of cultured beef and buffalo meat in India. Globally, beef is the main target for production of culture meat which may not be as per requirement of India. In the event of achieving large scale production of beef and buffalo meat in lab, Scientists need to work on producing animal-less milk by attempting to produce milk by cellular agriculture to ensure nutritional security of ever growing population.

Sheep meat (mutton): India possess 65 million sheep as per 19th livestock census (2012). Number wise sheep constitute only 12.71 % of the total livestock population. There is a huge gap between demand and supply of mutton. Hence, price of mutton is raising continuously. About 70 % of the sheep are located in Andhra Pradesh, Telangana, Karnataka and Rajasthan. Demand for mutton is higher than that of chevon (goat meat) in southern India. Decreasing grazing land and other factors have put pressure on sheep population resulting in reduction of population by 8.37 % as compared to 18th livestock census held in 2007. In urban areas, population of sheep decreased drastically by 33 %. In view of huge difference in demand and supply of mutton, decreasing grazing land, decreasing sheep population, concentration of sheep in very few states and increasing demand, production of cultured mutton appears to have good prospects in India under prevalent market condition.

Goat meat (Chevon): Goats are dual purpose animals which are reared for both milk and meat purpose. India possess 135.17 million goats as per 19th livestock census held in 2012 which is about 26 % of the livestock in terms of numbers. Goats contribute about 13.74 % of total meat and 4 % of total milk produced in the country. Population of goats decreased by 3.83 % as compared to 18th livestock census which may be due to decreasing grazing land. Demand for chevon is higher than that of mutton in northern India. More than 50 % of the goat population is in Rajasthan, Uttar Pradesh, Bihar, West Bengal and Maharashtra states. Demand for chevon is very high due to its leanness. Hence, there is a good scope for pursuing cultured chevon in the country provided goat milk is replaced suitably by milk from dairy animals or by animal-less milk.

Chicken: Demand for chicken is rapidly raising in the country because of higher protein content, lower fat content, lower price, small unit size, short period of rearing, increasing private participation etc. In the year 2017 – 18, about 49 % of the total meat produced in the country was from poultry which is mainly represented by chicken. Chicken is mainly raised using the concentrates which consists of maize as its major component. Chicken does compete with human food ingredients. Also, there is a huge demand for chicken in urban areas wherein income levels are generally high. Cultured meat definitely meets the requirements of niche consumers who can afford to pay higher cost for clean and painless meat and hence prospects for cultured chicken is high in India.

Pork: Globally, pork is the highest consumed meat. In India, pigs contribute only 5.22 % of the total meat production. Pig population of India was 10.29 million as per the 19th livestock census, 2012. The highest pig population is formed in eastern and north eastern (NE) states (63.10%), followed by northern (15.52%), southern (9.48%), central (5.97%) and western India (5.94%). The highest population is in the state of Assam (1.63 million), succeeded by Uttar Pradesh (1.33 million), Jharkhand (0.96), Bihar (0.65) and West Bengal (0.65 million). The northeastern part of the country houses 38.42% of the pig population of the country. As pork is consumed in population with lower economic income, pork consumers may not be able to afford the high cost of cultured pork. Hence, prospects for cultured pork are not very bright in India.

Cultured meat from the perspective of different stakeholders

Farmers: Livestock sector provides cushion against crop failure occurring consequent to uneven rainfall and fluctuations in prices of commodities. India is an agrarian country and major chunk of the population especially in rural areas depend on agriculture and animal husbandry which complement each other. Any program to produce cultured meat will be viewed skeptically by famers. Their concerns must be kept in mind while working on production of cultured meat. Care must be taken to ensure that meat production is not handed over to Corporates from farmers jeopardizing their livelihood.

Meat handlers: Meat handlers involve people who involve in slaughter of meat animals, preparation of cutup parts and retailing of meat. Sourcing meat from non-animal sources will definitely worry them. However, production of meat in large scale will definitely take few decades in India. By that time it is hoped that there will be enough employment opportunities to absorb them.

Processors: Meat product processors will have the option of getting meat from non-animal sources to cater to niche market. Cultured meat can open up new business opportunities and processors will be happy with the prospects of cultured meat.

Consumers: It will be a win-win situation for consumers as they will have an option of getting meat which does not involve slaughter of animals which is generally perceived to be a painful process. However, Indian retail environment is price sensitive. Unless cultured meat becomes reasonably cheaper, Indian consumers may not afford it except for high income category of consumers at high end restaurants.

Policy makers: Host of issues including nomenclature of the meat, regulations to control, health effect of the cultured meat, detecting fraudulent practices etc will come to fore with the advent of cultured meat. Policy makers must be ready to address these issues and develop implementable guidelines by keeping in mind concerns of all stakeholders.

Export sector: As and when cultured meat reaches the market, India will be a net importing country in initial stages. However, buffalo meat is the major export commodity from India. It is unlikely that any organization will invest in culturing buffalo meat which is primarily dairy animal and meat is produced after productive and reproductive period. Hence, Indian export meat sector may not get affected by the growing prospects of cultured meat.

Conclusion

India is expected to become most populous country in the world by 2027. To meet the animal protein requirements of the ever growing population, country needs to triple its meat production by 2050. This becomes challenging in the back drop of decreasing natural resources especially water and land. Cultured meat can play a major role in meeting the animal protein requirements of the growing population. Also, sentiments attached to meat production and sensitivities to welfare issues are higher in India which necessitate support to initiatives towards production of cultured meat. Completely replacing the conventionally produced meat with cultured meat appears to be an improbable proposition. At best, cultured meat can contribute in meeting animal protein requirement by providing an alternative source to consumers who are averse to consumption due to welfare and environmental issues associated with conventional meat production. Research in production of cultured meat is the need of the hour; else country may need to depend on multinational companies for getting lab grown meat and country must not be left out in this area of research.

References

References can be made available upon request from the author.

(Lead 20)

Nanosensors for the Assurance of Quality and Safety of Meat and Meat Products in Supply Chain

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Introduction

Quality assurance in food is of utmost importance because consumers demand safe and wholesome food, as well as governments, impose stringent regulations to ensure food safety and food hygiene. The most common reasons given by consumers for discarding muscle food were concerns about its safety and the willingness to consume only the fresh product. Having a technology that can "sense" product safety, quality, and/or freshness, preferably in real time, will deliver critical information to processors, distributors, and consumers, potentially resulting in better decisions about safety and food waste. Such technologies ideally would have features such as high sensitivity and specificity of analyte detection.

Nanotechnologies are projected to impact at least $3 trillion across the global economy by 2020, and nanotechnology industries worldwide may require at least 6 million workers to support them by the end of the decade (Roco et al., 2010). The small particle size and increased surface area give nanoparticle its unique feature and wide applications in different fields. Nanotechnology based devices that are used as sensors are called nano-sensors. They can detect the presence of pathogens, gases, spoilage, changing temperature, moisture, chemicals, and toxins. It can be applied as nano-sensorsin smart packaging.

Manufacture of nanomaterials

Preparation of metal nanoparticles: Metal nanoparticles are used as various types of catalysts, adsorbents and sensors. They have applications in different devices used for the safety and quality of products. Most of these applications critically depend on the size and shape of the nanoparticles. Hence, the synthesis of well-controlled size and shape of these particles is critical for their applications. There are several methods like chemical reduction, spray pyrolysis etc. for preparation of these metal nanoparticles. The metal nanoparticles with spherical shape and sharp size distribution such as Au are produced continuously by the chemical reduction method assisted by ultrasonic device where by changing the amount of tannic acid into the mixture of $AuCl_4H$ and sodium citrate dihydrate, particle diameter of Au nanoparticles can be controlled between 5 and17 nm (Kikuo and Wuled, 2004). The mono-dispersed Ag nanoparticles ranging below 10 nm in diameter have been obtained in more than 100 mM of Ag concentration of precursor liquid.

Emulsion-solvent evaporation method: It is one of the most common methods used for the preparation of nanoparticles. It has basically two steps, where the first step involves preparation of an aqueous phase by emulsification of the polymer and in the second step, nanospheres are formed by inducing polymer precipitation and subsequently solvent is evaporated. The nano-particles are harvested by ultracentrifugation technique where washing is done with distilled water to remove impurity (Song et al., 1997). The size can be controlled by adjusting the stirring rate, type and amount of dispersing agent, viscosity of organic and aqueous phases and temperature (Tice and Gilley, 1985).

Double emulsion and evaporation method: The above method has the limitation of poor entrapment of hydrophilic materials. Hence, to encapsulate hydrophilic agent, the double emulsion technique is used. In this method, aqueous material solutions are added to organic polymer solution with vigorous stirring to form w/o(water in oil) emulsions and this w/o emulsion formed is again added into second aqueous phase with vigorous stirring to form the w/o/w emulsion (Pal et al., 2011). The emulsion formed is then subjected to solvent removal by evaporation and nano particles can be isolated by centrifugation.

Salting out method: In this method, the polymer and material to be carried are initially dissolved in a solvent and subsequently emulsified into an aqueous gel, containing the salting out agent. The salting out agent here are an electrolyte or a non-electrolyte and a colloidal stabilizer. Sufficient volume of water or aqueous solution is used to dilute the oil/water emulsion formed to enhance the diffusion of solvent into the aqueous phase. This results in induced formation of nanospheres. Salting out does not require an increase of temperature and hence can be usefulfor heat sensitive substances (Lambert et al., 2001).

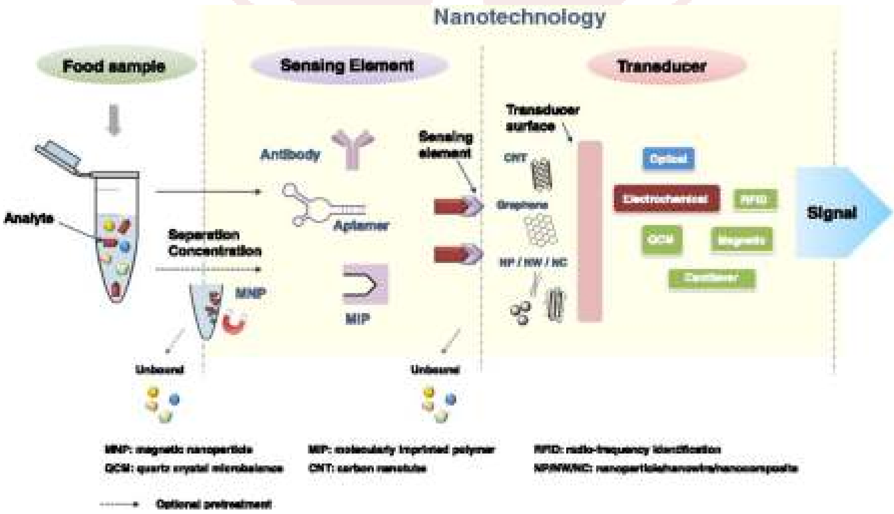

Fig. 1. Nanotechnology based sensors development (Wang and Duncan, 2017)

Nano-sensors

Sensors are devices that detect or measure physical, chemical, or biological properties and then record, indicate, or respond to those results. Biosensors in particular are analytical devices that combine a biological component with a physicochemical detector. The biologically derived component is a material or biomimetic compound that interacts, binds, or otherwise recognizes the analyte to be detected. Interaction between the biological element and the analyte results in a signal; a detector element physicochemically transforms (transduces) that signal, and frequently amplifies it into a form that is readily measurable and sometimes quantifiable.

There are many types of transducers, such as electrochemical, optical/visual, and mass based (Vigneshvar et al., 2016; Alahi and Mukhopadhyay, 2017). Nanomaterials are increasingly used as components of biosensors and can servea variety of functions, including as immobilization supports, for signal amplification, as alternatives to enzyme labels (nanozymes), and to aid in signal generation and quenching (Rhouati et al., 2017). In most cases, the choice to use nanomaterials is found on the desire to produce assays with greater sensitivity and specificity.

Noble metals (e.g., gold and silver) are frequently used for signal amplification because of their unique physicochemical properties; however, carbon, magnetic, metaloxide–based, and quantum dot nanoparticles have also been used (Rhouatiet al., 2017). Incorporation of a nucleic acid amplification step into the biosensor design, particularly those that do not require temperature cycling (e.g., loop-mediated isothermal amplification) can also increase analytical sensitivity (Giuffrida and Spoto, 2017).

Nanosensor applications for monitoring quality and safety of meat

Meat quality nanosensors

Chemosensors

Chemical sensors made from functionalized CNTs and their composites have been used to detect various types of biogenic amines such as putrescine and cadaverine resulting from the spoilage in fish and other raw meat products (Liu et al., 2015).

Electronic nose

Biomimetic devices such as electronic noses are being piloted for evaluating spoilage and shelf life of meats (Wojnowski et al., 2017). At the end of the sensing phase, an electronic reader allows signal processing so that results are displayed in a user-friendly manner.

The major types of chemosensory-based electronic nose technology include MOS sensors, conducting polymer (CP) sensors, quartz microbalance (QMB) sensors, and metal oxide field effect transistors (MOSFET). Certain manufacturers in recent years have also been developing hybrid or modular chemosensory systems that use multiple sensor types. The MOS and MOSFET sensors are considered to be 'hot' sensors, and the remaining sensor technologies and CP and QMB sensors are considered to be 'cold' sensors due to their operating temperatures (Schaller and Bosset, 1998). Recently, there has been an increase in the development of nanoscale sensors (primarily using metal oxide based) with an aim to miniaturize the sensing device. MOS sensors and CP sensors are the two technologies that have been used the longest in commercial electronic nose systems. Conducting polymer sensors are easily fabricated and are fabricated with a high degree of reproducibility. They also have the greatest range of selectivity and sensitivity. However, the MOS-based systems are less susceptible to water vapor variations, are more robust, have a longer useful life, and are cheaper to replace.

Table 1. Types of meat quality nanosensors

S.No.	Type of Nanosensor	Function	References
1	Gas sensor for the presence of gases, which may indicate meat spoilage.	Nanotechnology based sensors that can detect gaseous amines even in very low concentrations were developed.	Mills and Hazafy (2009); Duncan (2011)
2	Glucose/lactic acid sensor for Fermented meat	Colorimetric based on pH, Electrochemical sensor by redox reaction	Park et al., (2015)
3	Oxygen sensor for meat	Fluorescence, colorimetric based on pH, Electrochemical sensor, Laser	Meng et al., (2014)
4	Biogenic amines sensor for meat	Color-changing pH-sensitive dyes, Electrochemical sensor by enzyme redox reaction	Nopwinyuwong et al., (2010)
5	Gas sensor for meat	Tell-Tab™ Ageless Eye™ O_2Sense	IMPAK Corporation Mitsubishi Gas Chemical Inc. FreshPoint Lab.

Meat safety nanosensors

Nanosensors are engineered material of nano size material used for the detection of pathogens, toxins, early spoilage or contaminants in food. Nanosensors can provide quality assurance by tracking microbe throughout food processing chain through data capture for automatic control functions and documentation. Mobile diagnostics that use Internet-of-Things technologies to link sensor output to smart phones and cameras, and are even coupled with data entry on servers or the cloud, have been reported, particularly for detection of foodborne pathogens, food allergens, antibiotic residues, and shell fish toxins, in relevant sample matrices (Rateni et al., 2017). Although handheld mobile readouts are still in development with significant need for improvement (e.g., reducing signal-to-noise ratios, miniaturization, sample preparation, data interpretation, cost, and reliability), their future is bright because they provide options for portability and real-time results.

Aptasensors

Aptasensors are biosensors consisting of aptamers (the target-recognition element) and nanomaterial (the signal transducers and/or signal enhancers). Aptamers are single stranded nucleic acid or peptide molecules of size less than 25 kDa with natural or synthetic origin. They are highly specific and selective towards their target compound (ions, proteins, toxins, microbes, viruses) due to their precise and well defined three-dimensional structures. Aptamers are named as synthetic antibodies due to their selection and generation through an in-vitro combinatorial molecular technique called SELEX. Dissociation constants of aptamers are in nanomolar or picomolar range. Aptamers are extensively used as recognition elements in the fabrication of aptasensors. There are a wide variety of nanomaterials, which can be used in aptasensors (metal nanoparticles and nanoclusters, semiconductor nanoparticles, carbon nanoparticles, magnetic nanoparticles etc. (Sharma et al., 2015). Also, a wide variety of transducing systems have been employed in aptasensors for food quality assessment and safety. The principles of aptasensors are based on the property of the nanoparticle being used. Based on the detection systems, aptamers can be classified into optical and electrochemical systems.

Electrochemical nanosensors

Recently, numerous electrochemical nanosensors have been reported using impedimetric, potentiometric, and voltammetric techniques, for the detection of several bacteria and parasites. The achievement of sensitive detection limits for microbes was supported by incorporating nanomaterials like gold nanoparticles (AuNPs), carbon nanotubes (CNTs), and graphene oxide (GO), or by amplification of enzyme-labeled probes. Recently a method was reported for detection of the most common food pathogen, *Salmonella typhimurium*, in pork, exploring AuNPs and GO using an EIS-based technique with a limit of detection (LOD) of 3 CFU/mL (Ma et al., 2014). In an additional work, detection of *Staphylococcus aureus* was reported exploring single-walled carbon nanotubes (SWCNT) and a potentiometric technique achieving 800 CFU/mL in pig skin(Zelada-Guillén et al., 2011).

A representative scheme for detection of bacteria/toxin exploring various bioreceptors and nanoparticles is presented as Figure 2.2. Over the recent past, a variety of new immobilization supports have been proposed for making self-assemblies, biomolecule integration, and labels or signal enhancers by exploring various nanoparticles or carbon-based nanostructures to produce electrochemical biosensors of improved analytical performance.

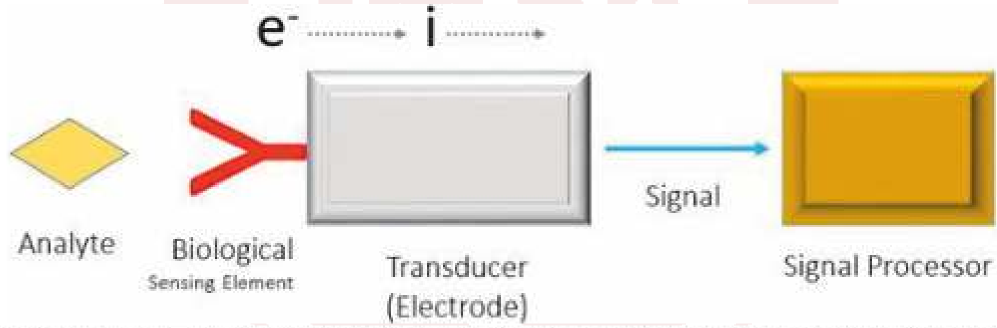

Fig.2.2.A. Schematic illustration of mechanism/principle of electro chemical biosensor

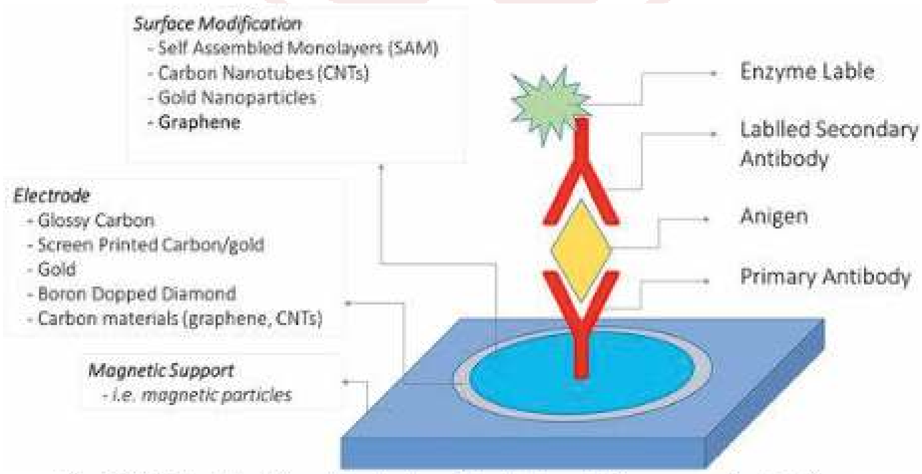

Fig. 2.2.B. Labeled/nonlabeled antibody based biosensor illustration

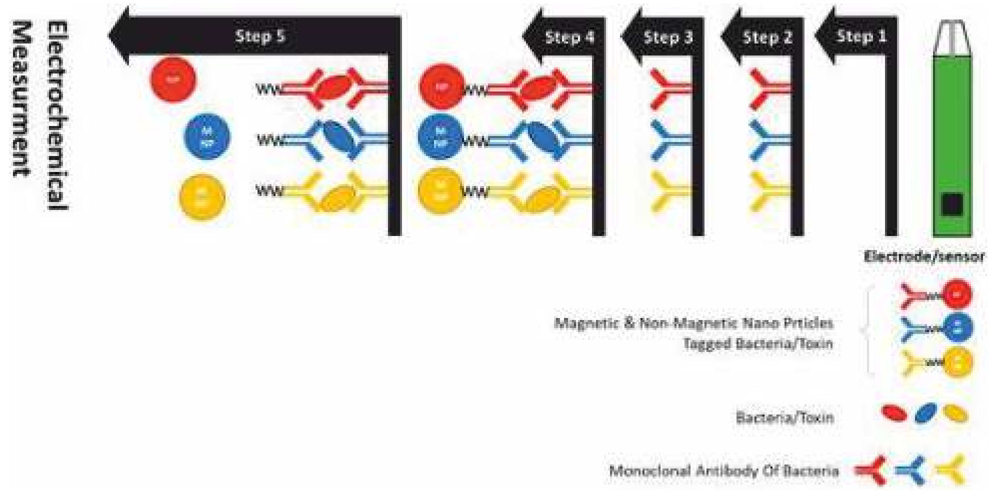

Fig.2.2.C. Schematics for bacteria and toxin detection using antibody based electrochemical biosensor

Nanosenors have provided food quality assurance via several methods among which is the detection of a pathogen such as *Escherichia coli* in a food sample by measuring the amount of scattered light by the mitochondria of the cell using high tech spectrometer. This sensor works on the principle that a protein of a known and characterized bacterium set on a silicon chip can bind with any other *E. coli* bacteria present in the food sample. This binding will result in a nanosized light scattering detectable by analysis of digital images (Horner et al., 2006).

Over the decade, biosensors have been produced to meet a specific need. 60 nm diameter fluorescent nanoparticles for in situ pathogen quantification in ground beef samples using antibody-conjugated silica has been developed (Zhao et al., 2004).

It was also a landmark when fluorescent dye biosensor particles attached to anti-*Salmonella* antibodies on a silicon/gold nanorod array was developed by Fu et al. (2008). Its mechanism was based on the visibility of the biosensor particle if salmonella bacteria are present in the food. Unlike the time-consuming conventional lab tests that are based on bacterial cultures, this biosensor can detect the salmonella in food instantly.

Stutzenberger et al. (2007) paved path in bacteriology of *Campylobacter* bacteria. They developed bioactive nanoparticles in the chicken feed specifically designed to bind to the biomolecular structures on the surfaces of *Campylobacter* sp.

Relevant to the poultry meat industry, nanosensors have been developed for the detection of antibiotics in chicken tissue (Ahn and Lim, 2015; Long et al., 2015; Lu et al., 2015; Mungroo and Neethirajan, 2014; Peng et al., 2013).

The use of nanosensors has been reported for the detection of *Salmonella* in chicken extract (Kim et al., 2015); *Vibrio* and *Salmonella* (multiplex) in chicken breast (Duan et al., 2015); *E. coli*, *Listeria*, *Salmonella*, *S. aureus* in chicken rinse (Sundaram, et al., 2013) and, *Salmonella Typhimurium* in chicken carcass wash water (Yang and Li, 2005).

Using universal protein G-liposomal nanovesicles and an immunomagnetic bead sandwich assay we can simultaneously detect *E.coli* O157:H7, *Salmonella* spp. and *Listeria* *monocytogenes* (Chen et al., 2006).

A quartz crystal microbalance based biosensor has been reported using 50 nm gold nanoparticles as amplification probes for DNA detection (Zhao et al. 2001). A gold nano-particle coated quartz crystal microbalance based DNA sensor has been reported for the detection of *E. coli* O157:H7 synthesized oligonucleotides (Rashidi and Kashravi-Darani, 2011). The use of nanoparticles amplifies the signals and improves the detection limit for pathogenic bacteria detection (Mao et al. 2006).

Mycotoxins from mycotoxigenic fungi, may also be an issue in poultry feed for foodproducing animals (Greco et al., 2014). The use of nanomaterials in the fabrication of nanobiosensors for the detection of mycotoxins in food and feed has been comprehensively reviewed (Raiet al., 2015). Nanosensors have also been employed in the detection of several pesticide residues that are widely used in agriculture (Liu et al., 2008; Xiang et al., 2011).

Table 2. Types of meat safety nanosensors

S.No.	Type of nanosensor	Function	References
	Biosensor for detection of *Salmonella Infantis,* associated with the egg and especially the chicken meat industry.	A network of single walled carbon nanotubes has been used for the construction of a field effect transistor (FET) biosensor for *Salmonella Infantis* detection and the device could detect at least 100 cfu mL − 1 of the pathogen in 1 h.	Villamizar et al. (2008)
	Pathogen sensor through a specified protein on silica chip	Detects specific pathogen in foods Detect specific pathogen by luminescence	Homer et al. (2006)
	Luciferase nanosensor	Dye attaches with *Salmonella* and *Campylobacter* which emit light or florescence	Stutzenberger et al. (2007); Fu et al. (2008)
	Spoilage sensor due to microbial growth	Natural dyes and nanocomposite (pH or reacting with volatile or non-volatile metabolites	Kandeepan et al. (2017)
	Poultry meat microbial quality sensor	MOS	Fox 3000, Alpha MOS America, Inc, Hillsborough, NJ, USA (Dorothy and Boothe 2002)
	Toxin sensor for meat	Toxin Guard™ Food Sentinel®	Toxin Alert SIRA Technologies
	Pathogen detection sensor for meat: *S. typhimurium*	Detection Principle: Amperometric Detection Limit: 1-10 cells/125 g	Xu et al. (2016)
	Toxin detection sensor for meat: Staphylococcal enterotoxin	Detection Principle: Array immunoassay Detection Limit: 0.5ngs/ml	Wu et al. (2016)

Meat traceability nanosensors

Nanobarcodes

Nanotechnology can help food industries in providing authentication, and track and trace features of a food product for avoiding counterfeiting, thus preventing adulteration and diversion of products destined for a specific market. Its mechanism is based on generating complex invisible nanobarcodes with batch information which can be encrypted directly onto the food products and packaging. A nanobarcode detection system created by Li et al.(2005)that fluoresces under ultraviolet light in a combination of colour that can be read by a computer scanner has been tested on some food and biological samples containing various combinations of *E. coli, anthrax, and tularemia bacteria, Ebola, SARS viruses* and several pathogens – and they were clearly distinguished simultaneously by different colour codes.

This nanobarcode technology offers food safety by allowing the brand owners to monitor their supply chains without having to share company information to distributors and wholesalers. By altering the stripe orders, different codes can be created and be assigned to every food item providing brand and authenticity in tracing food batches. NanoInk, Skokie, has developed a patterning technique called Dip-Pen Nanolithography to encrypt information directly onto food products or pharmaceutical pills and on packaging (Zhang et al., 2009). However, Barcode, a registered company in US, is currently using this detective tool for traceability to ensure wholeness.Oxonica (UK) produces unique reading strips for food items consisting of gold, silver, and platinum varying in width, length, and amount to create stripes of different reflectivity.

Nanomaterial based flexible radio frequency identification (RFID) tag sensors

Radiofrequency identification (RFID) technology is based on wireless communication systems and offers easyintegration into the Internet cloud system. The potential of RFID tag sensor technologies has beenstudied in different industrial sectors including healthcare and food safety.Tanguy et al. (2015) developed wireless and battery-free RF biosensor for monitoring of food quality. This research study showed that RFID tag developed from MWCNTs and g-MWCNTs can be used for faster detection of spoilage in food products.

Escobedo et al. (2017) fabricated a passive RFID sensing tag for detecting carbon dioxide, oxygen, ammonia, and relative humidity (RH), which were readable by a smartphone. The tag functions were based on NFC technology to harvest energy and for easy data transfer to a smartphone. In this RFID system, the use of NFC-enabled smartphones is the reader, which eliminates the requirement of an RFID reader. The gas sensor requires very low power to read an optical response using high-resolution digital color detectors. The Android™ operating system was applied for the power supplying and for receiving data from the tag. The RFID tag was inkjet printed on a flexible poly (ethylene naphthalate) (PEN) film using AgNP-based conductive ink. A digital color detector is located on the flexible PEN surface-facing sensing membranes for reading the optical response from a multigas sensor. A white LED was placed in the center of four sensing membranes to excite the sensors. The optical sensitivity of four membranes was detected by the color detector where oxygen gas has a luminescent response while all remaining three gases have a colorimetric response. The AgNP ink/PEN flexible film-based NFC/RFID tag sensor showed the limit of detection (LOD) as 1.3×10^{-3}% for O_2 gas, 7.9×10^{-4}% for NH_3 (gas concentration of 1.5×10^{-2}%), 0.23% for 5% concentration of CO_2 gas, and 1.8% for 15% humidity for a required frequency of 13.56 MHz, which was within the ISO 15693 protocol specification for wireless operation. The time response to collect and display the sensing results on the Android smartphone application was less than 1 s.

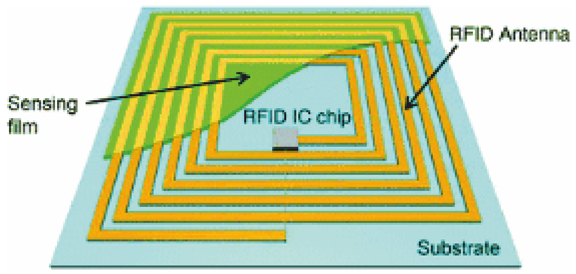

Fig. 3.2.A. Schematic illustration of a RFID tag sensor. The resonant antenna is coated with a chemically sensitive thin film and has an IC memory chip. [Reprinted with permission from Potyrailo and Surman (2013) Copyright © Elsevier.]

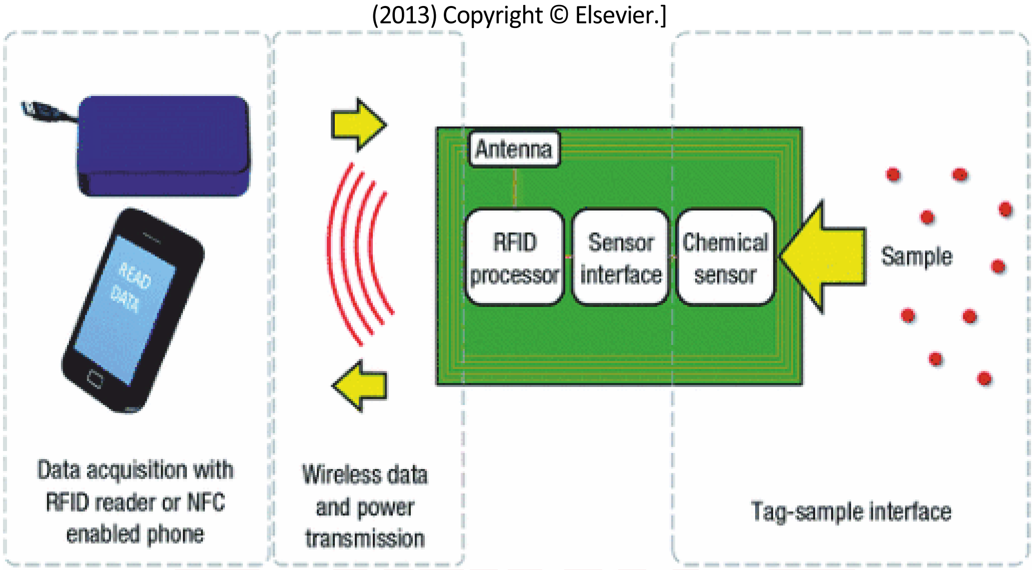

Fig. 3.2.B. Schematic illustration of an RFID-based tag chemical sensor platform and its operating principle. [Reprinted with permission from Kassal et al. (2013). Copyright © Elsevier.]

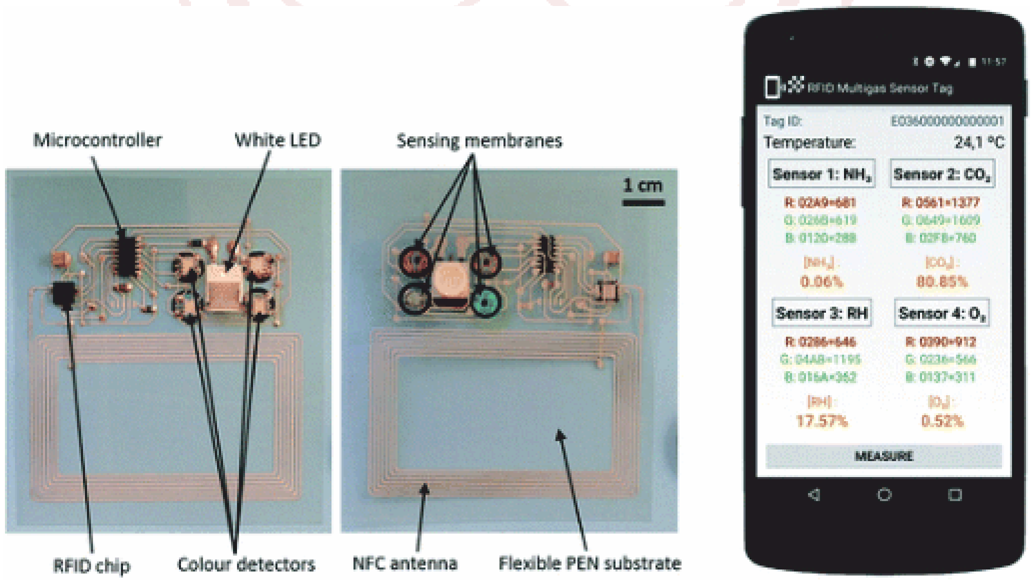

Fig. 3.2.C. (Left) Photographs showing both sides of the flexible multigas RFID sensing tag. (Right) A smartphone showing multigas sensing using the Android™ application. [Reprinted with permission from Escobedo et al. (2017) Copyright © American Chemical Society.]

Fig.3.3.A&B. RFID sensor layout for demonstration of determination of milk freshness. (A) Schematic of sensor positioning onto a milk carton and sensor-response readout with a pick-up coil. (B) Photo of milk cartons with attached RFID sensors. (Texas Instruments (Plano, TX)).

Meat adulteration nanosensors

Food forensics is investigation of food origin, adulteration and contamination. Furthermore, nanosensors employing Raman spectroscopy are ideally suited for food forensic. A simple sensing system for pork adulteration in processed meats using the DNA biosensor based on 20 nm gold nanoparticles (AuNPs) with aggregation property has been developed as a simple colorimetric detection of target DNA (Kuswandi et al., 2017). Adsorption of single-stranded (ss) DNA on AuNPs protects the particles against salt-induced aggregation. However, mixing and annealing of a 27-nucleotide (nt) ssDNA probe on AuNPs with denatured DNA of different processed meats differentiated between perfectly matched and mismatch hybridization at a critical annealing temperature (55 °C). The AuNPs change color from red to purple, in 10 mM phosphate buffer saline (PBS). At a hybridizing temperature (55 °C), non-target mismatched DNA provided hybridization products allowing probe to be free and adsorbed to AuNPs. This prevented AuNPs from salt-induced aggregation as the color still red. In matched DNA, hybridization would occurred, allowing probe to be occupied. This facilitated AuNPs from salt-induced aggregation and induced colorimetric change of particles from red to purple. These signals could be observed easily with naked eye. This label-free DNA nanobiosensor finds applications in food analysis and other DNA based screening.

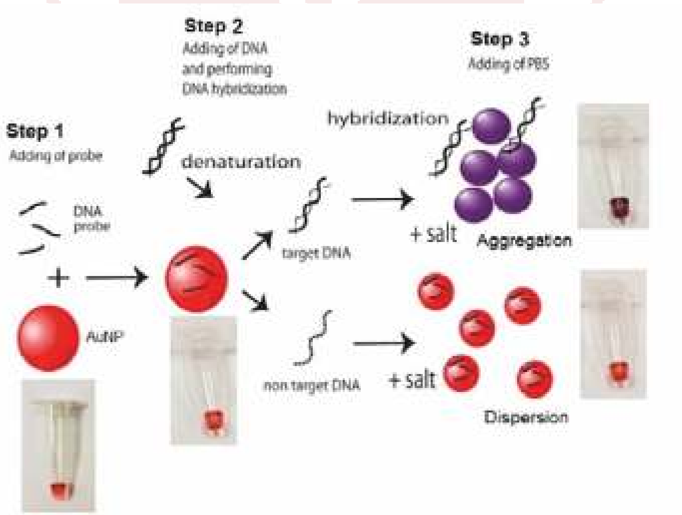

Fig. 4.A. Schematic of a colorimetric DNA detection based on AuNPs

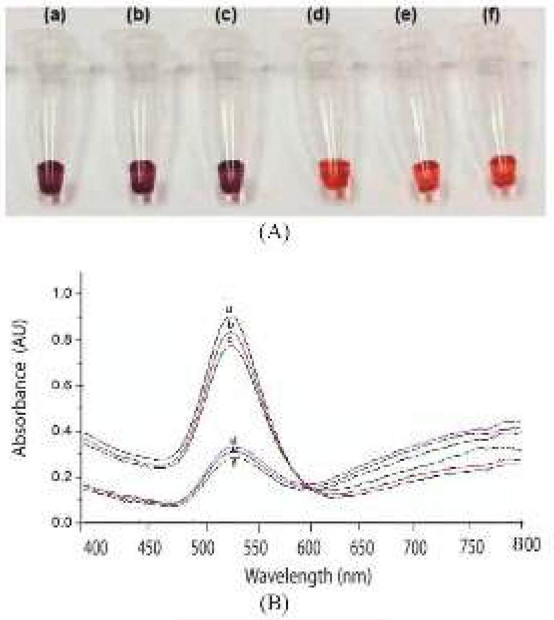

Fig.4.B.Detection of porcine DNA in mixed meatballs (A). Vials ((a)-(f) represent color of AuNPs in genomic DNA extracted from meatballs prepared with pure pork (a),1:1 (w/w) mixtures of pork-beef (b), pork-chicken (c), chicken beef (d), pure beef and pure chicken (f). The corresponding absorption spectra are labeled alphabetically (B). All vials are incubated at 95°C for 3min and annealed at 55°C for 2min with 27 merssDNA-AuNPs before adding the 10mM PBS

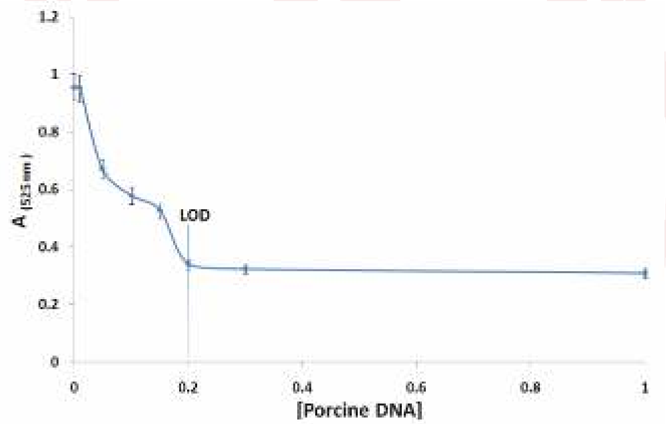

Fig.4.C. Determination of LOD for pork in the beef meat balls at 525nm, where the LOD is shown to be 20% (6µg/ml) of porcine DNA in mixed meatball preparation

Smart meat packaging nanosensors

Intelligent packaging nanosensors

The incorporation of sensors into the food packaging technology has resulted to what is called 'smart or intelligent packaging'. The principles of smart packaging engage the use of chemically or biologically made sensor to monitor the quality, integrity, wholeness, and safety of food from the producers to the costumers via delivery chain. This technology can result in a variety of sensor designed to change its coding when there is a breach of set parameters like pathogens invasion, leakage, carbon dioxide, oxygen, pH, time or temperature change. Thus, this technology is needed as online quality control and has great potential in the development of new sensing systems integrated into the food packaging.

An example of the latter is a label for poultry meat based on a reaction between hydrogen sulphide and a nanolayer of silver (Smolander et al., 2004). Sulphur compounds are produced during the decay of poultry meat, such as chicken or turkey. The nanosilver layer is opaque light brown, but when meat starts to deteriorate silver sulphide is formed and the layer becomes transparent.

The ultraviolet (UV)light-activated sensor had an irreversible response and was reusable. The nanoparticulate crystalline titania was selected for its design because it had greater photoactivity. These materials were incorporated in a polymer to create an oxygen-sensitive, UV-activated film that could be printed directly onto food packaging material (Millsand Hazafy, 2008), hence, intelligent packaging. One example is an oxygen detecting ink containing light-sensitive (TiO2) nanoparticles, which only detect oxygen when they are “switched on” with UV light. One of these methods is photo activated indicator ink for in-package oxygen detection which is based upon nanosized TiO2 or SnO2 particles and a methyleneblue where the colour of the films varies according to O2exposure– it is bleached when there is no exposition and blue when film is exposed (Milan et al., 2013). Other conductive inks for ink jet printing based on copper nanoparticles have also been developed (Park et al., 2007).

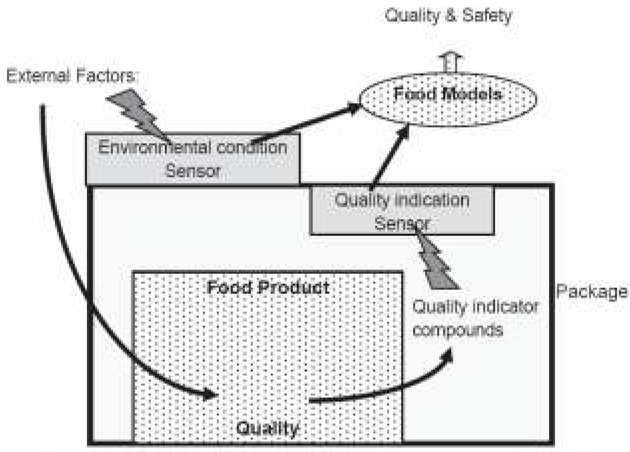

Fig.5.1.Schematic illustration of intelligent packaging with sensors that monitor environmental conditions, or quality attributes of the product related with overall food quality change.

Consumers' preferences for nanosensors in food packaging

Erdem (2014) showed a lack of a significant effect of nanosensors on choices consumers made, from the analysis of debriefing questions, it was found that more than half of the consumers (51%) indicated that the use of nanosensors in the packaging of chicken 'seems like a good idea'. The remaining 13% indicated that it' does not bother them', 20% were 'a bit concerned but not greatly', 10% were 'concerned for themselves and their families', and 6% were 'more than concerned.' Among those who thought that the use of nanosensors seems like a good idea, only 5%opted-in to the status quo alternative and 95% chose chicken alternatives with nanosensors.

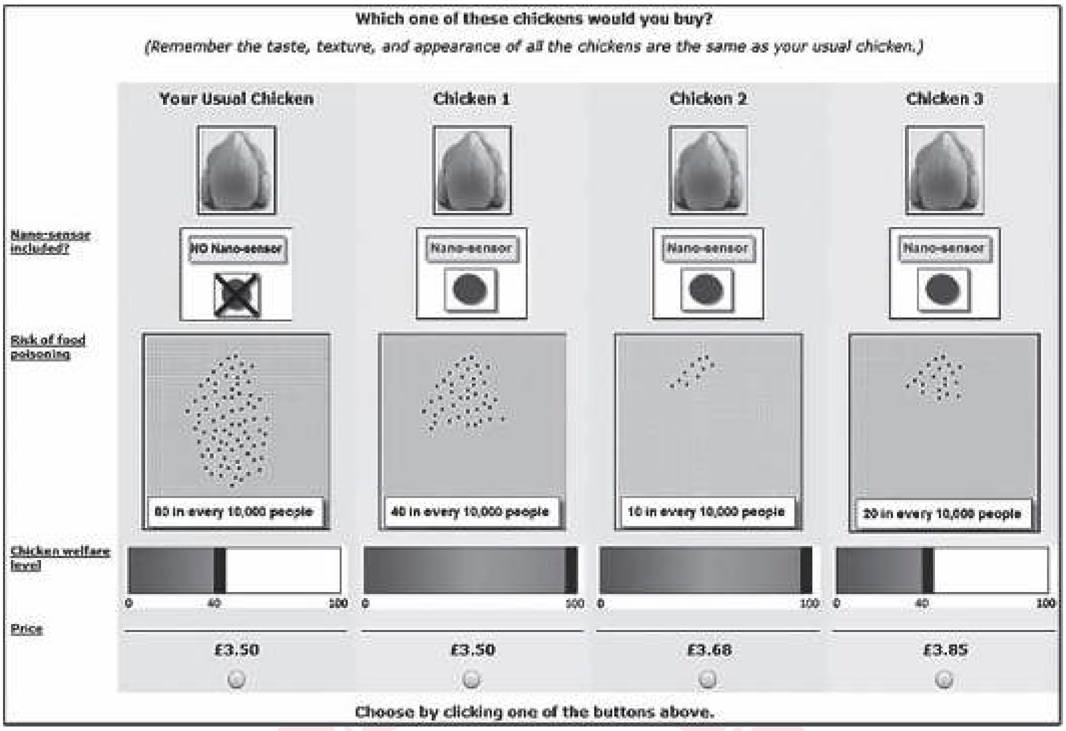

Fig.5.2. Consumers' preferences for nanosensors in food packaging

Gaps in application of nanosensors

There are a number of practical impediments to successful, routine use of biosensor technologies in foods and environmental samples. For sensors to be of the greatest value in food safety, analytical sensitivity (detection limits) must be high (<10 cells) and specificity needs to be high. In addition, sample size should be large and testing done frequently in order to account for low contaminant prevalence.

In short, assay sensitivity and specificity (detection limits and low propensity for false positive and false negative results) will need to improve for sensor technologies to gain more widespread use in food and agriculture. In addition, there is a pressing need to develop sample preparation methods and protocols that will efficiently concentrate and purify ananalyte from the matrix prior to use in the sensing device (Brehm-Stecheret al., 2009). This includes validating sensor performance in relevant natural sample matrices (i.e., various waters, foods, and environmental samples). Other factors related to conditions and ease of use, robustness, and cost are critical for success.

Safety aspects of nanosensors utilization in meat industry

Despite the tremendous benefits of nanosensors in the agriculture and food industry, there is a huge public concern regarding toxicity and environmental effect. There is very limited knowledge about its long term adverse effect on soil, plants and ultimately on human. The toxicity of nanoparticles in the environment depends on their size, type, charge, etc. Additionally, the influence of nanoparticles on the environment depends also of the environmental factors (humidity, temperature, wind flow rate, the nature of light, etc). However, properties of nanomaterials, small size and large surface allow easy dispersion and bonding in the environment and with human tissues.

Conclusion

The excellent specificity of the nanosensors and aptamers allows an analysis of wide variety analytes, including heavy metal ions, toxins, pathogens, small molecules, nucleic acids and proteins. Nanoparticles add on to the selectivity and convenience of the diagnostics, by the providing larger surface area for aptamer immobilization as well as by conferring their own opto-physical and electrochemical properties to the sensor. Some obstacles still exist in the development of field-applicable nanosensor techniques (sample pretreatment technique, specificity, expenses). It can be hoped that further insight into the probable solutions to these problems and in the development of novel nanomaterials will boost designing of affordable and easily operable nanomaterial based sensing system. However, the full potential of nanotechnology in meat sector is yet to be realized and can be achieved only with improved awareness and knowledge of the potential harm from nano-enabled products, and the long-term impacts of nanomaterials to the environment and human health. The future researches will be focused in the development of novel reliable material, methods and smart devices on the nano-scale, to the realization of IoNT vision, as well as to the evaluation of their impact on the human and environment. Moving towards green nanotechnology and green IoT will lead to a whole new world of safe nano products and their widespread applications with little or no hazards to human health and the environment.

References

References can be made available upon request from the author.

(Lead 21)

Developments in Sustainable Packaging of Muscle Foods

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Packaging plays a crucial role in the modern life. Packaging not only contains, protects and enhances shelf life a food but also provides base for labeling besides acting as a marketing tool. Traditional plastics are widely used for food packaging materials because of several unique properties. These are chemically inert, light weight and cost effective. They provide wide choices in respect of transparency, heat sealing, colour, heat resistance and barrier properties. They are moldable to make film sheets, shapes and structures.

Most of todays synthetic polymers are produced from petrochemicals and are not biodegradable. Their persistent use generates lot of environment pollution. Worldwide, more than 250 million tonnes of such plastics are being produced annually. Nearly 60% of the total plastic is used for food packaging sector while 40% of plastic produced is used only once and then discarded. Packaging industry has now started getting a bad publicity due to lot of single use plastic, non-recyclable materials, excessive use of resources, increasing landfills and harm being caused to marine environment. A plastic bag decomposes in decades and plastic water bottle takes 450 years to decompose. Several widely used packaging plastics can take up to 200-1000 years to degrade in landfills that emit green house gases.

Many of us are well aware of Great Pacific Garbage Patch which is bigger in size than the size of Spain and swimming with non-biodegradable plastic waste. The birds, fish and other marine life are dying because they either eat it or get entangled up in the plastics. Ghent University, Belgium scientists have predicted that by 2050, the volume of plastics accumulated in our oceans will be greater than that of fish. Global warming and climate changes are real threats that are happening right now. These are the results of increase in green house gases in the atmosphere. So we are required to reduce our individual carbon footprints. It should also be noted that synthetic plastics are manufactured from fossil fuel which is a limited, non-renewable resource and bound to be run out. These conditions call for urgent need to explore, design and use sustainable packaging from renewable resources in order to maintain ecological balance.

Sustainable packaging refers to the development and use of packaging that is reusable, renewable, recyclable and biodegradable/compostable while being designed to reduce environmental impact and ecological footprint. It takes the holistic view and is always an environmental friendly packaging. It is also referred as green packaging. Sustainable packaging offers many benefits like (i) reduction in waste (ii) recycling of used product packaging (iii) cleaner production process and (iv) most importantly, reducing threat to the environment.

Sustainable packaging follows the highly popular 3-R Principle of waste minimization - reduce, reuse, recycle in the context of both production and consumption.

- Reduce: Reducing the amount of waste at source is the best way to conserve the environment. Only required minimum packaging has to be used.
- Reuse: The packaging can be reusable either for the same purpose or for a different use. Reuse is preferred over recycling because it saves the cost of reprocessing and managing the generated waste.
- Recycle: Recycling is the process of converting the waste of one product which can again be used for creating new product. It reduces the environmental footprint.

The term biodegradable is used to describe those materials which can be degraded by enzymatic action of organisms like bacteria, yeast, fungi etc. This biodegradation results in the formation of carbon dioxide, water and biomass which are returned to the nature by way of biocycle. Biodegradation occurs in the presence of moisture and micro-organisms typically found in the environment. This process is triggered by heat and mechanical stress. Biodegradable materials are made from renewable sources, so they completely breakdown and decompose into natural elements within a short time after disposal- typically in a year or less. Compostable materials are also similar to biodegradable materials but they can degrade at a faster rate in designated sites under specific conditions of sunlight, temperature, wind etc. They provide rich nutrients once the material is completely broken down.

Eco-friendly packaging can be biodegradable, but it is mostly compostable because of its origin from 100% recyclable plant based materials. Eco-friendly packaging from biodegradable materials like corn starch, sugarcane bagasse, cassava etc. contribute to environmental sustainability because (i) they make use of renewable materials (ii) their manufacturing process consumes less energy (iii) they do not release harmful carbon (iv) they decompose in significantly less time and do not pile up in landfills (v)These materials do not pollute our planet.

Sources of biodegradable polymers:

- Polysaccharides: starches, wheat, potatoes, maize, cassava etc.
- Ligno-cellulose products: wood, straw etc.
- Others: pectin, chitosan, gums etc.
- Biopolymers are divided into three main categories according to their method of production:
- Biopolymers obtained from chemically modified natural products:
- Starches (wheat, potato, maize, cassava), cellulose, chitin and chitosan, soy based plastics etc.
- Biopolymers produced through fermentation of micro-organisms
- Polyesters, natural polysaccharide etc
- Biopolymers obtained from chemical synthesis
- Polylactic acid (PLA), polyglycolic acid (PGA), polycaprolactone, polyvinyl alcohol etc.

The packaging has to be either recyclable or biodegradable or compostable so that it does not end up in landfill. The use of biodegradable polymer reduces the environmental impact of non-biodegradable plastics. Some of the recent commercial developments in this field are given below:

- Bio4Pack, Netherland (2017) has succeeded in producing a sustainable packaging solution for fresh meat that meets the requirements pertaining to renewability as well as compostability. The dish is made out of PLA (polylactic acid), which is is made from sugarcane, providing renewable and compostable packaging for fresh meat. The impact additive gives the dish the required strength. A pigment gives the dish its characteristic green colour.
- Justine Muller(2017) extensively studied the polylactic acid (PLA) and starch as potential replacements for non-degradable petrochemical polymers on the basis of their availability, adequate food contact properties and competitive cost. Their combination as blend or multilayer films could provide properties that are more adequate for packaging purposes on the basis of their complementary characteristics.
- CP Foods, Thailand (2018) launched green packaging for meat range. It is also using plant-based Polylactic Acid (PLA) trays, which is a compostable bioplastic made from natural renewable resources, as a replacement for plastic tray in chilled raw chicken and pork products. The company has redesigned its food packages, for example, packages for fresh chicken, and pork products, to optimize all resources used in food production, reducing waste, especially plastic waste, and promote the use of environmentally friendly materials in accordance with the concept of Circular Economy. As a part of the initiative, CP Foods has redesigned many of its packages such as replacing raw chicken products' multilayer plastic package with a single layer package that is smaller and 100% recyclable, resulting in 24% cost saving.
- Plantic Technologies, Australia is using a combination of plant-based and recycled materials to create meat packaging. This type of packaging is unique when compared to commonly used oil-based packaging. The material is proven to give substantial environmental benefits through a reduction in CO2 emissions Plantic Technologies (2015) primary raw material is a naturally high amylose starch, derived from corn which has been hybridized over a number generations whose special chemical properties allow for a wide range of applications, including thermoforming, injection molding, film extrusion and blow molding, as well as rigid and flexible packaging. PLANTIC™ HP is 100% biodegradable sheet and can be used in a number of packaging applications. It provides outstanding gas barrier properties and is the high performance environmental material. Plantic Eco Plastic is high barrier multilayer rigid and semi rigid sheet used for packaging refrigerated goods such as meats and fish. The core layer of the structure is predominately made from corn starch and constitutes about 80% of the total structure. The skin layers are primarily polyethylene and polypropylene.
- Sirane's, Iceland launched Earth Packaging range of compostable food packaging solutions in January, 2019. The Earthpouch is made from a paper with a 100% plastic free heat-sealable coating which is then formed into a preformed stand-up pouch which provides total food security for dry and moist food products. It reduces both packaging waste and food waste. Other compostable food packaging from Sirane includes breathable bags and films for extending the life of fresh produce. Sira-Flex Resolve is a natural biopolymer which can be made into bags or films, can extend

shelf-life by many days. Sirane's Sira-Flex™ Resolve® is a unique plant-based breathable film developed to have the optimum balance between humidity control and O2 and CO2 permeability to prevent degradation. Other compostable products include absorbent pads for meat, poultry and seafood. Integrating anti-microbial or anti-bacterial technology, for example, can help extend the shelf-life even further, helping to achieve 20% reduction in food waste.

- **Accredo, USA has come up with** recyclable stand-up pouch which provides the consumer a more sustainable proposition of recyclability: Using renewably-sourced resin from sugar-cane feedstock (as opposed to hydrocarbon-based feedstock), Accredo has successfully pioneered sustainably produced packaging with a highly renewable content. It has end use market applications for frozen animal protein-based products (chicken, fish and shellfish). It reduces carbon footprint and impact of global warming and climate change. Accredo was the first company globally to manufacture a zippered stand-up pouch made from certified compostable component as per standards for compostability in industrial composting facilities. New developments in compostable film technology enable us to produce compostable packaging that achieves the highest moisture and gas barriers.
- Clyser (USA) has made promising advances in commercially viable plastics made from organic materials that can be replenished, such as polylactic acid (PLA) derived from corn. PLAnet™ shrink film from Clysar (USA) for example, is an ideal candidate for packages where renewable, bio-based content is desired. The industry's first 100% renewable, compostable PLA shrink film, 90% this film will biodegrade in 12 weeks in home or industrial composting facilities. It does not sacrifice packaging performance or appearance and display film offers balanced shrink in all directions.
- Total Packaging Solutions (TPS), USA provides expert eco-friendly packaging services across the food industry. TPS is source for 'green' eco-friendly solutions — certified disposable containers, tableware, and compostable packaging — made from renewable and sustainable bamboo products. Total Packaging Solutions supplies high quality MAP supplies to leading companies serving the food industry. Total Packaging Solution compostable products include **hot soup cups as well as bamboo & bagasse trays. Their barrier products include vacuum bags and vacuum as well as MAP pouches.**

Biodegradable vacuum pouches have been introduced in United Kingdom as Eco pouches. These are made up of corn starch, cassava and eucalyptus fibre. These pouches are 100% decomposable. They are ocean friendly and dissolve in marine environment within 26 weeks and in commercial composting conditions in 12 weeks. The pouches are a natural barrier to aroma, oil and grease. These are suitable for meat cuts, dressed poultry and cooked meat as well as poultry products.

Edible packaging is also environment friendly and reduces the waste and solid disposal problem. It is a thin continuous layer of edible material formed on or placed on the food. Thus package is an integral part of food and can be eaten along with food. Edible packaging retards moisture migration as well as gas permeability retain volatile flavor compounds and may improve mechanical handling. Edible collagen casings for salami and smoke house snacks are quite popular in this category. These casings are required to be kept in refrigerator when not in use and soaked in water for 2-3 minutes before putting on the stuffer.

A newer development in this field addresses the issues of poor barrier properties and weak mechanical properties generally encountered in biopolymers. The application of nano-composites could bring about modification in the properties of biomaterials. It can make them lighter and improve the strength as well. This technique promises to expand the use of biopolymers in processed muscle foods by supporting preservation and extending shelf life. Antimicrobials such as nano-particles of silver or titanium can be used for this purpose. Whey protein isolate (WPI) film embedded with titanium nano-particles have great potential for extending shelf life of packaged meat products.

Plant based sustainable packages made from renewable, low carbon or recycled materials are emerging as good alternative to plastic packaging. Their use is bound to increase and ultimately replace the fossil fuel based packages in future.

References

References can be made available upon request from the author.

(Lead 22)

Development of an Eco-Friendly Natural Packaging Material from Banana Leaves for Hauling of Meat and Fish Products

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Introduction

The menace of single use of plastic bags for packaging and carrying food materials and other house-hold items has been realized by all over the world. The single use of plastics is meant for use only once before they are thrown away or recycled, hence they are disposable. These comprise varieties of items which include polyethylene bags, sachets, straws, containers, cups and plates etc. Plastic is harmful to the environment as it is not biodegradable, which persists in the environment for ages and create pollution. It can take hundreds of years to decompose, thus, contaminating our soil and water in the process. The noxious chemicals used to produce plastics get transmitted to animal tissues and finally water and human food chain.

The plastic materials cause big impact on wild and marine life too. Birds consume plastic bags by mistake. Fish consume thousands of tones of plastic in a year ultimately transferring it to the food chain. Domestic animals also consume plastic materials in search of feed where animals are let loose for grazing as a system of rearing. Even plastic bags are causing menace by blocking the natural canals and drains in cities, thus creating artificial flood during rainy season. It is reported that around 14 million tones of plastic are used per annum in India out of which only 40 % are recycled.

Plastic materials interact with fresh meat and thus, micro-ingredients like BPA (Bisphenol-A) are absorbed by meat cut surfaces. These harmful substances enter into the human system through consumption of meat or fish and cause several endocrine disorders including male and female infertility, early puberty, breast and prostate cancer and polycystic ovary syndrome (PCOS), birth defects and miscarriages. Even reports indicate that these ingredients can raise the risk of diabetes, irritable bowel syndrome, gut disorders and high blood pressure.

Ban on single use plastic:

Realizing the ill-effects of plastic, many countries of the world including India have proposed to ban on the single use of plastic. This is in compliance with the call given by the UNO on 5th June, 2018 (World Environment Day) where the world organization gave a clarion call to all the member countries to reduce the use of plastic by using alternative materials. In response to this call, India hosted the 43rd World Environment Day with a theme "Beat Plastic Pollution" focusing on single use or disposable plastic. The Ministry of Environment, Forest and Climate Change of India requested all the citizens to take care of their social responsibility to reduce the use of plastic. Several states of India declared their plan to ban plastic. Ultimately, at the initiative of our Hon'ble PM, a nationwide partial ban is imposed on plastic bags and similar articles on 2nd October, 2019.

Problems arising for banning of plastic bags in meat and fish markets:

Very big percentages of middle class population as well as the meat and fish vendors depend upon single use plastic bags for wrapping and carrying fresh meat and fish. No doubt that these single use plastic are cheaper, handy and easy to carry, non-sticking, water proof and disposable. However, recent ban has created different sorts of problem particularly for carrying meat and fish. Meat and fish are high moisture perishable food items. Paper bags and news papers are not suitable because these items become wet and it is difficult to guard the products. Bags made up of cloth are also not good because of the water absorbing properties of yarns or threads and development of bloody patches outside the bag- which the customers feel as unaesthetic also it gets soiled very frequently. Most customers are unhappy with the paper bags during rainy season. Some customers even bring steel or aluminum utensils to carry fish or meat; however these are also not convenient. Earthen pots are also used by some customers against their will.

Alternative packaging material for meat and fish:

The immediate problems crops up due to imposition of ban on single use of plastic have been felt by most of the consumers and vendors. The alternative to plastic carry bags is keenly felt in meat, fish and milk markets. Many traders, dealers, business firms have started using alternative packaging materials for carrying meat and fish, however, due to obvious reasons, the materials are not competitive to plastics. The alternative single use packaging material must possess the following minimum qualities to be used for carrying meat and fish.

- Eco-friendly, biodegradable and non-polluting

- Easy availability
- Cheaper or cost-effective
- Non-sticking and moisture proof
- Recycling for development of secondary products.
- Non-poisonous

Certain agro-based alternative materials such as bio-plastic, chitosan from shrimp cells, sugarcane waste, sea weeds, wood pulp, tree leaves etc. are tried in market, but not without problems. Therefore, there is an urgent need to find alternatives to plastic polymer.

Conceiving the concept of banana leaves as packaging material:

While searching for alternative packaging material to plastic, a novel idea was developed i.e., use of banana leaves as packaging material. This concept was conceived because of the following visible advantages.

- India ranks first in banana production.
- Almost all the states of India produce and use banana leaves for different purposes i.e., packaging and carrying of food items, distribution of food in social and religious functions.
- Banana leaves are used for serving of foods in hotels and restaurants of southern states and tribal communities use it for wrapping of food items thus, it has cultural and ecological significance.
- Abundantly available as waste material after harvesting of fruits.
- Banana leaves are cheaper, large, flexible and water proof.
- Banana leaves contain large amount of polyphenols which are beneficial for health.
- Waxy coating of banana leaves develops a pleasant and acceptable mild flavor which enhances the taste of the food.
- No major technology is involved to prepare packaging materials
- Non sticking properties- suitable for meat and fish.
- Can be plasticized to enhance their strength and flexibility.

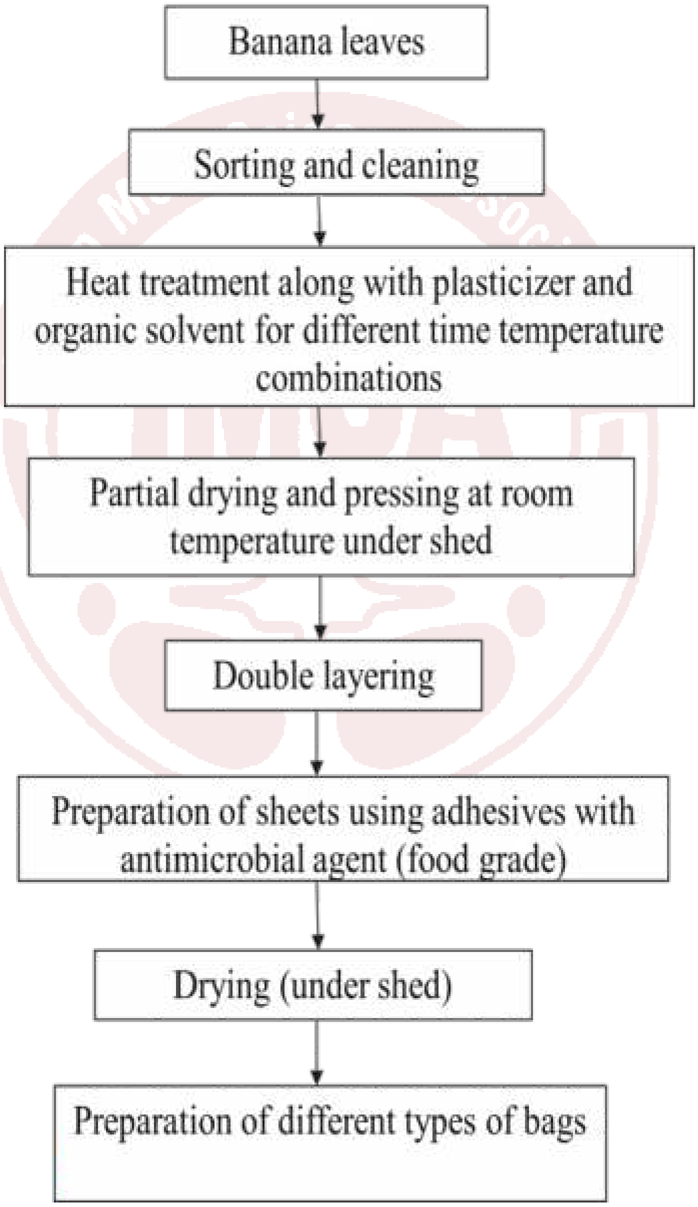
Research undertaken at AICRP on PHET, Khanapara Centre:

After conceiving, the idea of using the banana leaves as alternative to plastic packaging material, a pilot scale project was submitted to the All India Coordinated Research Project on Post Harvest Engineering and Technology, Ludhiana. The project was approved by the technical committee and a pilot scale work has been undertaken in the Khanapara Centre of AICRP on PHET, AAU, Guwahati, Assam with the following objectives:

- To develop the technology for preparation of an eco-friendly cost effective packaging material from banana leaves
- To study the properties of newly developed packaging material suiting the need for meat and fish products
- To determine commercial utility and adaptability of the packaging material

Technical Programme: There are around 20 varieties of banana in Assam, out of which eight varieties are abundantly grown for regular cultivation for banana production. Two common varieties namely Athia or Bhim kol (*Musa balbisiana*) and Chenichampa kol (*Musa champa*) were selected for this study. The banana leaves were cut apart from the banana trunk and kept for some time in normal environmental temperature for wilting. The leaves were then plasticized and processed to prepare banana leaf sheets as per the method outlined below. Double layered packaging sheets were made using food grade organic adhesive. Finally, the double layered sheets were used for preparation for different types of bags for packaging and carrying meat and fish. The sheets were subjected to quality studies to ascertain the properties and suitability to carry meat and fish.

Flow chart for preparation of banana sheets and bags



Results generated so far: This is an on-going project. Results generated so far are presented below:

- ***Availability of banana leaves***: Both the varieties are abundantly available in all the places of Assam. Thus, there will be no dearth in future to prepare banana leaf based industries.
- ***Selection of plasticizers***: Three plasticizers A, B & C and their combinations were tried in the study. Plasticizer combinations of A & B were found to be the best.
- ***Quantities of plasticizers used***: Banana leaves were boiled at plasticizer added water medium. Plasticizer A at the level of 3: 0.5 and B at the level of 3: 0.5 were found to be better.
- ***Time-temperature combination***: Boiling the banana leaves at 100°C in plasticizer added water for 20 seconds was found to be the best.
- ***Drying of plasticized sheets***: Drying at room temperature in the absence of light yields better banana sheets which help in preserving the green colour partially.
- ***Using of adhesive for pasting of plasticized sheets***: Six natural agricultural based ingredients were selected for preparation of an organic food grade adhesive and their ratios were standardized. The best combination was used for pasting to prepare a double layer banana leaf sheet.
- ***Designing and preparation of bags***: Banana leaf bags were prepared with different shapes and sizes to give a popular look ranging from half kg to five kg capacity.
- ***Standardization of variety of banana leaves***: Out of the two varieties tested for preparation of banana sheets, Chenichampa (*Musa champa*) variety had shown better tensile strength compared to Bhim kol (*Musa balbisiana*). Hence, Chenichampa kol may be recommended for preparation of sheets.
- ***Quality assessment***: Different quality parameters like tensile strength, bursting strength, tearing resistance, shelf-life, microbial quality, water activity, chemical composition of the packaging material are under study and could be reported at the end of the study period.

Way forward and Conclusion:

Considering the menace of using of plastic and its ill-effect on soil, water, air, environment and health, the world communities have come forward to reduce and stop the use of plastic bags in all walks of life. Here comes an urgent need to develop alternative and suitable packaging materials to plastic. It is expected that the present study would certainly contribute to some aspect towards solving the present crisis of environment pollution due to single use plastic.

References

References can be made available upon request from the author.

(Lead 23)

Recent Packaging Technologies for Fresh and Processed Meat

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Introduction

Fresh meat usually refers to the muscle from a recently slaughtered animal (mainly buffaloes, sheep, goat, pig and poultry) which has not undergone any process other than chilling (Zhou et al., 2010). It has high water content (about 75%) and abundant nutrients and thus is perishable. Packaging is one of the preservation technologies which protects foods including meat from adversary environmental factors that would otherwise cause quality degradation, and provides convenience for transportation and a communication link between consumer and food processor; thus, expanding the supply chain and retail markets (Barlow and Morgan, 2013).

Fresh packed meat has been one of the major meat products in the market since early in the 1900's. Vacuum packaging (VP) and modified atmosphere packaging (MAP) along with refrigeration, have become increasingly popular preservation techniques to extend the shelf life of meat and meat products, which have brought major changes in storage, distribution, and marketing of raw and processed meat products.

Packaging materials can provide physical, chemical and biological barriers against external factors, such as light, air, moisture, microorganism, insect, rodent, and mechanical damage. Thus, packaging delays meat quality deterioration such as microbial proliferation, discoloration, off-flavor, and nutrient loss. Currently, the most common materials used in food packaging are glass, metal (eg. aluminum, aluminum foil, tinplate, tinfree steel, and laminates and metallized films), plastics (including polyolefin, polyester, polystyrene, polyamide, ethylene vinyl alcohol, laminates and co-extrusions), paper and paperboard (Marsh and Bugusu, 2007). Plastics in particular are very popular in meat packaging, which can have different properties of strength, clarity, sealability and permeability to moisture and gases (Taylor, 1994). Selection of appropriate packaging films is critical to both the preservation effectiveness and also the cost (Muller, 1990).

Basic Functions of Packaging

Appropriate and sterile packaging is a necessity for every fresh or processed food. The packaging function is based on the capacity of the process to maintain food integrity during processing, transportation, marketing, and dispensing. Food protection could be based on the type of food product but generally it includes avoiding biological contamination, oxidation, moisture change, unpleasant aroma, and physical damage.

Modern Packaging System

Active Packaging

Active packaging emerged with the objective of consumer satisfaction in regard to demand for natural, recyclable, and bio-degradable packaging materials. In this packaging system, intrinsic conditions of the package are changed due to interaction of packaging material, food product, and the environment. Wholesomeness, safety, and aesthetic values are ensured by this condition, which provides longer shelf life. Gas absorbents and emitters control the atmospheric balance inside packaging. The controlled supply of active substances into the food via packaging helps to extend shelf life, and avoids unnecessary flavor (Paine and Paine 1983).

During storage, the atmospheric oxygen diffusing through the packaging material is absorbed by oxygen scavengers in which its response is based on oxidation of iron compounds. Most often, the agents that absorb oxygen via iron compounds are placed in sachets permeable to oxygen, whereas carbon dioxide reduces respiration of fresh goods, and prevents collapsing of package because of the presence of oxygen absorbers (Sekhon, 2010). Moisture scavengers present in form of sachet, absorbent tray, and absorbent pads control humidity and excess of moisture present inside the package. Antimicrobial packaging is performed in the form of solutions, which contain active component inside the packaging material.

Examples of the common active packaging applications that are used within the food industry are oxygen scavengers, carbon dioxide scavengers/emitters, ethylene scavengers, preservative releasers, ethanol emitters, moisture absorbers, flavor/odor absorbers, and temperature control packaging.

Types of active packaging

Antimicrobial active packaging

According to Cooksey (2001) and Coma (2008), there are three basic categories of antimicrobial packaging: i) incorporation of an antimicrobial substance into a sachet/pad connected to the package from which the volatile bioactive substance is released during further storage; ii) direct incorporation of the antimicrobial agent into the packaging film; and iii) coating of packaging with a matrix that acts as a carrier for antimicrobial agents so that the agents can be released onto the surface of food through evaporation in the headspace (volatile substances) or migrate into the food (non-volatile additives) through diffusion.

Antioxidant active packaging (oxygen-scavenging packaging)

High levels of oxygen present in meat packaging can facilitate microbial growth, lipid oxidation, development of off flavours and off odours, colour changes and nutritional losses. Lipid oxidation not only results in the development of off-flavours (rancidity), but also the potential formation of toxic aldehydes and the loss of nutritional quality because of polyunsaturated fatty acid (PUFA) degradation (Gomez Estaca et al., 2014). Therefore, control of oxygen levels in meat packaging is important to limit the rate of such deteriorative and spoilage reactions. Antioxidant active packaging can be used as a means of improving product quality and extending shelf life of meat and meat product through controlling the level of oxygen.

Carbon dioxide emitting/generating packaging

CO_2 has inhibitory activity against a range of aerobic bacteria and fungi, as well as direct antimicrobial effect, resulting in an increased lag phase and generation time during the logarithmic phase of microbial growth. Therefore, a carbon dioxide generating system can be viewed as a technique complimentary to oxygen scavenging (Suppakul et al., 2003). For most applications in meat and poultry preservation, high CO_2 levels (10–80%) are desirable because these high levels inhibit surface microbial growth; thereby extending shelf-life(Kerry et al., 2006). The inhibitory action of CO2 has differential effects on different microorganisms. Whereas aerobic bacteria such as Pseudomonas can be inhibited by moderate to high levels of CO_2 (10–20%), lactic acid bacteria can be stimulated by CO_2. Furthermore, pathogens such as C. perfringens, C*. botulinum* and *L. monocytogenes* are minimally affected by CO2 levels lower than 50%. However, there is concern that by inhibiting spoilage microorganisms, a food product may be made to appear edible while containing a high quantity of pathogens that have multiplied due to a lack of indigenous competition. Moreover, a higher production of *C. botulinum* toxin with high concentration of CO_2 has been reported even though a decrease in the growth rate was observed.

Intelligent Packaging

The legal definition of "intelligent food contact materials and articles" is "materials and articles that monitor the condition of packaged food or the environment surrounding the food" (The Commission of the European Communities, 2004). In contrast, an academic definition for intelligent packaging was proposed by Yam, Takhistov, & Miltz (2005) which is "a packaging system that is capable of carrying out intelligent functions (such as detecting, sensing, recording, tracing, communicating, and applying scientific logic) to facilitate decision making to extend shelf life, enhance safety, improve quality, provide information, and warn about possible problems".Compared with "active" packaging that positively changes the condition of the package to improve food safety and quality to extend shelf life and "intelligent" package is able to track the product, sense the internal/external environment of the package, and communicate with the consumer. Therefore, an intelligent packaging is one that monitor the quality/safety condition of a food product and can provide early warning to the consumer or food manufacturer, whereas an active packaging is one that takes some actions (e.g. release of an antimicrobial or antioxidant) to protect the food product.

An intelligent packaging system contains smart devices which are small, inexpensive labels or tags that are capable of acquiring, storing, and transferring information about the functions and properties of the packaged food. The most commonly used smart devices in intelligent packaging of meat and meat products are such as Barcode (UCP barcode, RSS barcode, PDF 417 barcode, Aztec code, and GS1 barcode), Radio frequency identification (RFID) tags, Time-temperature indicators, Gas indicators, Freshness indicators, Pathogen indicators and biosensors,

Modified atmosphere packaging

It is a technology where in foods are packaged in high barrier packages in which air has been replaced with an artificial (modified) atmosphere. Commonly used gases are oxygen, carbon dioxide and nitrogen. For red meats, high-oxygen MAP systems utilize atmospheres containing approximately 0% to 30% carbon dioxide, 60% to 80% oxygen, and up to 20% nitrogen. The elevated oxygen concentration enhances the bright red meat color and the elevated carbon dioxide concentration inhibits the growth of aerobic spoilage microorganisms.

Mother bag concept in MAP

These are the simplest two-phase packaging systems, consisting of retail-ready packs inside an outer preservative pack. The retail-ready packs may be overwrapped trays or lidded packs. In both cases, retail films must be highly gas permeable, first, to allow the meat contact with the carbon dioxide preservative atmosphere and later, on removal from the mother pack, to allow atmospheric oxygen to bloom the meat.

Nanotechnology

Nanotechnology involves the application of materials with at least one dimension of less than 100 nm. Particulates, platelets and fibers are the 3 main classes of nanomaterials. Because of their nanoscale dimensions, these materials have proportionally larger surface area and consequently more surface atoms than their microscale counterpart. When added to compatible polymers, the nanomaterials can dramatically enhance the material properties of the nanocomposites, including improved mechanical strength, enhanced thermal stability and increased electrical conductivity. Thus, applications of nanomaterials in food and meat packaging are promising for improving mechanical properties, barrier properties, and/or conferring the packaging with new functionalities such as antimicrobial and antioxidant activity, biodegradability and intelligence ability (Chaudhry, 2011), as well as ability to withstand the stress of thermal food processing, transportation, and storage. In the food packaging sector, nanocomposites are commonly mixtures of polymers with inorganic or organic nanomaterials, typically 1-7 % of modified nanoclays.

Silver nanoparticle packaging

Silver nanoparticle (Ag-NP) is an anti-fungal and anti-microbial agent with high temperature stability and low volatility and has been claimed to be effective against 150 different bacteria types (Kumar & Munstedt, 2005). The antimicrobial property of Ag-NP may arise from its adhesion to the bacterial cell surface, leading to degradation of membrane lipopolysaccharides resulting in the formation of "pits" in the membranes and hence their malfunction. (The nanoparticles may also penetrate into the bacterial cell, damaging DNA, and may release antimicrobial $Ag+$ ions which bind to molecular electron donor groups in the cell and cause microbe death).

Metal oxide nanoparticle packaging

Metal oxide materials such as titanium dioxide (TiO_2), zinc oxide (ZnO) and magnesium oxide (MgO) possess antibacterial activities mainly because they generate reactive oxygen species that can damage microbial cell DNA. One benefit of utilization of metal oxides over organic antimicrobial agents is their higher stability. In addition, metal oxide nanaomaterials have other properties including UV-blocking, and ethylene or oxygen scavenging activities.

Nanoclay packaging

Polymers incorporating clay nanoparticles were among the first polymer nanomaterials for food packaging. Several different polymers and clay fillers can be used for obtaining clay–polymer nanomaterials and the most used polymers are polyamide, nylon, polyolefins, polystyrene, ethylene– vinylacetate copolymer, epoxy resins polyurethane, polyimides and polyethylene terephthalate. A widely available natural and relatively cheap nanoclay is montmorillonite (MMT), which is a hydrated alumina-silicate layered clay consisting of aluminium hydroxide between silica layers (Paiva, Morales, & Diaz, 2008). Modified MMT has been obtained by substituting inorganic cations of MMT with organic ammonium ions to achieve a more homogeneous distribution of clay in the matrix, and consequently substantial improvements in the gas and water barrier properties of the composite (Bharadwaj, 2001). The improved barrier properties of polymer–clay nanocomposites are probably due to the complex and long path around the clay layers required for gas and water to diffuse through the film.

For example, thin films of sodium montmorillonite clay and branched polyethylenimine were deposited on various substrates using layer-by-layer assembly to obtain a transparent clay–polymer material with an oxygen barrier at almost 100%. Clays have also been reported to improve mechanical properties, thermal stability and resistance to fire of polymers such as polyethylene, polypropylene, nylon, poly(e-caprolactone) and polyethylene terephthalate (PET).

Other nanomaterial packaging

Chitosan is a linear polysaccharide consisting of randomly distributed β-(1-4)-linked D-glucosamine (deacetylated unit) and N-acetyl-D-glucosamine (acetylated unit), which is made by hydrolysis of shrimp and other crustacean shells with the alkali, sodium hydroxide. The Chitosin Nano particle and its derivatives have greater antibacterial activity than chitosan itself because of their higher surface area and charge density. CSNP can be incorporated in biopolymers and has been developed into edible or biodegradable antimicrobial food packaging materials.

Cellulose is a natural plant cell wall polymer. Generally two types of nanomaterials – microfibrils and whiskers, can be obtained from cellulose. The microfibrils have nanometre scale diameters (2–20 nm) and micrometre scale lengths whereas the whiskers have the diameters of about 8–20 nm or less and lengths ranging from 500 nm up to 1–2 µm.

Other type of nanoparticles that have been incorporated into biopolymers for tailoring their properties are carbon nanotubes (CNT) and/or carbon nanofibers (CNF). The major purposes of adding this type of nanoparticle into biopolymers is to increase their biodegradation rate, enhance mechanical properties, increase thermal and electrical conductivity and improve gas and water vapour barrier properties. Therefore, the CNTs have the potential to be used in food packaging applications, such as microwavable packaging and intelligent packaging designs, due to their good electrical and thermal conductivity. However, the issues of a strong black colour and the potential toxicity of CNTs should be seriously considered before they are used for food packaging. Therefore, this newly emerged food packaging technology extends storage time, improves safety and quality of food, and reduces packaging waste (Pal, 2017).

Edible coatings and films and biodegradable packaging in meat industry

Edible coatings or films are defined as continuous matrices prepared from edible materials made up of proteins, polysaccharides and lipids. Edible coatings are either applied to or made directly on foods while films are independent structures. These coatings and films are located on the food surface or as thin layers between several parts within the product with the aim of improving overall food quality and extending shelf-life by functioning as barriers to moisture, gas and solute transmission. Moreover, they can be used to incorporate functional food substances, such as antimicrobials, antioxidants, flavouring agents and nutrients, to improve safety, stability, sensory, and nutritional properties of foods (Silva-Weiss et al., 2013).

With regard to meat and meat products, edible coatings and films not only help reduce the rate of moisture and gas transfer, but more importantly, can incorporate antimicrobial and antioxidant agents to prevent contamination by and growth of both pathogenic and spoilage organisms, and thus delay lipid oxidation. In this way the edible coatings and films can help ensure quality, microbial safety and extendthe shelf-life of meat and meat productsKhan et al. (2013).

Materials for making edible coatings and films

Polysaccharide-based edible films and coatings e.g. Cellulose and derivatives, Chitosan and derivatives, Pectin - Pectin,and Seaweed extracts

Protein based edible films and coatings. Proteins of both plant and animal origin can form coatings and films with good mechanical properties and O_2 and CO_2 barrier functionality, particularly at low relative humidity. These coatings and films however, exhibit relatively poor water-barrier characteristics and are brittle and susceptible to cracking due to the strong cohesive energy density of the polymer.

Plasticizers can be incorporated into protein-based e.g *Plant origin* - Corn zein, the prolamin fraction of corn protein, is insoluble in water except at very low or high pH due to its high content of nonpolar amino acids. Corn zein coatings and films possess a good oxygen barrier and relatively good water barrier properties. *Animal origin* - Casein (80% of total milk protein), whey protein (20% of total milk protein), and their combination have been used to make coatings and films. Caseins can form colourless, flavourless and flexible films from aqueous solutions without further treatment. Casein based coatings and films are resistant to thermal denaturation and/or coagulation, thus remaining stable over a wide range of pH, temperature, and salt concentration (Khwaldia et al., 2004).

Lipid-based edible films and coatings

Lipid based coatings and films are very effective moisture barriers due to their hydrophobic character, and are used primarily to inhibit moisture loss from foods and to improve consumer appeal by adding a glossy finish to the treated products. A wide variety of lipid compounds including natural waxes, acetylated monoglycerides, fatty acids, and resins are commonly utilised.

Conclusions

Meat and meat products are highly nutritious foods that however also favours the growth and proliferation of spoilage and pathogen microorganisms, making them high risk in terms of quality deterioration and food safety. The oxidation of meat lipids and proteins (e.g. myoglobin) also contribute to quality deterioration of meat and meat products. Modern meat packaging should serve as an efficient tool for maintaining quality and safety, as well as increasing product value, promoting sales and imparting information. Therefore, selection of appropriate packaging materials, packaging methods/conditions, and storage environments are the key to obtaining high quality packaged meat products.

Currently, application of Vacuum Packaging and MAP with overwrapped thermoforming films is a common practice in meat packaging to extend the shelf-life and maintain good quality. Development of novel thermoforming films with improved mechanical and barrier properties and optimization of the MAP technologies are the major current research foci in this area.

To achieve longer shelf-life, antimicrobial and antioxidant active packaging have been developed which positively change the conditions of the package to effectively improve the food safety and quality.

The use of edible coatings, especially those which incorporate antimicrobial and antioxidant substances has great potential for meat and meat products through preventing moisture loss, delaying and controlling microbial growth and lipid oxidation, avoiding changes in texture, flavor, and color, and reducing drip loss. Therefore, more research is needed to improve the manufacturing and application processes of edible coatings and films intended for the meat industry to ensure that their use is economically feasible and appropriate for each product.

Growing environmental awareness along with increasing oil price has led to increased demands for the development and application of alternative biobased packaging materials. Several studies have demonstrated that biobased multilayer films can guarantee the quality and shelf-life of some meat and meat products. Biobased and/or biodegradable packaging, like conventional packaging, must fulfill a number of important functions, including containment and protection of food, maintenanceof sensory quality and safety, and communication of information to consumers. Therefore, it is necessary to continuously investigate the combinations of different newly developed biobased materials to obtain biobased packaging solutions meeting technical and consumer requirements.

Intelligent packaging is an emerging and exciting branch of packaging science and technology that offers great opportunities for enhancing food safety, quality, and convenience, and consequently decrease the number of retailer and consumer complaints. The introduction of quality and freshness indicators (temperature indicators, time–temperature integrators, and gas-level controls), the increased convenience of product manufacturing and distribution methods, the invention of smart permeability films, and theft and counterfeiting evidence systems will help maximize the safety and quality of food products. However, issues such as those relating to legislation, and economicsalso need to be addressed.

Nanotechnology products and applications can potentially revolutionize the food packaging sector, and meet many of the industry's needs in relation to innovative, strong, lightweight and active and intelligent materials. The advancement of nanotechnology should provide new packaging solutions that can positively affect the shelf-life, quality, safety, and security of foods, which will ultimately benefit both the producers and consumers. However, more research is needed especially on the migration behaviors of nanomaterials in food and their potential impacts on consumer health and safety, and the environment.

In spite of the great possibilities existing for innovations in food packaging, each packaging technology has peculiar drawbacks which will need to be addressed by meat and packaging scientists in the future. We can imagine that simple traditional packing will be replaced with multi-functional packaging, such as a packaging with biodegradable, active and intelligent functions. To develop successful meat packaging systems, key product characteristics affecting stability, environmental conditions, and consumer's packaging expectations must all be taken into consideration. Thus, a sustainable packaging solution can be achieved only if it is socially responsible, economically viable, and environmentally sound.

References

References can be made available upon request from the author.

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Role of Bio Active Components of Egg in Human Nutrition and Health

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Hen egg is one of the original and natural functional foods. Eggs are a conventional food containing nutrients that play fundamental roles beyond basic nutrition (Herronand Fernandez, 2004). Egg possesses an excellent nutritive value and constitutes a traditional food used in many basic and formulated preparations. Besides its important reserve of highly digestible proteins, lipids, vitamins and minerals, egg contains molecules with numerous health promoting and biotechnological properties. Many are preventative in nature; others have therapeutic potential.Eggs are also relatively rich in fat-soluble compounds and can, therefore, be a nutritious inclusion in the diet for people of all ages and at different stages of life. In particular, eggs may play a particularly useful role in the diets of those at risk of low-nutrient intakes such as the elderly, pregnant women and children (Natoli et al., 2007). Eggs can be consumed throughout the world, having no use restrictions on religious grounds (Abeyrathne et al., 2013). Eggs are commonly available and low in cost or more affordable, represent a "complete food" required for wellbeing and are recognized by consumers as versatile and wholesome with a balance of essential nutrients to sustain both life and growth (Qureshi et al., 2007, Zampelas, 2012, and Zazpe et al., 2011). In short, eggs are an inexpensive and low-calorie source of high-quality protein and other nutrients beneficial to human health, details of which are as follows.

Proteins

Protein quality, a measure of the efficiency of use of the consumed protein by the human body, is determined by the presence and proportions of these amino acids of the protein.Egg proteins, about 6.5 g/egg, contain a balanced supply of the 9 amino acids essential to human health: histidine; isoleucine; leucine; lysine; methionine; phenylalanine; threonine; tryptophan; valine (Patrignanie t al., 2013). The protein quality of eggs is high, 91% if cooked (OJEU, 2007) and is the standard for evaluating other foods (OJEU, 2004). Amino acids are vital for production of enzymes, some hormones, hormone receptors, DNA components, and other functional components required for growth, tissue maintenance, and regulation of metabolic functions. Proteins in the egg white such as lysozyme, ovotransferrin, and avidin have proven to exert numerous biological activities (Tey and Heine, 2009, Hasan et al., 2013 and Netting et al., 2013).

Lysozyme is effective against Gram positive bacteria particularly as it catalyses the hydrolysis of the ß-(1-4) linkage between N-acetylmuramic acid and N-acetylglucosamine of bacterial peptidoglycan, which is the structural component of the Gram-positive bacterial cell walls. (Tenovuo et al., 1991). Lysozyme is also largely used as a food preservative. It shows high activity against mesophilic and thermophilic spore-former bacteria such as *Bacillus staerothermophilus, Clostridium thermosaccharolyticum* and *Clostridium tyrobutyricum* (Johnson, 1994). It is used in cheese to prevent contamination because of the absence of inhibition on starter and secondary cultures required for the ripening of the cheeses. Lysozyme also prevents the growth of pathogenic bacteria on refrigerated foods: *Listeria monocytogenes, Clostridium botulinum, Clostridium jejuni* and *Yersinia enterocolitica* are susceptible to the lytic activity of lysozyme (Johnson, 1994).

Lysozyme from egg albumen is also effective for a wide range of viral skin diseases: herpetic lesions, verruca vulgaris and plantaris, aphtous stomatitis, polymorphous exudative erythema, molluscum contagiosum (de Douder and Morias, 1974). Moreover, when combined with specific immunotherapy, lysozyme cures viral sinusitis or bronchitis (Gavrilenko et al., 1992). The antiviral action of lysozyme might be due to the precipitation of viral particles and by its immune-enhancing action on the host together with its interaction with the pathogens (Sava, 1996).

Lysozyme from egg albumen affects also some components of the immune system of the host which may explain part of its reported activity: reduction in thymus hyperplasia, activation of host immunity against subchronic enterocolitis, against child viral hepatitis and polyomyelitis, increase in absolute granulocyte counts after antiblastic therapy, modification of the lymphocyte responses (Sava, 1996). Lysozyme may also control the imbalances of immunity during autoimmune diseases. These activities were mainly attributed to human lysozyme, but hen egg white lysozyme has been shown to be effective on human immuno-competent cells.

The fibriform glycoprotein of ovomucinhas anti-hemagglutination activity against swine influenza virus, bovine rotavirus and hen Newcastle disease virus (Tsuge et al., 1996).

Ovotransferrin from egg albumen inhibits Gram-negative bacteria by depriving bacteria of iron that is essential for their growth (Lock and Board, 1992). Ovotransferrin is used in infant nutrition for the treatment of infants with acute diarrhoeas (del Giacco et al., 1985). Recently, the iron chelating activity of ovotransferrin has been shown to increase the stimulation by an inhibitor of AMPc ß-lactamase (Syn 2190) of some antibiotics which are efficient against most ßlactamase-producing bacteria (Babini and Livermore, 2000). Ovotransferrin therefore appears as a key factor for drug associations able to overcome the cephalosporin resistance. The peptidic fragment of hen ovotransferrin kills bacteria by damaging the biological function of its cytoplasmic membrane (Ibrahim et al., 2000). The strong bactericidal activity against both Gram-positive (*Staphylococcus aureus*) and Gram-negative (*Escherichia coli*) strains brings the authors to envisage therapeutical applications for this natural peptide.

Two peptides derived from ovalbumin namedovokinin and bradykinin B1are effective in preventing hypertension (Fujita et al., 1995).Bradykinin B1lowers the systolic blood pressure in spontaneously hypertensive rats when administered as an emulsion in egg yolk. Ovokinin (2-7) is obtained by chymotryptic digestion of ovalbumin (residues 359-364; Matoba et al., 1999). When orally administered, this vasorelaxing peptide reduces the blood pressure of spontaneously hypertensive rats in a dose-dependent manner. Ovokinin (2-7) is being used for designing peptide derivatives with activity comparable to that of synthetic anti-hypertensive drugs clinically used (Matoba et al., 2001). The relaxation due to ovokinin (2-7) is mediated by nitric oxide and an unknown receptor. The peptides from egg albumen possess inhibitory effect on enzyme of conversion of angiotensin (ECA) responsible for physiological mechanism conducting to hypertension (Miguel et al., 2004). Pepsin is very efficient to obtain active (ICA and antioxidant) peptides (molecular weight lower than 3000 Da) from egg albumen. These peptides diminish significantly the blood pressure of spontaneous hypertensive rats.

The avidin from egg albumen is used to reinforce anticancer treatments (Gasparri et al., 1999). Tumour avidination potentiates the antitumour activity of biotin-TNF (tumour necrosis factor a), used as a local or loco regional anticancer drug. The potentialisation of avidin as antitumour may involve changes in host-tumour relationships and/or host-mediated antitumour responses. Therefore, pretargeting with avidin could be a realistic possibility to improve the therapeutic index of some anticancer drugs.

The oral administration of an active egg albumen product was obtained by fermentation with Saccharomyces cerevisiae and spray drying (Araki et al., 1992) improves the nonspecific phagocytic activity of neutrophils in weanling piglets and in calves (Nakagawa et al., 1993).

Family 2 cystatins, including egg cystatin, affect the host's immune response through the cytokine network. Chicken cystatin stimulates nitric oxide production from mouse peritoneal macrophages (Verdot et al., 1996) and interleukine production by human gingival fibroblast cell lines and murine splenocytes at physiological concentrations (Kato et al., 2000). It could then be envisaged for the host defence against infectious or parasitic agents, as well as against cancer cell metastasis (Nakai, 2000).

The complex avidin-biotin is used in a very wide spectrum of biochemical or diagnostic applications because of the lack of interaction between the carboxy-containing side chain of biotin and avidin. This site can be modified chemically and attached to a wide variety of biologically active material, without altering the binding of avidin with the other moiety of biotin derivative or conjugate. In addition, avidin can be derivatised with various molecules or probes (Bayer and Wilchek, 1994).

Proteins from egg albumen are used to obtain a biodegradable plastic material with suitable mechanical properties to be a potential substitute of synthetic polymers in certain applications. (Jerez et al., 2005.)

Lipids

Lipids are the primary components of egg yolk (about 65% of the dry matter). They are composed of triglycerides (65%), phospholipids (29%), out of which 86% are phosphatidylcholine and 14% phosphatidylethanolamine, cholesterol (5%), and free fatty acids (< 1%). Yolk is a plentiful source of lipids out of which some are particularly suitable for nutrition or health. Particularly, omega 3 fatty acids (ω3) are considered to be an essential nutrient for brain function and visual acuity in humans (Maki et al., 2003). Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the main ω3 fatty acids. Eggs contain about 70 mg of omega-3 (ω3) fatty acids. They are particularly useful for pregnant and nursing mothers for optimising growth of their infants especially as breast milk is currently low in ω3 due to the modern diet of mothers. Phosphatidylcholine is an amphiphilic lipid containing ω3 fatty acids as non-polar part, and choline as polar part. Choline is an important nutrient in brain development, liver function, and cancer prevention (Gutierrez et al., 1997). Choline is routinely added to commercial infant formulations as anessential nutrient. Consumption of phosphatidylcholine increases plasma and brain choline levels and accelerates neuronal acetylcholine synthesis.

Yolk phospholipids are naturally rich in phosphatidylcholine (86% of the total phospholipids), which is more than three-fold higher than natural soy phospholipids. It has been demonstrated that consumption of yolk phospholipids tends to alleviate the symptoms of Alzheimer disease (Juneja, 1997).The polyunsaturated fatty acids, alpha-linolenic acid (n-3) and linoleic acid (n-6) are essential to human health. Linoleic acids are metabolized to arachidonic acid; alpha-linolenic acid to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (OJEU, 2004 and OJEU, 2003). These essential long-chain fatty acids are components of phospholipids which contribute flexibility to cell walls and reduce plasma cholesterol levels. The EPA and DHA also appear to reduce risks of cardiovascular, central nervous system, and mental health diseases, inflammation, and immune infections (OJEU, 2003). In addition, they have preventive and therapeutic roles for other chronic diseases.

Egg yolk is commonly used as a protectant in semen extenders to preserve mammalian spermatozoa against cold shock but the precise mechanism by which egg yolk acts is unknown. It has been proposed that the low-density fraction of yolk, mainly composed of low-density lipoproteins (LDL) from yolk, could be responsible for the resistance against cold shock and for the improvement of motility of spermatozoa after storage. Foulkes (1977), and Graham and Foote (1987), suggested that LDL could adhere to cell membranes during the freeze-thaw process, thus preserving spermatozoa membranes. Phospholipids, which surround the lipid core of triglycerides and cholesterol, play an essential role in the stability of the LDL structure because association forces are essentially hydrophobic (Cook and Martin, 1969).

Phospholipids form yolk could serve as encapsulation systems (liposomes, double emulsions) and proteins from albumen as microspheres and microcapsules to entrap hydrophobic (liposomes, microcapsules) or hydrophilic (microspheres) compounds. More precisely, in human and in animal nutrition, liposomes could be used to increase bioavailability of hydrophobic vitamins like vitamin E.

Vitamins and Minerals

Generally, egg is an excellent source of vitamins, and particularly of vitamins A, D, E, K, and B1, B2, B9, B12. Vitamins A, D and E, and K, and are fat soluble and present in the yolk. Whereas vitamins B1 (thiamine) and B12 (cyanocobalamin), are water soluble and situated in albumen. B2 (riboflavin) and B9 (folate) are water soluble and equally distributed in yolk and albumen. Levels of B2 and B12 are relatively high; levels of B5, B9, A, and D are moderate. Adequate maternal folate levels reduce the risk of neural tube defects in new-born infants (Domingo, 2014). It also contains the minerals calcium, iron, magnesium, phosphorus, selenium, sodium, and zinc. Egg contains about 200 mg of cholesterol which plays functional role in steroid hormones, vitamin D, precursor for bile risk of cardiovascular disease (Koplin et al., 2014). Consumption of 1 egg/day does not increase serum cholesterol and risk of cardiovascular disease among healthy men and women (Koplin et al., 2014).

Antioxidants

Eggs contain several antioxidants which reduce free radicals arising from cellular metabolism. These antioxidants include:

i) Selenium which acts to reduce the oxidative stress from free radicals promoting heart disease (Álvaro et al., 2014). ii) Carotenoids in egg yolk (such as lutein and zeaxanthin) play a role in the prevention of cataracts and age-related macular degeneration (Tan and Joshi, 2014) iii) Vitamin E reduces the oxidation of fats in low-density lipoprotein improving cholesterol transportation and balance with decreased risk of heart attack and death from heart disease (Álvaro et al., 2014). The capacity of metal chelation of phosvitin from yolk gives remarkable antioxidant potentialities. Phosvitin contains about 110 phosphoseryl residues (50% of its amino acids), responsible for its iron binding capacity (Itoh et al., 1983). Phosvitin inhibits phospholipid oxidation catalysed by Cu^{2+} and even more by Fe^{2+} (Lu and Baker, 1986). However, phosvitin loses its antioxidant capacity when oxidation is catalysed by haeminic iron. It is likely that haeminic iron cannot be chelated by phosvitin because it is buried into a porphyrin structure which limits the interaction of iron and phosphoseryl residues of phosvitin. Heating phosvitin at 110 °C for 20 and 40 min does not cause the release of iron bound to phosvitin. Consequently, phosvitin could be a very important natural food antioxidant.

Antibodies

Hen's egg is a good source of antibodies like "IgY"; better than mammalian immunoglobulin "IgG". In a 6-week period, a hen produces about 298 mg of specific antibodies ("IgY"), compared with only 17 mg from a rabbit. These immunoglobulin antibodies are important egg constituents, with high nutritional value, may help to relief human discomforts from viral and bacterial infections.

Egg yolk is a potential source of antibodies for humans.The antibody activity of egg yolk is due to g-livetins, named IgY: Yolk Immunoglobulin (Leslie and Clem, 1969). IgY are present in yolk. g-livetin is a glycoprotein that contains heavy chains (60 – 70 kDa) and light chains (22 kDa) and represents about 3% of yolk dry matter. Numerous applications of hen IgY antibodies have been evaluated in human against dental plaque formation or against rotavirus diarrhoea in trout, to protect against *Yersinia ruckeri*, or in swine to control bacterial respiratory disease (Shin et al., 2001).HenIgY antibodies against specific proteins can be raised for biological quantification such as detection by ELISA of fungi (Vohringer and Sander, 2001).The IgY-technology is a method used for production of polyclonal antibody (Ab) in chicken (Schade et al., 1996) and it is of great interest for research fields which need large amount of Ab for prophylactical or therapeutical purposes in human and veterinary medicine.Egg antibodies (IgY from yolk) are promising for use in immunoassays (Schade, 2004) to quantify toxins or pathogenic viruses.

Consumers acceptance of functional foods:

Consumers do not see functional foods as one homogeneous product category and different attitudes affect their interest in using functional foods (Urala and Lahteenmaki, 2007). Bech-Larsen and Scholderer (2007) noted that their acceptance of functional foods depended on their perception of the nutritional qualities of the base-product. As seen previously, the general good impression of eggs and health is a positive factor for the acceptance of functional eggs. Another positive factor for eggs is that functional eggs look similar to regular eggs and therefore are more likely to be accepted by older people, one of the fastest growing target segments for functional foods (Saher et al., 2004 and Bowman, 2005).

Role of Price:

As seen in a number of national surveys, price is always at the top of the consumers' mind in their buying decision. Most respondents (69%) reported that low in price was the most important factor in their buying decision for foods, ahead of "high in nutrients" (58%). Price was also the key decision factor far above the interest in health benefits brought by nutritionally-enhanced eggs.

Role of knowledge and information provided:

Consumers have little knowledge about nutrition and the benefits delivered by functional foods. They are also very sceptical about the information provided, especially by food manufacturers or producers (Verbeke, 2008, Siro et al., 2008 and Landstrom et al., 2009). Proper education programs are complex, requiring interactions between consumers and the food industry, the retailers, the health sector and governments (McConnon et al., 2002).

Role of claims:

Government support of the claims was also a major positive determinant in the acceptance of functional foods. However, health claims have been allowed for some time, communication of these benefits has limited success and could have in fact misled consumers (Hassler, 2008).

Role of health professionals:

The health professionals have a great role to play in assisting consumers in their buying decisions.

References

References can be made available upon request from the author.

(Lead 25)

Technological Advances into Duck Meat and Its Products

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World population increased from 5.81 billion to 7.43 billion between 1996 and 2016 to the tune of 1.4% increase per year on average (FAO, 2017) and based on related predictions, it is expected to exceed 9.7 billion by 2050. Accordingly, providing food security for the world's increasing population while sustainability aspects are considered a major challenge for the upcoming years. Animal husbandry will have a significant role in fulfilling this demand and the poultry sector has the biggest potential to provide animal proteins in the most inexpensive and effective way, also considering economic advantages and environmental load. The meat and egg of waterfowls (duck and goose) have high nutritional value and consumers mostly prefer them not only because of their taste, but also for their nutritional value and the fact that they contain optimum quantity of essential amino acids and fatty acids. Since times of its galloping growth, the farmers, entrepreneurs and researchers are in search of alternate poultry species and duck has been considered as next to the usual poultry industry. In Asian countries, the popularity of duck along with its demand is more pronounced compared to other part of the globe. Asian countries alone accounts for 84.2% of total duck meat produced in the world (FAO, 2017). Duck meat is also been considered as delicacy in Europe and America. In recent years, China has become the highest duck meat-producing country in the world and has dominated more than half of the word duck meat production.

Ducks have a number of advantages over other poultry species, in particular their better disease tolerance. They are hardy, better manageable excellent foragers and easy to herd, particularly in wetlands, where they tend to flock together. In spite of its important contribution in overall agriculture economy in many Asian countries, ducks are still being considered as one of the neglected avian species and needs more commercial exploitation. Duck farming significantly contributes to livelihood of farmers in terms of nutrition and income. In some developing economies, duck farms still operate under traditional system with low productivity and practically with no breeding farm. However, a changing technical, social and economic environment in has spurred an interest toward intensification of this sector in recent years. Research and development and market and support services are critical to boost the economic importance of duck rearing especially where small scale production is prevalent. Development of commercial strains, feeding strategy, and institutional innovations must be strengthened, and regulations and standards must be implemented for sustainable small-scale duck production. Farmers can be organized into cooperatives to facilitate efficient supply management, technology diffusion, improved production and access to market.

To promote organized and larger units of duck meat and egg processing, intensive duck farm management monitoring, sanitation, surveillance, biosecurity and emergency response systems, and food safety and traceability, should be addressed. Marketing of duck meat and its products needs innovation to attract the consumers and increase market demand. Interventions for the production of low-fat duck meat and development of ready-to-cook or ready-to-eat duck meat-based products are required to popularize duck meat. Further processing of duck by-products can also serve as a profitable business. A persuasive approach by the researchers to solve these problems and good policies from the government to popularize the duck meat as a food choice will hopefully attract the society to use duck meat in greater quantities. Therefore, this write up will highlight the nutritive value of duck meat, current global demands, particularly in Asia and technological interventions to meet the consumers' demands through processing of different ready to eat duck meat products.

References

References can be made available upon request from the author.

(Lead 26)

Nutritional Manipulations for Value Added Chicken Egg and Meat

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Abstract

In India, poultry is one of the fastest growing sector and provides good quality protein to the growing population at a cheaper rate. Today, the consumer is more health conscious and is looking for products which can satisfy both his nutritional needs without jeopardising with health. Chicken meat and eggs contain more saturated fatty acids and cholesterol which are mainly responsible for the newer emerging life style diseases including cardio vascular, diabetes etc. This has prompted the animal nutritionist to produce novel animal products with desired chemical composition to suit the health needs of the consumers. In this context, the chicken meat and egg composition can be easily altered and egg is the best vehicle to incorporate several health-promoting components in it. This has increased the focus of the nutritionist on functional foods customized to confer health benefits to the consumers. By formulating the diet of chicken with different feed ingredients, herbs and supplements, value added and health promoting chicken egg higher in n-3/n-6 PUFA, anti oxidants, low cholesterol and lean meat with desired egg yolk and skin color can be made available to the consumers. Chicken meat and eggs with low cholesterol adopting suitable feeding strategies and herbal additives are already in the market having higher carotenoids, Vit E, higher and correct balance of n-3/n-6 polyunsaturated fatty acids. Need based consumer demand can be satisfied by adopting suitable feeding strategies but the product will come at a premium which necessitates to study the consumer demand before going in for the production of functional foods.

Keywords: Chicken, designer, egg, organic, omega-3 fatty acid, chromium, cholestrol

Nourishing the ever increasing human population with healthy and safe animal food has always been the priority of animal nutritionists. Life style and metabolic diseases related with age and health of the human population has brought focus on functional foods (Zanini, 2006). Nutrition of birds has a significant impact on poultry meat composition, quality and safety. The response of a bird to its feed is closely related to the changes in the growth of the skeleton, muscle and fat depot. Therefore poultry meat is increasingly being experimented for production of functional foods to extend health benefits and prevent life style diseases. Functional foods defined as "designed to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions, and may be similar in appearance to conventional foods and consumed as a part of regular diet" (ARS, 2010).

Chicken meat consumption in the modern society is constrained owing to higher content of saturated fatty acids which have been found to be responsible for increasing life style diseases prompting the human nutritionists to recommend, reducing the intake of saturated fatty acids because of its relationship with the development of cardiovascular diseases. The chemical composition of the animal can be altered by adopting suitable feeding strategies. As meat and eggs can be a major source of dietary fat, changing the lipid content and FA composition of foods can be an effective way to improve the consumer's health. This has led to increased interest in manipulating the composition of meat and eggs especially for the poly unsaturated fatty acids (PUFA). Many researches have studied how the inclusion of different fat sources in the broiler's diet affect the proportion of fatty acids, mainly polyunsaturated fatty acids, in meat and the amount of fat deposited by the birds. (Anna Haug et al., 2007)

Manipulation of the animal feeding has given way to production of newer customized animal products to satisfy the consumers needs. Manipulation or value addition in case of poultry products can be done before the product is produced, i.e**."pre-slaughter or pre-oviposition value addition".** Products like, organic / designer **/** functional eggs and meat will come under this category. The other category is **"post-slaughter or post-oviposition value addition"**, which is usually referred as **"post harvest technology"**. A lot of research work has already been done in various parts of the globe and many individuals and companies have come out with novel products to suit the health conscious consumers like low cholesterol eggs, chicken meat with high polyunsaturated fatty acids and high anti oxidants, organic egg/ chicken, lean meat etc. The consumers are ready to pay a higher price for these animal products, which are safe and healthy owing to the presence of special health promoting components like n-3 fatty acids, anti-oxidants, extra vitamins, minerals and non-nutrient components. In this paper, the nutritional manipulations for value addition of eggs and chicken meat will be discussed.

Dietary manipulations to produce designer eggs /meat:

Feeding management is the first step towards producing functional foods of animal origin especially eggs and meat. By dietary manipulations, need based animal products can be produced which attract good premium in the market. Despite 3 to 4 times more expensive, compared to the normal animal produce, still the demand for designer egg/meat is growing at a rate of around 10 per cent per annum. Narahari (2004).

Pre-slaughter or pre-oviposition value addition through Organic and cage free Eggs production

Organic and cage-free eggs are in demand and fetch a higher premium compared to the eggs produced in commercial farms. According to the American Egg Board (AEB), organic eggs are those obtained from hens fed rations having ingredients that were grown without pesticides, fungicides, herbicides or commercial fertilizers. Moreover, these hens are reared free from cages and fed organic feeds free from any performance enhancers like antibiotics, antimicrobials, coccidiostats and other drugs. According to the United States Department of Agriculture, organic means that the laying hens must have access to the outdoors and cannot be raised in cages. Only natural molting can occur within the flock; forced molting is not allowed. Organic certification also requires maintenance of basic animal welfare standards. The organic foods are usually free from residues of pesticides, drugs and other harmful chemicals. The chemical composition of cage reared and free-range hens' eggs are reported in Table 1.

Organic egg harvested from the birds reared in free range pastures are quite popular amongst the consumers especially the one with brown shelled and carry a good premium and return to the farmer. One of the important consideration concerning organic egg is its medicinal value in terms of high PUFA and a better n-6/n-3 ratio of fatty acid content due to the scavenging in the free range pastures compared to the birds reared in cages. One of the main feeding strategy to produce organic egg is to rear birds in free pasture lands allowing it to meet its requirement of macro nutrients including protein, energy and minerals.

When it comes to macronutrients, there is little difference between organic eggs and conventional eggs. Organic eggs contain similar amounts of protein, carbohydrates, and some fats as conventional eggs do. However, recent research finds organic eggs to have more micronutrients than conventional eggs. Findings from Penn State University suggest that organic chicken eggs have three times more omega-3 fatty acids than their caged counterparts. The eggs also contained 40% more vitamin A and twice as much vitamin E.

Egg is the best vehicle to incorporate several health-promoting components in it. The internal components of the egg can be altered by nutritional manipulations. (Singh et al 2010). Chicken intestinal tract is short and can rapidly assimilate dietary nutrients for deposition in the egg. Fat-soluble vitamins in the diet are readily transferred to the liver and then the egg yolk. Naber (1979) classified nutrients in the egg by responsiveness to dietary change and determined that all the fat-soluble vitamins, including A and E, and the unsaturated fats, linoleic and linolenic acids, were egg responsive and that hen diet had a marked influence on the egg concentration. Accordingly, birds reared in grass pastures enhance vitamin E in eggs of pastured hens more than clover, and pastured hens supplemented with commercial mash produced eggs with significantly more vitamin E and total omega-3 fatty acids compared to eggs from caged hens fed only commercial hen mash (H D Karsten et al., 2010). Birds reared in grass pastures dominated by Italian ryegrass (*Lolium perenne L.*) having higher content of a-tocopherol (vitamin E), 20-fold more linolenic acid (an omega-3 fatty acid) and 2.66-fold less linoleic acid (an omega-6 fatty acid) then commercial feed, their the egg yolk accumulated 30% more a-tocopherol and almost three-fold more omega-3 fatty acid than the eggs of the commercially fed hens. The ratio of omega-6 to omega-3 was also significantly lower in the pastured hens compared to those fed only commercial feed. (Lopez-Bote et al., 1998)

Since the composition of the egg yolk can be easily manipulated by altering the feed composition, many individual scientists and companies have produced and patented these eggs. The eggs so produced have been called as 'designer eggs'. Taking the cue, a **Designer Egg**, rich in n-3 fatty acids and antioxidants was developed in the late 80s by Sim, Jiang and their associates in the University of Alberta, Canada and patented their egg as **Professor Sim'sDesigner Egg**. Saturated fatty acids were replaced by n-3 PUFA in the egg yolk by feeding hens with diets having flax seeds and incorporated natural antioxidants like vitamin E, selenium and carotenoid pigments. Since the N-3 PUFA will undergo rancidity quickly, it is essential to prevent the rancidity of the designer egg yolk lipids, by incorporating anti-oxidants in the hens' diet.

Table 1. Chemical composition of cage and free-range (organic?) hens' eggs

Component	Farm egg	Free-range egg
Yolk cholesterol* (mg/g)	12.9 a	11.2 b
Yolk carotenoids** (mcg/g)	36.1 a	60.8 b
Roche yolk colour	7.2 a	11.7 b
SFA (mg/g yolk)*	100 a	78 b
MUFA (mg/g yolk)*	133	130
W - -6 PUFA (mg/g yolk) NS	33	32
W - 3 PUFA (mg/g yolk)**	3.5 a	30.0 b
W - 6/ W - 3 ratio**	9.2 a	1.1 b
Yolk vitamin A (mcg/g)*	10.37 a	11.55 b
Yolk vitamin E (mcg/g)**	73.7 a	102.2 b
Vitamin B 12 (ng/g)**	10 a	18 b
Egg selenium (ng/g)*	53.2 a	40.6 b
Iron (mcg/g)**	23 a	32 b
Zinc(mcg/g) NS	14	16
IgY (mg/g yolk)**	12.2 a	19.2 b
T.B.A. value of yolk*	0.26	0.21
Chromium (ng/g)**	1.2 a	10.1 b
Betaine (mg/g)*	0.52	1.2
Taurine (mg/g)*	1.3	2.8

Narahari. D (2004). ** Significant ($P<0.05$); ** highly significant ($P<0.01$); NS Not significant ($P>0.05$)*

In India, Narahari (2004) has developed Herbal Enriched Designer Eggs (HEDE), which are not only rich in n-3 PUFA, vitamin E, selenium, carotenoids, certain B complex vitamins and trace minerals; but also rich in herbal active principles like, Allicin, Betaine, Euginol, Lumiflavin, Lutein, Sulforaphane, Taurine and many more active principles of the herbs, depending upon the herbs fed to the hens (Table-2). Moreover, these eggs had about 25 % lesser cholesterol in their yolks, compared to ordinary eggs.

Eggs having low cholesterol and enriched with vitamins and omega-3 fatty acids are available from 'Kansal Agro' and 'Suguna Foods' in some of the metro cities of India (thehindubusinessline.com) About 100 ml of the egg liquid from Kansal Agro contains three times more vitamin A, eight times more vitamin D_3, ten times more vitamin E and five times more folic acid and the cholesterol content is 179 mg compared to 420 mg in regular egg. Similarly Omega-3 enrichment can be achieved by feeding flax seed (Caston and Leeson 1990; Jiang et al. 1992), marine algae (Mary and Elswyk 1997), fish oil (Yu and Sim 1987; Hargis et al. 1991), and rapeseed oil (Ceylan et al. 2011) to laying hens. Also Chromium can be used for production of low cholesterol eggs and using such eggs can also avoid/delay/decrease the severity of diabetes. (Daisy et al., 2017).

Table 2 Active principles present in herbs/ herbal enriched functional eggs and their role in human health

Active principles	Source	Effect on human health
Allicin, Allylic sulfide	Garlic, onion and their leaves	Lower L.D.L. cholesterol and anticarcinogenic
Betaine	Sugar beet, grape pulp	Reduces plasma homocysteine, which damages arterial walls
Carotenoid pigments	Spirulina, marigold petals, alfalfa, red pepper	Antioxidant, anticarcinogenic
Eugenol, eugenic acid	Basil leaves	Immunomodulators
Flavonoid compounds	Turmeric powder	Antimicrobial, antioxidant
Lutein	Bay (curry) leaves, Marigold petals	Antioxidants, Improves vision
Lycopene	Tomato pomace, grape pulp	Lowers LDL (bad) cholesterol, antioxidant, anticarcinogenic
Nirangenin	Citrus pulp	Reduces LDL cholesterol
O-3 PUFA	Flax seed, canola, fish, oils insects, worms	Reduces LDL cholesterol, hypertension, angina, atherosclerosis
Phytosterols	Seeds, weeds, legumes fenugreek	Increases HDL (good) cholesterol, reduces blood sugar
Quercitin, Luteolin, Diosgenin, citogenin	Fenugreek, spices	Stimulates insulin secretion, antimicrobial, tonic
Statin	Brewery waste, yeast, fermented products	Lowers LDL cholesterol
Sulphoraphane	Brocoli, cauliflower, cabbage, radish leaves, waste	Anticarcinogenic and antioxidant
Taurine	Milk, eggs and meat products	Prevents atherosclerotic plaque formation
Tocotrienols	Brans	Lower LDL cholesterol

Narahari. D (2004)

N -3 Fatty Acids enrichment

The fatty acid composition of the egg and meat can be altered through dietary manipulations despite the fact that total fat per cent remains the same. Eicosapentaenoic acid (20:5, n-3; EPA), docosahexaenoic acid (22:6, n-3; DHA) and α-linolenic acid (18:3, n-3; LNA) are the most important n-3 polyunsaturated fatty acids (PUFA) in human nutrition. Further LNA is the precursor for synthesis of EPA and DHA (Simopoulos, 2008). Balance of n-3 to n-6 fatty acids (approximately 2:1) is the key to human health and imbalance in its ratio has been listed as one of the reasons for coronary artery diseases, hyper tension and diabetes, as well as some auto immune and inflammatory diseases and the modern diets are generally imbalanced in terms of n-6/n-3 PUFA (>10:1) ratio (Simopoulos, 2008). Also worldwide research conducted recently suggest that, dietary and lifestyle factors contribute to the development of many non-infectious diseases, including obesity, cardiovascular and degenerative diseases (Bosma-den Boer et al., 2012, Chakma and Gupta, 2014).These findings have prompted the nutritionists to produce chicken meat and eggs with higher and balanced proportion of n-6/n-3 PUFA. One of the most efficient ways to enhance the accumulation of desired PUFA in the chicken meat is the modification of dietary fatty acids composition (Bhalerao et al., 2014). There is no doubt that the composition of fatty acid profile of the diet influences the body fat deposition and forms the basis for development of functional foods. For improvement of nutritive value of poultry meat a lot of experimentation has been done with ω-3 fatty acids (Crespo and Esteve-Garcia 2001).

Dietary incorporation of mustard oil, linseed oil or fish oil at 2% and 3% levels during starter and finisher phase can enrich broiler chicken meat with n-3 PUFA without affecting the bird's performance and sensory characters of meat (Sridhar et al., 2017). Replacing soybean oil with linseed oil in broiler diets with the addition of pomegranate peel extract (PPE) enriched muscle meat with omega-3 fatty acids and antioxidants and improved broiler immunity and their serum lipid profile. PPE supplementation also increases the phenol and flavonoid content in broiler meat and increases lysozyme activity and lower abdominal fat (Asmaa et al., 2019; Crespo and Esteve-Garcia 2001). Carcass quality changes associated with unsaturated fatty acids may be tearing of skin during plucking and increased cooking loss. Though, a general problem with enriching poultry meat with LC-PUFA may be the more liquid fat, there appears to be minimal effect on breast tenderness with improved flavour but reduced perceived juiciness.

Flax seed (linseed), marine algae, fish oil and rape seed oil have been added to chicken feed to increase the omega - 3 fatty acid content in the egg yolk and meat at the expense of saturated fatty acids like palmitic and stearic acids Narahari (2004). The fatty acid composition of oils rich in W -3 PUFA, regular eggs and W -3 PUFA enriched eggs (designer eggs) are shown in Table. 3

Table 3: Fatty acid composition of oils rich in W --3 PUFA, regular eggs and W -3 PUFA enriched eggs

	C 16:0	C 18:0	C 18:1	C 18:2	C 18:3	C 20:4	C 20:5	C 22:5	C 22:6
Flax seed	6.00	3.00	17.30	13.40	55.30	-	-	-	-
Fish oil	17.30	2.90	12.80	0.90	0.80	1.50	17.70	1.40	6.20
Canola oil	3.00	2.00	56.00	20.30	9.30	-	-	-	-
Lupin seed oil	6.10	1.50	50.00	17.40	10.60	-	-	-	-
Fenugreek oil	26.00	10.00	3.00	6.40	16.70	-	-	-	-
Soya bean oil	10.00	5.00	28.90	50.70	6.60	-	-	-	-
Regular egg	21.50	8.00	42.10	13.80	0.22	1.75	-	0.15	0.08
Designer egg	16.90	6.20	41.70	13.70	4.58	-	0.73	0.89	5.83

Source: Narahari, D. (2004) Feeds and Feedstuffs, Pixie publications, Karnal, India.

The generic egg has only 60 mg omega-3 fatty acid as compared to an omega-3 enriched egg which may have upto 600 mg (Shane 2014), although in certain cases taste is adversely affected by high levels of fish oil or flax seed. In designer eggs the N-6 / N-3 PUFA ratio is decreased to about 1.5, from as much as 20 in regular eggs. This favourable change in designer eggs, will supply about 50% of the daily requirement of N-3 PUFA to the consumers, without any change in the sensory quality of the egg. Narahari, D. (2005).

Enriching Anti Oxidants in meat

- The advantages of enrichment of the egg and meat with anti oxidants include:
- Decreased susceptibility to lipid peroxidation
- Prevention of fishy odour to the product
- Designer foods could be a good source of antioxidants in human diet
- Prevents destruction of fat-soluble vitamins
- Prevents denaturation of natural fat-soluble pigments
- Promotes the overall health of the consumers

Unsaturated fatty acids especially PUFA are very much susceptible to oxidative rancidity (OR) leading to loss of flavour, texture, consistency, appearance, and nutritional value of the meat. Antioxidants prevent lipid oxidation in meat and thus maintain its PUFA content. There is agreement among the nutritionists to explore and use the anti oxidants derived from plants rather then synthetic which are acceptable to the consumers. Antioxidants (mainly α-tocopherol) play a significant role in preventing oxidation of LC-PUFA while enriching poultry meat with ω-3 fatty acids. Numerous studies conducted have concluded that total phenolic contents and antioxidant activity in the breast meat are improved significantly when chickens are fed diets containing α-tocopherol and pomegranate peel extract (PPE). Dietary supplementation with 200 and 300 mg/kg PPE improves the antioxidant potential and quality indices of broilers breast meat (Hassan et al., 2017). The antioxidant potential of PPE was equal to that of α-Toc in refrigerated meat. DHA content in thigh muscles can be increased without causing fishy flavour by feeding menhaden fish oil up to 3% along with 0.1% ethoxyquin (antioxidant) (Huang et al., 1990). Dietary supplementation of α-tocopherol (Guo et al. 2003) and selenium (Yaroshenko et al. 2004) significantly reduce thiobarbituric reactive substances (TABRS) in tissues and significantly improves meat functional properties under heat stress.

Enriching Anti Oxidants in eggs

Intake of antioxidants through diet is known to be important in reducing oxidative damage in cells and improving human health. Although eggs are known for their exceptional, nutritional quality, they are not generally considered as antioxidant foods (Chamilla et al., 2015). Eggs have various natural occurring compounds including the proteins ovalbumin, ovotransferrin and lysozyme in egg white, as well as phosvitin, carotenoids and free aromatic amino acids in egg yolk. Owing to high lipid content, some lipophilic antioxidants such as lutein/zeaxanthin, vitamin E, carotenoids, selenium, iodine lycopene and others can be transferred from feed into egg yolk to produce antioxidant-enriched eggs (Surai et al., 2006). Fruits, vegetables, oil seeds, nuts, cereals, spices, herbs, and grains are important sources of antioxidants such as phenolics, flavonoids and carotenoids which can be incorporated in the bird's diet to increase the content of anti oxidants in egg yolk.

Dietary manipulations to increase the content of Omega-3 fatty acids generally increases the susceptibility towards fatty acid oxidation and rancidity and so it was suggested to enrich the egg contents with anti oxidants like Vit. E and carotenoids to decrease the fatty acid oxidation and increase the shelf life for storage. Though egg contains natural antioxidants like vitamin-E, selenium, carotenoid pigments, flavinoid compounds, lecithin, however, these levels are not sufficient to protect the designer eggs rich in N-3 PUFA which necessitates to increase the anti-oxidant levels in the designer eggs. Many egg proteins such as ovalbumin, ovotransferrin, phosvitin, egg lipids such as phospholipids, as well as certain micronutrients such as vitamin E, vitamin A, selenium, and carotenoids, are reported to have antioxidant properties. In addition, eggs can be further enriched with antioxidants (*i.e.*, carotenoids, vitamin E, selenium and iodine) through manipulation of poultry feed (Ngo D et al., 2011; Cotterill O.J et al .,1977; Li-Chan et al ., 2008; Seuss-baum I et al ., 2007).

Carotenoids are naturally occurring in egg yolk in varied amounts depending on hen's feed. Feed fortification with natural sources such as marigold (*Tagetes erecta*) or alfalfa

(*Medicago sativa*) extracts are sources of lutein, while other sources such as corn (*Zea mays*) and red pepper (*Capsicum annuum*) provide zeaxanthin and capsanthin respectively (Breithaupt, D.E., 2007; Leeson, S., 2006). Lutein and zeaxanthin are two major egg carotenoids that can be found in human serum, skin and eye macular and involved in the protective roles against oxidative stress (Serpeloni et al., 2010; Roberts et al., 2009). Lutein content of enriched eggs can be increased up to 15-fold compared to the control group, for example enriched egg contains around 1.9 mg of lutein (Surai et al., 2000) Lutein enriched eggs show a higher lutein bioavailability compared to lutein, lutein ester supplements, and spinach (Chung et al., 2004).

Lycopene is a hydrocarbon carotenoid reported to have strong antioxidant properties effective in reducing the risk of prostate carcinoma (Wertz et al., 2004; Olson et al., 2008). Although lycopene is not usually found in eggs, lycopene enrichment can be achieved via feed fortification with tomato powder and lycopene can reduce yolk lipid peroxidation (Akdemir et al., 2012).

Vitamin E is the major lipophilic antioxidant compound in our body that may provide the primary protection against free radical induced lipid peroxidation (Traber et al., 2007). The daily requirement is approximately 15mg-tocopherol equivalents per day (Péter et al., 2013). Since vitamin E is needed to protect membrane lipids from being peroxidized, this amount can be increased with higher intake of polyunsaturated fatty acids (Sanders et al., 2007; Valk et al 2000). Egg can be enriched to provide around 20 mg of vitamin E per egg, which is more than the daily requirement, and also provide protection against unsaturated fatty acid peroxidation (Surai et al., 2006).

Folate, a water soluble B-group vitamin is shown to reduce the incidence of neural tube defects in newborns (Honein, M.A., 2001). Egg yolk can be enriched with highly bioavailable folate through fortification of feed with folic acid to provide up to 12.5% of the recommended daily intake of folate (House, J.D. et al., 2002,2003). Almost all the folate in egg exists in the form of 5-methyltetrahydrofolate (5-MTHF), and showed high stability during cooking (Seyoum, E., 1998). Folates are reported to have antioxidant properties and among different forms, 5-MTHF was reported to have the most prominent antioxidant activity which was attributed to the electron donating effect of the 5-amino group (Rezk, B.M et al., 2003).

Lowering Cholesterol Content

There is a growing concern among the population for low cholesterol animal foods. This has caught the fancy of the animal nutritionists to alter the fatty acid composition of the meat through dietary manipulation. Best results have been obtained in case of pig and poultry for lowering the cholesterol content of the meat by animal feeding.

Even though the dietary cholesterol is insignificantly correlated with the serum cholesterol levels, the consumers are scared of high cholesterol foods, like eggs. A large egg contains about 200 mg of cholesterol and chicken meat contains about 60 mg per 100 g. Research towards lowering egg cholesterol has centered mostly on dietary and pharmacological interventions. Chromium, copper, nicotinic acid, statins, garlic, basil (tulasi), plant sterols, N-3 PUFA supplementation to chicken feed has been found to reduce the yolk and carcass cholesterol levels significantly (Narahari 2005).

Similarly, dietary Linseed oil =2-4%, Fish oil (body oil and not liver oil)=1-2%, Garlic=0.5%, Basil=0.3%, Spirulina=0.2%, Bay leaves=0.5%, Nicotinic acid=200mg / kg, Neomycin=10ppm, Strains of yeast=0.5-1%, Guar Gum=1%, Grape seed pulp / Tomato pomace (lycopene)=2-5%, Citrus pulp (nirangenin)=2-5%, Chelated Copper=200ppm, Organic Chromium=2ppm, Roselle seeds=0.5% and many more herbs in chicken diets has been reported to reduce the yolk and chicken fat cholesterol levels by 10-25% (Narahari 2005). Dehydrated alfa alfa reduces cholesterol content and total lipids in chicken breast meat. Sunflower oil, soyabean oil, canola oil, linseed oil reduces fat and cholesterol content in cockerel thigh and breast meat. Moreover, these substances are having synergistic effect in reducing the cholesterol levels. Also cinnamon has been experimented successfully in the diet of the broilers to reduce the cholesterol content (Homseng et al 2018). Supplementation of cinnamon oil (500, 1000 ppm) in diet decreased the cholesterol levels of serum and chicken meat and improved the nutritional quality of chicken meat as cinnamon oil plays an important role as an endogenous antioxidant and conferring protection against tissue damage (Ciftci et al. 2009).

Conjugated linoleic acid (CLA) enrichment:

Conjugated linoleic acid (CLA) is a group of positional and geometrical isomers of 18-carbon unsaturated fatty acids and is one of the lipid molecules which imparts beneficial effects to human health. Conjugated linoleic acid is a term used to describe positional and geometric isomers of linoleic acid (C18:2n-6; LA). The two main isomers are cis-9, trans-11 and trans-10, cis-12. The mechanism by which dietary conjugated linoleic acids impart their reported effects involved the regulation of lipid mediator synthesis, and/or transcriptional regulation of gene expression through peroxisome proliferator activated receptors (Suriya Kumari et al., 2017). CLAs exhibit anticarcinogenic and anti-inflammatory properties (Wahle et al., 2004; Bhattacharya et al., 2006). Chicken is very sensitive to dietary manipulations and many studies have shown that concentrations of CLA in yolk lipids increased linearly as dietary CLA increased (Abhishek et al.,2014). Several studies have shown that conjugated linoleic acid (CLA) influences the composition of meat. Dietary CLA is reported to reduce the content of monounsaturated and polyunsaturated fatty acids in meat (Szymczyk et al., 2001) and increase the concentration of saturated fatty acids (Schafer et al., 2001; Badinga et al., 2003). When CLA is used in diets with oleic, linoleic, or linolenic acids, the undesired effects of increasing saturated fatty acids was reduced (Du et al., 2000; Kim et al., 2007; Martin et al., 2007).

Eggs produced by hens when fed with 5.0% CLA will contain 310 to 1000 mg of CLA per egg (Chamruspollert and Sell, 1999; Suksombat et al., 2006) which could provide a substantial amount of CLA in human foods to meet the proposed CLA requirement. Inspite of the beneficial effects of CLA enrichment, it affects the texture and juiciness of the meat by making it tough and dark.

Lean Meat Production

Consumers prefer chicken meat with high protein, low fat and cholesterol. In fact, chicken and yolk fats are not fats, but oil; because their SFA content is only one third of TFA, nearly 45% is cardiac friendly MUFA and the remaining are PUFA. Lean meat with low carcass fat (<5%) and cholesterol (<50mg/100g) can be easily produced by dietary manipulations (Narahari. D. 2005).

Chromium enriched yeast at 1 g/kg diet improved the carcass quality. Organic chromium had increased the weight of pectoral muscles and the meat had less fat and cholesterol content. Chromium Methionine (Cr Meth) has been used as an feed additive to increase the lean body mass A recent study also reported that maternal Cr restriction significantly decreased the percent of lean body mass and fat-free mass in rat offspring (Padmavathi et al., 2010). The effects of Cr have been investigated for potential use as feed additives in animal production. Cr Meth bio availability is more compared to other sources of Cr owing to the fact that Cr Meth chelate will cross the intestinal barrier and will be metabolized without being digested since it is chelated with amino acids. (Ohh and Lee, 2005). CrMet, as a highly bio-available complex, has lesser environmental hazards and would be more beneficial since it is able to improve the meat colour, decrease fat percentage and increase muscle (Ys Li. et al., 2013).

Feed additives like Ractopamine hydrochloride and L-Carnitine by virtue of their lipolytic and growth promoter properties have also been used to produce lean carcass. Ractopamine, clenbuterol and salbutamol, a β-agonists improved the body weight gain and reduces the body fat content (Carr et al., 2009). Clenbuterol can be used as for repartitioning of nutrients as it diverts the nutrients from fat deposition to muscle tissues deposition (Sillence, 2004; Zuo et al., 2010). Salbutamol incorporation also favour higher body weight gain with improved feed efficiency (Yasmeen et al., 2013).

L-carnitine, a zwitter ion compound (Bremer, 1983), is involved in the transportation of long chain fatty acids across the mitochondrial membrane for oxidation (Owen et al., 2001). In poultry, it is primarily concerned with fatty acid metabolism. L-carnitine increased the yield of breast and leg muscles and also reduced the abdominal fat content (Rabie and Szilagyi, 1998; Xu et al., 2003; Kheiri et al., 2011).

Narrowing the E: P ratio, either by increasing the protein level or decreasing the energy level also produces lean meat. Increasing the lysine level in the pre-starter diets and methionine level in the finisher diets will increase the lean breast meat yield in broilers. Addition of fish oil to broiler diet at > 2% level will reduce the abdominal fat pad thickness and cholesterol levels; but this technique is not advisable because, it will impart an undesirable fishy taint to the meat and also produce a condition called as oily bird syndrome. Further dietary incorporation of linseed oil at 67 or 100% also lowers the abdominal fat content. (A K Panda et al., 2015).

Pigment Enrichment of Yolk and Skin

Physical appearance and color is the first attraction of the consumers towards the animal products and the farmers and the animal nutritionists are working together exploring the natural and synthetic additives to confer choice based color especially to the yolk and skin of the birds. In many countries, deep yellow or orange colour yolks and yellow skin broilers are preferred over pale yolks and skin. Natural carotenoid pigments like carotenes, xanthophylls, cryptoxanthin, zeaxanthin, lutein present in alfalfa, corn gluten meal, blue green algae - spirulina, marigold petal meal and capsicum will impart rich yellow and orange colours to the yolk and skin. Besides providing attractive colour, they act as anti-oxidants and anti-carcinogenic agents. Most of these natural pigment sources are used in feeds at 1-5 % levels to increase the yolk and skin colour. The active pigments extracted from these sources are sufficient at 0.05 - 0.1 % level, to give the same level of pigmentation. Turmeric powder at 0.5 kg along with red chilli powder at 1 kg / T of feed, not only improve the skin and yolk colour, but also act as anti-microbial agents and anti-oxidants

Marigold petal meal is one of the natural feed additive which is a rich source of xanthophylls and lutein and can be used in layer diets as egg yolk pigmenting agents. (Lokaewmanee et al., 2010). Lutein is an excellent natural pigment to prevent the macular degeneration and cataracts responsible for poor sight in elder people (Karadas et al., 2006). Eggs are good source for enrichment with lutein which in turn is capable of increasing the concentration of this pigment in human plasma (Lokaewmanee et al., 2010; Mansoori et al., 2008). Research demonstrates that carotenoid absorption in the human intestine is increased when consumed with lipids, suggesting that eggs are good delivery system for carotenoids (Amar et al., 2013). Carotenoids from egg yolk are more bio-available compared to spinach or pigment supplements. Numerous studies including use of marigold petal meal have reported an enrichment of caroteinoid pigments in egg yolk and improvement of color of desi chicken egg yolk that is most preferred by the health conscious consumers. (Tamilvanan Sujatha et al., 2015).

Conclusion

Emerging life style diseases are a consequence of imbalance in the modern food which necessitates the supply of healthy and balanced animal food to the consumers for healthy life and increased longevity. Poultry meat and egg has a potential for production of functional foods to extend health benefits and prevent life style diseases. By formulating the diet of chicken with different feed ingredients, herbs and supplements, value added and health promoting chicken egg higher in n-3/n-6 PUFA, anti oxidants, low cholesterol and lean meat with desired egg yolk and skin colour can be made available to the consumers. The production of the functional foods will also add cost but will return a higher premium. Therefore the producers of functional food must conduct a market survey and see the market potential before going in to produce them.

References

References can be made available upon request from the author.

(Lead 27)

Slaughter House By-Products: Disposal Methods and Further Utilisation

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In most parts of our country, the approach towards the slaughter of animals in unauthorised slaughter house leading to wasteful losses of a whole range of valuable by products. The link of developing by-product industry along with slaughter house was not developed except some modern abattoirs, since slaughter is very scattered particularly takes place in meat shops leads to poor quality meat as well as wastage of by-products, hence revenue generation goes negative side.

The contributions of meat sector towards income generation, employment and foreign exchange earnings resulting in substantial increase in the slaughter of food animals. Such large scale slaughter of food animals generates huge amount of wastes which need safe and proper disposal for food safety and human health as well as nutrient utilization.

Indian scenario

In India the total availability of offal/bones, generated from large slaughter houses is estimated to be 21 lakh tones/ annum. According to various statistics 107 million livestock and more than 650 million poultry birds were slaughtered annually in India leading to production of 6.3 million tonnes meat. It leaves huge loads of by-products. Export value of edible offals from different livestock species of India was estimated to be 54751 lakh. The yield of animal by-products ranges between 50-60% of the live weight. It accounts for more than 10 million MT of edible and inedible by-products.

The estimated loss of Rs 1,000 crore/annum from slaughter houses by-products and Rs 600 crore from dead and fallen animals. Proper utilization contributes significantly to the profitability of meat business as it may account for expenses towards slaughter house operations or even more thus benefiting the farmers, processor and consumers. (Chatli et al., 2005). The value of unprocessed by-products from buffalo and sheep in India was reported to be 30% and 35% respectively (Chatterjee et al., 1991) which is quite high.

Uses of Meat by-products

The major inedible by-products include wool, hair, fiber, skin, blood, bones, horns, bristles, hooves, manure, litter, fish scales, hatchery by-products, snout, teeth, trimmings etc.

Blood: The blood is potentially a most valuable source of protein (17%) with balanced profile of amino acids. Plasma can also be used as a substitute for eggs in baked goods because it has excellent foaming property (Del *et.al.,* 2008). Blood is used to prepare blood puddings, blood sausages, bread, biscuits, blood cake and blood curd (Ghosh, 2001). Research has been carried out on application of transglutaminase in meat products. Transglutaminase is blood factor XIII which is separated from organs, blood or microbes and acts as an enzymogen in blood plasma.

Hides and Skins: Hide is principal by-products worth of Rs. 30,220 crores out of which Rs 20,000 crores come through exports (FAO, 2014). But unfortunately, they are not exploited up to their full potential, as often they are thought of as intrinsically unclean and finally end up being discarded or wasted because of ignorance and misinformation. The value of these raw hides and skin accounts 10-15 % of the total realization from slaughtered animals. Converting hide/skin in to processed leather enhances their value by 5-6 times (Naidu, 2003). The leather produced from hides and skin is used at industrial level for production of foot wares, garments and assorted leather goods such as wallets, passport cases, key chains, hand bags and brief cases etc and contributes immensely to the Indian economy by way of exports (Ranks 8^{th} in the world) (Anon, 2008), The Indian leather industry meets 10% of global finished leather requirement. India exports finished leather to the Europe, North America, Hongkong and China (Anon, 2008).

Utilization of Bones: Approximately 5.0 lakh tones of bones are available in the country but only 50% are collected and used. Bones are the raw materials for tallow, crushed bones, bone sinews, ossein, di-calcium phosphate, bone meal, bone clear, glue and gelatine. Bone Morphogenic Protein (BMP) is extracted from bones which have no antigenicity; therefore it is used in human facial, dental and aesthetic surgeries. Slaughter house bones are also used to extract soup stock, buttons, handles and in sugar refinery, water purification systems, steel hardening etc.

Extraction of gelatine: Gelatin is extracted from the bones which are separated during deboning of meat. Gelatin has wide applications in foods; it is main ingredient in jellies (Jamilah & Harvinder, 2002). Gelatin finds its application in making capsules, ointments, cosmetics, and emulsions. Gelatin also is used in manufacture of photographic films, paper, and textiles.

Edible tallow and lard Fat: Tallow and lard are obtained by rendering of animal tissue is further bleached and deodorized before using in food. Lard and tallow is used in shortenings and margarine (Ghotra et al. 2002). Lard is also used in emulsified products and sausages

Hoofs and horns: Neat's foot oil is pale, golden yellow coloured oil obtained from spongy tissues (stearin) present in hooves of cattle, buffalo, sheep, and goat by the process of wet rendering. Neat's foot oil found its applications such as in ointment preparation in wound healing, lubricant in delicate machinery, fat liquoring agent in finishing of leather and oil adjuvant in pharmaceutical preparations. The Horns are used for manufacture of gelatin and some other articles like button, handles, combs etc. Horns and hoofs also are also used for manufacture of horn and hoof meal, having high amount of nitrogen is used as fertilizer.

Utilization of slaughter by-products for isolation of bi-active peptides: Certain meat proteins have important physiological activities. For example collagen has a positive influence on the delivery and bioactivity as bone morphogenic protein-2 and ectopic bone formation enhancing bone healing (Bhakta et. al., 2013). Bioactive peptides can also be generated during food processing or from precursor meat by-products by microbial fermentation or by chemical I enzymatic hydrolysis using proteolytic enzymes derived from animals, microorganisms or plants (Bhat, 2015). Bioactive peptides are known to have antimicrobial, antioxidative, antithrombotic, antihypertensive, anticarcinogenic, satiety regulating and immunomodulatory activities and may affect the cardiovascular, immune, nervous and digestive systems.

Utilization of Pancreas: Pancreas can be effectively utilized for isolation of digestive enzymes and hormones for industrial applications.

Medicinal uses of meat by-products: In many countries like India, Japan and China, animal organs and glands have been widely used for different medicinal purposes. In most cases, the active principle in a gland amounts to only a minute fraction of the whole; therefore it is necessary to gather large amount of glands for processing. The first widely used drug of animal origin was pepsin.

Poultry by-products and their uses: Poultry waste management has become very profitable business since poultry meat shop associations at Shivamogga, Karnataka are now a day's collecting all by-products (feathers, hair, mortalities and animal excreta) except giblets from meat shops and converting them into organic fertilizers. Where as modern poultry meat processing plants are effectively utilizing the solid waste into meal and its one of the ingredient in dogs pedigree food. The poultry shanks are now a day's became expensive since they find suitable export potential to China for production of food delicacy.

Developing sustainable biocomposites/Bioinsole by converting biomass (chicken feather waste) using nanotechnology, we could save thousands of barrels of fuel annually. (Dhoolappa *et. al.,* 2016) This patented idea is of first of its kind and a promising technology to convert waste to health and wealth. The novelty of our product is affordability (Rs 150/pair as compared to existing diabetic insoles Rs 1000/pair), rendered anti-odour, fully biobased and completely biodegradable. The technology has the potential to disrupt the current bioinsole market at global level. This is a billion dollar global market opportunity.

Solid waste management of slaughter house

The organic sludge obtained after liquid waste after treatment can be used as fertilizer. The water with reduced organic matter is used for rearing fish as indicator organism of safety as well as economic purpose. The recommended methods for treatment of solid waste are

Composting: Composting is recommended as eco- friendly process for disposal of dead animals, birds, manure and slaughter house waste. It is an aerobic biological process employing naturally occurring micro-organisms to convert biodegradable organic matter in to humus like product. The optimum Carbon to Nitrogen ratio required for composting is about 30:1. The total time required for composting is about 90 days. Different methods of composting are aerobic bin composting, windrow composting, aerated static pile composting, In-vessel composting

Rendering: Rendering is the recovery of fat from a material by heating. It includes all the process leading to the conversion of slaughter house offal into stock feeds, fertilizers & fats. Fat recovered from fresh & healthy part is used for edible purpose. Fat recovered from decomposed & condemned material is used for inedible purpose. (Ex. soap making). Clean & fresh material gives good stock feed. Decomposed & contaminated with other extraneous matter is used for fertilizers. In dry rendering method, the raw material is processed in dry rendering melter (cooker). Steam is applied to jacket only not to the material to be processed. cooking (100^{0}C, 45 psi for 20 minutes) Sterilization(120°C, 45 PSI for 20 min, & drying (100° C for one hour) takes place in one operation & in one vessel only & there is no loss nutrients what so ever. Fat is released from fat cells is dispersed throughout the material (crackling). Later fat recovered through centrifugal turbine fat extractor. Meal is milled and packed in plastic bags.

Incineration: It is a controlled combustion process in which the waste is burnt and converted into gases operates at temperatures between 900 and l200°C.

Bio-briqueting: Biomass briquettes mostly made of green waste and other organic materials for a biofuel substitute to coal and charcoal, commonly used for electricity generation, heat, and cooking fuel. Briquettes are mostly used in the developing world, where cooking fuels are not as easily available. The rumen ingesta and dung, which are waste for the meat plants shall be convened into bio-briquette which is a valuable bio-fuel. This dewatered rumen fibres shall be mixed with binders like molasses and shall be converted into bio-briquettes in bio-briquette unit.

Bio-Diesel production: Biodiesel, prepared from animal fat /technical fat-more specifically slaughterhouse animal fat viz. tallow, lard, and poultry fats. Biofuels prepared from animal fat/ slaughter house waste is popularly known as second generation biodiesel and has the potential to meet the global energy needs owing to overall cost-effectiveness and acceptable fuel properties. It was also found to have a commendably higher octane value of 72, as compared to 64 of petro-diesel, which means better efficiency.

Biomethanation: Biomethanation is a complex microbial process in which organic compounds are degraded into methane and carbon dioxide by a variety of anaerobes. Methane for electricity production. In many cities across India, sewage treatment centers and organic waste treatment plants (those treating organic municipal solid waste,) already use anaerobic digesters to generate biogas and electricity.

Rumen content as Animal Feed: Rumen content is potential biological resource that can be used as for poultry and swine feed. The rumen content, which is rich in nutrients, could be used as food mixture of poultry, pigs, and sheep. (Nova, 2000) The fermented dried rumen contents with *Trichoderma harzianum* product in laboratory scale was fed to ducks.

By-Products as Livestock Feed: Animal by-products including condemned parts or even whole carcasses can be utilized as a feeding supplement for the live stocks including poultry and pet animals. Ex: meat meal, bone meal, carcass meal etc for supplemented feeding.

Organic liquid fertilizer from Dead animals: Some farmers of in and around Sagar, Shimoga Dist., Karnataka are converting dead cattles/cow into liquid organic fertilizer. The dead animal will allowed decaying for 3-4 months in local cattle dung and urine mixture with added butter milk, jaggary and waste papaya fruit. Spraying of liquid fertilizer leads fruitful results in enhanced crop production. They consider this as one of easy way for organic agriculture production. (Anand, 2018 and Srinivas, 2018)

Liquid waste management:

As per pollution control board norms effluent treatment plant (ETP) is necessary in all the modern slaughter houses/ meat plants for solving of liquid waste. The screened liquid waste is taken to equilibrium tank with air flotation technique helps in removal of scum, followed addition of flocculants. Later aerobic secondary treatment having aerators with activated sludge system and clarifier decreases the organic content of liquid waste to desired level. Waster with reduced BOD is used for irrigation purpose and dried sludge as organic fertilizer.

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References can be made available upon request from the author.

(Lead 28)

Organic Meat: Challenges And Opportunities

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Introduction

Believe in the nurturing power of nature and go natural- be healthy. The term "organic" denotes a product obtained from a food production system that is socially, ecologically and economically sustainable (IFOAM, 1998). According to the definition given by the Council of the European Union, organic production is a system of farm management and food production that combines the best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards, and a production method in line with the preferences of certain consumers for foodstuffs produced using natural substances and processes (EU, 2007).The Government of India has been constantly stressing on the priority to the organic food sector, both from the farm sustainability perspective as well as from the point of view of addressing consumer demand. There is an urgent need for the nation to work for the ways and means to promote organic farming in this direction. In traditional India, the entire agriculture was practiced using organic techniques, where the fertilizers, pesticides, etc., were obtained from plant and animal products. The bovines not only provided milk, but also provided dung which was used as fertilizer. But after that, green revolution came in picture to increase food security where natural/organic fertilizers and pesticides were replaced by chemical fertilizers and pesticides. These lead to introduction of various chemicals into food chain, which are now taking a toll on human health. To rectify this problem and meet consumers' demand, farmers are gradually shifting back to organic farming in India with the belief that organic farming is healthier. Though the health benefits of organic food are yet to be approved at scientific forum, consumers are willing to pay higher premium for the same.

Organic food is raised or processed by biological, mechanical and physical methods in a way that maintains the vital quality of each ingredient and the finished product. It is produced, without involving the application of manmade fertilizers or pesticides and without using genetically modified organisms. Organic foods typically are not processed using irradiation, industrial solvents, or synthetic food additives. Organic meat, poultry, egg and dairy products come from animals reared under organic animal husbandry practices. Historically, organic food has been associated with mostly fruit and vegetables but as the organic food market is expanding, other food items are finding their way into the organic food market (O'Bryan *et al*., 2008). The demand for organic meat products has increased steadily over the last 20 years (Willer & Kilcher, 2011). A major driver for this increase has been consumer perception that organic livestock products typically contain higher concentrations of nutritionally desirable compounds, therefore making them 'healthier' (Oughton & Ritson, 2007). However, the claim of organic food is still scientifically not proven and it is uncertain over whether, and to what extent, organic production standards result in significant and nutritionally relevant changes in food quality (Dangour *et al*., 2010).

Conventional Vs Organic Meat

Organic meat production is an alternative to conventional one and is rapidly developing in response to increasing consumers' demand for better meat quality and enhanced food safety. The consumer might not be aware that the product is organic because differentiation between conventional and organic food may not be that much discernible. Organic food production focuses on animal health and welfare, good environmental practices and product quality whereas conventional food production focuses on reducing costs and maximizing production through weight gain and feed efficiency (Sundrum, 2006). Organic meat production involves natural practices and avoids chemical fertilizer and pesticide laced feed. However the manpower requisites and cost of production are higher but production is healthier for human being and environment too. In conventional meat production, practices involve maximizing the production and minimizing the cost by utilizing chemically processed feed, antibiotic and hormones. Conventional food production may also be safe for consumption as there have not been any record of ill effect from consuming conventional foods. However, doubt may be there regarding long term effect of conventional foods with the reasons that chemicals are incorporated into the feed and processing.

Organic Meat Production

In India, The National Standards for Organic Production (NSOP) developed by Ministry of Commerce and Industry, Government of India, provides guidelines for organic production. There are no worldwide regulations especially for governing the processing of organic meat, however guidelines for the production, processing, labeling and marketing of organically produced foods have been given by Codex Alimentarious Commission which was utilized by various countries to set their own standards, similarly India promulgated the National

Standards for Organic Production. Organic meat production consists of some basic principles in accordance with standards (NPOP, 2005). It mainly includes two segments; (A) Animal Husbandry, (B) Processing and Handling of Food.

Animal Husbandry:

Animal Husbandry Management

- The certification programme shall ensure that the management of the animal environment takes into account the behavioral need of animal. It includes sufficient free movement, fresh air, natural daylight, fresh water resting area and protection against excessive sunlight, temperature, rain and wind.
- All animals shall have access to open air and/or grazing area. Poultry and rabbits shall not be kept in cages. Landless animal husbandry systems shall not be allowed.
- The natural day length is prolonged by artificial lighting according to species, geographical considerations and general health of animals.
- Herd animals shall not be kept individually.

Length of Conversion Period

- Animal products may be sold as "product of organic agriculture" only after the farm or relevant part of it has been under conversion for at least twelve months and provided the organic animal production standards have been met for the appropriate time.
- Animals present on the farm at the time of conversion may be sold for organic meat if the organic standards have been followed for 12 months.

Brought-in Animals

- All organic animals should be born and raised in the organic holding. When organic livestock is not available, the certification programme shall allow brought-in conventional animals according to the following age limits: 2 day old chickens for meat production, piglets up to six weeks and after weaning and calves up to 4 weeks old which have received colostrums and are fed a diet consisting mainly of full milk.
- Breeding stock may be brought-in from conventional farms but maximum replacement rate should be 10 percent.

Breeds and Breeding

- Breeds should be chosen which are adapted to local conditions.
- Reproduction techniques should be natural.
- Artificial insemination is allowed.
- Embryo transfer techniques are not allowed.
- Hormonal heat treatment and induced birth are not allowed unless under veterinary advice.
- The use of genetically engineered species or breeds is not allowed.

Mutilations

- Mutilations are not allowed.
- The certification programme shall allow the following exceptions: castrations, tail docking of lambs, dehorning, ringing and mulesing.

Animal Nutrition

- The livestock should be fed 100% organically grown feed of good quality.
- Minimum 50% feed shall come from the farm itself or produced in co-operation with other organic farms in the region.
- The following products shall not be included nor added to the feed; synthetic growth promoters, appetizers, preservatives, artificial colouring agents, urea, farm animal by-products (e.g. abattoir waste) to ruminants, droppings, dung or other manure (all types of excreta), genetically engineered organisms or products etc.
- Vitamins, trace elements and supplements shall be used from natural origin.

Veterinary Medicine

- Natural medicines and methods, including homeopathy, ayurvedic, unani medicine and acupuncture, shall be emphasized.
- The uses of conventional veterinary medicines are allowed when no other justifiable alternative is available but the withholding period shall be at least double the legal period.
- Synthetic growth promoters and hormones for heat induction and heat synchronization are prohibited.
- Vaccinations shall be used only when diseases are known or expected as in endemic areas.

Transport and Slaughter

- Transport and slaughter should minimize stress to the animal. Transport distance and frequency should be minimized.
- Animals should be inspected regularly during transport.
- Animals should be watered and fed during transport.
- Each animal shall be stunned before being bled to death but exceptions can be made according to cultural/religious practices.
- No chemical/synthesized tranquilizers or stimulants shall be given prior to or during transport.

Processing and handling of food

General

- Organic products shall be protected from co-mingling with non-organic products.
- All products shall be adequately identified through the whole process.
- The certification programme shall set standards to prevent and control pollutants and contaminants.

- Organic and non-organic products shall not be stored and transported together except when labeled or physically separated.
- Certification programme shall regulate the means and measures to be allowed or recommended for decontamination, cleaning or disinfection of all facilities where organic products are kept, handled, processed or stored.
- Besides storage at ambient temperature, the following special conditions of storage are permitted: controlled atmosphere, cooling, freezing, drying and humidity regulation.

Pest and Disease Control

- Pests should be avoided by Good Manufacturing Practices (GMP) and recommended treatments are preventive, mechanical, physical, biological methods and pesticidal substances approved in national standards.

Ingredients, Additives and Processing Aids

- The ingredients used should be organic.
- In cases where an ingredient of organic agriculture origin is not available in sufficient quality or quantity, the certification programme may authorize use of non organic raw materials subject to periodic re-evaluation. Such non-organic raw material shall not be genetically engineered.
- Water and salt may be used in organic products.
- Minerals (including trace elements), vitamins and similar isolated ingredients shall not be used.
- For the production of enzymes and other micro-biological products the medium shall be composed of organic ingredients.

Processing Methods

- Processing methods should be based on mechanical, physical and biological processes.
- The following types of processes are approved: smoking, extraction, precipitation and filtration.
- Extraction shall only take place with water, ethanol, plant and animal oils, vinegar, carbon dioxide, nitrogen or carboxylic acids. These shall be of food grade quality, appropriate for the purpose.
- Irradiation is not allowed.
- Filtration substances shall not be made of asbestos nor may they be permeated with substances which may negatively affect the product.

Packaging

- The materials used must not affect the organoleptic character of the product or transmit to it any substances in quantities that may be harmful to human health.
- Use of polyvinyl chloride (PVC) materials is prohibited.
- Laminates and aluminum should be avoided.

- Recycling and reusable systems shall be used wherever possible.
- Biodegradable packaging materials shall be used.

Labeling

- Labeling shall convey clear and accurate information on the organic status of the product.
- Where a minimum of 95% of the ingredients are of certified organic origin, products may be labeled "certified organic" or similar and should carry the logo of the certification programme.
- Where less than 95% but not less than 70% of the ingredients are of certified organic origin, products may not be called "organic". The word "organic" may be used on the principal display in statements like "made with organic ingredients" provided there is a clear statement of the proportion of the organic ingredients.
- Where less than 70% of the ingredients are of certified organic origin, the indication that an ingredient is organic may appear in the ingredients list. Such product may not be called "organic".
- The person or company legally responsible for the production or processing of the product shall be identifiable.

Storage and Transport

- Integrity should be maintained during storage and transportation of organic products.
- Organic products must be protected at all times from co-mingling with non-organic products.

Organic meat handling and processing

Essential requirement especially for organic meat production are facilities of certified slaughter unit, meat inspection, meat processing, sanitation, safety measure (HACCP), waste management, record keeping etc. In the United States, the animals slaughtered in a federally inspected plant, and certified organic meat must additionally require a certified organic slaughter facility. Animals to be slaughtered must be certified organic, and be traceable by individual animal or flock. Once a facility is located, it may require a trip of several miles for animals that can lead to stress and loss of meat quality (Minka & Ayo, 2010). An option now available is the mobile slaughter unit (MSU). In 2010, the USDA announced compliance guidelines for MSUs under Food Safety and Inspection Service (FSIS, 2010). Among the advantages of an MSU versus a fixed structure are the lower costs and reduced stress on animals. The live animal must be inspected prior to killing and there must be a means of humane stunning before killing.

The application of physical and chemical interventions and combinations thereof is advised to extend meat and poultry quality and safety by the inhibition or inactivation of microbes. The manufacture of organic meat and poultry products may include the use of hot water and/or organic acid rinses for pathogen inactivation on carcass surfaces, vacuum packaging, refrigerated storage of carcasses and fabricated cuts, use of approved substances in further processed and/or ready-to-eat (RTE) products, and low-temperature storage, distribution, and retail display. Food antimicrobials have been successfully applied to carcasses for inhibition of spoilage and pathogenic microorganisms, incorporated into brine and marinating solutions and injected into non-intact products for deep-tissue decontamination, added into formulations of, or applied topically to surfaces of processed products to inhibit surface-contaminating microbes (Schirmer & Langsrud, 2010). Antimicrobials approved for use in organic food manufacture, including weak organic acids, chlorine and oxidizing compounds, microbially produced antimicrobial substances, and bio-preservation technologies. Numerous studies have detailed the efficacy of LAB-derived bio-preservation technologies for the inhibition of Gram-negative and Gram-positive microbes on fresh and processed meat and poultry (De Martinis *et al.*, 2002).

Processors must continue the record keeping paper trail that was begun by the producer to ensure the integrity of the final organic product. Ingredients and processing aids must be documented as to certify the meat or meat products organic. The management of liquid and solid waste products during meat and poultry processing in fixed facilities is similar for both conventional and organic processing systems.

Impact of Organic Product

Nutritional value and health

Consumers perceive organic food as healthier, better tasting, more environment friendly, and safer than food produced conventionally (Hughner *et al.*, 2007). The most acceptable theory of bovine spongiform encephalopathy (BSE) outbreak was transfer of 'scrapie' from sheep to cattle via meat and bone meal which is widely used as a source of protein in livestock feed (Watson & Redman, 1999). 'Organic meat production' undoubtedly reduces the risk of potential public health problems occurring, by prohibiting the use of antibiotics, hormones and pesticides, which are suspected to have endocrine disrupting, carcinogenic, teratogenic, immunosuppressive and nervous effects (Lee *et al.,* 2001), and by applying more stringent safety margins (i.e., withdrawal period) to acceptable practices such as use of antibiotics on individual sick animals (Redman & Holden 1994). Organically produced animal products have lower levels of veterinary drugs and pesticides residues. As regular uses of antibiotics are prohibited organic meat potentially reduces the risk of contamination by antibiotic resistant bacteria particularly, *E. coli* O157: H7 infection. The 'organic' label provides the assurance that no food ingredient is subjected to irradiation and that genetically modified organisms have been excluded (Kouba, 2003). Apart from food safety, food quality is also important factor in organic meat production. Major differences between organic and conventional meat production are lower total fat content, higher content of intramuscular fat, more unsaturated fatty acids (including *n*-3 fatty acids) etc. Several studies have investigated the difference between organic vs. conventional meat production given in table 1.

A concept of higher fat quality in organic pork is also confirmed by the studies carried out by Kim *et al.* (2009) on Korean native black pigs. Among polyunsaturated fatty acids (PUFA), *n*-3 PUFA, have a beneficial influence on health; the ratio of *n*- 3 acids to *n*-6 acids is crucial as well. The proportion of *n*-6:*n*-3 was lowered in organic pork by more than half. Organic pork contains a high level of polyunsaturated fatty acids (PUFA) and a lower content of saturated fatty acids (Nilzen *et al.*, 2001). Lower content of total fat in organic poultry meat was also noted

(Castellini *et al.*, 2002). Due to pasture feeding, organic lamb meat showed a higher content of conjugated linoleic acid (CLA), an indirect product of biohydrogenation in rumen, which is considered very beneficial to human health (Pariza *et al.*, 2001). Beef from organic farms have the lower ratio of PUFA (*n*-6:*n*-3) due to high concentration of alpha-linolenic acid (LNA) (18:3, *n*-3)found in grass (Wood *et al.*, 2003). From nutritional viewpoint, organic veal meat proved to be more valuable due to a higher content of *n*-3 acids, reduced *n*-6:*n*-3 ratio and a higher CLA level compared to conventional veal. There is no clear scientific evidence that organic meat can better protect consumers from chemical contamination than can conventional meat, even this is one of the major forces driving consumers to buy organic products. Existing research does not support differences in either the prevalence or antimicrobial resistance of food-borne pathogens from organic or conventional production systems (Ricke *et al.,* 2012).

Table 1. The comparison of quality indicators of organic and conventional meat

The kind of meat	The examined indicators	Results	Author
Pork	Fat-free body mass Content of intramuscular fat	Higher in ORG meat Higher in ORG meat	Sundrum and Acosta, 2003
Pork	Composition of fatty acids Content of TBARS	Lower SFA level and more PUFA in ORG meat Higher in ORG meat	Hansen *et al.,* 2006
Pork	Fat-free body mass Content of total fat Content of intramuscular fat	Lower in ORG meat Higher in ORG meat Lower in ORG meat	Olsson *et al.,* 2003
Mutton	Composition of fatty acids Content of intramuscular fat Content of total fat Content of TBARS	Higher n-3 PUFA level and lower n-6 PUFA level in ORG meat Higher in ORG meat Lower in ORG meat Higher in ORG meat	Fisher *et al.,* 2000
Lamb	Composition of fatty acids	Higher n-3 PUFA level (in particular linolenic acid) in ORG meat, comparable n-6:n-3 ratio	Angood *et al.,* 2008
Poultry	Content of abdominal fat Content of iron Content of breast and thigh Meat Composition of fatty acids Content of TBARS Meat pH Content of total fat	Lower in ORG meat Higher in ORG meat Higher in ORG breeding Higher PUFA and SFA levels and lower MUFA level in ORG meat; higher n-3 acids level (in particular DHA) in ORG meat Higher in ORG meat Lower in ORG meat Lower in ORG meat	Castellini *et al.,* 2002

**ORG, organic meat; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SFA, saturated fatty acids; TBARS, thiobarbituric acid reactive substances.*

Sensory characteristics

Organic pork is less tender than pork meat from conventional sources (Danielsen *et al.*, 1999). Greater physical activity of the organic chickens was also responsible for a lower content of abdominal adipose tissue and better developed breast and thigh muscles, which would increase the commercial value of the meat (Lewis *et al.*, 1997). Organic meat has a higher content of intramuscular fat, which is defined as 'marbling' due to its appearance. It is a favourable property and is considered a sensory assessment, since it relates to higher meat juiciness and tastiness (Ricke *et al.,* 2012). Organic meat had a higher content of *n*-3 PUFA and displayed a better nutritional quality in terms of juiciness, tastiness and general acceptability compared to the conventional lamb available on the market. The greater juiciness resulted from a higher content of intramuscular fat in the organic lamb chops (Angood *et al.,* 2008). Fibrous texture ($p \leq 0.05$) and fatness sensation ($p \leq 0.01$) were found to be significantly lower in the organic samples than in the conventional samples (Revilla *et al.,* 2008). Kim *et al.* (2009) studied and found that the organically reared pigs had lower shear force values than the conventionally reared ones. Castellini *et al.* (2002) found that organic broilers had increased cooking losses due to lower ultimate pH and water-holding capacity.

Market Status and Potential

India is bestowed with lot of potential to produce all varieties of organic products due to its various agro climatic regions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic and export sector. Total area under organic certification process (registered under National Programme for Organic Production) is 3.56 million hectare (2017-18). This includes 1.78 million ha (50%) cultivable area and another 1.78 million hectare (50%) for wild harvest collection. Among all the states, Madhya Pradesh has covered largest area under organic certification followed by Rajasthan, Maharashtra and Uttar Pradesh (http://apeda.gov.in). The Indian state of Sikkim just achieved the feat of being the world's first organic state and has been awarded UN Future Policy Gold Award (2018), also known as the Oscar for best policies, beating 51 nominated policies from 25 different countries. As per the available statistics, India's rank in terms of World's Organic Agricultural land was 9th and in terms of total number of producers (835,000 organic farmers) it was at 1st position (FIBL and IFOAM Organics International, 2019). This picture makes clear about availability of organic land, feed and also potential of organic food production.

The North American market for organic products is reporting the highest growth worldwide. The meat sector is the fastest growing organic food industry with sales expanding by 51 % in 2005 (Organic Monitor, 2006). The global sales increased to US$89.7 billion in 2016 from US$7.9 billion in 2000. Country wise, the top consumers of organic products are the US (US$43.1 billion), followed by Germany (US$10.5 billion) and France (US$7.5 billion). India produced around 1.70 million MT (2017-18) of certified organic products which include all varieties of food products namely oil seeds, sugar cane, cereals & millets, cotton, pulses, medicinal plants, tea, fruits, spices, dry fruits, vegetables, coffee etc. In the food market segment, oilseeds comprised half of India's overall organic food export, followed by processed food products at 25%. The production is not limited to the edible sector but also produces organic cotton fiber, functional food products etc. India is the largest exporter of organic cotton worldwide. The total volume of export during 2017-18 was 4.58 lakh MT. The organic food export realization was around INR 3453.48 crore (515.44 million USD). Organic products are exported to USA, European Union, Canada, Switzerland, Australia, Israel, South Korea, Vietnam, New Zealand, Japan etc. However, despite the promising performance in terms of exports, the local consumption of organic produce is still at a nascent stage with a market share of less than 1% (http://apeda.gov.in).

Standards and Regulations

FAO/WHO Codex Alimentarius Commission and IFOAM (The International Federation of Organic Agriculture Movements) are the two main basic international standards which were followed by different country to make their own standards. Many countries formulate their own standards like US National Organic Program (NOP) by United States, EU Regulation from EC 834/2007 and 889/2008, United Kingdom Register of Organic Food Standards (UKROFS) by UK, and Japan Agricultural Standard (JAS) by Japan etc.

Similarly the Government of India has implemented the National Programme for Organic Production (NPOP). The national programme involves the accreditation programme for Certification Bodies, standards for organic production (NSOP- National Standards for Organic Production), promotion of organic farming etc. Even though the standards are in effect since 2000, the certification scheme and hence the certification mark came into existence in 2002. The NPOP standards for production and accreditation system have been recognized by European Commission and Switzerland for unprocessed plant products as equivalent to their country standards. Similarly, USDA has recognized NPOP conformity assessment procedures of accreditation as equivalent to that of US. With these recognitions, Indian organic products duly certified by the accredited certification bodies of India are accepted by the importing countries. Accreditation regulations shall apply to all certification agencies whether they are individuals, firms, co-operatives, societies which are already engaged, or which propose to engage in the work of certifying organic crops/products.

Implementing organic standards require inspection and the end product of the inspection is certification. Certification ensures that organic products are produced, processed and packaged according to organic standards. Certification also ensures that consumers, producers and traders against fraudulent labeling of non-organic products. The accreditation process involves inspection by inspectors, appointed by the accredited inspection and certification agencies, will carry out inspection of the operations through records maintained by the operators as per specified formats and also by periodic site inspection. Based on compliance with the standards and certification programmes, accredited inspection and certification agencies will certify the organic status of products and operations, specifying their conditions and recommendations (NPOP, 2005).

A trademark "India Organic" will be granted on the basis of compliance with the National Standards for Organic Production (NSOP). Communicating the genuineness as well as the origin of the product, this trademark is owned by the Government of India. Only such exporters, manufacturers and processors whose products are duly certified by the accredited inspection and certification agencies, will be granted the license to use the logo which would be governed by a set of regulations.

Challenges and Constraints

Regulations related issue: The Indian certification processes are seen to be tiresome, inefficient and recognized as the major issue that diminish the progress of the sector. Excessive paper work and poor control of certifying agencies on ground and weak accreditation process is the key issue. In this regard third party certification system is felt to be generally good. For every producer especially small producers it is not easy to be accessible. Small producers sometimes may have only a small amount of produce and is not be viable for the farmer to sell it directly. The Food Safety and Standards Authority of India (FSSAI) have decided to consider the organic food regulations as "Enabling Regulations" and not for prosecution, particularly for small original producers and producer organization during the initial phase of its implementation till April 1, 2020. Small producers (turnover of less than Rs 12 lakh) may be allowed to sell organic food without any certification i.e. NPOP/PGS-India," as mentioned by FSSAI. Radical revamp of the overall system and regulation, introduction of more international practices, drastic reduction of paper work and digitalization is the need of time.

Organization of organic sector: Organic sector seems to be unorganized and unmonitored. This can be improved by motivating and educating the producer and assuring consumers too. This will help to grow domestic as well as global market. Defined vision, policy, infrastructure, regulation, support, skill development etc. are the basic need to boost the sector. The efforts and plans of government with the producers are required for direct linkage to the market. Organic producers need to be pooled and channelized through established supply chains to ensure maximum benefits. Collective effort under a national plan and platform can provide focus and impetus to place "India Organic" in the premium global supermarket.

Market related issue: Development of the domestic market is extremely critical for the overall sustainability of the organic sector. The old fashion marketing system, with most producers selling directly to the consumers, or through one small specialized grocery store, is becoming less important, as market share, due to the entry and fast expansion of supermarket chains and of the franchising approach to distribution. They require a stable and homogeneous flow of planned supply, in big quantities. There are very few retail shops in India that store and sell organic food items. Many fake organic products are also available in the markets, which are diminishing the profits of genuine vendors. Credibility of Indian certification in top markets of Europe and USA was opined as not universally acceptable. Perception of spurious exports from India as 'certified' is a challenge to be overcome and impact overall credibility. Therefore organization: associations, cooperatives, platforms can play major role in marketing the organic food. The challenge ahead is to organize the markets more and more, in order to benefit the consumers, the producers and the environment, without losing the characteristics which made the organic market a bit different from the conventional one.

Economic issue: Investment required in organic food production is more therefore the cost of organic food products is higher than that of conventional food items. Although ensured higher profit from organic product, it is difficult to invest such amount for small producer.

Opportunities and Future Scope

Organic sector in India have lot of potential, only matter is the right interventions should be made. India has an inherent advantage in organic cultivation because of its varied geography and climatic conditions. As the awareness level has been rising among people nowadays at a very fast pace because of easy access to mass information through the internet or media, people know how organic products are produced and how they are beneficial for them. As a result of this, more and more people in India are going for organic than traditional.

The total consumption of organic products has exceeded day by day. Many aspects of organic meat production remain either undeveloped or not considered as of yet. Small producers from all over India are backbone and their involvement is strictly needed to develop organic sector. In addition to more scientific research on organic meat, there is a need for improving the consumer awareness about specific regulations directed towards organic meat production, processing, and retail. In order to increase the organic food purchases from those consumers, an expansion of the organic market can be a solution. For the organic meat market to continue growth the production base must expand to meet increasing market demands, followed by industry integration and developing more value-added and further processed organic meat products. Government of India plays role in providing policy, subsidy or incentive to encourage new beginner or small producers and manage a supply chain between domestic and global market.

Conclusion

The world's largest number of organic cultivators and adequate land in India shows assurance in organic sector. Increasing interest by consumers in organic meat may be due to their concern of potential food safety and quality issues. The perceived differences in food safety, nutritional quality and sensory characteristics between conventional and organic meat must be focused on claims that need to be substantiated. Organic production promising the animal welfare, sustain environment and also build economic strength is the demand of present time. There are several challenges at every stage from production to final consumption which needs to be addressed in order to develop the industry further, especially related to certification, organization, marketing etc. Appropriate approach is requisite to lift the immense potential of organic food/meat industry in India.

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(Lead 29)

Entrepreneurship Opportunities in Meat Sector

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Meat foods play a very imperative role in human health by providing all essential nutrients needed for growth and maintenance. India produces about 7.4 million tonnes of meat annually from all species comprising buffalo meat (1.45 million tonnes), beef (0.34million tonnes), chicken (3.46 million tonnes), chevon (1.04 million tonnes), mutton (0.56 million tonnes), and pork (0.47 million tonnes). Around 72 per cent of Indians are now on non-vegetarian dietary habit and regular meat consumption is rigorously increasing over the years. Holding of 11.6% of world livestock population and 17.71% of the world human population, India has tremendous potential in meat production, processing and marketing. The Indian meat market was valued close to USD 30 billion and is one of the fastest growing industry at a CAGR of 22 per cent (Mintel Industry Research Report, 2017).

The net output from the unit of investment is comparatively high in livestock farming relative to other agricultural activities even under adverse climatic conditions. However, existing livestock production system in India “produce a lot to get a little” is putting pressure on environment. Further, livestock and poultry producers and processors in India are required to ensure food safety, environmental responsibility, animal health and welfare and traceability. Hence, effective blending of scientific knowledge with understanding of market dynamics and business principles are imperative to create business ventures in meat value chain. The article describe about various entrepreneurship opportunities in meat value chain comprising meat animal and poultry production, meat production and processing, value addition and marketing.

Meat animal production

The primary objective of first segment is production of meat animals and poultry with higher body weight at optimum slaughter age to yield quality meat.

Integrated meat animal production: Except chicken, this segment has not made significant strides in our country although sheep, goats and pigs are reared by the countrymen for meat production using extensive and semi-intensive methods. Inadequate feeding and complete dependence on free grazing, lack of awareness about superior quality breeds/animals for breeding, poor access to preventive and curative health care led to poor live weight goats and sheep (< 10.0 Kg) . At the same time, technological interventions have resulted in transformation of unorganized and unscientific chicken farming practice in India to a highly successful commercial production system. Poultry industry is one of the fastest growing sub-sectors with 8-10% growth. Poultry egg and meat sector contributes Rs. 699 billion to the National GDP of Rs. 1,24,486 billion in 2015-16 (0.56%). Similar to organised poultry production system, sheep, goat and pig farming need to be taken-up on intensive/semi-intensive concept in larger scale with complete integration. Crop residue based complete feed to be promoted on large scale in rural areas along with silage and other fodder development programmes to curtail the major production cost. It will be a practical alternative to prevent adverse effects of crop burning on climate and at the same time solves the livestock feed and fodder shortage. The integrated production will also suffice mandatory requirement of traceability of food products as per the Food Safety & Standards (Food Recall Procedure) Regulations, 2017.

Growing male buffalo calves to higher weights: Every year, several millions of male calves are removed from the buffalo production system by the farmers to save dam's milk due to non remunerative cost of raising male animals. These calves could be salvaged for meat production, which would increase meat production. The buffalo male calves could be raised upto 1 year of age with high protein / high energy diet to yield 250 kg body weight and 150-kg meat. Meat from such animals is tender, lean and juicy and fetches good price in the export market. Moreover, hides of well grown calves also have good demand (Ranjhan, 1999). According to an estimate, the available male buffalo calf potential is about 15 million. In addition, there are surplus female calves that are culled for various reasons. An additional 1-1.5 million tonnes of buffalo meat per annum could be produced when calves are reared to a higher body weight of 200 - 300 kg. However, at present a far less number of male buffalo calves survive to maturity and the meat yield from these calves is very low. Though there is scheme by Govt. of India for male buffalo calf rearing, due to the restrictions in the Animal Preservation Acts on their utilization for meat production, the practice has not taken up so far.

Growing demand for natural and organic meat: A growing worldwide trend towards consumption of meat from animals/birds reared under free-range condition is evident. The demand for such produce is steadily on increase in response to the concerns of animal welfare and move away from the widespread use of antibiotics and feed additives. Organic animal production system, which follows natural process of animal production with utmost regards for food safety and food security is emerging as an effective alternative to address all these issues. All the products and services in the organic food value chain are likely to fetch premium price in the market as they are targeted for niche consumers who are quality conscious and would be willing to pay premium price for quality products.

Meat production, processing and value addition

The second major segment deals with slaughter of meat animals and poultry for harvesting of meat and edible offal and aspects pertaining to post-harvest handling, processing, by-products utilization and value added meat products. The primary objective of this segment is supply of clean and safe meat and meat products to the consumers.

Meat production: For domestic consumption, slaughtering is performed in designated abattoirs or slaughterhouses maintained by local bodies. The conditions in the vast majority of public slaughterhouses catering to the domestic market are highly appalling; premises are old and dilapidated; hygiene is neglected; meat inspection is scanty; carcasses and edible offal are usually contaminated; carcasses and edible offal are handled and transported to meat stalls in all sorts of unhygienic methods. Meat is sold as hot meat (pre-rigor meat without any chilling) and most of the meat is consumed on the same day. At the other extreme, there are state-of-the-art modern export oriented abattoirs and meat processing plants with excellent cold chain facilities and practicing meat hygiene to the core as per international standards.

Despite spectacular increase in broiler production and marketing, processed, value-added poultry product sector in India are in juvenile stage. In the present scenario poultry trade is either in the form of sale of live birds or as skin-out carcasses in wet market. The primary and secondary processing (further processing) sector (poultry meat) is predominantly unorganized with wet market activity and only 11% of this is organized. A very small proportion undergoes further processing as dressed whole carcass, cut-ups or value added products. Establishment of about 45 modern, mechanized poultry processing plants, vertically integrated poultry companies with their own retail outlets/expansion in domestic food processing, proliferating fast food outlets and entry of multinational fast-food chains has provided impetus to the growth of this sector over the last decade. Supply of clean and safe meat to the public is the responsibility of the government. Improvisation of the traditional abattoirs at nominal investment is the immediate solution to achieve the objective of enforcing hygiene. It will also include newly built low cost non-mechanized abattoirs with overhead railing system or abattoirs with off-the-floor slaughter facilities. Medium and small capacity abattoirs should be established with all the components to produce clean and safe meat, efficient by-products utilization, effluent treatment, chilling, packaging to ensure the norms stipulated by Food safety and standards act, 2006 enacted from Food Safety and Standards Authority of India (FSSAI) for production of hygienic meat.

Further processing and value addition: At present further processing and value addition of meat in India remains less than 2.0% with the exception of poultry where ~7.2% of meat undergoes processing. The Indian market is witnessing a revolutionary change and several multinational companies are introducing globally known products in the Indian markets. There has been an increase in both, the number of players in the frozen products segment and the availability of convenience and ready to eat meat products. Compared to broiler industry, which is growing at 12-15% per annum, the ready to eat meat products segment is growing at more than 20% in India. Even though, cultural patterns rather than income dominate meat consumption in India, the ready to-eat meat sector is growing with consumer affluence. Large meat processing companies like METRO, SPAR Hypermarket, Walmart, etc. have already entered into retail sector and catering to the demands of urban population. KFC, Suguna Daily Fresh, Venky's Xprs, Godrej-Tyson have created the infrastructure to market poultry products in most of the western and southern cities in India. But such initiatives in sheep, goat and large animal meat are almost absent. However, the Government plans to triple the capacity of food processing sector in India from the current 10 per cent of agriculture produce through investments in mega food parks, will generate momentum towards development of viable meat processing sector.

Traditional meat products: Traditional meat products have tremendous mass appeal with unique sensory attributes. Large varieties of traditional food products of indigenous taste profile are being prepared and consumed in Hyderabad. Biryani, haleem, kebabs, koftas, tandoori items and meat curries are few to name. Even the multinational companies like Subway, KFC, and McDonald etc. have realized the importance of traditional meat products for Indian customers and started blending western products with traditional meat products or introducing new ethnic products with their brand. Considering this, traditional meat products will have huge demand among quick service restaurant chains if organized on more scientific lines. Process optimization, large scale production, safety management and better packaging will further boost their acceptability. Most of traditional meat products are generally confined to the native geographical region mainly due to their shorter storage stability. There is huge demand for indigenous meat products from ethnic population residing various parts of the globe, especially to South-east and Middle-east countries. Further, the existing market is limited to a few identified snacks and meal accompaniments and specialty foods like haleem, kababs, biryani, tandoori items etc. However, many are still awaiting the larger recognition. Extending the shelf life through technological interventions will boost the commercial value of traditional meat products. Retort processing is a promising technology for increasing the shelf life, which will ensure their availability throughout the year. Hence shelf-stable traditional meat products could be produced in large scale and find export potential in different geographical areas.

Scope for value added meat products processing in India: National Food Processing Policy aims to increase the level of food processing from 10% in 2010 to 25% in 2025. Urbanization and fast changing socio-economic and cultural aspects have increased the demand for value added and convenience products. Ready to eat (RTE) foods symbolize processed foods; consequently no further processing is required. They are more convenient option as they are easily available, have a long shelf life, store the nutrients and reduce risk of food poisoning. The RTE meat foods contributed 40% revenue share to the Indian RTE food market in 2017 (RNCOS 2017). According to Associated Chambers of Commerce and Industry of India (ASSOCHAM), the quick service restaurants (QSR) sector in India is likely to grow from current 8,500 crore to Rs. 25,000 crore by 2020 at a compounded annual growth rate (CAGR) of 25%. Because of huge anticipated growth, leading manufacturers are focusing on expansion of their respective meat processing business across India and setting up new manufacturing plants to ramp up production capacities and broaden overall product line.

Marketing of meat and meat products

Though retail meat outlets of supermarkets in metropolitan cities catering to high end markets with all kinds of meat and meat products are at par with standards in developed countries, vast majority of meat retail shops lack minimum facilities like portable water supply, knife sterilizers, fly proofing, fly killers, air curtains for hygienic handling of meat. Lack of hygiene in the traditional meat markets have given rise to online meat selling market, which has better supply chain management and technological intervention than the offline options.

Branding in meat/poultry Industry: The evolution of modern retail outlets with better packaging, labeling, and cold chain facilities will hopefully address the drawbacks of the existing situation. Branding is a tool for improving marketability of meat/poultry produce. Many commodities like edible oil and milk are now transformed into the brands. The milk is a classic example of commodity which came over the challenge of perishability, sourcing, storage, supply chain and has produced various brands of dairy products. Chilled/frozen chicken has slowly started entering into consumer's refrigerator even though the availability is limited to some cities. Consumers in some cities are now witnessing few branded chicken shops and even the supermarkets have started to allocate a corner for the meat and fish.

Harnessing E-commerce: With the growth of digital media marketplace in the last five years, food retailing has also grown dramatically, becoming an even stronger presence in the lives of people. Lack of products choices and unhygienic conditions in the traditional 'seller-centric market' largely drive the consumers towards online meat selling market, which has better supply chain management and technological interventions. In addition to the fresh meat category, the online retailers are also offering processed and semi processed meat products to satisfying their customers demand and convenience. This will help to cover larger population of wider geographical area. Invasion of online ordering is considered as a new adaptive technique of urban families. Companies are innovating the subscription models which were limited for milk and newspaper to be extended to other products. E-commerce in India is projected to reach USD 100 billion by 2020, and big players like Tata and Reliance have already ventured into the sector to tap the potential. There are a number of start-ups, Licious, Big Basket, Grofers, Starchick, TenderCuts, Zappfresh, Neatmeats and others, offering meat and meat products.

Conclusion

Large livestock wealth coupled with strong consumer base fuels greater prospects for pink revolution in the country. Emerging consumption of convenience and value added meat products will not only diversify the food production system, but also will provide huge employment opportunities to large number of micro, small and medium scale entrepreneurs. Effective interventions like using genetically superior animals for breeding, improved feeding and husbandry management, reducing the mortality rate, linking small producers to market, creating better infrastructure for meat production, minimizing the post-harvest losses, increased value addition and further processing, e-marketing will play key roles in the shaping the meat sector development in the country. Strong public-private-producer partnership (4P's) by connecting producers, input-suppliers, service providers, financial institutions, retailers and exporters will reduce the risk and ensure prosperity of the meat sector.

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(Lead 30)

Meat Industry for Alleviation of Protein Security and Employment Generation

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Introduction

Livestock sector plays a multifaceted role in socio-economic development and national economy. It is considered to have a positive impact on family income, gainful employment and poverty reduction. Animal husbandry sector provides large self employment opportunities. According to one estimate, appx. 32 million people in India are employed in livestock rearing including poultry farming and this figure does not include the people engaged in processing and marketing activities of livestock products. It is also considered as subsidiary occupation to a large section of the society especially those are living in the draught prone areas, hilly, tribal and other remote areas. Moreover, the livestock sector is considered as egalitarian occupation than agriculture. It generates a continuous stream of income and employment for the livelihood of the rural people. In the last decade it has been observed that livestock sector has emerged as an engine for agriculture growth as well as potential sector for export earnings. According to estimates of the Central Statistical Office (CSO), the value of output from livestock sectors at current prices during 2015-16 was Rs 591691 crore which is about 28.5 % of the value of the output of from total agriculture and allied sector (DHADF Annual Report, 2016-17). It is growing at an annual growth rate of 6.2% which is much higher than the growth of the agricultural sector which accounts for 2.8%. It also providesfood in the form of milk, meat, egg and ultimately food and nutritional security. Apart from above mentioned food production functions, it also contributes to industrial sector by providing hides, skin, bones, blood, fibers and other non-edible animal by-products.

Several empirical studies have been conducted and documented on the status, development, employment opportunities in production, processing, trade in dairy and fishery sector. However, this paper relates with the development and employment opportunities in meat and meat products including poultry and poultry products sector.

Meat Sector Dynamics

With the rapid development in our country, the consumption of meat and other livestock products is increasing. Meat is highly demanded food items of human being due to presence of plentiful proteins, minerals and all the B-complex vitamins with excellent digestibility and well-balanced composition of essential amino acids. Population growth, urbanization, changed life styles and increased per capita income are fuelling a massive increase in demand for food of animal origin all around the world. Delgado et al (1999) made a prediction that the demand for milk will double and that for meat will treble in India by 2020. As per World Bank projection, worldwide demand for food will increase by 50% and for meat by 85% by 2030. Governments and industries must prepare for meeting demand of meat in the country with long run policies and investments to satisfy ever rising consumer demand, improve nutritional status, generation of income opportunities and alleviate environment stress.

India has a huge livestock population and ranks 1st in the world for cattle, buffaloes and goat population. India also has 2nd and 5th largest number of sheep and chicken in the world, respectively. Livestock sector serves as an important source of milk, meat, wool proteins. It provides employment to over 300 million rural people and contributes enormous amount of draught power and biomass that enriches the agricultural fields. India has been witnessing impressive growth in meat production, which as increased from 3.6 million tons in 1992-93 to 7.02 million tons in 2015-16 (BAHS, 2016) which is 2.70% of the world's meat production. The contribution of meat from buffalo is 1611.01 thousand tonnes (22.95%), while cattle contributes 329.36 thousand tonnes (4.69%), sheep 485.53 thousand tonnes (6.92%), goat 942.91 thousand tonnes (13.43%), pig 387.55 thousand tonnes (5.52%), poultry 3263.81 thousand tonnes (46.49%). India has the distinction of producing largest amount of buffalo meat in the world. It is also 2nd and 5th largest producer of goat meat and chicken in the world, respectively.

The annual growth rate for the meat production in the year 2015-16 was 4.92% with highest annual growth rate of 13.25% reported in 2011-12 due to inclusion of production from commercial poultry by many States during that period. In the year 2015-16, Jammu & Kashmir has the highest annual growth rate of 67.0%. The State reported that they adopted changed/revised the data reporting system and filled the previously existed data gaps and hence there were higher growth rate. Among other States, 9 States have reported their growth over 7% and a total of 16 States/UTs have reported the growth more than the national average. Uttar Pradesh being the major meat producing State registered a growth of only 1.48 % during 2015-16. The largest producer of meat is Uttar Pradesh which produces 20.2% of the total meat production in the country followed by West Bengal that produces 9.8% of the meat production. Maharashtra is the third largest meat producer state in the country which produces 9.6% of the total meat production.

India contributes 2.7% of world meat production and on the basis of per capita availability of meat, India ranks 170th in world. According to Basic Animal Husbandry &

Fisheries Statistics, as on 31.03.2015, there are about 1652 registered slaughter houses in the country, among the states, Maharashtra is No. 1 having 302 registered slaughter houses.

Indian meat export is expected to expand in the global market domain with the liberalized economic policies and implementation of the WTO agreement. On a domestic circuit, the consumption of the meat has increased significantly in the last one decade due to urbanization, improvement in economic status, changing food habits and establishment of the fast food centers of international brands such as Mc Donald's, Kentucky Fried chicken (KFC) etc. Though there is a sea change in the meat industry during the last one decade with the establishment of the state of art, fully integrated slaughter houses, meat processing plants. The further impetus to the meat industry was provided with the establishment of National Meat and Poultry Processing Board in 2009. Ministry of Food Processing and Industries identified as 'sunrise industry' has provided special status to meat industry. The Honorable Prime Minister of India during his address to the CSIR society meeting in January, 1999 stressed on the 'pink revolution' and identified buffalo as black gold, not only potential meat animal, moreover a potential source of animal by products including hide, bones, casings, horns, hooves etc. This sector when organized on the scientific lines will generate more employments in rearing of meat animals and processing of meat and meat products, their by products for allied industries.

Export of meat

Meat and meat products from India are finding wider acceptance in world market mainly because of the fact that the Indian meat is internationally price competitive. Ministry of Food Processing Industries (MFPI) has established National Meat and Poultry Processing Board (NMPPB) at New Delhi to support the healthy and organized development of meat sector for clean and wholesome meat production. NMPPB formulates uniform and effective meat quality testing systems and looks for reduction of environmental pollution due to meat industry. It also gives priority on R & D for production and marketing of newer value added meat products for domestic and international markets. NMPPB also serves as a single window service for producers and manufacturers and exporters of meat and meat products promote and regulate the meat industry for increasing exports and help industry for establishing self-sustainable and viable projects. Further, Food Safety and Standards Act, 2006 regulates and ensures the processed meat sector to produce safe and quality products in order to meet the requirements of International trade and make the Indian food and meat industry competitive in the global market.

The meat for export trade, mainly buffalo, little sheep and chicken are produced from privately owned modem integrated meat processing plants. About 56 such plants were registered under APEDA. These plants utilize all the slaughterhouse byproducts for production of meat cum bone meal, tallow, etc. and also produce value added meat and byproducts. They practice strict sanitary and phytosanitary measures as per International Animal Health code of O.I.E.

In the year 2012, India overtook Brazil as a top bovine meat exporter in the world with a record export of 1.10 million tones worth Rs. 17,400 crores (Table. 5) according to Agricultural and Processed Food Products Export Development Authority (APEDA). Buffalo meat has been in the top three export items in the agriculture commodity basket. India's buffalo meat exports have been growing at an average of nearly 14 per cent each year since 2011. United States Department of Agriculture (USDA) has predicted that Indian buffalo meat exports could increase in the coming years because of competitive pricing and quality.

India's exports of meat and meat products was Rs. 27,728 Crores in 2016-17, which include the major products like Buffalo Meat (Rs. 26,307.93 Crores/ 3,933.81 USD Millions), Sheep/ Goat Meat (Rs. 8,71.08 Crores/ 130.17 Millions), Poultry Products (Rs. 531.65 Crores/ 79.51 USD Millions), Animal Casing (Rs. 13.84 Crores/ 2.07 USD Millions) and Processed Meat (Rs. 4.58 Crores/ 0.69 USD Millions).

The demand for Indian buffalo meat in international market has sparked a sudden increase in the meat exports. Buffalo meat dominated the exports with a contribution of over 89.08% in total Animal Products export from India. The main markets for Indian buffalo meat and other animal products are Vietnam Social Republic, Malaysia, Egypt Arab Republic, Indonesia and UAE.

Components of the meat industry

A synoptic view of meat sector including by products related industries reveal various distinct components which has a great potential for generation of employments.

- Rearing of meat animals.
- Trade in live meat animals.
- Slaughtering of animals by individual butchers in domestic market and mechanized abattoirs/export oriented units.
- Transportation of fresh frozen meat from the point of production to the consumer as well as port for export to various countries.
- Processing of meat into various processed value added meat products in retail chains and wholesale including export.
- Marketing and processing of raw hides and skins.
- Marketing and processing of:
  - Inedible offals into valuable processed by products such as gelatin, ossein, Dicalcium phosphate (DCP), Neat's foot oil etc.
  - Rendering units for production of meat cum bone meal, bone chips etc.
- Production of casings from intestines.
- Marketing and processing of hooves, horns etc. in cottage industry for the preparation of artisans.
- Marketing and processing of glandular by products and blood for the production of pharmaceuticals.
- Research and Development.
- Human Resource Development or capacity building programs.
- Design and equipment development for slaughtering, dressing and processing in meat industry.
- Quality Assurance and Safety.

- Consultancy Services.

Job outlook

- The meat processing occupation varies as per the different components listed above. Basically we can separate the employees as skilled/ unskilled workers and qualified professionals. There is about 25% employment is in slaughtering, dressing and processing operations of meat animal. These are skilled workers and require constant training to improve their skill with the advancement of technologies.
- The major quantum of employees in the meat processing jobs especially manual components require little or no training prior to be hired.
- Veterinarian for animal welfare, establishing of disease free zones for rearing of meat animals, meat inspection services and quality assurance programs.
- The veterinarians with the basic degree of Bachelor of Veterinary Sciences and Animal Husbandry (B.V.Sc. and A.H.) are trained in livestock production and management practices, Ante-mortem and Post-mortem inspection of meat animals and proper disposal of the condemned carcasses and parts with the notifiable diseases.
- The veterinarians with Master's degree (M.V.Sc.) in Livestock Products Technology (Meat Science and Technology) can be instrumental for establishing of the quality assurance programs and food safety management systems based certification such as HACCP, ISO 9000,ISO 14,000and GMP etc. Their skill and knowledge can also be utilized for the processing, preservation and packaging aspects of meat and meat products.
- Marketing executives for marketing of meat and meat products, poultry and poultry products, slaughter house processed by products in domestic and international circuit.
- Engineers with a basic degree in civil, Process Engineering, and mechanical are required for the refinement of traditional equipments, development of new equipments with better quality, higher capacity, energy efficiency, safety of the employee and animal welfare in slaughtering, dressing, processing, packaging of meat industry and its allies.

Training Advancements

- The most of the workers involved in the different segments of meat industry are not formally trained. They have learned the techniques through as their family business or with experience. The continuous scientific training with the advancement in the technologies is being required in terms of global standards in the meat sector. Indira Gandhi National Open University (IGNOU) initiated this project with awarding of Diploma in Meat Technology. However, author stressed on the needs of various vocational and certified training programs as follows:
  - Diploma in Small Animal Slaughtering and Dressing Operations
  - Diploma in Large Animal Abattoir Practices
  - Apprenticeship in Poultry Processing Technology.
  - Diploma in Leather Processing Industry.
  - Diploma in slaughter house by-products Processing Technology
  - Diploma in Quality control in Meat sector

- Meat technologists require specific training in product development, packaging technology including nutritional labeling and preservation.
- Various institutions provide advance training in Meat Science and Technology. Presently, there are 21 veterinary colleges offering post graduate / M.V.Sc degree and 11Ph.Ddegrees in LPT/ Meat Science& Technology. CSIR institute, Central Food Technological Research Institute,Mysore (CFTRI) andDefense Food Resource Laboratory,Mysore (DFRL) also awarding degree and training in the area of Meat Science & Technology. ICAR alsohas some component of Post Harvest Technology in all the animal science institutions likeIVRI, CARI, CIRG, CSWRI etc. for conducting research and training in this area. Central Institute of Post Harvest Engineering and Technology (CIPHET), Ludhiana and IIT institutes are also working on the development of low cost meat processing equipments and many other aspects of Meat Science & Technology. National Research Centre on Meat (NRC) is an exclusive institute which is covering all the aspects related with the requirements of meat industry.

Employment Scope in India

- A Meat Technologist can get job as a quality assurance manager, production manager, laboratory supervisor, meat packaging manager or as a technician in various abattoirs and meat plants.
- In Hotel industry, for product development, production and quality control departments.
- A Post Graduate candidate in Meat Technology can work as Professor or Scientist in various veterinary colleges, research institutions, inspection boards or quality control cells.
- Leading global food joints such as Godrej Foods, ITC Agro, Venky Foods Limited, McDonald's, KFC, Hindustan Liver Limited etc. are also biggest employers.
- Integrated state of art, modern abattoirs and poultry processing plants such as Allana Sons Private Limited, Fair export, Al- Kabeer Food Industries Limited, Hind Agro Industries limited, Alchemist Poultry Processing Plants etc. recruit Meat Technologists and Veterinarians to ensure and monitor quality and hygiene of meat and meat products in their units.
- Ministry of Food Processing and Industries, National Institute of Food Technology and Entrepreneur Management (NIFTM), Food Safety and Standards Authority of India and National Meat and Poultry Processing Board also hire specialists in order to synergize the growth and development of meat industry in India.
- Directorate of Marketing and Inspection, Agricultural and Processed Food Products Export Development Authority (APEDA), NABARD, nationalized and private banks,Beauroof Indian Standards (BIS), Export Inspection Agency (EIA) recruitMeat Scientists to govern licensing and financial systems in India.
- Self Employment/Entrepreneurship: Trained meat technologists can also go for establishment of their own units for production of fresh meat, processed meat, by products processing units etc.Various schemes are also promoted by Department of Animal Husbandry and Ministry of Food Processing & Industries, for the self-employment.

The way Ahead

The meat industry in India with the advantage of liberalized world trade can gain a significant share of the export as well as domestic food market with generation of million of employments in the different components of meat sector. There is an immediate need to formulate the action plan to harmonize the standards, to provide incentives to the farmers for quality livestock production, stringent quality control measures, strategies for export, popularization of meat products to accomplish the meat mission in India.

All this support for the bright future of meat sector in India and it is expected to provide employment opportunities to more than 50 million people in next one decade in different components of meat sector.

References

References can be made available upon request from the author.

(Lead 31)

Women Empowerment through Entrepreneurship Development in Meat Animal Production and Processing in J&K

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As per Livestock Census 2012, India is the home for huge livestock population of different species of food animals e.g. ruminants (cattle, buffalo, sheep and goats) and monogastrics (pigs and poultry).It had 190.9 million cattle, 108.7 million buffaloes, 135.2 million goats, 65 million sheep and 10.3 million pigs which represents 12.5%, 56.7%, 17.4%,7.1%, and 1.5% world's livestock population, respectively. After independence, the number of food animals has increased significantly. Since ages livestock rearing had remained an integral component of Indian rural economy with regards to its contribution to Gross National Product (GNP) as well as employment in the rural and peri-urban areas. It also contributes to national economy and socio-economic development of the people by providing the way for livelihood security and essential nutrition through various products viz. milk, meat, eggs. Besides that, the livestock are the source of valuable non-food products e.g. hides, skin, bones, dung and draught power. Livestock are the source of health and wealth for the farmers and act as the source of financial institution – living bank and insurance during crisis period or emergencies (Birthal and Jumrani, 2017).Currently livestock are more valued and better known for their food production potential. Fast and ever-increasing urban population, sustained economic growth, increasing income, more participation of women in workforce, improvements in transportation and storage facilities, greater awareness among the consumers and development of supermarkets are also fuelling the demand for livestock products. Sustained livestock production to provide livelihood, food and nutritional security to a large population is dependent on efficient utilization of animal resources and livestock products. Processing of milk, meat, egg, wool and skin for the development of value-added products contribute to sustained demand for livestock and their products and efficient marketing of these products provide reasonable returns to the farmers.

Role of Livestock in Entrepreneurship Development

Livestock production is largely in the domain of women. Women comprise three fourths of the workforce engaged in livestock production. Thus, livestock development may be considered as an important pathway for reducing gender disparities, particularly in the economies where right to own land are biased towards men. Livestock are the assets that are not bound by any property rights and can be owned by women to consolidate their bargaining power within the household. Livestock can impact a household's nutritional status via the family members who control the income generated from sale of livestock and livestock products. Women are the primary caretakers of household food security and therefore with a greater control over resources they allocate more of these to nutrition, health and education of the children (Jumrani and Birthal 2015). Malapit*et al.* (2013) have found improved maternal and child nutrition in the Nepalese households where women had a control over income from livestock production.

Indian meat industry is largely dependent on goat, sheep, poultry, pig, cattle and buffaloes for raw material. Meat obtained from sheep goat, poultry and pig is primarily for domestic consumption in the form of hot meat. A major chunk of meat from buffaloes is diverted to export markets in the form of raw, deglandular, deboned frozen meat. Due to increase in food delicacy and urbanization, a significant growth in the production and consumption of meat based products has been recorded. Traditional semi-processed and ready-to-eat products are gaining popularity among the consumers.

In India animal husbandry is a significant economic activity and on an average about 40% of the rural households are engaged in dairying. Income from livestock contributes 10-12% of the total income of our rural households. Due to exponential population growth and increased nutritional demand, the requirement for milk and animal products is steadily rising. Hence, it would be an opportunity to our farmers for adopting cost-effective production of quality commodities through livestock to accomplish the market demand, which inevitably multiply their income. Increased consumption of livestock products, particularly in the fast-growing economies of the developing world, has been an important determinant of rising prices for livestock products. These price surges provide new incentives and opportunities for using livestock as an instrument to help poor people to escape poverty due to the multiple benefits that they offer and the multiple roles that they play in different production systems. Livestock provide income, create employment opportunities, food and nutrition security across different production systems and along different value chains. It also plays important roles in securing household food security.

Livestock sector form an important livelihood activity for most of the farmers, supporting agriculture in the form of critical inputs, contributing to the health and nutrition of the household, supplementing incomes, offering employment opportunities, and finally being a dependable “bank on hooves” in times of need. India has vast livestock resources which play a vital role in improving the socio-economic conditions of rural masses. Livestock is also of significant social and cultural importance, supplementing family incomes and generating gainful employment in the rural sector, particularly among the landless, small, marginal farmers and women.

The livestock sector is poised for revolution in developing countries. Livestock production is a vital activity in rural areas and has helped to provide employment and income generation for farmers, rural women and weaker sections. India possesses large livestock resources but their production and utilization is not up to the optimum or comparative levels of developed countries. Extensive production system contributes directly to the food and livelihood security because they produce highly valuable nutrients for humans, such as protein, than they consume. Thus, we can say that livestock significantly contribute to sustainable human nutrition and economy of the nation. Livestock rearing can contribute to the farmer's risk management of natural calamities in many ways. Livestock require very little resources as they are mostly very well adapted to the local requirements and can survive on meagre feed resources without any housing needs. The consumption of livestock products is more responsive to income change as compared to staple food grain grains (Joshi and Kumar 2012). This response is bigger in the case of rural consumers and much bigger for the rural consumers in both rural and urban areas. This indicates that the poor and rural consumers allocate more of their food budget to livestock products when their income increases. The rising demand for livestock products has led to a substantial increase in the number of buffaloes for milk; sheep, goats and poultry for meat.

Who is an entrepreneur?

An entrepreneur is an individual who takes risks and starts something new. The term entrepreneurship come from a French verb “entreprender” and German word “unternehmen” both these means to undertake. Entrepreneurship play a key role in the development of economy in both developed and developing countries (Sharma *et al.* 2019).

Women Entrepreneurs

Women entrepreneurship means the process in which women initiate a business, gather all resources, undertake risk, face challenges, provide employment to others and manages the business independently. During past few decades, the contribution of women entrepreneurs has been well recognized in the socio-economic upliftment of their families and societies. Women have multiple role in the society. They want to be efficient worker for which they work hard to fulfil the job requirement. Sometime Indian women find it very difficult to adjust themselves for dual role as they have to perform the role of traditional house wives or mother at home and to compete with their menfolk in their businesses or industries.FAO report indicates that globally more than 50% of the food is produced by women. Our former President Dr. APJ Abdul Kalam had said that “Empowerment of women is essential for building Good Nation, when women are empowered, society with stability is assured.

Women entrepreneurs is synonymous with women empowerment. Govt. of India defines “A women entrepreneur as an enterprise owned and controlled by a woman having a financial interest of 51% of the capital and giving at least 51% employment generated to women. Women entrepreneurship has been recognized as an important factor for triggering and sustaining economic growth. Women entrepreneurs in India are playing an important role in generating employment both directly and indirectly. By setting up small scale industries, they offer jobs to people. Women entrepreneurs are also contributing towards improving the balanced regional development and improvement of living standards in the country. Women entrepreneurs in the country reproducing variety of goods on a large scale and offering them at low rates, as a result achieving improvement in the standard of life. Majority of the women operate their medium and small enterprises under very adverse conditions. Not it is very difficult for them to find premises, find markets for their products, access information and credit but they also have limited access to training especially in the rural areas. Their education levels are low, they are all responsible for all the domestic chores and they have to seek permission from their family members to travel to trade fairs or for training especially in the rural areas.

Rural and tribal farm women play a crucial role in development of livestock and allied fields including livestock production, post-harvest operations, fisheries etc. In addition to their role in livestock production, women are gainfully employed in agri based allied activities like dairying, animal husbandry, poultry, goatery, rabbit rearing, post-harvest technology, value addition, packaging etc. Their roles range from managers to landless labourers. Animal rearing for meat production and poultry keeping in India is not just a large economic activity but also an integral part of our social and cultural heritage. These sectors provide employment opportunities to the landless and land owners and the income thus generated is judiciously utilized by the women for children education, family nutrition and emergencies.

Contribution of Livestock Sector in Women Empowerment

India is an agrarian country and livestock sector is an integral component of it where, livestock production is largely in the hands of women and contribution of women in animal husbandry work is significant. In general, women are more involved in livestock and backyard poultry production than in crop production. Women have been at the fore-front of dairy cooperative movement, which was initially carried under the Operation Flood Programme and later also under the Integrated Dairy Development Programme implemented by the Government. Women are the custodian of household food security. They are often the producers of agricultural products and translate these products into food and nutrition security of their households. About 70% of the agricultural worker, 80% of food producers, and 10% of those who processes basic foodstuffs are women thus making up more than two third of the work force in agricultural/allied sectors. Most of the animal farming activities such as cleaning of barn, washing of animals and hygienic maintenance, fodder collection, feeding, watering, and health care, management, milking, collection of dung for fertilizer and fuel, care of sick, pregnant and lactating animals, milking, household-level processing and value addition (ghee, curd, khoa, lassi and desi butter-making). Women are heavily involved in almost all aspects of livestock production, with the exception of marketing, as this activity requires their absence from the home. Cash income obtained from women's work in livestock production is quite high, especially with regard to the sale of milk, curd, butter and ghee. When women generate income from livestock resources, they spend most of it on the education and nutrition of their children.

Since women usually manage household meals, they have a primary role with regard to the nutritional status of the household, especially the children. Because of this traditional role, women have therefore the potential to influence and promote a balanced diet. Most of the work and decision-making by women takes place at the household level, in which important decisions are taken jointly by both the man and woman heading the household. These decisions include which animals have to sell and at what price, disease diagnosis and treatment of sick animals. Women's typical role within a livestock production system is different from region to region, and the distribution of ownership of livestock between men and women is strongly related to social, cultural and economic factors.

Role of Livestock Sector in Entrepreneurship Development in J&K

Jammu and Kashmir is predominantly an agrarian economy with about 60% of its population engaged in agriculture and allied sectors. In Jammu and Kashmir, animal husbandry plays a significant roleas it contributes a handsome amount for the state revenue. The state has a precious wealth of livestock in the form of cattle-buffalo, sheep, goats, poultry etc. As per 19th Livestock Census 2012, the total livestock population in J&K was9.2 million with cattle -2.79 million, buffaloes-0.74 million, sheep-3.39 million, goat-2.02 million, pigs-0.0024 million, horse and ponies 0.15 million, mules 0.037 million, donkeys-0.017 million, yak-0.055 million besides8.28 million poultry. Out of the total livestock population in J&K, sheep contributes the highest with 36.84% followed by cattle 30.41%, goat21.93%, buffaloes 8.03%, horses and ponies 1.57% and other livestock species such as pigs, camel, The contribution of livestock sector to the fragile economy of J&K state is significant: 6% of the state GDP and 25% of the total agricultural output (40% if draught power and dung is accounted for) (Ganai and Risam 2019). In spite of a large natural and human resource base, the state lags behind in industrial development.

The cattle and poultry amongst all the livestock are considered the most important tool for the development of rural economy. Despite being the major contributor to agricultural GDP, there are huge gaps in demand and supply of the animal products in the state. The livestock available in the state are not able to supply the sufficient quantity of meat and meat products. The state is importing animal products worth over Rs. 2500 crores/annum which is almost twice the revenue earned through export of the horticulture products. It has been estimated that by 2030 the demand for the milk, meat and eggs shall grow by 300%, 400% and 3600% from the present production level (Ganai and Risam 2019).

Jammu and Kashmir is ideally suited for meat industry development. Due to the climatic condition there is a great demand for meat and the majority of the population of the region is non-vegetarian and there are many varieties of traditional meat products that are indigenous and popular in the state. However, there is a huge gap between demand and supply as the state is unable to provide these components in sufficient quantities. At present, Jammu and Kashmir is dependent on other states like the Punjab, Himachal Pradesh and Rajasthan to supplement their poultry, chevon and mutton products, despite the fact that the state itself has the potential to provide and meet the domestic demand.Thus, the meat sector in Jammu provides many opportunities for women to operate micro and small-scale enterprises that are affordable and manageable by rural people. They create a large number of non-farm employments and income opportunities in relatively poorly developed areas and require small capital and little sophisticated managerial and technical skills. Furthermore, there are no meat processing plants available in and around Jammu which increases the chances of the success of micro and small-scale meat-based enterprises. However, most of the poultry farmers in Jammu mostly sell live chicken which fetch low prices for their produce. One-way poultry farmers in rural areas can improve this situation involves value addition. Value addition can be defined as a process of increasing economic value and economic appeal of a commodity. Value is added by changing a commodity's form, colour, taste and other such methods to increase the shelf life of perishables. Value of a product can also be added by capturing the market at the right time. This may include transporting the product to places where it can earn more income, or storing it and selling when there is high demand. Value addition minimizes wastage and improves quality of a commodity which realizes better prices. Value addition on meat can therefore increase purchasing power of women entrepreneurs thus improving their standards of living. Technology plays a central role in value addition process. Value addition through use of appropriate technology can, therefore, be seen as an effective tool in rural women entrepreneurship development.Value addition is an important avenue for efficient utilization of livestock resources with increased demand and higher returns. Value added products offer increasing convenience to the consumers. The growth of the products industry assures the farmers a regular off take of their produce at reasonable prices and provides variety to the consumers. It involves larger component of the labour where India is at the advantage with lower labour cost in the world. This sector has substantial employment potential. Processing aids to produce value added, variety and convenience meat products to meet life style requirements. It offers better utilization of different meats cuts and edible byproducts. It facilitates incorporation of non-meat ingredients for quality and economy. It helps preservation, transportation, distribution and marketing to over larger populations. Processing promote employment, entrepreneurs ventures and exports and minimizes imports. Value added products and are further processed products with increasing convenience to consumer through decreasing preparation time, minimizing preparation steps.

Although the State of Jammu and Kashmir has an enormous potential and conducive environment for poultry development on commercial lines as well as backyard poultry, still there is significant gap between requirement and production of poultry and poultry products. Besides, State has rich resources like availability of maize, plenty of manpower and huge market for consumption of poultry and poultry products, development of entrepreneurs in poultry sector is not taking required pace in the State. The flight of capital on account of imports of poultry amounts to be more than Rs. 900 Crores annually.

Demand and Supply of Poultry and Poultry Products in J&K (2017-18)

Particulars	Demand	Supply	Imports
Day Old Chicks (Crores)	6.94	1.1	5.84
Poultry Meat (Metric Tonnes)	87000	75000	12000
Table eggs (Crores)	108.25	20.5	87.75
Poultry Feed (Metric Tonnes)	173500	88500	85000

Source: Poultry Policy for J&K (2018)

Import Statistics of Poultry and Poultry Products in J&K (during last 5 years)

Year	Table eggs (Crores)	Broiler (Lakh Nos)	Day Old Chicks (Crores)
2013-14	66.10	56	5.59
2014-15	70.50	51	5.52
2015-16	78.43	64	6.14
2016-17	78.04	93	5.33
2017-18	87.75	96	5.84

Source: Poultry Policy for J&K (2018)

The Govt. of Jammu and Kashmir and State Agricultural Universities have taken few initiatives for the establishment of backyard poultry units. These projects have proven a great success in the area with a good response from the farmers and women in particular. Rural women are rearing backyard poultry in the area which besides generating the subsidiary income is also providing a source of high-quality animal protein for the rural poor. The aim of these projects is to contribute to poverty reduction through entrepreneurship development with a particular focus on rural women. The essential elements are to incorporate the technical skills that encourage the initiatives of rural women entrepreneurs and to enhance the human capacities required to foster entrepreneurial dynamism. To respond to the needs of women to materialize their economic potential and thereby to improve their standard of living, it is necessary to design training programmes for human resource development for increased competitive entrepreneurship.

Hurdles in Women Empowerment through Livestock Production

Although the role of women in animal husbandry practices is so important socially and economically, they have remained obscured for long because women seldom play any major role in political activities or decision-making processes. Women face greater constraints than men in accessing natural resources, extension services, marketing opportunities and financial services as well as in exercising their decision-making powers. These constraints often prevent women from reaching their full potential within the agricultural sector, including livestock, and therefore compromise the achievement of overall household food security and nutrition. Despite women's considerable involvement and contribution, significant gender inequalities also exist in access to technologies, credit, information, inputs and services probably because of inequities in ownership of productive assets including land and livestock.

About 50% of the world's population are women. It is estimated that even though two third of the world's total work is done by women, only 10% of global income is earned by women and a meagre 1% of global property is owned by women. Rural farm women are invisible in statistics while women are extensively involved in agricultural and animal husbandry activities. Sometimes women feel handicapped themselves as they have little resources to improve animal productivity, to manage risk and buy good quality animals which could respond to inputs for productivity enhancement. At the same time, poverty reduction requires paradigm shifts through which the under-privileged should be enabled to earn better and gradually grow out of subsistence system through application of appropriate technology, skills, market linkages, information and service delivery systems. Despite the fact that women produce much of the food, it has been noticed that they also remain more malnourished than most men are. In many societies, women eat less food than men do, especially when the food is scarce, such as just before the harvest, or when the workload increases without a corresponding increase in the food intake.

Since last many decades, “women empowerment has also been the agenda of every government in India; “Mahila Sashaktikaran is a government slogan for every political party and it is a part of every party manifesto. There are laws against female feticide, domestic violence, dowry, sexual harassment at workplace etc. Yet in the second decade of the 21st century, Indian women still remain second class citizens, everywhere. Is the woman being able to reap the benefits provided to them under the Constitution of India or the laws made for their safety and security? The answer unfortunately is not encouraging. There is a long way to go to achieve the goal enlisted in the Constitution (Suri 2019).

Women Technology Park: A Way To Women Empowerment

With the financial support of Department of Science and Technology, New Delhi first Women Technology Park in J&K was established by Division of Livestock Products Technology, F.V.Sc.&A.H, SKUAST-Jammu in the panchayat ghar of Deoli village of Bishnah block in November, 2017 with a target women population of Bishnah and R.S.Pura block of Jammu District. This Women Technology Park is a technology modulation and a training centre to show case livelihood technologies for women. The objective of women technology park is to promote development and adaptation of appropriate technologies, transfer of proven technologies and demonstration of live technology models to benefit women. It recognizes the likely benefits of an improved and structured mechanism for delivering technologies to the rural areas. The women technology park has been established with the objective of empowering women through inputs of Science and Technology.

The concept of establishment of Women Technology Park is to provide a “linkage” between rural women farmers and the scientist. It is a centre established in the women farmer's community to create an environment and attitude so that the scientist cum technologist can extend the recent developed methodology that can be adopted and practiced by rural women at their own work farm/place to establish their own micro-enterprise to become entrepreneur and self - reliant. The Women Technology Park showcase the proven technology on profitable dairy farming, profitable poultry farming, profitable sheep and goat farming, profitable fish farming, vermi-composting, clean milk, meat, egg and fish production. It improvises rural women farmers on processing of milk products, meat products, egg products and fish products. Processing of raw material (milk, meat, egg, fish) into products (dairy products, meat products, egg products and fish products) can not only increases the cost multiple times but also enhances the shelf-life and functionality of the products.

The aim of Women Technology Park is to create awareness among rural farming community and give trainings of proven technology to reap maximum benefits from their existing resources. Its objective is to make them aware about “processing” so that can enhance their income multiple times. It also facilitates rural women in providing backward as well as forward linkages that ensure the marketability of their produces. The modus operandi of the

Women Technology Park is the interaction of Scientist with rural women having farms of dairy, poultry, hatcheries, goatery and fisheries and thoroughly understand their knowledge, behaviour, practice and problems. They scientifically intervene in their farming system in order to enhance their existing knowledge, make them aware about latest scientific procedure on farm management to reap maximum profit from existing resources. The rural women farmers are then identified based on these farm visits and invited to visit WTP. They are then extended with the latest and proven technologies on profitable dairy, fishery, poultry farming system and convincing them on processing of their raw resources viz. milk, meat, fish and egg. We make them understand the obvious fact that converting their raw resources into products can easily enhance their income multifold. The motivated and interested women are then and there selected for hands on training in the Division of Livestock Products Technology to learn the proven and latest technology on processing of milk products (Mozzarrela cheese, functional kalari, whey drinks, sweets made from khoa and chhana etc.), processing of meat products (indigenous meat products, meat snacks, meat pickle, barbecues, tawa and karahi meat products etc.), processing of fish products (fish pickle, fish snacks, fish fries, tandoori fish etc.). Based on the keen interest and farming background of women farmers are selected for hands on “training on processing of livestock products”. These trainees are also getting start-up grant in the forms of goods required in processing of livestock products absolutely free of cost to set up their own micro-enterprises to become entrepreneur and be self-reliant.

The deliveries at Women Technology Park are Integrated mission of creating awareness and addressing health and sanitation related issues, helps in combating food borne and zoonotic diseases. There is a greater loss of money in treating these diseases owing to lack of hygienic practices. Simultaneously the diseased person is not available for work which leads to economic loss too. Creating livelihood generation by imparting technical skill development to human resources for taking value addition in livestock (milk, meat and fish) product as entrepreneur and thereby increasing their economy at least by 100% and enhancing the quality of life. The value addition in livestock products has manifold advantage which includes economic gain, increasing the shelf-life of the product, health promoting effect on consumption of value-added livestock products, increasing its nutritional potential in combating undernourishment. So far, more than 600 farms (poultry farm, dairy farms, fishery farm) have been visited under the project and has been scientifically intervened for enhanced profitability. More than 75 training cum awareness programme has been organized with more than 1500 beneficiaries. There are more than 50 beneficiaries who have received start up grant in the form of goods essential for preparing livestock products and started up their own micro-enterprises and became self-reliant and set an example for other women to come up and take up processing of livestock product as profession to earn their livelihood.

Way Forward

Women empowerment is the necessity of the hour as no community will be developed if both genders of the population is not moving with equal pace. Gender equality and women empowerment is a pre-requisite for poverty alleviation and over all development of the society. Sanitation and hygienic practices adopted at personal, livestock and environmental level helps in better and clean livestock production (also leading to Swach Bharat Abhiyan). Specialized business development institutions are often not available or their services are not affordable for rural entrepreneurs. For women entrepreneurs, specialized support institutions hardly exist to cater their specific needs. Thus, entrepreneurial and technical training, advisory and information programmes often have to be carried out within a non-conventional set-up.

Despite strong untapped potential, the Indian meat industry has not been able to achieve the desired status. Further within the sector, quality and hygiene issues are at the alarming stage. Organization of hands on training specifically for the rural women on hygienic meat production, value addition at the farmers door steps in their environment, in local language and at time convenient to farm women may be of paramount importance and may encourage potential new entrepreneurs and number of private meat processing entrepreneurs can also increase. Value addition to the meat is an age-old practice in the world as well as in India. Value addition in livestock products and adopting it as an entrepreneurial activity (microenterprise) by the rural women may enhance their income by more than 100%. Hands on training can encourage potential new entrepreneur. Besides getting the economic benefits, these products are designed to play a significant role in providing nutrition and health promoting benefits. Indigenous meat products are an integral part of Indian heritage. These products have great social, religious, cultural, medicinal and economic importance and have been developed over a long period with the culinary skills of housewives and street vendors. Development of such type of products will not only provide surplus income to the rural women but it will be also helpful in alleviating the malnutrition widespread in the rural society by providing very good quality animal proteins in the form of various types of products. Implementation of such activities may give rural women a chance to reduce their poverty through training on skills for various income-generation activities based on meat products. Such training programme will also be helpful in development of cottage rural industries as well as will help in improving the socio-economic status of the rural women by providing subsidiary incomes from the development and sale of different value added products like tandoori chicken, fried chicken, chicken soup, fish fry, tawa fry, chicken pickle, chicken snacks, meat patties, nuggets, sausages, chicken croquettes, egg pickles, enrobed eggs besides the traditional meat products of Jammu and Kashmir. Development of these types of products does not require any sophisticated equipment or heavy infrastructure. These value-added products can be simply prepared in the households using kitchen utensils.

References

References can be made available upon request from the author.

Oral/Poster

(MAP 01)

Livestock and Fish Production in Haor Areas in Bangladesh: Impact On Livelihood, Food And Nutrition Security

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Abstract

This study aims at assessing and analyzing the impact of livestock and fish production on livelihood, food and nutrition security of haor people. A survey was conducted using structured questionnaire covering 200 households. Data were collected in the year 2017. Average annual family income is BDT 246300.72 where contribution of livestock and fisheries are respectively 23% and 7.94%. Total income increases significantly with the increase in income from agriculture, livestock and fisheries. The yearly family expenditure increases significantly with the increase in food expenditure, land size and education. The annual family expenditure is BDT 248309. Rice is the staple food. Average daily per capita consumptions of rice and all food items respectively are 385 and 1172 g where consumption of meat, milk, egg and fish are respectively 69.24 g, 44.10 g, 15.84 g and 46.32. Daily per capita calorie intake is 2419 kcal and calorie received from livestock and fisheries are 74.18 Kcal and 47.60 Kcal. Daily per capita protein intake is 86 g where livestock and fisheries contribute respectively 16.62 g and 4.63 g. People consume almost all 12 categories of food items and average HDDS is 11.85. Binary logistic and multinomial logistic regression suggest that increase of family size results in the corresponding decrease of food security and increase in expenditure on food items results in the increase of food security condition. There is significant poverty prevalence among the haor people. The major problems of the haor area people are loss of resources due to natural calamities, high price and inadequate supply of agricultural inputs. There are enormous scopes of utilizing resources for higher livestock and fish production with a view to achieving food and nutrition security in the haor area. A package of policy options is suggested to increase the food and nutrition security of haor people.

Keywords: Livestock and fish production, food and nutrition security, haor, calorie and protein
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(MAP 02)

Production of Selenium Enriched Functional Meat: Effect of Supplementing Different Doses of Selenomethionine in Total Mixed Rations (tmr) of Sheep

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Abstract

Selenium is an important micronutrient required for animals and human beings. It works as an anti-oxidant, immune modulator, improves fertility, and aids in many essential biological functions in the body. Selenium supplementation at optimal doses in the diets of meat animals would be beneficial to both the animals as well as the consumers of animal produce. Supplementing selenium to sheep in the form of selenomethionine was found to be more efficient in incorporating selenium into muscle tissues. Excess supplementation of selenium to animals beyond tolerable levels leads to toxicity. In the current experiment, a study was conducted to determine the optimal dosage of supplementing selenomethionine in sheep diet for effective incorporation of selenium into meat. Selenium in the form of Selenomethionine was supplemented in the total mixed rations (TMR) to four different groups of Nellore brown ram lambs @ 0, 250, 500 and 1000 ppb. The feeding trial was carried for 120 days. Feed intake and growth performance were recorded during the period. After the feeding period, animals were slaughtered to study the carcass characteristics and meat quality parameters. Blood parameters, selenium levels in muscles and organs, glutathione peroxidase (Gpx) levels in plasma and erythrocytes were also determined. Supplementation of selenomethionine or its dose had no effect ($p>0.05$) on feed intake or growth performance of ram lambs. Dressing yields and proximate components of meat were also similar between the groups. Blood biochemical parameters were also not affected by selenium supplementation or its dose except Glutathione peroxidase (Gpx). Plasma Gpx ($p<0.001$) and erythrocyte Gpx ($p<0.05$) levels increased with supplementation of selenium. Selenium content in LD muscle, thigh muscle and breast muscle increased significantly ($p<0.001$) as the level of supplementation of selenium in the diet increased from 0 to 500 ppb (47,123 and 83 ppb in control vs 180,505 and 273 ppb in group supplemented with 500 ppb of selenium respectively). The increase in selenium content in muscles was not significant ($p>0.05$) between groups supplemented with 500 ppb and 1000 ppb. Based on the results it was found that supplementing selenium in the form of selenomethionine in sheep diets @500 ppb was optimal for effective incorporation of selenium into meat.

Keywords: Selenium supplements, sheep production, functional meat, meat quality.

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(MAP 03)

Comparison of Meat And By-products Yield And Value From Major Food Animals

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Abstract

The evaluation of carcass traits is essential for assessing the meat production potential of food animals. The production and utilization of livestock products is important for increased returns and sustaining the livestock production enterprise. The proportion of meat and by-products such as blood, head, skin, alimentary tract, organs and feet differ with the variation inbody weight of the animals.Therefore, a research was undertaken to compare the meat and by-products yield and value from the food animals. The animals slaughtered in local municipal slaughterhouse/institute experimental abattoir/retail shops were utilized to record various carcass traits. Each livestock species (buffalo, sheep, goat, pig and poultry) were grouped into different slaughter weights, sex and breeds and the data were collected.The data were collected using a standardized proforma specific to each species of animals and the collected data was subjected to statistical analysis.The results indicated that theaverage dressing percentage in buffalo, sheep, goat, pig, chicken and ducks were 47.36, 45.59, 45.77, 69.79, 59.09 and 51.57 respectively. The under-utilized by- products are stomach and intestine in buffalo (24%), pig (10%), chicken (5%) and duck (6%); skin with feathers in chicken (14%) and duck (21%); blood: 5% (average of all animals); heart, liver and lungs in buffalo (3%) and pig (3%); and trimmings: 1.5% (average of all animals). It was found that the by-products significantly contribute to the value of the slaughtered animal. It is concluded that huge scope exists for research and exploitation of the under-utilized animal by- products.

Keywords: Food animal, meat yield, by-products yield, carcass and meat quality.

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(MAP 04)

Community Based Duckling Production By Using Rice Husk Incubation System At Baniachong, Habiganj District in Bangladesh

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Abstract

A total of 140 duck producing farm families from Vatiapara, Baniachong, Hobigonj, Bangladesh were interviewed to know their existing practice and income generation for livelihood improvement. More than seven thousand ducklings were produced monthly from ten thousand hatching eggs in each household and the hatchability rate is about 70%. During extreme misty condition (Agrohayan, Pous, Magh; particularly late November to mid-February) the enterprise remains almost stop. Hence, the yearly turn over can be calculated nine months hatching operation in full swing. The total yearly duckling production was around sixty four thousands with an annual cash transaction is almost 16.00 lakh taka from each household in a village which is really a matter of thinking. Although there is some seasonal variation of hatching egg, on an average each eggs price 10.50 taka. A farm family produces about 7088 ducklings as a month which can be converting of a total gross monthly income 177200 BDT. Excluding hatching eggs price, hidden labour cost, rice husk, cloths, carrying cost and other related cost, the net income of a family 66535 BDT per month. In this way, the farmers of the locality are leading their livelihood very smoothly. In conclusion, this model for community based duckling production system can be transferred to other haor, basin and low land areas of the country for enhancing duck production as a profitable enterprise.

Keywords: Duckling, ice husk incubator, community based, profitable enterprise.

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(MAP 05)

Effect of Feeding Moringa Oleifera And Spirulina Platensis As Feed Additives in Laying Hen

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Abstract

Two hundred native chickens at the age of 26 weeks were selected and continued for 42 weeks. The birds were housed in a close, ventilated caged-layer house and were distributed in five dietary groups having 40 birds in each group with 5 replications having 8 birds per replication. Five dietary treatment groups were produced from the basal feed as follows: positive control (T1), including 2 different levels of *M. oleifera* leaf meal 1% (T2), *M. oleifera* leaf meal 1.5%, (T3) and 2 different levels of *S. platensis* 1% (T4), and *S. platensis* 1.5% (T5). The average egg weight was found to be increased in additives groups. Serum cholesterol levels were significantly reduced (P<0.01) in all additive groups. In contrast, total egg cholesterol content in T2 and T5 was the lowest with the value of 173.95 and 226.21 mg/100g compared to control group, 283.86 mg/100g. Omega 3 fatty acids in egg (g/100g) of the said dietary treatments were increased in T2 group with the value of 1.57 and 1.55 in T4 group. However, higher omega 3 fatty acid was found in commercial egg 1(CE1) with the value of 2.03 (g/100g). It may be concluded that herbal enriched functional meat and egg, rich in n-3 PUFA, antioxidant and other herbal active principles can be produced by feeding hens with functional feed containing bioactive ingredients.

Keywords: *Moringa oleifera*, *Spirulina platensis*, feed additives, laying hen, fatty acids
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(MAP 06)

Dietary Probiotics on Broiler Growth Performance And Meat Quality Traits In Producing Antibiotic Free Chicken

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Abstract

A total of one hundred ninety two one day old Cobb broiler chicks were studied to know the potentiality of two different single strain probiotics replacing antibiotic. The groups were control (basal diet), antibiotic (basal diet + 0.05% OTC), and 2 different single strain probiotics with basal diets separately. The birds were arranged randomly following CRD design in floor pen with 4 replications having 12 chicks in each. The data were analyzed using computerized software package, SAS. Statistical differences (p<0.05) were observed in body weight gain

(1791, 1787 g/b for the probiotic groups) compared to 1674 g/b in control with FCR 1.63 and 1.61 for probiotics and 1.74 for control. Among the dietary treatment groups there was a lowering trend noticed in FCR in probiotic fed broilers. Lipid oxidation value (TBA) showed significantly lowest ($p<0.05$) in probiotic fed birds (8.63 and 8.80 µ moles of malondialdehyde (MDA) per 100 g of meat than control (11.20). This lipid oxidation is inversely correlated with the shelf life of a product. The probiotic group possessed statistically similar values with antibiotic fed broilers. No remarkable variation was observed in internal development of broiler chicken. In conclusion, addition of probiotic can be used in maintaining growth, improving meat quality and in place of oxytetracycline that could be utilized for safe poultry meat production.

Keywords: Probiotic, antibiotic alternative, broiler, safe meat, lipid oxidation.
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(MAP 07)

Incidence of Antibiotic Resistance Among Eskape Pathogens from Shrimp Aquaculture Farms in Kerala

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Abstract

The present study was carried out to monitor the occurrence of antibiotic-resistant pathogens such as ESKAPE (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and *Enterobacter* spp) in shrimp aquaculture farms from Kerala. A total of 500 samples including shrimp, water, sediment and shrimp feed from 53 farms were screened for pathogens using standard isolation protocols (ISO). Bacterial identification and antibiotic susceptibility testing (including MIC) were performed by employing the BD Phoenix M50 automated system. Out of the 53 farms, 16 (30.2%) were found to be positive for ESBL (Extended spectrum beta-lactamase)-producing enterobacteriaceae and 31 (58.5%) for methicillin-resistant staphylococci. Among a total of 115 Gram-negative and 150 Gram-positive bacteria isolated, distribution of ESKAPE pathogens were as follows: *E. faecium* (0), *S. aureus* (21), *K. pneumoniae* (17), *A. baumannii* (2), *P. aeruginosa* (11), *E. cloacae* (21). Other important species included *Escherichia coli* (29), *Citrobacter amalonaticus* (18), *S. haemolyticus* (18), *S. epidermidis* (14), *S. saprophyticus* (3) and *S. kloosi* (5). All isolates of *E. coli* were ESBL producers and 51.7% (n=15) of them were observed to be multidrug resistant, with resistance mainly towards tetracycline, trimethoprim-sulfamethoxazole and gentamicin. Cefotaxime MIC was found to be ≥32 µg/ml for *E. coli* isolates almost invariably. Importantly, two isolates of *K. pneumoniae* were identified as potential carbapenemase producers. This suggests that the presence of important AMR pathogens in aquaculture settings, reveals the potential possibility of contamination from different sources such as domestic sewage, hospital discharge and animal waste and the

aquaculture settings could act as a potential reservoir and dissemination of AMR pathogens. So strict Good Aquaculture Practices (GAP), Bio-security measures, maintaining water quality and microbiological parameters etc, must be properly maintained to avoid the contamination with AMR pathogens. In short, our study calls for enhanced nation-wide surveillance of AMR pathogens in aquaculture settings to further assess this issue.

Keywords: Antibiotic resistance, ESBL, ESKAPE pathogens, MRSA,shrimp aquaculture farms.

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(MAP 08)

Effect of Level of Education of Consumers on Consumption Pattern, Awareness And Hygienic Practices For Meat And Meat Products In Ludhiana City

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Abstract

In the present study, effect of consumers' education level on consumption pattern, awareness and hygienic practices adopted for meat and its products in different zones of Ludhiana city through contact survey method was assessed. A bilingual (Punjabi and English) questionnaire/interview schedule comprising questions related to meat consumption, processing pattern, awareness of consumers regarding type of meat and hygiene was designed. The city was divided in four different hypothetical zones and 200 respondents from each zone were selected purposively to constitute a total sample size of 800 respondents (256 females+ 544 males) for the study and two indices based on questions were constructed. Consumers were pooled in four different educational groups viz. secondary (1), senior secondary (2), graduation (3) and post-graduation (4). It was observed that level of education has a significant ($p< 0.05$) effect on preference of meat cut and type of processed meat. Level of awareness regarding different processed products had a positive correlation with educational status. Analysis of responses revealed that consumers with better educational qualifications were more aware regarding hygienic considerations of meat along with animal welfare issues. It could be depicted from the study that consumers from educational group 1 and 2 preferred fresh meat over frozen meats. The respondents in lower educational groups had higher preference for traditional meat market than organized units. It can be concluded that educational status of consumer largely affects the progress of this industry. However, if consumers are educated about processing and value addition through different training and orientation programmes, it would provide a major push to meat industry in India.

Keywords: Consumer survey, hygiene, education, processing pattern, questionnaire, awareness.

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(MAP 09)

Effect of dietary supplementation of Ashwagandha root powder on carcass parameters of broilers

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Abstract

A total of 300, one day-old commercial broiler chicks were procured and randomly distributed into 30 subgroups means six dietary treatments with five replicates per treatment and each replicate had ten birds for 42 days. The first group was kept as a control (T1) and given the basal diet without antibiotic formulated as per BIS (2007) while in second group (T2) with antibiotic, third (T3), fourth (T4), fifth (T5) and sixth (T6) groups were supplemented with Ashwagandha root powder (ARP) @ 0.25, 0.5, 0.75 and 1%, respectively in the diet. At the end of feeding trial, one bird was selected from each replicate and different carcass traits were measured with respect to percent live weight. Dressed, eviscerated, drawn, giblet, thigh and breast weight percentage were increased significantly in 0.75% and 1.0% ARP supplemented groups while no change in thymus and spleen as compared to control group. A significant reduction was notified in abdominal fat percentage. This increase in carcass parameters may be due to active ingredients of Ashwagandha responsible for secretion of digestive enzymes, better feed utilization leading to better growth performance. Quality of the breast and thigh muscles in terms of ether extract and crude protein got improved at 0.75% and 1% ARP supplementation showing hypolipidemic and anabolic effect of ARP. Thus, the dietary supplementation of Ashwagandha root powder leads to significant improvement in the growth performance and different carcass parameters thereby help in achieving a profitable and sustainable poultry production.

Keywords: Chicken broiler, ashwagandha root powder, growth performance, meat and carcass quality.

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(MAP 10)

Physico-chemical properties of shelf stable meat pickle from kadaknath

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Abstract

Kadaknath meat pickle was prepared adopting technique to enhance shelf stability. The product was prepared involving two cooking methods i.e. steam cooking(T1) and microwave cooking (T2) followed by dehydration to get steam cooked+dehydration(T3) and microwave cooked+dehydration (T4) treatments. The results revealed that dehydration increases product

yield and the highest product yield was found in T3 (95.68%) whereas the lowest in T1 (92.79%). Dehydration lowered the water activity (aw); lowest water activity of 0.84 was found in T4 treatment. Proximate characteristics of the meat pickle showed that the highest protein and lowest moisture was found in steam cooked+ dehydration (T3) i.e 34.01% and 39.40 % respectively. Similarly highest fat was reported in T3 as 16.15 % and ash above 4.0%. Storage study revealed that there was significant ($P<0.05$) decrease in pH from day 0-100 in all the four treatments, however pH of T3 and T4 i.e. dehydrated variants of product was lower as compared to T1 and T2. On the other hand the dehydrated treatments (T3 & T4) were having higher free fatty acid (FFA) and titrable acidity (TA) than the T1 and T2 samples. Similarly T3 and T4 were having higher values as compared to the T1 and T2 for thiobarbituric acid (TBA) values, however the TBA values in pickles were well within the prescribed limit. A significant ($P<0.05$) increase in TA, FFA as well as TBA value with the increase in storage period of meat pickle was also evidenced.

Keywords: Kadaknath, Meat, Pickle, Dehydration

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(MAP 11)

Extension push to meat production & processing for enhanced productivity and doubling farmer's Income

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Abstract

Increasing per capita income and changing food habits among the people have shown green signal for the growth of meat sector in India. The per capita annual meat consumption in India is below 5 kg which is quite less as compared to the recommended figures of ICMR i.e. 10.95 kg. The picture becomes grimmer when compared to world average of 14 kg per annum. The nutritional security of the people for animal origin proteins can be sought through enhanced meat production and processing. The extension organizations have to play an important and definitive role in ushering this dream target. The increased awareness of the livestock farmers about scientific animal rearing, products harvesting, quality assurance, processing, value addition and marketing will certainly enhance their knowledge, confidence and will lead to increased innovation adoption by them. Various studies have shown that the majority of respondents in the study group were satisfied with the video based instructions and teaching for educating them. This is attributed to engagement of multiple senses of the target users and ability to retrieve information again and again. The newer social media tools help the extension agents to reach the unreached livestock farmers for the dissemination of farming system specific technology to them. This advantage also needs to be harvested in the newer sectors like meat production and processing. Technical support and solutions to the end users through various extension tools will surely help in achieving enhanced meat production and processing.

Keywords: Meat production, extension push, enhanced productivity, doubling farmer's Income, technical support.

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(MAP 12)

Impacts, adaptability and mitigation of climate change and livestock

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Abstract

Global demand is expected to double in livestock products by 2050, due mainly to improved worldwide living standards. While, because of the effect on the quality of feed and dried crops, the availability of food, production of animal and milk, animal disease, breeding of animals and biodiversity, climate change is affecting livestock production. The study looks at the global impacts on livestock production of climate change, the contribution to climate change of livestock production and local climate-change adaptation and livestock mitigation strategy. Climate fluctuations will restrict livestock production, with animal waters expected to grow by a factor of three, a 70-percent increase in demand for agricultural lands and a food security issue because approximately 1-3 of the world cereals is used for feeding. Furthermore, 14.5% of the global GHG (greenhouse gas) emissions are related to livestock, causing more climate change. The livestock industry will therefore be a central player in reducing GHG pollution and improving international food security. Therefore: a) the analysis of the use of the adaptation measures and the mitigation measures adapted to the site and to the livestock production system in use and b) the policies promoting and encouraging the implementation of climate change adaptation and mitigation measures are important for transitioning to sustainable livestock production.

Keywords: Livestock, climate, GHG, adaptation, mitigation, livestock production.

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(MAP 13)

Food synergy: the alchemy of meat factor

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Abstract

We all consume considerable quantity food items daily in several combinations. Meat, poultry and fishes form a substantial part of the dietary intake all around the world. Consumption of animal origin products majorly red meat has shown an increase up to 150 per cent in absorption of non-heme iron. From the aforementioned example, food synergy could be loosely defined as an interactive process among food of different origin which is capable of affecting human nutrition and health in complex ways. This absorption difference between meat and other food items (mainly vegetarian diet- legumes, beans etc.) was initially attributed to meat and ascorbic acid as they increased HCl secretion in stomach. However, when this food alchemy was observed in people with achlorhydria, need to explore the potential causing

factor escalated. Recent studies have shown that protein component of the meat product is the undiscovered facet of this research which primarily attributed to increased absorption, now termed as meat/magic factor. This magic factor if used wisely can help, if not entirely in curbing then in substantially reducing the anemia problem, which the country is encountering with nearly 70 per cent of residing females having low iron content. Therefore, there's a need to further explore this meat factor and its exploitation for benefit of public by incorporating the concept of food synergy in balanced diet.

Keywords: Food synergy, anemia, magic factor.

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(MAP 14)

Clean meat factory: potential solution to Indian food security crisis

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Abstract

India with a population dynamic of 1.3 billion has an ever-increasing demand of food supply. As per global hunger index (2019), India bags 102nd position among 117 countries screened. This index indicates that the country is home to largest number of hungry people in world with statistics signifying an average over 200 million people are food insecure and the country's encountering a major food security crisis. To curb this problem, an initiative needs to be taken which has risen in form of clean meat. So, by definition clean meat/cultured meat/artificial meat/in-vitro meat is essentially lab grown meat made by growing muscle cells obtained through muscle biopsy in nutrient serum and encouraging them to grow into a muscle tissue. The final product tastes identical to raw meat, nonetheless can be altered in composition (protein, mineral and vitamin content) as per the demand and need of the consumer. The meat so grown is comparable to organic meat as its devoid of any hormones, growth promoters and antibiotics making it safe for consumption from ethical point of view. Simultaneously, it will help massively in reducing livestock sector contribution towards waste water and greenhouse gases emissions which are more than combined production of world's transport industry. Artificial meat is cruelty free meat, thus would concur with the increasing trend of veganism among people. By 2050, food industry (UN population prospects) wouldn't be able to meet the global food requirement, clean meat would be great initiative in combating the food crises. With greater good comes certain disadvantage, for artificial meat would be its acceptability by conservative people, who strictly follow their religion and belief's, high manufacturing and retail price, requirement of skilled labour, stringent laboratory protocols and unawareness among public. Thus, acceptability of artificial meat in near future and role played by it in limiting India's hunger problem will largely lie with initiatives taken by government and its acceptability by majority of public.

Keywords: Clean meat, artificial meat, global hunger index, public health.

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(MAP 15)

Amalgamation: a better way to enhance meat popularity among consumers

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Abstract

Amalgamation or Incorporation is the best way to overcome the demand of improved, convenient and fast food buildup due to changes in lifestyle of consumers in recent years. Incorporation of value added products changes the physicochemical, textural and sensory properties. It also reduces fat content which changes binding properties, tenderness, juiciness, mouth feel and overall appearance of processed meat. Incorporation of value added substance is done either by dietary supplementation or raw meat value addition. Incorporation of value added substances in raw meat increases water retention, provide fibers, flavonoids and decreases yield percentage, product pH, protein percentage, fat percentage, water activity and also inhibit the proliferation of spoilage microorganisms such as *Salmonella*, *Listeria monocytogen* etc. hence reduce perishability. Substance like probiotic strain *(Lactobacillus plantrum),* calcium lactate powder, soy protein isolate, inulin, carrageenan, chitosan, ginger extract B-glucans etc. are used in raw meat incorporation. Whereas dietary incorporation reduces intramuscular fat proportion, increases juiciness, production of more favorable polyunsaturated fatty acids and also increases essential and nonessential amino acids and growth performance of animals. Substances like spineless cactus, dehydrated leguminous forages (contain alpha Linolenic acid, Vit.E and Beta carotene), guava seeds powder, dietary fatty acids and green tea extract etc. are used in dietary incorporation of animals. So incorporation of different beneficial substance in meat could be a better way to enhance meat popularity among consumers.

Keywords: Natural antioxidants, probiotic, tenderness, value addition.

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(MAP 16)

Organic livestock products production for sustainability of ecology and economy

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Abstract

In current industrial era, the farming and animal husbandry practices has become more intensified and mechanized with a sole aim of maximum output in minimum period. This has hampered the delicate ecological balance and cycles of the farming system. The bad effects include unseen problems associated with GM diet, antibiotic resistance, lifestyle diseases, and harmful insecticides/pesticides in our food chain. Thus the need of the hour is to shift the

production methods for a sustainable production in place of conventional production system. Organic farming is a holistic production management system, which promotes and enhances agro-ecosystem health including biodiversity, biological cycles and biological activity. It sums up under stringent standards with respect to organic animal feed, welfare, restricted use of preservatives, adulterants, toxic pesticides, synthetic fertilizers, growth hormones and antibiotics or genetically modified organisms (GMOs) hence, producing healthy milk/meat/eggs free from residues. India ranks 9th in World's Organic Agricultural land with highest number of organic producers worldwide and exported their produce **under a unified logo "Jaivik Bharat".** National Programme for Organic Production (NPOP) enlists all the laws for production and export from India. Though a fair volume of organic produce is exported from India, however a very small volume of organic livestock products are being exported, because of various challenges and misconceptions faced by the producers. Organic milk/meat/egg products are tastier, free from additives, antibiotic and hormonal residues and thus widely preferred by consumers and have ready market. The consumers are ready to pay premium price for the authentic, certified and labelled organic livestock products. However, the producers lack knowledge and awareness about the certification and labelling of organic produce. Hence for the sustainability of organic animal husbandry, the focus should also include social, economic, ecological and animal welfare components.

Keywords: Organic farming, livestock products, sustainability, ecology, animal welfare.
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(MAP 17)

A survey on wet market practices in western regions of Tamilnadu

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Abstract
Most of the people in India prefer fresh meat than chilled or frozen meat. The local butcher shops are called as wet market because they sell only fresh meat and the floors are always wet. There are several factors which affect the meat quality in wet market. The post-mortem factors such as temperature and time of exposure of meat to environment. The scientific rationale behind the attitude of consumer towards wet market was not explored. Hence, a study was conducted to know the wet market practices followed in Tamilnadu. For this a survey was conducted in 30 butcher shops located in and around Namakkal, Salem and Coimbatore districts of Tamilnadu. The collection of data includes details of butchers and workers, details of retail shop which includes demographic details, slaughter details and time taken for selling entire chevon. The practices followed during the sale of chevon were also documented in the survey. About 50 per cent of the butchers preferred to slaughter animal in common place near the shop so that the transportation of carcass, frequent handling and exposure of carcass to various environmental conditions was reduced. All the shops were open type (100%) no glass

panel shops were documented. For the display of chevon they used hooks for hanging in 70 per cent of the shops while in 10 per cent of shops they use banana leaf. In majority of shops (53.3 per cent) time taken for selling entire meat was up to 6 hours. In 20.00 per cent of shops the repeated dipping of carcass in same water and spraying of water on the carcass were observed. In remaining 60 per cent of the shop no such practices were observed. Hence it is found that in eastern region of Tamilnadu the time taken for selling entire meat was short but the exposure of the carcass to open environment cause the quality changes very soon.

Keywords: Butcher shop, environment, exposure and wet market
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(MAP 18)

Nutritional strategies for enhancing conjugated linoleic acid: a multifunctional nutraceutical in animal products

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Abstract

Nutritional quality is becoming a major issue in food choices because of increasing consumer awareness of the link between diet and health. Animal products especially meat and meat products have a negative image because of saturated fatty acid which have been associated with heart diseases. To fulfill the consumer demands, there is a large interest in the animal industry to improve the composition and health value of products of animal origin. So there is a need of nutritional management for enhancement of CLA and polyunsaturated fatty acid (PUFA) in meat. There are different nutritional strategy like increasing the oil seed, vegetable oil and grazing on pasture which is going to affect the CLA content in ruminant's products. Plant secondary metabolites like tannins, saponins, terpenes etc. going to effect the ruminal microflora ultimately ruminal biohydrogenation ultimately concemtaration of CLA in ruminal fluid. It has been found that supplementation of 1.79 percent *T. chebula* extract lowered ($P \leq 0.01$) the concentration of stearic acid by 25, 34 and 25 percent and increased vaccenic acid and CLA by 83, 35, 15 and 17, 29, 59 percent in rumen liquor, plasma and muscle, respectively. Total MUFA and PUFA content in muscle were enhanced by 25 and 35 percent, respectively, whereas SFA reduced by 20 percent in compared to control. Δ9-desaturase activity was also increased in treatment group as evident by more desaturase assay (47%) and desaturation indices. Enhancement of CLA, PUFA content and decreasing the level of SFA content in animals products is useful strategy in human health point of view, moreover dietary CLA are currently attracting considerable interest because of its health benefits to humans like anticarcinogenic, antiatherogenic, antidiabetic and immunomodulatory properties. Now days, people are more concerned about foods, which possess specific health attributes beyond its organoleptic and nutritional properties. There is a need of different nutritional intervention researches in ruminants to increase the functional food components in their products which is going to affect

the animal product quality.

Keywords: Conjugated linoleic acid, nutraceutical, animal products, health benefits.

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(MAP 19)

Study of growth promoting effects of *Glycyrrhiza glabra* and *Turmeric longa* on fingerlings of *Cyprinus carpio* (koi carp)

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Abstract

The present study was designed to investigate the growth effect of *Curcuma longa* and *Glycyrrhiza glabra* (GB) incorporated in combination in fish *Cyprinus carpio*. A total of 50 fingerlings were divided into two groups. One group was given control diet (D1). The other diet was supplied with both additives (D2) and was tested for duration of two months. Experimental diets for corresponding treatment groups and the control group were prepared by mixing wheat bran, de-oiled mustard cake, soybean meal and vitamin mineral mixture. Rate of incorporation of the powdered root of *Glycyrrhiza glabra* (GB) was 1% in the test group and *Turmeric longa* is added at the rate of 0.5% while there was no incorporation in the control group. Fishes were fed @ 5% body weight per day. Morphometric parameters were analyzed to see the growth performance. Body weight, body length, standard length, fin length, body depth and pre dorsal fin length were used as parameters under morphometric analysis. Parameters were measured after every 15 days. Fingerlings fed with diet D2 showed Body length increases from average 5 g to 14.65 g while in control group it increases to 11.25 g similarly, length increases from 4.5cm to 12.03 cm in D2 group and 8.05 in D1 group. Futhermore similar trend is observed for other parameters also. Comparison of D2 with control reveals that the supplementation @ 0.5% *Turmeric longa* and 1% *Glycyrrhiza glabra* significantly improved the growth of fish.

Keywords: Growth, *Curcuma longa, Glycyrrhiza glabra, Cyprinus carpio, fish* fingerlings.
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(MFPD 01)

Development and quality evaluation of restructured buffalo meat slices by using egg white powder as a novel binder

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Abstract

The influence of egg white powder on quality characteristics of restructured buffalo meat slices (RBMS) processed by hot-set binding system was evaluated. The treatments were control (RBMS processed without addition of egg white powder), T1 (RBMS added with 1 per cent egg white powder), T2 (RBMS added with 2 per cent egg white powder) and T3 (RBMS added with 3 per cent egg white powder) and the remaining ingredients are same for all treatments. The developed RBMS were analyzed for various physico-chemical, proximate, textural and sensory characteristics. T3 had significantly ($P<0.05$) higher cooking yield, batter stability, water-holding capacity than remaining formulations. Highest per cent diameter shrinkage (12.61) was observed in control than other formulations. Addition of various levels of egg white powder did not significantly ($P>0.05$) influenced the per cent collagen content and collagen solubility. Addition of various levels of egg white powder significantly ($P<0.05$) influenced proximate composition (moisture, protein and fat) of RBMS. RBMS added with 3 per cent egg white powder had significantly ($P<0.05$) higher per cent moisture and protein content than remaining formulations. Various levels of egg white powder differently affecting the textural attributes of restructured buffalo meat slices. RBMS incorporated with 3 per cent egg white powder had significantly ($P<0.05$) lower gumminess and hardness and higher cohesiveness, adhesiveness than control and remaining formulations. Addition of 3 per cent egg white powder in RBMS had significantly ($P<0.05$) superior sensory scores than control and remaining formulations. Based on the results, it can be concluded that addition of 3 per cent egg white powder had efficient binding in restructuring process thus recorded superior quality characteristics than control and remaining formulations.

Keywords: Restructured buffalo meat slices, egg white powder, hot-set binding system, quality characteristics.

Acknowledgement: The authors are highly thankful to Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh, India for the financial support to carry out the above research work.

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(MFPD 02)

Quality improvement of chicken spread with incorporation of different humectants

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Abstract

The present study was conducted to improve the quality characteristics of chicken meat spread with incorporation of different plasticizers. Pre-standardized chicken spread was prepared by incorporation of different plasticizers/humectants *i.e.* glycerol, pectin and sorbitol separately at three suitable concentrations of each *i.e.* 0.5%, 1%, 1.5% replacing water. Chicken spread prepared chicken spread incorporated with 1.5% sorbitol (S), 1% glycerol (G) and 1% pectin (P) were selected on the basis of sensory evaluation. These three selected treatments were further compared with control (C) to select the best humectant on the basis of various physico-chemical properties and sensory evaluation. Cooking yield and moisture content of P and G were significantly (P<0.05) lower than C, however values of S were comparable to C. There was no significant difference in pH, protein, fat and ash content as well as in lightness values between control and treatments. Redness values of S and G were significantly (P<0.05) lower than C, however values of P were comparable to C. S again had significant (P<0.05) lower yellowness values than P, whereas C and G had comparable values with S and P. Among the sensory attributes, no significant difference was observed in colour and appearance, texture, juiciness, saltiness, mouth coating and meat flavour intensity scores however, flavour, spreadability and overall acceptability scores of S were significantly (P<0.05) higher than control as well as treatments. Therefore, chicken spread incorporated with 1.5% sorbitol as plasticizer/humectant was selected as the best treatment.

Keywords: Chicken spread, sorbitol, glycerol, pectin, humectants, plasticizer, quality characteristics, overall acceptability.

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(MFPD 03)

Effect of addition of mango peel on rheological characteristics as well as textural properties of chicken patties

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Abstract

Present study was carried out to study the effect of addition mango peel powder as fat replacer of at 1.0% (MP1), 2.0% (MP2) and 3.0% (MP3) level with replacement of 50% vegetable oil in formulation on the rheological behavior of emulsion and textural properties of the product. The formulation of low fat chicken patties was maintained by addition of water accordingly. Dynamic oscillatory measurements revealed predominant visco-elastic behavior of emulsions on addition of mango peel powder, as storage modulus values (G') were higher than the loss modulus values (G").textual profile analysis showed significant effect on significant (P<0.05) effect on hardness, fracturability, cohesiveness, gumminess and chewiness values, however color profile showed significant increase in yellowness value on incorporation of mango peel powder in low fat chicken patties. Sensory panelists were recorded no significant difference between sensory score of MP1 and MP2, henece the addition of 2% mango peel powder addition is effective for the development of low fat chicken patties without affecting quality parameters.

Keywords: Mango peel, rheological characteristics, textural properties, chicken patties
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(MFPD 04)

Assessment of antioxidant and sensory properties of amla (*Emblica officinalis*) fruit and seed coat powder incorporated cooked goat meat patties

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Abstract

The present study was designed with the purposes to assess the shelf life of goat meat patties incorporating with amla fruits extract and amla seed coat extract as natural preservatives and to assess their effect on physico-chemical and sensory attributes of the product under vacuum packaged refrigerated (4±1oC) storage. The products incorporated with amla fruit extract and amla seed coat extract had lower thiobarbituric reacting substances (TBARS) value, free fatty acid (FFA) value and pH value than the control. As advancement of storage period total phenolic content was decreases. The sensory attributes like colour and appearance, flavour, juiciness and overall acceptability were decreased significantly (p≤0.05) as storage day advances. Sensory evaluation scores showed that goat meat patties incorporated with amla fruits extract and amla seed coat extract were equally acceptable as reference product and rated good to very good for colour and appearance, flavour, juiciness and overall acceptability. Goat meat patties with amla fruit and its seed coat extract can be stored safely without much loss in its quality even up to 21 days under vacuum packed refrigerated storage.

Keywords: Goat meat patties, amla extract, shelf life, vacuum refrigerated storage, quality attribute.

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(MFPD 05)

Development and quality evaluation of value added enrobed beef cutlet

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Abstract

Meat continues to be an important food in the diet of many people and red meat forms a part of the habitual balanced diet, particularly in developed countries. Value addition through processing of meat into meat products increases the returns to a greater extent by income generation and employment opportunities. Beef cutlets were prepared and their shelf life was assessed at refrigerated (4±1°C) storage for 7 days. Physico-chemical characteristics such as pH, TBA, Tyrosine value were analyzed and microbial studies viz., Total viable count, psychrophilic count, coliform count, yeast and mould count were determined on '0', 1st, 3rd, 5th and 7th day of storage. There was a progressive increase in pH, TBA and Tyrosine value throughout the storage period. Results on Physico-chemical characteristics and microbial studies showed highly significant difference (P<0.01) between the storage days. However, TVC, psychrophilic, Yeast and mould counts were well within the acceptable limits (viz., log7 cfu/g for mesophilic counts, log4 cfu/g for psychrophilic count and log3 cfu/g for coliforms, log3 cfu/g for yeast and mould) and coliforms were absent throughout the storage period. This may be due to addition of spices, herbs and condiments rich in anti-microbial properties. This indicates that the deterioration of the cutlet quality was not due to microbial spoilage but might be due to development of rancidity. Hence, based on the Physico-chemical studies cutlet were acceptable upto 5th day of refrigerated (4±1°C) storage. The deterioration of cutlet on 7th day was not due to microbial spoilage but due to development of rancidity.

Keywords: Beef cutlets, storage study, shelf life, enrobing, quality attributes.

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(MFPD 06)

Slices developed after optimization from buffalo-calf and goat meat and its physico-chemical properties

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Abstract

The juiciness, tenderness and flexibility evaluation showed that 3 mm particle size slices differed significantly (P≤0.05) and had highest value than 6 mm for both buffalo and goat meat. The binding, air pockets/ pin holes had again the lowest score in 6 mm category and it differed significantly (P≤0.05) from 3 mm. The overall acceptability scores clearly indicated that 3 mm slice with highest score and was significantly (P≤0.05) superior to 6 mm and 3+6 mm for buffalo

and goat meat slices. Similarly the overall acceptability scores observed for slices from buffalo and goat meat with variable fat, revealed that the slices having 10 % fat were significantly ($P \le 0.05$) superior to that prepared from 15 and 20 %. A significant ($P \le 0.05$) difference existed between meat slices from both species, prepared by tumbling for 1 hour and 3 hours, when parameters like texture, juiciness, tenderness, flexibility and binding were analyzed, where the former scored higher values than the latter. The selected product on the basis of sensory results having 3 mm particle size, 10 % fat content and 1 hour tumbling time was compared for different physico-chemical features. The emulsion stability, cooking yield revealed a significant ($P \le 0.05$) difference having the higher values in buffalo calf meat than the goat meat. The protein and fat content revealed that buffalo calf meat slices had significantly ($P \le 0.05$) higher (17.35) protein than the goat meat (15.21) whereas goat meat slices had significantly ($P \le 0.05$) higher (10.33) fat content than the buffalo calf meat slices (7.84). The cohesiveness and chewiness were the only attributes of texture profile analysis that indicated the significant ($P \le 0.05$) difference in products prepared from the two species. Similarly the L* and b* values of colour parameter showed a significant ($P \le 0.05$) difference.

Keywords: Buffalo and goat meat, slices, quality attributes, colour parameter.

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(MFPD 07)

Effect of different levels of vinegar on beef preservation at refrigerated storage

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Abstract

The present study was conducted to evaluate the sensory (organoleptic), physicochemical and microbiological quality of raw beef incorporated with different levels of vinegar at refrigerated storage (4±1 ºC). Fresh beef samples were divided into three different batches i.e. T0 = control (without vinegar), T1 = 5% vinegar and T2 = 10% vinegar. The samples were evaluated for sensory properties (color and flavor), physicochemical properties (pH, cooking loss, FFA, POV and TBARS) and microbial counts (TVC, TCC and TYMC) on 0, 3rd and 7th days of storage. The obtained results showed that addition of different levels of vinegar significantly ($p<0.05$) influenced on sensory, physicochemical and microbiological properties compared to control samples. Comparatively better color and flavor were found in T1 and T2 respectively among the treatments. Better pH was observed in T0 and better cooking loss was observed in T2 than other treatments. POV, FFA and TBARS values were found better in T0, whereas the other treatments fluctuated slightly. TVC, TCC and TYMC values were significantly lower in higher vinegar treated groups along with at different day's interval. It might be stated from the experiment that vinegar is a means of fresh beef preservation for short time. From this study, it also concluded that 10% vinegar is effective for short term preservation of beef satisfactorily at refrigerated condition.

Keywords: Beef, vinegar, sensory and microbiological quality.

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(MFPD 08)

Development of low-fat pork nuggets with incorporation of whey protein concentrate

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Abstract

In the present study the level of incorporation of protein based fat replacer i.e. whey protein concentrate was standardized for the development of low-fat functional pork nuggets. Whey Protein Concentrate (WPC) was incorporated at the 2%, 4% and 6% level after the replacing the refined vegetable oil in the prestandardized formulation of pork nuggets. Developed products were evaluated for physico-chemical properties (pH, cooking yield), instrumental colour, texture profile and sensory properties (8- point descriptive scale) and compared to high fat control (10 % fat). The pH values showed significant decreasing trend with increase in the incorporation level of WPC. The cooking yield was slightly higher for the treatment products in comparison to the control product. The values of Instrumental colour and texture profile analysis was comparable among control and treatment products. Sensory analysis of products showed increase in appearance score with increase in the level of WPC, whereas the flavour and texture scores showed declining trend with increase in the level of WPC. Sensory scores for most parameters including the overall acceptability for the 4% WPC incorporated pork nuggets was comparable to control. Hence the incorporation of WPC at 4% level resulted in development of low fat pork nuggets.

Keywords: Low fat, whey protein concentrate, sensory, colour, texture.

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(MFPD 09)

In-vivo meat model storage stability of response surface optimized kiwi pomace extract

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Abstract

Present research was planned to study the effect of response surface optimized antioxidant-rich bioactive Kiwi fruits by-products extracts i.e. kiwi pomace extract (KOE) in chicken emulsion during refrigeration storage (4±1°C). The bioactive extracts were added at the level of 0.5%, 1% and 1.5% in chevon emulsion along with control samples without added kiwi pomace extracts. Storage of nine days were followed by evaluating various physico-chemical, microbiological, sensory quality characteristics. The pH was significantly ($p<0.05$) higher in control than all the treatments and aw showed decreasing trend throughout the storage period. Microbiological quality and oxidation efficacy values viz. TBARS, PV and FFA followed an increasing ($p<0.05$) trend throughout the storage period of nine days irrespective of added

level of KOE, showing and strong microbial stability and lowest oxidation in samples treated with 1.5% KOE. The sensory panelists awarded comparatively higher scores to all the KOE treatments than control and T-3 showed highest score. From obtained results, it was concluded that kiwi pomace extracts could be a potential candidature to be used as novel natural anti-oxidants for in chicken emulsion and can be added the level of 1.5% in the chicken meat products.

Keywords: Kiwi by-products, kiwi pomace extracts, lipid oxidation, chicken emulsion.
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(MFPD 10)

Effect of retort processing on the physico-chemical properties and fatty acid profile of healthier goat meat nuggets

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Abstract
This study aimed at developing shelf stable goat meat nuggets with healthier fatty acids by retort processing and evaluating its influence on physicochemical, colour, textural properties as well as fatty acid profile with respect to control. Retorting with curry based products has been reported. Non curry based meat products retorting has been sparsely reported. The product has been retorted without any structural changes in the product with modified retorting approach. In regard to proximate composition of the products, retort processed nuggets had significantly lower ($P<0.05$) fat content than control. There was no significance difference in the pH value of control and retort processed nuggets. Hunter colour lightness, redness and yellowness values of the nuggets were significantly increased ($P<0.05$) due to retort processing compared to control. Texture profile analysis of the products showed that retort processing significantly increased ($P<0.05$) the hardness, gumminess and chewiness values of the nuggets. However adhesiveness, cohesiveness and springiness of both the products remained statistically similar. Fatty acid profiling of both the nuggets revealed that retort processed product had significantly lower ($P<0.05$) C18:0, C18:2, C18:3 whereas proportions of C14:0, C16:0, C17:0 and C18:1 were significantly higher. Thus, shelf stable healthier goat meat nuggets can be processed through retort processing with minimal loss of nutrients.

Keywords: Shelf stable, goat meat nuggets, retort processing, fatty acid profile.
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(MFPD 11)

Effect of ambient storage on the quality characteristics of buffalo meat extruded product incorporated with tapioca flour

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Abstract

Buffalo meat contributes a major share in the total meat export from our country. In order to improve the palatability of the buffalo meat a value added meat extruded product was developed using the tapioca flour as a binder. Hence a study was conducted to found the quality characteristics of buffalo meat extruded product using tapioca flour in three different proportions viz 15:85, 25:75 and 35:65. The Physico-chemical characteristics such as cooking yield, expansion ratio, bulk density, water absorption index, water solubility index were significantly higher in 15:85 proportions compared to other two and sensory evaluation were also found to be better in 15:85 proportions. Hence it is stored at ambient temperature for three months and subjected to further analysis such as physico-chemical characteristics (viz. pH, thiobarbituric acid no. tyrosine value, hardness and fracturability) and sensory analysis on every fort night interval during the storage period of three months. There was a significant increase in the thiobarbituric acid no, tyrosine value and hardness throughout the storage period but no significant difference were found in sensory evaluation hence it could be concluded that tapioca powder can be included in buffalo meat extruded product in 15:85 proportion.

Keywords: Buffalo meat, hardness, sensory evaluation, tapioca powder.

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(MFPD 12)

Standardization of formulation for the development of low fat chicken patties

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Abstract

During the study efforts were made to optimize formulation of chicken patties. Chicken patties were prepared with three levels of vegetable fat viz. 6.0 (F1), 8.0 (F2) and 10.0%(F3) to optimize the level of added fat in chicken patties. The best formulation with optimum fat percent level was selected on the basis of sensory evaluation. Result showed that the F3 had comparatively higher sensory scores than F2; but there was no significant difference between F2 and F3 for any sensory attribute. Keeping in view the health concerns, it is concluded that 8% vegetable fat addition in standard formulation is most suitable for preparation of acceptable quality emulsion based meat products.

Keywords: Low fat, vegetable oil, added fat, **c**hicken patties, sensory evaluation, health concern

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(MFPD 13)

Process optimization of emulsion based chicken patties

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Abstract

Present study was conducted to optimize processing conditions in terms of time and temperature for preparation of chicken patties. Chicken patties were cooked in preheated oven at three different time-temperature combinations viz T1-150oC for 25 min, T2-160oC for 20 min and T3- 170oC for 15 min by monitoring cooking temperature of chicken patties in geometric centre with the help of probe thermometer. The best treatment was selected on the basis of sensory evaluation. Sensory panelists recorded significantly ($P<0.05$) higher sensory scores for T2 than T1 and T3 of all attributes. T1 and T3 were not much liked by sensory panelists due to under and over cooking of product respectively. From the study, it is concluded that 160oC for 20 minutes the best time temperature combination for cooking of chicken meat patties.

Keywords: Emulsion based products, time, temperature, processing conditions, sensory evaluation.

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(MFPD 14)

Assessment of antioxidant potential of Fenugreek (*Trigonella foenum-graceum*) seed extract and its effect on ground chevon patties

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Abstract

The present study was undertaken to evaluate the antioxidant potential of fenugreek (*Trigonella foenum-graceum*) seed extracts (FSE) through different kind of biochemical test (Total phenol content (TPC), Total flavonoid content (TFC), DPPH free radical scavenging assay, (3 ethylbenzothiazoline-6-sulfonic acid (ABTS) and Nitric oxide radical scavenging assay) and its effect on ground chevon patties at refrigerated temperature (4±10c) up to 30 days of storage. The result showed that FSE exhibited high TPC (145.23±2.49mg of gallic acid (GAE) per g), TFC (72.62±2.56mg rutin/g) and IC50 value of FSE for DPPH, ABTS and Nitric oxide radical scavenging assay was found 35.31±2.97, 67.08±9.75 and 68.05±8.51 respectively. Product treated with FSE had significantly ($P<0.01$) lower thiobarbituric acid value (mg malonaldehyde/kg), tyrosine value (mg/100g) and free fatty acid (oleic acid/100 g) as compared to control during storage. It can be concluded that fenugreek seed extract has good

antioxidant activity and its incorporation significantly improved the quality attributes of product at refrigerated temperature (4±10c) up to 30 days of storage.

Key words: Chevon patties, fenugreek extract, antioxidant activity, quality attributes.
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(MFPD 15)

Effect of *Emblica officinalis* pulp and seed coat powder as natural preservatives on the storage quality of chicken nuggets

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Abstract

The present study was aimed to investigate the effects of *Emblica officinalis* pulp powder (EPP) and seed coat powder (ESCP) treatment on the quality changes of vacuum packaged spent hen meat nuggets during storage at 4±1°C for 25 days. On the basis of preliminary trials and relevant literature, three different levels of incorporation i.e. 0.5%, 1% and 1.5% were tried replacing lean meat in formulation. Physico-chemical, microbial, proximate and sensory qualities of nuggets were analysed at periodic intervals. EPP and ESCP treated vacuum packed nuggets were significantly lower in total plate, pyschrophilic, yeast and mould, coliform count compared to control. Vacuum packaging in combination with EPP and ESCP treatment significantly inhibited lipid oxidation in nuggets as observed from its thiobarbituric acid reactive substances values. EPP, ESCP and vacuum packaging has no significant effect on proximate values of the samples during refrigerated (4±1°) stored period. On sensory evaluation, 0.5 per cent pulp added nuggets had the higher overall acceptability than all other samples. It can be concluded that GPP, GSCP and vacuum packaging have a potential for development of functional spent hen meat nuggets.

Keywords: *Emblica officinalis*, pulp and seed coat powder, chicken nuggets, storage study.
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(MFPD 16)

Advanced technology for tenderization of muscle foods

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Abstract

Tenderness is one of the most important quality parameters of meat in consumer perceptions and price. The tenderization process, which can be influenced by both pre- and post-slaughter

interventions, begins immediately after an animal's death and is followed with the disruption of the muscle structure by endogenous proteolytic systems. Tenderization is the generalized term for the process that leads to improvement in tenderness and can used only is measured post rigor. There are three main factors that impact on the tenderness of meat are background toughness related to collagen content, rate of tenderization during aging, and muscle contraction during the onset of rigor. These newer methods of meat tenderization resulted in better efficiency and high quality meat products. The post-slaughter technological involvement like electrical stimulation, suspension methods, blade tenderization, tumbling, use of exogenous enzymes, and traditional aging are some of the methods currently used by the meat industry for improving tenderness of meat foods. In the meat industry there are several emerging tenderization techniques are used which are more beneficial than the currently used techniques. The different emerging technique such as high-pressure processing, ultrasound, hydrodynamic-pressure processing, pulsed electric field, Smart Stretch and Pi-Vac Elasto-Pack system some of the current applied methods used in the meat industry. These new emerging techniques resulted the maximizing the tenderness of meat as quick, economical, non thermal, green, and energy-efficient that maximized utilization of tenderness of meat.

Keywords: Tenderization, muscle foods, high-pressure processing.
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(MFPD 17)

Quality characteristics of chevon patties incorporated with inulin and pineapple peel powder

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Abstract

Present study was envisaged to assess the effect of various fibre combinations on the quality characteristics of chevon patties. Based on several preliminary trials, 5 combinations of inulin (as source of soluble fibre) and pineapple peel powder (as source of insoluble fibre) were used to develop chevon patties viz. C (without inulin and pineapple peel powder), T1 (with 1.0% inulin powder only), T2 (with 1.0% inulin and 1.5% pineapple peel powder), T3 (with 1.0% inulin and 3.0% pineapple peel powder) and T4 (with 1.0% inulin and 4.5% pineapple peel powder). The developed products were assessed for various physico-chemical, proximate, instrumental colour, texture profile and sensory analysis. The incorporation of inulin and pineapple peel powder combinations resulted in significant ($P<0.05$) increased in emulsion stability and ash content, whereas protein and fat content recorded decreasing trends upon increasing levels of fibre combinations in formulation. Crude fibre content of treatments was significantly ($P<0.05$) higher than control and it exhibited significantly ($P<0.05$) increasing value upon increasing levels of pineapple peel powder in formulation. The overall acceptability of T3 was comparable

to T2 and C and significantly ($P<0.05$) higher than T4. Thus, good quality fibre enriched chevon patties can be prepared by incorporation 1.0% inulin powder and 3.0% pineapple peel powder.

Keywords: Chevon patties, inulin, pineapple peel powder, quality attributes.
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(MFPD 18)

Quality evaluation of Goat meat biscuits incorporated with groundnut hull powder

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Abstract

The present study was envisaged to develop high fibre goat meat biscuits by incorporating groundnut hull powder. Based on several preliminary trials, three different levels of groundnut hull powder (GHP) replacing refined wheat flour viz. 2%, 4% and 6%, were incorporated in biscuit dough, resulting in preparation of 4 types of goat meat biscuits as C (without GHP), T1 (2% GHP), T2 (4% GHP) and T3 (6% GHP). The developed biscuits were assessed for various physico-chemical, proximate, instrumental colour and texture, and sensory attributes. The pH value of meat biscuits exhibited a decreasing trend with increasing levels of GHP. The ash and crude fibre content of T3 was recorded highest followed by T2, T1 and C samples. The appearance and flavour scores of T1 was recorded highest. The overall acceptability of T2 was recorded comparable to T1, which in turn exhibited significantly higher value than T3 and C. Thus it can be concluded that good quality fibre enriched goat meat biscuits can be prepared by incorporating 4% GHP.

Keywords: High fibre, goat meat biscuits, groundnut hull powder, quality attributes.
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(MFPD 19)

Physico-chemical, microbiological and sensory properties of chevon nuggets incorporated with grape seed extract

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Abstract

Study was conducted to prepare chevon nuggets incorporating grape seed extract (GSE) with three different levels (0.2%, 0.5%, and 1%) replacing lean meat in the formulation. On the basis of various quality parameters, nuggets incorporated with 1% was selected for further studies. The selected as well as control samples were packaged in aerobic packaging under refrigeration (4±10C) and evaluate various physico-chemical, microbiological and sensory properties for 28 days with seven day interval. Throughout storage period TBA value (mg malonaldehyde/Kg), tyrosine value and free fatty acid value (% oleic acid) increase significantly for control as well as treated products; however, grape seed treated nuggets showed a significantly lower value than control. While pH value showed no significant variation during the storage. Total plate count (log cfu/g), psychrophilic count (log cfu/g), yeast and mold count (log cfu/g) were maintained better for treatment throughout the storage. While colliform count (log cfu/g) was not detected during the storage. All the sensory parameters decreased as the storage period increase. The overall acceptability of grape seed extract incorporated chevon nuggets significantly higher than control. Therefore it is concluded that incorporation of grape seed in chevon nuggets increase the shelf life, nutritional quality with making a functional food.

Keywords: Chevon nuggets, grape seed extract, functional ingredients incorporation, microbial quality.

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(MFPD 20)

Shelf life extension of chicken meatball incorporated with kair (*Capparis decidua*) extract stored at refrigeration temperature

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Abstract

The antioxidant and antimicrobial efficacy of kair (*Capparis decidua*) extract was studied in chicken meatball under refrigeration storage temperature. In the preliminary trials, standardization of the meat, potato, pearl millet flour at different levels in meatball and compared for sensory properties. The meatball having 65% meat, 15% potato and with 1.5% pearl millet flour was found to be better over other treatments. The chicken meatballs were prepared by as control (without kair extract), kair extract at different concentrations levels as 0.2%, 0.3%, and 0.5% levels. Chicken meatball treated with kair had significantly (P<0.05) lower thiobarbituric acid value, tyrosine value and free fatty acid (FFA) compared to control during storage at refrigeration temperature. Addition of kair significantly (P<0.05) reduced the total plate count, total psychrophilic, yeast and mold count, and coliform count during storage conditions. The kair treated chicken meatball recorded significantly superior score of colour, flavour, texture, juiciness and overall acceptability than control. It can be concluded that kair has excellent antioxidant properties and can be used to extend the shelf life of meat product.

Keywords: Kair extracts, chicken meatballs, refrigeration storage, quality attribute shelf life.

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(MFPD 21)

Studies on microbiological quality of curry leaves extract and powder incorporated chicken patties during refrigerated storage

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Abstract

The present study was carried out to evaluate the microbiological quality of chicken patties prepared by incorporation of curry leaves extract at the level of 1% (E1), 2% (E2) and powder at 0.4% (P1), 0.6% (P2) were assessed at 0, 5, 10, 15 and 20 days of storage period (4±10C). The microbial studies revealed significant (P<0.05) increase in total plate count in control and curry leaves treated groups throughout the observation period but psychrophilic counts were observed 15thdays onward. All the curry leaves treated products showed lower microbial load compared to control product. Yeast and mould count were not detected in any of the products throughout the storage period. The P2 and E2 groups showed lowest microbial load during the entire storage period. Curry leaves extractor powder at the level of 2% or 0.6% respectively can be incorporated to make the chicken patties microbiologically safe upto 20 days of refrigerated storage (4±10C).

Keywords: Chicken patties, microbiological quality, curry leaves extract and curry leaves powder

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(MFPD 22)

Assessment of antioxidant potential of rosemary (*Rosmarinus officinalis* L) leaves extract and its effect quality attributes of chicken powder incorporated fried chicken snacks

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Abstract

The present study was undertaken to evaluate the antioxidant potential of rosemary (*Rosmarinus officinalis* L) leaves extracts (RLE) through different kind of biochemical test (Total phenol content (TPC), Total flavonoid content (TFC), DPPH free radical scavenging assay, (3 ethylbenzothiazoline-6-sulfonic acid (ABTS) and Nitric oxide radical scavenging assay) and its effect on quality attributes of chicken snacks at ambient temperature up to 60 days of storage. The result showed that RLE exhibited high TPC (136.66±7.41 mg of gallic acid (GAE) per g), TFC (37.13±6.04 mg rutin/g) and IC50 value of RLE for DPPH, ABTS and Nitric oxide radical scavenging assay was found 40.76±2.81, 70.48±2.13 and 70.00±4.67 respectively. Product

treated with RLE had significantly (P<0.01) lower thiobarbituric acid value (mg malonaldehyde/kg), tyrosine value (mg/100g) and free fatty acid (oleic acid/100 g) as compared to control during storage. It can be concluded that rosemary leaves extract has good antioxidant activity and its incorporation significantly improved the quality attributes of product at ambient temperature up to 60 days of storage.

Keywords: Fried chicken snack, rosemary extract, antioxidant activity, shelf life, quality arrtibute.

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(MFPD 23)

Effects of processing methods on the quality attributes of meat Batters (Rista)

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Abstract

The physicochemical, Textural and rheological properties of Mutton batters produced by a chopping process with various amounts of Fat content were studied. The batters made of different formulation of fat were shaped in spherical form traditionally called as Rista in Jammu and Kashmir. The batter processed by chopping with 3%, 5% and 7% fat, was compared for their physicochemical and sensory characteristics. The higher the fat content the greater springiness and chewiness were observed. The cohesiveness was found to correlate positively with fat content. The volume increase was found higher in 5% fat contained Rista. The increase in diameter was found to showing an increasing trend with increase in fat content; however the higher fat content resulted in disordered shape of the cooked Rista. The pasting properties were found to depict significant variation upon increase in fat content. The higher cooking time was found to be depicted by higher fat contained rista.

Keywords: Processing Method, meat batter, rista, quality attributes.

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(QCMT 01)

Effect of custard apple (*Annona squamosa*) pulp extract on quality of chicken breast fillets

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Abstract

Skinless and boneless chicken (Broiler) breast fillets were dipped in distilled water, 100 ppm BHT solution and 0.1, 0.3 and 0.5 % aqueous solutions of 50% ethanol extract (CPuE) of custard apple (Annona squamosa) fruit pulp for 10 min. The fillets were drained for 15 min, packaged in presterilized LDPE pouches of 55µ thickness, stored under refrigeration (4±1OC) and analyzed on 0, 3rd, 6th and 9th day of storage for sensory, physicochemical and microbiological parameters. Total Phenolic content (TPC), Ascorbic acid content, DPPH radical scavenging assay and Ferric Reducing Antioxidant Power (FRAP) of CPuE were respectively 137.53±0.39 µgGAE/mg, 1057.51±0.43 µg AA/mg, 90.24±0.32 % and 947.24±0.24 µMFe(II)equi/g of the extract. On zero day of storage the fillets treated with 0.3 and 0.5% solution of CPuE had significantly ($p<0.01$) lower score than the control for colour, odour and general acceptability on 5 point hedonic scale. However, they were acceptable respectively till sixth and ninth day with significantly ($p<0.01$) higher scores than the control that was acceptable only up to third day of the storage. The pH, TBARS value, Tyrosine value, ERV, WHC, Total plate count and Psychrophillic count of the sixth day samples treated with 0.3% CPuE were respectively 5.92±0.01, 0.468±0.000 mg MDA/Kg, 9.41±0.19 mg/100g, 17.88±0.14, 67.15±0.29%, 4.99±0.01 log10 CFU/g and 3.74±0.02 log10 CFU/g, whereas those of the ninth day samples treated with 0.5% CPuE were respectively 5.87±0.07, 0.475±0.001 mg MDA/Kg, 9.41±0.23 mg/100g, 18.30±0.20, 64.34±0.30%, 4.99±0.011 log10 CFU/g and 3.80±0.01 log10 CFU/g.

Keywords: Custard apple extract, chicken fillets, TPC, TBARS value, tyrosine value.
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(QCMT 02)

Evaluation of extent of correlation between sarcomere length, pH, live weight and carcass weight

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Abstract

A total of 40 pigs were weighed and slaughtered at weights of 65, 85, 105, 125 kgs and above.

Ultimate pH values were decreased with increasing slaughter weights. There was a significant decrease in the sarcomere length with increasing slaughter weight. Correlations were found between live weight and pH45 (r = 0.31), Carcass weight and pH45 (r = 0.32) and sarcomere length and live weight (r = -0.95), pH and sarcomere length (r = -0.95). It was found that pH in hot processing was much correlated to carcass weight than live weight. There was a negative correlation between sarcomere length to live weight (r = -0.95) and pH (r = -0.46).

Keywords: Sarcomere length, live weight, carcass weight, pig.

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(QCMT 03)

Effects of feeding regime on carcass characteristic, meat and product quality of rabbits raised in semi-arid region of Rajasthan

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Abstract

The study was carried out to evaluate the effect of dietary inclusion of different roughage sources on carcass traits, meat and product quality of rabbits. Four groups consisting of 25 rabbits in each were fed ad libitum complete feed block (CFB) made up of concentrate-70 parts, molasses-5 parts and roughage -25 parts per quintal from 30 to 90 days of age. Different roughage sources used were cowpea hay (Cowpea CFB), urd straw (Urd CFB), Stylosanthes hay (Stylo CFB) and mulberry leaves (Mulberry CFB). Six representative rabbits were slaughtered from each group at the end of the feeding experiment (90 days) to assess carcass traits and meat quality. The live body weights were comparable in different groups with values of 2099, 2086, 2040 and 1931 grams in G1, G2, G3 and G4, respectively. The carcass length was significantly ($p<0.05$) lower (29 cm) in the G2. Significantly ($p<0.05$) lower carcass weight and weight of forequarter were recorded in G4 with values of 944 and 365 grams, respectively. Among meat quality attributes, cooking losses (%) were significantly ($p<0.05$) lower (20.67) in G2. The meat pH (45 min. after slaughter) was significantly ($p<0.05$) higher with values of 7.10 and 7.27 in G3 and G4, respectively. The color attributes of rabbit meat indicated that, redness values differed significantly ($p<0.05$) among groups with 7.44, 9.49, 10.29 and 7.36 in G1, G2, G3, G4, respectively. TBARS value of rabbit meat was significantly ($p<0.05$) lower in G2with 0.42 ppm malonaldehyde on day 1 to 1.38 ppm malonaldehyde on day 9 of refrigerated storage. The meat from different groups was processed into nuggets and it was observed that the color attributes of nuggets revealed significantly ($p<0.05$) higher redness scores (5.21) in G2. The findings of the study indicated that all the diets were able to produce 2.00 kg pre-slaughter weight in 90 days. Redness scores of rabbit meat and rabbit meat nuggets were significantly affected by the diet. The feeding of urd straw as roughage source indicated a positive effect on almost all the attributes of meat and nuggets.

Keywords: Rabbit, feeding, carcass characteristics, meat quality, meat nuggets.

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(QCMT 04)

Effects of different silage feeding on carcass traits and meat quality in Malpura lambs

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Abstract

Present study was undertaken to produce mutton with natural antioxidant. The finisher male lambs (20) were divided equally in four groups. The lambs were stall-fed with the diet containing one of silage prepared from either (i) G-I: Cholai (Amaranthus viridis)+Bajra (Pearl millet) (ii) G-II: Cholai + Bajra (66.67%)+Senjna (Moringa oleifera) + Bajra (33.33%), (iii) G-III: Chaulai + Bajra (33.33%) + Senjna + Bajra (66.67%) or (iv) G-IV: Senjna+Bajra. The lambs in all the groups were offered concentrate@ 400g/day/animal. The lambs were fed up to 5 months of age. The pre-slaughter weight and dressing yield on empty body weight basis varied non-significantly (P>0.05) from 23.16, 22.8, 22.28, 23.36 kg respectively for Gr-I, II, III and IV. The dressing yields in lambs on empty body weight basis were 55.14, 56.75, 54.94 and 55.73%, respectively. The loin eye area was comparable among the groups and values were 12.01, 11.37, 12.36and 11.96 cm2 respectively. Forequarter and hindquarter weights, offal weight, primal cut-up parts; chilling losses didn't differ among the groups. The average lean yields (57.6, 55.73, 54.98 and 54.31%) were comparable. Total separable fat yield (11.76, 14.19, 14.52 and 14.53%), dissected bone yields (28.01, 27.95, 29.29 and 28.35%) were comparable among the groups. Meat quality evaluation indicated that cook losses, lean: fat and meat: bone ratios were comparable. Firmness and work of shear were significantly higher in Gr-III and IV. The extent of the lipid oxidation after 5 months of frozen (-18±10C) storage in different groups were 1.27, 1.29, 0.97 and 1.17 ppm malonaldehye respectively for Gr-I, II, III and IV. The TBARS values were significantly (P<0.01) lower in Gr-III. Thus, it could be concluded that inclusion of silage in the diet of Malpura lambs from 3 to 5 months of age, gives desirable carcass with lean, fat and bone content. Feeding of silage with Moringa oleifera leaves protects lipid oxidation in meat during storage. This could be useful to reduce use of synthetic antioxidants and enhance keeping quality of mutton naturally.

Keywords: Malpura lambs, silage feeding, carcass traits, meat quality.

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(QCMT 05)

Effect of ageing on sheep meat quality at 4±1 °C for time period

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Abstract

Meat from aged animals can be improved by ageing. Ageing is process of fresh meat kept under

controlled temperature during a certain period of time thereby improving its tenderness by sensorial and textural parameters. Fresh meat kept under 4±1°C improved the tenderness and minimise risk of microbial spoilage. The aim of this research was to investigate the changes of quality parameters of sheep meat during wet ageing. Meat was aged at the following conditions: vacuum packed in polyethylene/ polyamide pouches and stored for 9 days at 4±1 °C. During wet ageing (on the 0, 7th, 14th, 21st days) the following quality parameters were analysed: moisture content, water activity, pH value, tenderness and Texture. The obtained results indicated a pH value decrease in meat during ageing ($p<0.05$). It is closely related to many other characteristics of meat, affecting the suitability of their processing and culinary applications, such as colour, tenderness and shelf life. pH of fresh meat that gives information on post-mortem muscle glycolysis, which makes it possible to detect meat quality defects. Experimental results showed a very strong positive correlation between moisture content and water activity. The changes of water activity were not significant ($p>0.05$) increased in lamb meat. The appropriate results were obtained regarding the toughness of meat samples. Based on the results, wet ageing process is more suitable to improve meat quality.

Keywords: Sheep meat, ageing, tenderization, low temperature, quality defects.
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(QCMT 06)

Proteolytic effect of natural tenderizers on myofibrillar and stromal proteins of raw and cooked emu meat

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Abstract

The present study was conducted to evaluate the effect of *Cucumis trigonus Roxb* and *Carica papaya* on tenderization of raw and cooked emu meat. Fresh emu meat was procured from local market and cut into small chunks of approximately 3 cm3 size and were randomly distributed into three groups as control, T1 and T2. The treatment groups exposed to natural tenderizers (cucumis and papaya) at the dose rate of 10% W/V. The muscle fibre diameter, sarcomere length, cooking yield, pH, shear forces, and size and band pattern in muscle proteins were studied to evaluate the tenderness and acceptability of raw and cooked meat. The muscle fibre diameter and sarcomere length of the meat exposed to natural tenderizers were slightly lower than control. The significant ($P<0.01$) reduction was also observed in cooking yield, pH and shear forces of muscle fibers exposed to cucumis and papaya compared to control. However, there was significant ($P<0.01$) improvement in flavor, juiciness, tenderness and overall acceptability scores of all treated samples compared to control. Furthermore, SDS-PAGE technique was used to evaluate the natural tenderizers on chunks of emu meat, stored at 4±1oC for 24 hrs. There was increase in proteolysis of muscle proteins as evidenced by reduction in the number of protein bands in cucumis and papaya treated meat chunks compared to control. These results suggest that natural tenderizers may enhance the flavor

and tenderness of the meat that ultimately lead to the increased acceptability by consumers.

Keywords: Emu meat, natural tenderizers, tenderization of meat, quality attributes.
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(QCMT 07)

Comparative study on the carcass traits of commercial native chicken, backyard native chicken, commercial broiler and spent layer chicken

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Abstract

To study the effect of class of chicken on the carcass traits an experiment was conducted on 12 birds of either sex in each commercial native chicken, backyard native chicken, commercial broiler and spent layer chicken. Birds were slaughtered by Jatka method and carcass traits were recorded. Live weight, dressed carcass weight, dressing percentage and meat: bone ratio was significantly higher (P<0.01) in commercial native chicken, commercial broiler and backyard native chicken than spent layer chicken. Meat bone ratio was significantly (P<0.01) higher in commercial broiler than backyard native chicken. Yield of giblet was significantly higher (P<0.01) in backyard native chicken than the other three groups. Influence of sex was significant in all the parameters and higher values were recorded in males than females for dressing percentage and meat bone ratio. The dressing percentage and meat bone ratio was higher in the commercial broiler.

Keywords: Carcass traits, native chicken, backyard poultry, spent layer, dressing percent.
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(QCMT 08)

Assessment of physico chemical characteristics and chemical analysis of chevon under simulated wet market conditions

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Abstract

A wet market is a combination of farmers market and open air butcher shops where the routine slaughter activities are carried out for the sale of hot meat. The wet market practices followed during the display of meat, time and temperatures affecting the meat qualities could not be

traced in the literature. Hence a study was carried out to find the meat quality changes happened in wet market practices followed during the slaughter of goats and display of meat by simulating the wet market conditions in the laboratory for 6 hours. Twenty four numbers of 6 months old tellicherry male goats was selected and slaughtered by standard procedure. The carcass was exposed to room temperature (simulated wet market conditions) for 6 hours. On hourly interval the samples were collected and physico chemical parameters was analysed and at 3 hours interval chemical analysis like tyrosine value, protein solubility and collagen solubility was analysed. Among the physico-chemical characteristics pH, water holding capacity, muscle fiber diameter and sarcomere length were increased as the storage time increases but shear force value increased significantly from 3.28±0.15 kg/cm2 to 7.07±0.34 kg/cm2 at 5th hour then shear force value significantly declined to 5.65±0.31 kg/cm2 at 6th hours. On chemical analysis, except sarcoplasmic protein solubility all other parameter showed significant increase as the storage time increases. Exposure of meat to simulated wet market conditions for 6 hours resulted in faster pH decline, decrease in sarcomere length and increased collagen solubility. Significant tenderization effect and protein denaturation started after 5 hours of slaughter.

Keywords: Chevon, Shear force value, Tenderness, Temperature and Wet market
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(QCMT 09)

Market analysis of meat and meat products

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Abstract

The present survey based investigation was undertaken in four major cities in NCR (Ghaziabad, NOIDA, Gurugram, Delhi), Lucknow and Bareilly city with an aim to identify the meat consumption pattern and the preferred convenience meat products prevailing in the market. From each city 2-3 retail meat shops, engaged in selling of fresh meat and convenience/ traditional meat products, were identified randomly. A total 15 retail meat shop owners and 403 consumers, visiting those shops were interviewed by using a well designed questionnaire. The survey showed, according to retailers, on an average 32.86 kg fresh meat and 20.33 kg processed meat products were sold per day. Among retailers 80% revealed that the fish meat is gaining preference to the consumers other than chicken and chevon. They also indicated the increasing demands for healthy, less spicy, and ready to eat meat preparations among a specific group of consumers (health club members). According to consumer's opinion, it was found that an average consumption of meat and meat products was 6.58kg/month/family. In relation to meat species preference, the chicken meat was the most preferred meat by 50.28% consumers, followed by the goat meat as the second choice by 34.42% consumers. During purchase of meat/meat products 53.46% of consumers preferred the “taste” as their first criteria of purchase, where as 20.66% preferred nutritive value and 17.71% preferred brand

name as criteria of purchase. It has also been observed that 62.85% of consumers preferred convenience meat products as compared to regular meat cuisines available in those shops. Among convenience meat products the maximum preference was given to *Seekh Kabab* (both chicken and chevon) by 43.42% of consumers. Based on survey it appeared that consumption of fresh and processed meat is gaining momentum and chicken is the most preferred meat. Taste of meat product and convenience are determining criteria for preference and among the convenience products popularity of *Seekh Kabab* is still high.

Keywords: NCR cities, Lucknow, Bareilly city, meat consumption behavior, preference of meat products, *Seekh Kabab*.

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(QCMT 10)

Effect of cottonseed cake on carcass characteristics and physico-chemical properties of broiler chicken

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Abstract

The study was conducted to evaluate the effect of the locally available non-dehulled cottonseed cake on the poultry broiler chicken meat. For this purpose, day old broiler chicks (n=108) were divided into 4 main treatment groups T0, T1, T2 and T3. Each treatment group was further divided in 3 replicates with 9 chicks in each. T0 served as standard control diet and was given standard corn- soy flake- groundnut based ration. Treatment T1 was given ration containing 20 per cent non-dehulled cottonseed cake and T2 was given ration containing 20 per cent fermented non-dehulled cottonseed cake whereas treatment T3 was given ration containing 20 per cent non-dehulled cottonseed cake with additional supplementation of ferrous sulphate (600ppm) and lysine (2%). All the four broiler diets were formulated and prepared conferring to ICAR (2013) standards. Control T0 exhibited significantly ($P<0.05$) higher carcass weight, dressed weight, dressing percentage, breast muscle yield and cooking yield. Substitution of non-dehulled cottonseed cake as protein replacer at 20 per cent level affected the liver, heart and gizzard. Liver, heart and gizzard weight were significantly higher ($P<0.05$) in treatment T2 compared to control and numerically higher than other treatment groups. There was significant difference in the proximate composition of raw chicken samples from different treatment groups except for crude protein and crude fibre. Dry matter was found to be significantly ($P<0.05$) higher in control T0 compared to other treatments. Whereas, ether extract, total ash and phosphorous were found to be significantly ($P<0.05$) higher in treatment T1 compared to control T0 and treatment T3. Calcium value was significantly ($P<0.05$) higher in control T0 compared to treatment T3 and numerically higher than treatment T1 and T2. Whereas, iron was significantly higher in T1 and T2 compare to T0 and T3. Overall acceptability of chicken meat was higher in treatment T1 and T2. Therefore, it can be concluded that cottonseed meal can be used for enhancing the quality attributes of chicken meat, however further study is needed for best possible combination of feed along with cotton seed meal.

Keywords: Fermented cottonseed meal, Broiler chickens, carcass characteristics, meat quality, sensory attributes.

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(QCMT 11)

Influence of transport and lairage period on pork quality

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Abstract

An attempt was made to study the effect of slaughter time, transport and lairage period on pork quality. The pigs were transported from long distance and short duration and they were lairaged. They were evaluated for blood glucose, lactate and cortisol levels after transport and lairage period. pH and drip loss were also determined. The pH levels were high in pigs with short duration transport. Lactate levels were high in pigs which were slaughtered immediately. The glucose levels were in the range of 4.5-5.1 mmol/L and lactate was 4.7-10.5 mmol/L in the study. If the lairage duration examined the blood glucose levels were increased after 6 hrs. If the pigs were kept in stys the levels were decreased after 72 hours. A negative correlation before serum cortisol and pH45 was observed.

Keywords: Transport, lairage time, influence, pork quality.

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(QCMT 12)

Effect of different temperature-time conditions on quality of fresh pork

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Abstract

Present study was conducted to assess the quality of fresh pork samples exposed to different temperature-time conditions. Immediately after slaughter, pork samples from ham region of pig carcass were exposed to four different temperatures viz. 4±1ºC, 18±2ºC, 25±2ºC and 37±2ºC until ultimate pH was achieved. These temperatures conditions were decided to simulate different weather conditions to which market pork is commonly exposed at retail shops. The physico-chemical analysis of samples was initially first at 1hr and then at every 2-3 hr interval until ultimate pH (~5.5) of pork was attained. After attainment of ultimate pH, all samples were kept at 4±1ºC and physicochemical analysis was carried out after 24 hrs. The pork samples held at 37±2ºC exhibited higher core temperature, rapid pH decline, higher percentage of free water, high shear force value and more cooking loss as compared to other treatments. In contrast the samples kept at 4±1ºC showed slow pH and core temperature decline, however ultimate pH was attained only after 24hr of slaughter. Percentage free water, Warner-Bratzler shear force value and cooking loss were lower at 4±1ºC as compared to other exposed temperature, L* (lightness) value showed no significant difference between treatments, however a slight increase in the L* value during storage at any particular temperature was observed. Therefore, the increase in temperature from lower (4±1ºC) to higher (37±2ºC), has shown detrimental effect on quality of fresh pork as depicted by

decreased water holding capacity, higher cooking loss and high shear force value.

Keywords: Pork, quality assessment, temperature, pH, water holding capacity.
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(QCMT 13)

Comparison of quality characteristics of muscle and edible byproducts of Uttarafowl and Kadaknath chicken

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Abstract

Uttarafowl is a recently recognized breed by NBAGR (Accession no. INDIA_CHICKEN_2400_UTTARA_12019 found in higher altitude of Uttarakhand. Present investigation was envisaged to evaluate the quality characteristics of muscle and edible by-products of Uttarafowl in comparison that of Kadaknath. Uttarafowl Purebred (UPB), Crossbred (UCB) and Kadaknath (K) were compared for their carcass quality characteristics, proximate composition, WHC, cooking yield, cholesterol content and fatty acid profile. Texture profile of the chicken roast developed was also studied. Mean dressing % value was highest ($P<0.05$) in Uttarafowl crossbred followed by Uttarafowl purebred and Kadaknath, whereas, K showed the highest value of water holding capacity and UCB showed the lowest. UCB showed the highest ($P<0.05$) cholesterol content, followed by UPB and K. Fatty acid analysis revealed that the skeletal and heart muscle of Kadaknath had higher ($P<0.05$) value of omega-9 fatty acid, while muscle of Purebred Uttarafowl had a higher ($P<0.05$) omega-3 fatty acid value. Texture profile analysis showed higher ($P<0.05$) hardness value of K whereas, higher ($P<0.05$) cohesiveness, springiness and chewiness of UPB. Uttarafowl was found superior to Kadaknath for in dressing %, cooking yield and omega-3 fatty acid content whereas, Kadaknath was comparatively higher in protein content, and omega-9 fatty acid and lower cholesterol content.

Keywords: Uttarafowl, Kadaknath, fatty profile, meat and carcass quality, cholesterol content.
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(QCMT 14)

Evaluation of correlation between Myofibril fragmentation index (MFI) and fiber diameter (FD) of pork muscle

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Abstract

The myofibril fragmentation index (MFI) is strongly associated with indices of meat tenderness, such as Warner-Bratzler shear force and sensory tenderness. The MFI is normally determined on fresh muscle. Ten pork longisimus dorsi muscle samples were evaluated for MFI and FD. MFI and FD were 86, 106, 126.2, 109, 125.8, 117, 136.8, 95, 106.8, 100.8 and 7.2µm, 9.6 µm, 12 µm, 9.6 µm, 12 µm, 12 µm, 14,4 µm, 9.6 µm, 9.6 µm, 9.6 µm respectively. Average values MFI and FD were 110.9±15.5 and 10.56±2.02 µm. Correlation is not significant for myofibril fragmentation index and fiber diameter between the muscle samples where as correlation is significant at the 0.01 level (2 tailed) for myofibril fragmentation index and fiber diameter of the fresh pork muscle. Based on observation lower the fibre diameter values lower the myofibril fragmentation index and visa versa.

Keywords: Fragmentation, muscle fiber, pork.

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(QCMT 15)

Identification and quality evaluation of preferred convenience meat product in Bareilly city

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Abstract

The present study was conducted in Bareilly city, Uttar Pradesh with an aim to identify the most preferred convenience meat product and its quality status. A survey was conducted by interviewing 30 street vendors and restaurants owners in different part of the city, who were engaged in selling of convenience ready to eat meat products. According to survey, 76.66% (23 No) retailer revealed both chevon and chicken *Seekh Kebab* was most preferred convenient product. Among meat species preference, 73.91% (17 No) *Seekh Kabab* retailers told that chevon *Seekh Kabab* was most cherished. During survey, *Seekh Kabab* samples were also collected aseptically in LDPE pouches from 23 shops and stored in refrigerator for further evaluation of their quality attributes, *viz*. proximate composition (Moisture, Protein, Fat, Ash), Thiobarbituric acid reactive substance (TBARS) and Aerobic Plate Count (APC). It was found that, moisture, protein, fat and ash percent varied in all *Kabab* samples between 55.20-59.63%, 11.13-13.12%, 10.34-12.55% and 1.70-2.79% respectively. It was observed that the TBARS values, which indicate the fat quality of the samples, varied between 1.64-2.28mg malonaldehyde/kg of sample. The APC was quite higher than the standard acceptable FSSAI limits in all the samples, the lowest count was observed 5.34 log10 CFU/g. The higher APC indicate the post processing contamination of samples during handling of cooked meat products.

Keywords: Bareilly city, *Seekh Kabab*, proximate composition, TBARS, Microbial quality.

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(QCMT 16)

Effect of the season and post slaughter time on various aspects of pig meat quality

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Abstract

Study was conducted to evaluate the effect of the post-slaughter handling on pork quality during different seasons viz. January to February (average temp. 15±5ºC), March to April (average temp. 25±5ºC) and May to June (average temp. 35±5ºC). For this pork samples from local market of Bareilly were collected at different time points i.e. morning, afternoon and evening to evaluate their physicochemical and sensory properties. Analysis was carried out after 24 hr at refrigeration (4±1ºC) and 15 days at frozen (-18±2ºC) storage after slaughter. Results revealed higher temperature and lower water holding capacity, shear force value, myofibrillar index as well as *L** (Lightness) value during hotter months than relatively cooler months. However, mean pH value and salt soluble proteins were higher during cooler than the hot season. No significant effect of different seasonal temperature on proximate composition of pork at different time points was observed. Sensory scores for pork samples collected during hotter months were significantly lower than cooler months. Hence increase in environmental temperature from lower (4±1º C) to higher (37°±2ºC) showed detrimental effect on overall quality of pork as depicted by decreased WHC, sensory scores and higher shear force values.

Keywords: Pork, water holding capacity, myofibrillar index, salt soluble protein.

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(QCMT 17)

Effect of age and sex on carcass traits and meat quality of Malpura sheep

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Abstract

The present study was conducted to ascertain the effect of age and sex on carcass traits and meat quality of Malpura sheep, raised in similar feeding and raring conditions. The study was designed by equally dividing 24 animals into four groups with 6 each, viz., Ram lamb (G-1), Ewe lamb (G-2) (10-12 months each), Ram (G-3) and Ewe (G-4) (20-24 months each). The average pre-slaughter weight was 23.83, 17.0, 35.82 and 28.08 kg for G-1, 2, 3 and 4 respectively. Dressing percentage for G-1, 2, 3 and, 4 on Empty Live Weight (ELW) basis were 52.35, 51.26, 53.7and 52.93% respectively. Whereas the loin eye area were 12.26, 9.91, 17.81 and 13.11cm2 respectively in the four groups. The weight of edible and inedible offal were significantly higher

(P<0.001) in male than female in same age group. Subcutaneous fat and inter-muscular fat in different cut up parts was found significantly higher (P<0.001) in G-4. Weight of dissected bone was significantly higher (P<0.001) in G-3 than other group and it increased with increasing of age of animals. Average lean percentage of different cutup parts were significantly higher (P<0.05) in G-3. In respect to meat quality attributes, G-4 showed significantly higher (P<0.001) fat percentage. The shear force values were found significantly higher (P<0.01) in G-3, whereas and the total meat pigment were higher in G-4 (P<0.01) as compared to other groups. The collagen content and sarcomere length was significantly higher (P<0.001) in G-4 and G-1 group respectively. The study showed that the pre-slaughter weight, loin eye area, yield of different edible offal's and lean yield in primal cuts were higher in adult animals as compared to young one, while above parameter were found higher in male compared to female in same age group. Fat content and total meat pigment were found higher in female compare to male in same age groups. Collagen content was higher in adult animal while sarcomere length was higher in young animals. Findings of the study concluded that, age and sex had significant effect on carcass traits and meat quality of Malpura sheep.

Keywords: Malpura sheep, carcass traits, lamb, ram, ewe.
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(QCMT 18)

Evaluation of meat quality of common carp *Cyprinus carpio* L. on acute exposure to Quinalphos and its amelioration using ascorbic acid

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Abstract

Extensive use of quinalphos (QP), an organophosphorus pesticide, is likely to reach the aquatic environment and thereby posing a health concern for aquatic organisms and the consumer. This study was conducted to access the acute effect of QP on carp meat quality and its amelioration using ascorbic acid (vitamin C), as a natural water-soluble vitamin. *Cyprinus carpio* L. were exposed at sub-lethal concentrations of QP i.e. 0.75 µg/L and 1.5 µg/L; and 40 mg/L concentration of vitamin C along with 1.5 µg/L for 96 hours. Drip loss was determined in the frozen (-200C) muscles after 4 months of storage. Increased drip loss of about 3.20 % and 14.86 % in low and high dose QP exposed groups, respectively indicates changes in muscle metabolism due to oxidative stress induced after exposure to pesticide. However, co-exposure with ascorbic acid significantly reduced the stress and drip loss (7.36%) in high dose pesticide group. Evaluation of sensory attributes of meat samples based on 8-point descriptive scale revealed decline in the organoleptic properties like colour and texture following QP exposure. The colours of flesh were found slightly poor to fair in QP treated fish, whereas improvement was noted in ascorbic acid co-exposed group. Texture was slightly undesirable to slightly desirable in pesticide exposed fish meat, which indicate changes in protein and fat content in

the treated fish. The texture became moderately desirable upon ascorbic acid co-exposure with QP. The reduction in sensory parameters may be due to biochemical changes occurring in the muscles after pesticide exposure. Histological study further suggested the ameliorative effect of ascorbic acid against QP-induced alterations on muscle morphology, intramuscular connective tissues and fat distribution. Study on scale morphology showed damaged xanthophores and chromatophores leading to hyperpigmentation in the skin of pesticide exposed fish which may affect consumer acceptability. Skin colour was normal in fish co-treated with antioxidant along with QP. In conclusion, the simultaneous supplementation of ascorbic acid during sub-lethal QP exposure showed partial amelioration on carp meat quality.

Keywords: *Cyprinus carpio* L, quinalphos, ascorbic acid, fish meat.
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(MFSQ 01)

Artificial intelligence based muzzle recognition technology for individual identification of animals

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Abstract

Commonly followed methods for identification of bovine animals are ear tagging using different systems like visual tags, RFID tags, bar coded ear tags, QR coded tags etc. Retention of these tags over long period, especially over the years, during different handling, rearing and weather conditions often pose problem and compromises the effectiveness of identification. In addition, tampering of the ear tags compromises the traceability system. In view of these issues, animal identification verification systems or the methods which can validate the identity of the animals are required. Molecular traceability verification techniques based on Microsatellite genotyping and SNP genotyping are cumbersome, laborious and costly. Also, their field applicability is challenging especially in Indian scenario wherein farms are spread over broad geographical area often in remote villages. To address this issue, Clonoid Private Limited has developed a noninvasive Artificial Intelligence (AI) based muzzle recognition system for individual identification of animals which was field tested by ICAR NRC-Meat, Hyderabad. Method involves capturing image of the muzzle of bovine dairy animals using mobile camera (minimum 5 MP). The captured images can be uploaded on to the 'GoMukh' app with corresponding animal identification number. For confirming identification of the unknown animal, fresh images can be taken and compared with the pre-uploaded images. App has complex algorithms which will compare the image with the available images and confirm identity of the animals. To field test the technique, muzzle images of 198 buffalo and cattle were captured using a cellphone camera along with details of the animal like tag number species etc. Images were processed using muzzle identification software 'GoMukh'. 'GoMukh' unambiguously identified all the animals tested. Blurred images were automatically rejected by the app. Among the readable images, 98% were of good quality and were identifiable using the app. All the test animals were successfully identified without any cross identification or wrong identification by the software. None of the images were wrongly assigned to any other individual. We find the AI based muzzle recognition system 'GoMukh', to be highly reliable and believe that the system will be of great use for animal identification requirements in the field.

Keywords: Artificial intelligence, muzzle recognization, GoMukh, animal identification.

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(MFSQ 02)

Prediction of quality of chevon through near infrared spectroscopy and multivariate analysis

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Abstract

The aim of this study was to test the ability of near infrared (NIR) reflectance spectroscopy to predict chevon quality traits. Analytical samples were collected from114 longissimus dorsi (LD) muscle from 9th to 14th ribs from 38 castrated goat (Wether) carcasses having two teeth aged slaughtered at local market in Mymensingh district. A total of 342 NIRs were collected and stored in computer by DLP NIRscan Nano Software. Partial least square regression model for calibration and validation were developed for data analysis through Unscrambler X software. Reference traits were dry matter, crude protein, ether extract, ash, moisture, cooking loss, and drip loss. Prediction models were satisfactory for dry matter, crude protein, ash, moisture, and drip loss. The most promising model found for ash (R2 0.85), and RMSE also very low 0.15. To assess the practical utility of the prediction models the ratio performance deviation (RPD) and the range error ratio (RER) were calculated. RPD were 2.21, 1.40, 1.75, 1.78, 2.10, 1.36, and 2.13 for drip loss, cooking loss, dry matter, moisture, crude protein, ether extract and ash respectively. It indicates that crude protein, drip loss and ash values are adequate for analytical purposes as values above 2.0 are adequate for analytical purposes. Range error ratio were 9.27, 5.81, 7.20, 7.21, 13.80, 4.12 and 11.46 for drip loss, cooking loss, dry matter, moisture, crude protein, ether extract and ash respectively. RER values between 7-20 classify the model as poor to fair and indicate it could be used for screening purposes. So for the above RER values the model is fair to good except cooking loss (5.81) and ether extract (4.12). On the basis of the results, the method suggested was reasonably efficient as a rapid assessment method of ash, drip loss, crude protein, moisture and dry matter through NIR spectroscopy and multivariate analyses. Further studies with larger samples should help to improve the model quality.

Keywords: NIRS spectroscopy, calibration, cross validation, longissimus dorsi, proximate components, cooking Loss.

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(MFSQ 03)

Gel-free electrophoresis for fractionation of buffalo meat proteins

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Abstract

This study was undertaken with an objective to characterize buffalo meat proteins using gel-free electrophoresis. The EXPEDEON GELFREE 8100 was designed to maximize protein recovery in liquid phase during molecular weight based fractionation as a quick alternative to routinely

used SDS-PAGE. Total and salt soluble proteins were extracted from Longissimus dorsi muscles of water buffalo meat and purified using TCA-Acetone precipitation, filtered through 0.45 µ filters and quantification was done through BSA-BCA kit. Desalted and denatured protein samples (~500 µg) mixed with 5X acetate sample buffer, 1 M-DTT and deionized water were loaded (150 µl) onto a loading chamber of 12% (3.5-50 kDa) and 5% (3.5-500 kDa) Tris-Acetate expedeon cartridge. The 1X HEPES running buffer was filled into anode and cathode buffer chambers and the proteins were fractionated at 50-100 V and 3-11 mA. During separation, a constant voltage is applied between the anode and cathode reservoirs, and each protein mixture is electrophoretically driven from a loading chamber into a specially designed gel column. Proteins were concentrated into a tight band in a stacking gel and separated based on their respective electrophoretic mobility in a resolving gel. As proteins elute from the column, they are trapped and concentrated in liquid phase in the collection chamber, free of the gel. The instrument is paused at specific time intervals, and a total of 13 fractions were manually collected from collecting chamber using a pipette. For confirmation of protein separation, SDS-PAGE fractionation of all the 13 fractions was carried out. Current study indicates the suitability of gel-free fractionation as an effective protein separation tool for further characterization using mass spectrometry.

Keywords: Gel free electrophoresis, buffalo meat, protein separation.
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(MFSQ 04)

Change in physico-chemical, textural and proteome properties of sheep (Ovis aries) meat during ageing

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Abstract

This study was conducted to unravel the variation in meat quality between Longissimus thoracis et lumborumt (LTL), Psoas major (PM) and Semitendinosus (ST) muscles of Indian sheep (*Ovis aries*) at refrigeration temperature over a period of 15 days. Raw meat was evaluated for pH, water-holding capacity, R Value, protein extractability, collagen content and solubility, myofibrillar fragmentation index, myoglobin and metmyoglobin, muscle fibre diameter, instrumental color and SDS-PAGE. Cooked meat cubes were also evaluated for Warner-Bratzler shear force values. Higher (P<0.05) R value, protein extractability, muscle fibre diameter, protein extractability, water holding capacity, drip loss and myofibrillar fragmentation index was observed in all the muscles during ageing. Reduction (P<0.05) in Warner-Bratzler shear force values were observed on ageing compared to 0' day in all the muscles. The L* a * and b* values showed high variation during ageing. By proteome analysis several proteins were identified whose expression levels are associated with important meat

tenderness. The proteins identified by MALDI TOF MS/MS are Adenylate kinase isoenzyme, Intracellular hyaluronan-binding protein, Lymphocyte antigen 86, Actin, Integrin alpha-6, and PDZ and LIM domain protein 3. These results suggest tenderization of hot boned sheep meat subjected to ageing. Present study revealed that, meat from different muscles of sheep differ significantly in their quality and each comes with their own advantages and disadvantages and therefore, requires different processing strategies for their effective utilization.

Keywords: Sheep meat, proteome properties, meat quality, ageing.
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(MFSQ 05)

Turmeric (*Curcuma longa*) powder has potential to replace nitrite in meat processing?

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Abstract

Investigations were carried out to evaluate the antioxidant and antimicrobial effect of turmeric on raw minced chicken stored at 4±1°C. Antioxidant effect of 1000 ppm turmeric (T1000), 5000 ppm turmeric (T5000), 200 ppm nitrite (N) and 500 ppm ascorbic acid (A500) were compared on 0, 2, 4 and 6th day of storage. Thiobarbituric acid reacting substances (TBARS) values were observed to be lowest for N; however no significant difference ($P<0.05$) was noticed between N and T5000, and both were superior to A500 and T1000. Peroxide value was found to be lowest in T5000 and highest in N. Free fatty acid value was found to be lowest in T5000 and highest in A500 among all treated samples. Antimicrobial effect of heated turmeric 1000ppm (HT), Turmeric 1000ppm (T), meat masala 1000ppm (MM), 4% ginger + 4% garlic + turmeric 1000ppm (GGT), nitrite 200ppm (N) and control (C) on minced chicken stored at 4±1°C were compared on 1, 4, 7 and 10th day of storage. N (7.19±0.60) was found most effective ($P<0.05$) against total plate count followed by GGT> HT>T> MM. For *Clostridium sporogenes* in anaerobic agar medium, N (6.609±0.61 log CFU/g) was most effective ($P<0.05$) followed by T>GGT>HT>MM. The lowest value for *Clostridium perfringens* in anaerobic agar medium was found in N (6.86±0.58 log CFU/g) followed by HT>GGT >T>MM. HT (6.44±0.54 log CFU/g) was found to have lowest value for E. coli count in EMB agar medium followed by N>GGT>T>MM. GGT and HT can be used as nitrite replacer in chicken mince to an extent but were found to be less effective than nitrite. Effect of turmeric and nitrite on germination and outgrowth of spores of *Clostridium sporogenes* and *Clostridium perfringens* in vitro (TPGY and FTM medium respectively) and chicken mince stored at 37°C. The sporicidal activity of turmeric and nitrite against spores of *Clostridium sporogenes* and *Clostridium perfringens* was also studied. Five treatment groups: 1000ppm Turmeric (T), 1000ppm Heated Turmeric (TH), 1000 ppm Turmeric with pH adjusted to 7.80 (TpH), 1000 ppm Turmeric + 1.75% NaCl (TS) and 200 ppm Nitrite (N) along with Control (Con) were compared. TS showed highest inhibitory effect on germination and outgrowth of spores of *Clostridium sporogenes* among all the above turmeric

combinations but was found significantly ($P<0.05$) lower than N in TPGY as well as in chicken mince. TpH was found to be superior or equal to TS in its inhibitory effect on germination and outgrowth of *Clostridium perfringens* in FTM and in chicken mince. Sporicidal activity of N measured as mean log reduction (1.39 ± 0.10) in viable spore count of *Clostridium sporogenes* was highest followed by TS (1.28 ± 0.10) and there was no significant difference between them. Highest log reduction in viable spore count of *Clostridium perfringens* was observed in N (0.90 ± 0.02 log CFU/g) followed by TS (0.60 ± 0.02 log CFU/g). It can be concluded that salt potentiated the inhibitory activity of turmeric in TS almost up to the level of N against *Clostridium sporogenes*. However, against *Clostridium perfringens*, TS inhibition was next only to TpH. Therefore, salt potentiated turmeric (Ts) has potential to replace nitrite as food safety additive in meat products.

Keywords: Antioxidant, ascorbic acid, minced chicken, nitrite, turmeric, chicken mince, antimicrobial effect.

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(MFSQ 06)

In vitro assessment of antagonistic activity of protective culture in whey protein based films

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Abstract

Protective cultures are antagonistic cultures that include food grade bacteria, which inhibit food spoilage and pathogens through competition for nutrients and/or production of primary or secondary metabolites. The biodegradable films were developed using whey protein concentrate (WPC; 6%) and incorporated with *L. bulgaricus, L. acidophilus, L. rhamnosus, L. lactis, L. plantarum*, and mixture of all the cultures. The developed films were compared with control (whey protein films without any protective culture) against the pathogens viz. *E. coli S. aureus, L. monocytogens, S. typhimurium* using zone of inhibition method and broth inhibition method. All the cultures used in the study were procured from IMTECH, Chandigarh. The protective cultures were incorporated in the films @ 105cfu/ml. The test organisms were used at the dose of 103cfu/ml. The biodegradable films with *L. plantarum* exhibited highest antimicrobial activity against all the test organisms. The zone of inhibition was measured highest against *E. coli* whereas no visible zone was formed against *S. typhimurium*. The antimicrobial activity was followed by films with *L. rhamnosus* and it exhibited highest activity against *L. monocytogenes*. The broth cultures depicted the highest reduction with films with *L. plantarum* against all test organisms except *L. monocytogenes* which was inhibited highest by films with *L. rhamnosus*. There was 30% reduction in *S. typhimurium* population using films with *L. plantarum*. Results concluded that the biodegradable films loaded with protective cultures can be successfully utilized in food packaging system to control the problem of food

pathogens.

Keywords: *L. plantarum*, antagonistic cultures, *L. rhamnosus*, food pathogens, lactic acid bacteria.

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(MFSQ 07)

Simultaneous determination of oxytetracycline and chlortetracycline residues in buffalo meat using RP-HPLC

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Abstract

Tetracycline class of antimicrobial agents are most widely used in bovine therapy by virtue of their relative efficacy in some common bacterial diseases. Although irrational use of tetracyclines including oxytetracycline and chlortetracycline in buffaloes carries the risk of their presence in edible tissues which can be responsible for deleterious effects in consumers, studies related to the quantification of its residues in buffalo meat has received only minimal attention. Hence, there is an urgent need for a rapid, accurate, and economical method for the determination of these antimicrobials in the buffalo meat. After extraction of the meat samples for these two tetracyclines, the analysis of the antimicrobials was carried out using a reverse phase C18 column at an oven temperature of 40ºC. The chromatographic separation was accomplished with an isocratic mobile phase consisting of 0.1M oxalic acid, methanol and acetonitrile (70:15:15, v/v).The flow rate of the mobile phase was maintained at 1.5 ml/min and injection volume was 50 µl. A UV detector was operated at a wavelength λmax 360nm. The linearity, recovery, selectivity, intraday as well as interday variation and precision of the modified method were evaluated from buffalo meat samples at drug concentrations ranging from 25-1000 ng/g. Mean extraction recoveries of oxytetracycline and chlortetracycline were in the range of 90-97 %.The limits of quantification for oxytetracycline and chlortetracycline were 38.30 and 36.63 µg/kg, respectively. About two hundred and fifty field samples of buffalo meat were analysed for residual tetracyclines. This multi-residue method has high applicability for routine analysis of tetracyclines in buffalo muscle tissue below Codex MRL of 200 µg/kg.

Keywords: RP-HPLC, Buffalo meat, Tissue residues, oxytetracycline, chlortetracycline.

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(MFSQ 08)

Determination of polycyclic aromatic hydrocarbons and heterocyclic amines in processed meat products by reverse phase HPLC

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Abstract

Consumption of processed red meat products especially smoked, grilled and deep fat fried

meat products is implicated one among the dietary causes for cancer. Higher levels of heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs) found in these processed red meat products are related to the development of certain types of cancer in meat consumers. Studies related to quantification of these compounds in processed meat products consumed in India received minimal attention. In this context, method of extraction and quantification of 13 priority polycyclic aromatic hydrocarbons and 4 priority heterocyclic amines from processed meat products using high performance liquid chromatography has been optimized and validated with recovery and reproducibility and other factors. HPLC parameters, such as mobile phase composition and flow has been standardized for determination of PAHs and HCAs using florescence detector and PDA detector respectively. Extraction and clean up was carried out by solid phase extraction (SPE). The concentration of 13 PAH and 4 HCA showed good linear relationship and linear correlation coefficient was ranged between 0.995 & 0.999 and 0.096-0.999, respectively. Analysis of PAH and HCA standard spiked samples resulted in recoveries between 70 & 100 % and 73 & 106 %, respectively. The method described is employed for determination of the PAHs and HCAs compounds in the processed meat products collected from various parts of country.

Keywords: Polycyclic aromatic hydrocarbons, heterocyclic amines, processed meat products, reverse phase HPLC

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(MFSQ 09)

Development and qualities of novel pathogen specific bioactive composite protein films infused with cocktail bacteriophages (SALMONELEXTM)

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Abstract

Application of host specific bacteriophages to prevent the growth of pathogenic microorganisms that may be present on food surfaces is an innovative concept however its incorporation in packaging material is still unknown. Hence the present study was aimed to develop and evaluate qualities of protein based composite film infused with cocktail bacteriophage (SALMONELEXTM) effective against the *Salmonella typhi*. The developed bioactive composite protein based film was evaluated for stability and release of phages, antimicrobial efficacy by disk agar diffusion and liquid diffusion at ambient temperature as well as morphology by scanning electron microscopy.

Protein (gelatin and casein (1:1) cross-linked with transglutaminase enzyme@ 40 U/g of protein) based bioactive composite was developed by using various concentration [2%, 4% and 6% (v/v)] of cocktail bacteriophages (SALMONELEXTM).Composite films are able to stabilize phages at ambient conditions without significant loss in activity over a period of 28 days. Additionally, the films are able to release a significant ($p<0.05$) concentration of SALMONELEXTM in an aqueous environment at 30 ± 20C within 5 hrs of incubation. The physical (thickness, total soluble mass, transparency and swelling index), mechanical (tensile

strength, elongation at break, penetrability, WVTR and GTR) properties of films differ significantly ($p<0.05$) as compared to control (without Phage) with addition of bacteriophages. However, all the properties were comparable amongst the films infused with 2% and 4% (v/v) bacteriophages. Higher bacteriophage concentration (6%, v/v) results in significant ($p<0.05$) loss of physico-mechanical properties of films. Addition of bacteriophage altered the film surface, as observed by SEM. There was a higher porosity of the protein films containing higher concentration (6%, v/v) of bacteriophage. Hence concluded that development of pathogen specific composite protein film infused with cocktail bacteriophages (SALMONELEXTM) @ 4% (v/v) can be an effective approach of preserving the antimicrobial activity against *Salmonella typhi* with reducing the risk of antibiotic resistance that can further be applied in meat packaging industry for the prevention of microbial contamination.

Keywords: Composite protein film, cocktail bacteriophages, SALMONELEXTM,
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(MFSQ 10)

Differentiation of fresh and frozen-thawed chevon by enzymatic assay

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Abstract

Fresh goat meat is more valuable and preferred by consumers than frozen meat, which instigates illegal selling of thawed meat as fresh for higher profit. Temperature fluctuation, freeze-thaw abuse during storage and transportation, causes physicochemical, structural and molecular changes have detrimental effect on meat quality. A study was undertaken to evaluate different enzymatic assays for differentiating fresh from frozen-thawed chevon. Meat was collected and packed aerobically in LDPE pouches and subjected to different freeze-thaw cycles to simulate the conditions of fraudulent practices occurring during field/transportation/retail conditions. Meat press juice (exudate) was collected from fresh and frozen-thawed meat after different cycles using compression method. Among all, the activity of HADH enzyme had shown significant difference in meat press juice of fresh and frozen-thawed chevon. The activity of HADH was directly proportional to the variance of absorbance value per minute. The physico-chemical and microbiological characteristics had shown significant correlation with the activities of different enzymes at different stages of freeze-thaw cycles. pH, Shear force value, L* value, a* value and cooking loss were decreased; TBARS, thawing loss, b* value, SPC and psychrophilic counts were increased with repeated freeze–thaw cycles. Therefore, measurement of the HADH activity in exudates of meat proved to be a suitable method for distinguishing fresh and frozen-thawed chevon.

Keywords: Fresh and Frozen goat meat, differentiation, HADH activity, enzymatic assay.
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(MFSQ 11)

Enzymatic assay for discrimination of fresh and repeated frozen-thawed buffalo meat

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Abstract

Buffalo meat has many outstanding attributes such as lower intramuscular fat, cholesterol and calories and higher units of essential amino acids, biological value and iron content. All these have led to an unprecedented increase in demand for fresh meat particularly among health conscious consumers. This instigates some retailers to sell frozen-thawed meat as fresh which is having higher demand. Considering this, the study was undertaken for differentiation of fresh from repeated frozen-thawed buffalo meat by measuring activities of different intra-cellular mitochondrial enzymes. Buffalo meat was collected, packed aerobically in LDPE pouches and subjected to different freeze-thaw cycles to simulate the fraudulent practices prevailing under field conditions. Meat press juice collected from fresh as well as frozen-thawed meat after different cycles using compression method was subjected to different enzymatic assays. The results of enzymatic assays revealed that activity of β-hydroxyacyl-Coenzyme A-hydrogenase (HADH) was significantly higher in first and second cyclesof frozen-thawed buffalo meat than fresh meat. The activities of enzymes at different stages of freeze-thaw cycles had significant correlation with physico-chemical and microbiological parameters of buffalo meat. Shear force, pH, cooking loss, L* and a* value were decreased whereas TBARS, thawing loss, aerobic plate count, psychrophilic count and b* value were increased with repeated freeze-thaw cycles. The results revealed HADH based enzymatic assay of meat press juice can be used as effective method for differentiation of the fresh and repeated frozen-thawed buffalo meat.

Keywords: HADH, buffalo meat, enzymatic assay, frozen-thawed.

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(MFSQ 12)

Computerized technology for meat quality estimation

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Abstract

With consumer concerns increasing over for food quality and safety, the food industry has begun to pay much more attention to the development of rapid and reliable food-evaluation systems over the years. Nowadays people tend to include more meat in their diet thanks to the improvement in standards of living as well as an increase in awareness of meats nutritive values. To ensure public health, therefore, there is a need for a rise in worldwide meat

production and consumption. Further attention is also required as to how the safety and the quality of meat production process should be assessed. Classical methods of meat quality assessment, however, have some disadvantages; expensive and time-consuming. An alternative method i.e. computer vision (CV) is employed for the assessment of various quality parameters of muscle foods. Computer vision has several advantages over the traditional methods. It is non-destructive, easy and quick, hence, more efficient in meat quality assessments. Computer vision, comprising a nondestructive assessment approach and closes with a discussion on the future challenges and expected opportunities of the practical application of computer vision technology in the meat industry.

Keywords: Meat, quality estimation, computer vision.
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(MFSQ 13)

Improving the quality and safety of frozen muscle foods

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Abstract
Freezing is one of the most commonly used forms for preservation of meat including fish meat. Current approaches, such as air blast freezing and cryogenic freezing, can lead to some degradation in performance, such as damage to cell structure, increased fall loss and reduced sensory value. New methods of freezing have therefore been developed to mitigate the drawbacks of traditional methods of freezing. The analysis explains the enhancement of the performance properties of frozen muscle tissues by novel freezing techniques, including high pressure freezing, electrical and magnetically assisted freezing, ultrasound assisted freezing and antifreeze proteins. Such performance attributes include microstructure, moisture loss, colour, tenderness, protein denaturation, lipid and protein oxidation, and microbial counts. The concepts of these new freezing technologies are implemented and the impacts of these technologies on regulating the development and growth of ice crystals and on complex protein changes are also addressed. The novel freezing approaches have positive effects on improving the performance of frozen muscles. At the micro level, most innovative methods have some capacity to control the formation and growth of ice crystals, thereby producing a smaller, more homogenous and regular distribution of ice crystals, leading to better microstructure and improved quality characteristics of frozen meats. Complex protein changes are taking place under some of these innovative freezing and therefore the potential negative impact of protein changes should also be considered for commercial applications of these technologies in the frozen food industry.

Keywords: Cryogenic freezing, protein oxidation, frozen muscles.
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(MFSQ 14)

Optimization of process protocol for the extraction of bioactive compounds from *Spinacia olaricia* leaves using Response Surface Methodology (RSM)

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Abstract

The effect of solvent concentration (methanol/water, 55-65%), extraction time (10-20 min) and extraction temperature (60-70 ºC) such as their interaction on extractability of phenolics compounds from *Spinacia olaricia* leaves measured on the basis of antioxidant efficacy parameters viz. 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid (ABTS), 1,1-diphenyl-2-picrylhydrazyl (DPPH), total phenolic (TPC). The process conditions for the phenolic compound extraction were optimized using Response Surface Methodology (RSM). The central composite rotatable design (CCRD) showed that polynomial regression models were in good agreement with the experimental results for ABTS, DPPH and TPC, respectively. The experimental values of ABTS, DPPH and TPC were 46.52%, 38.99%, 231.71mg GAE/100 g DW, respectively. The experimental values agreed with those predicted the suitability of the model. The most suitable conditions for the antioxidants extraction were recommended to be methanol/water concentration of 60% (v/v), extraction temperature of 65°C, extraction time of 15 min, for *Spinacia olaricia* leaves extracts.

Keywords: *Spinacia olaricia*, Response Surface Methodology, phenolic compound, optimization.

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(MFSQ 15)

Antimicrobial and antioxidant activity of palmarosa essential oil (*Cymbopogon martini*) for prospective application in meat products

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Abstract

The present study was designed to investigate in-vitro antimicrobial and antioxidant efficacy of Palmarosa Essential Oil (*Cymbopogon martini*) for its potential application in meat products. Antimicrobial efficacy was determined zone of inhibition assays and Minimum inhibitory concentration (MIC) method against Gram-positive (*Bacillus cereus, Listeria monocytogenes* and *Staphylococcus aureus*) and Gram-negative (*Salmonella entericaserovar* Typhi, *Escherichia coli* and *Shigella flexneri*) organisms. Different concentrations of essential oil was tested and it was found that there was a strong inhibitory effect on microorganisms with zone size ranging from 12.5 mm to 28 mm against tested organisms. The antioxidant activity for various oil concentrations as determined by 1 diphenyl-2picrylhydrazyl (DPPH) and 2-2-azinobis-3ethylbenthiazoline-6-sulphonic acid (ABTS) methods revealed that it has prominent radical scavenging activity. A comparison with synthetic antioxidant revealed that it can substitute it to around 30-40%. It can be concluded that Palmarosa essential oil possesses significant antimicrobial and antioxidant activity and can have potential application in meat products for enhancement of shelf life.

Keywords: Palmarosa essential oil, zone of inhibition, MIC, ABTS, DPPH.
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(MFSQ 16)

Studies on the effect of ultimate pH on the microbiological quality of pork hams

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Abstract

Aerobic and psychrophilic plate counts were obtained with a view to study the effect of ultimate pH on the quality of pork hams. 36 pork hams were collected from the experimental slaughter unit of Department of LPT, NTR CVSc, Gannavaram. They were stored for 0, 5, 10, 15, 20 and 25 days at 4°C. The aerobic plate counts of the hams which recorded an ultimate pH of less than 5.85 were significantly lower than those which recorded an ultimate pH more than 5.85 and ranging between 5.85 to 6.1. Loins at low ultimate pH had consistently 1.5 log CFU/gm lower aerobic plate counts than their counter parts and the time to reach 7 log CFU/gm was approximately 10 days longer than the others. Similar trends were observed with psychrophilic counts. The rate of increase in plate counts was high for the hams which recorded a pH of more than 6. All the samples with off odours had 8.6 to 9.2 log CFU/gm with a pH value of more than 6.8.

Keywords: Ultimate pH, microbial quality, pork ham.
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(MFSQ 17)

Microbiological quality of poultry meat in the Bikaner city

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Abstract

Poultry meat can be contaminated with a variety of microorganisms, including those capable of spoiling the product during chill storage, and certain foodborne pathogens. Human illness may follow from handling of raw meat, undercooking or mishandling of the cooked product. This paper presents an investigation of the microbiological quality of poultry meat sold in the market of Bikaner city. Bacteriological analysis was performed on 50 samples of fresh, retail-cut chicken meat. Samples were collected from retailers (kept in cooling condition at +4 ºC, deep-freezers at -18 ºC, respectively), and then bacteriologically tested for the presence of bacteria *Salmonella* spp., *Listeria monocytogenes*, *Staphylococcus aureus* and *Enterobacteriaceae*. Total count of aerobic mesophilic bacteria was also determined. Bacteriological tests were performed by means of standard methods of isolation and identification of individual species of bacteria. With regard to microbiological quality and contamination of chicken meat, of importance is the finding of *Salmonella* spp. (10.60%), *S. aureus* (30.30%), *L. monocytogenes* (3.03%), *Enterobacteria* (34.84%). Total bacteria count found in frozen ground chicken meat was 5.23 ± 0.50 log10 CFU/g, whilst it was lower in cut chicken meat. Total bacteria count in chicken breast fillets amounted to 4.72 ± 0.38 log10 CFU/g, 3.67 ± 0.88log10 CFU/g in chicken breasts with skin, respectively. Results of the study suggest that a significant risk of meat spoilage and an increase in the number and species of bacteria depend on the specific part of analysed chicken meat, mode of packaging and storage after distribution to the market.

Keywords: Poultry meat**,** foodborne pathogens, bacteriological quality, health risk.
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(MFSQ 18)

Understanding the concept of food terrorism and food defense

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Abstract

Food and agriculture are key elements of the critical infrastructure of every country because they provide products that are essential for life. Deliberate release of a chemical, biological or radio nuclear agent, defined as food terrorism, could potentially cause severe harm and pose a huge burden on public health systems. Food defense is defined as all the steps, programmes and measures that protect the food supply of a nation from intentional or deliberate acts of tampering or contamination. Deliberate contamination of food by chemical, biological or radionuclear agents can occur at any vulnerable point along the food chain, from farm to table, depending on both the food and the agent. The diversity of sources of foods, including the global market, makes prevention difficult, if not impossible. At the same time, many developing countries lack basic food safety infrastructures and are vulnerable to deliberate acts of sabotage. The potential effects of food terrorism include illness and death, effects on economic trades, impact on public health services and other social and political implications. Most countries lack an efficient response system that takes into account food terrorism. Plans to respond to food safety emergencies should complement, not replace, other critical activities, and resources should be allocated on the basis of the nature and likelihood of such threats. The two major strategies for countering the threat of food sabotage are prevention and response, including preparedness. Although the magnitude of the current threat to food and agriculture is hard to assess, the vulnerabilities are real, and there are clear steps that can be taken to protect the food supply and to deter potential attacks.

Keywords: Food quality, food safety, food terrorism, preparedness, challenges.
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(FTF 01)

Studies on shelf life of developed functional mutton rolls incorporated with gooseberry powder and its extracts

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Abstract

The study was conducted with an objective to evaluate the effect of gooseberry incorporation as natural preservatives on shelf life of developed functional mutton rolls. The rolls were prepared with addition of gooseberry powder (1%) and their aqueous and ethanolioc extracts (at 10% levels each) besides other ingredients which were added in control. BHT at 0.01% level was taken as positive control. The products were stored at refrigerated temperature (4±1°C) and their physico-chemical properties, sensory evaluation, and microbiological quality were analyzed at regular interval of 4 days. The results indicated that the products containing gooseberry had higher sensory scores, and lower TBA values as well as total plate counts than control products during storage. The instrumental color values (*L**, *a**, and *b**) also indicated the effect of gooseberry on objective scale. Control samples were microbiologically spoiled after 12th day whereas gooseberry treated samples were within the microbiological safety limits up to 16 days of storage. It can be concluded that gooseberry powder (1%) and their aqueous and ethanolic extracts (10% each) can be incorporated individually to increase shelf life of developed functional mutton rolls without compromising the sensory quality at refrigeration (4±2°C) temperature.

Keywords: Gooseberry, mutton rolls, storage stability.

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(FTF 02)

Development of chicken meat patties by incorporating curry leaves aqueous and ethanolic extracts

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Abstract

A study was conducted to develop chicken meat patties by incorporating different levels of aqueous and ethanolic extracts of curry leaves powder individually to chicken meat. Aqueous and ethanolic extracts of curry leaves were prepared by dissolving 10 g of curry leaves powder per 100 ml water and ethanol (70%) respectively. DPPH radical scavenging activity and phenolic content of ethanolic extract of curry leaves were significantly higher in comparison to aqueous extract. Sensory scores of patties incorporated with 9 ml aqueous extract/ 100 g minced meat and 4 ml ethanolic extract/100 g minced meat individually was comparable with control and selected for further studies. Both the extract treated patties had significantly higher total

phenolic content in comparison to control. Incorporation of extracts did not result in any significant effect on pH, water holding capacity, cooking yield and instrumental colour (lightness, redness and yellowness) of chicken meat patties. Extract treated patties had significantly higher flavour and overall acceptability scores during refrigerated storage. Thiobarbituric acid and free fatty acids values of extract treated patties were significantly lower in comparison to control patties at the end of refrigerated storage. Moisture content decreased significantly in all the treatments while standard plate count and psychrotrophic count increased significantly with the increase in storage period. All the products were microbiologically safe and organoleptically acceptable up to 16th day of refrigerated storage. It is concluded that healthier chicken meat patties with significantly higher total phenolic content and better sensory scores during refrigerated storage can be prepared by incorporating curry leaves aqueous (9 ml) and ethanolic extract (4 ml) individually per 100 g of minced chicken meat.

Keywords: Chicken patties, curry leaves extract, quality attributes, storage study.
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(FTF 03)

Optimization of level of rice bran to develop fiber enriched functional chevon sausages

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Abstract

The present study was conducted to optimize the level of rice bran as natural fiber source to develop fiber enriched functional chevon sausages with incorporation of rice bran. Pre standardized chevon sausages were incorporated with three different levels of rice bran replacing 5, 10 and 15% of goat meat respectively and evaluated for various physico-chemical and sensory properties to select the best treatment. Among the physico-chemical properties, pH of emulsion as well as product, emulsion stability, cooking yield, fat and ash content increased significantly ($P<0.05$) with increased level of rice bran, however there was no significant difference in moisture and protein content. Lightness and yellowness values decreased significantly ($P<0.05$) at 10 and 15% level, but there was no significant difference in redness values between control and rice bran incorporated chevon sausages. All sensory attributes, colour and appearance, flavour, texture, juiciness, saltiness, mouth coating, meat flavour intensity and overall acceptability scores decreased significantly ($P<0.05$) at 10 and 15% level, but sensory scores of chevon sausages incorporated with 5% rice bran were comparable to control and this product was well accepted by sensory panellists. Therefore, 5% rice bran was selected as optimum level to develop fiber enriched functional chevon sausages.

Keywords: Chevon sausages, functional, rice bran, natural fiber source, optimum level, sensory evaluation.
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(FTF 04)

Functional efficacy of lipase inhibitor from *Phylanthus emblica* in convenience red meat products as anti-obsesity measure

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Abstract

Fat makes fat, so goes the saying, and a large proportion of the public believes that fat in the diet is the main cause of obesity. Consumption of higher quantities of processed red meats intake has been found directly associated with the risk of obesity. Besides targeting the product directly, another approach under anti-lipid measures includes intentional impairment of fat digestion in the body. The present study was carried out with objective to examine the *Phylanthus emblica* for their anti-lipase, antioxidant and antimicrobial activities and evaluate its functional efficacy as lipase inhibitors in convenience red meat products. Preparation of water and ethnaolic : water (90:10) extracts from *Phyllanthus emblica* fruits was standardized and extracts were evaluated for their porcine pancreatic lipase inhibition activities using DNPB and Triolein as substrates. As antioxidant parameters total phenolics, total sponin, DPPH (FRSA %), FRPA and as antimicrobial (disc diffusion assay) properties the zone of inhibition against common food born organism were evaluated for both kinds of extracts. The water extract was incorporated in formulation of goat meat product and resistance against lipase induced in-vitro digestion was measured in form of representative microscopic images of fat droplets, fatty acid profile, TBARs and FFA values. Three levels of incorporation of water extracts viz: T1-2.5%, T2-5% and T3-10% in conventional goat meat nuggets were explored and based on proximate compositions, physicochemical, mineral profile, fatty acid profile, instrumental colour profile, antioxidant and finally sensory scores of goat meat nuggets the optimum level of incorporation was adjudged. Water and ethanolic extract of *Phyllanthus emblica* fruits revealed the porcine pancreatic lipase (PPL) inhibition activity 63.76% and 67.94% using DNPB (2, 4-dinitrophenyl butyrate) as substrate and 56.17% and 64.36% using Triolein as substrate, total phenolics 40.82 and 59.52 mg GAE/g, total saponin in plant 6.86%, DPPH FRSA 54.89% and 59.84%, FRPA 1.26 and 1.61 respectively. Either of the extracts did not exhibit any measurable zone of inhibition by antimicrobial disc diffusion assay. Results from in-vitro digestion of extract incorporated products revealed the resistance against fat digestion evident from bigger size of fat droplets, minimal changes in fatty acid composition, TBARs and FFA values in treated products. The conventional goat meat nuggets prepared using three different levels viz: 2.5%, 5% and 10% of water extract revealed slight changes in cooking yield, proximate parameters, colour scores and fatty acids composition. Extracts incorporated products had improved ash content, mineral profile particularly for Ca, P, Mn, Zn, Fe and Cu and improved antioxidant potential as higher TPC and DPPH (FRSA). Based on sensory evaluation of the product it was found that although incorporation of water extracts led to decrease in sensory scores, however the products incorporated with *Phyllanthus emblica* fruits extract had overall acceptability in range of very good to excellent even at 10%. From the above results it was concluded that *Phyllanthus emblica, Eucalyptus globulus, Tinospora cordifolia* can be incorporated as natural pancreatic lipase inhibitor and source of antioxidant in convenience red meat products as anti-obesity measure.

Keywords: *Phyllanthus emblica* fruits, natural lipase inhibitor, red meat products, anti-obesity.
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(FTF 05)

Development and quality assessment of guar gum incorporated low fat Kadaknath chicken nuggets

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Abstract

Low fat kadaknath chicken nuggets were developed using guar gum at three different levels (GG-1 0.5%, GG-2 1% and GG-3 1.5%) by replacing added fat. The emulsion stability and cooking yield differ significantly (P<0.05) among the various treatments. Guar gum added low fat kadaknath chicken nuggets had significantly (P<0.05) lower fat content compared to control. Moisture content was higher in treatment as compared to control. The protein and ash content did not show any significant difference among the treatments. Moisture and fat retention was significantly (P<0.05) lower in control as compared to guar gum incorporated kadaknath chicken patties. Sensory attributes of guar gum incorporated low fat kadaknath chicken nuggets indicated that there were non-significant (P>0.05) difference in the mean scores of general appearance, mouth coating, saltiness and juiciness. Flavor and texture scores at GG-1 and GG-2 were comparable to control although scores were significantly (P<0.05) lower for GG-3. Overall acceptability revealed that there was significant (P<0.05) variations among different guar gum incorporated low fat kadaknath chicken nuggets. A significant (P<0.05) lower score were observed for GG-1 and GG-3. However, score for GG-2 was comparable to control. Hence, nuggets with 1% guar gum (GG-2) was found superior and most acceptable by the sensory panelists and finally chosen as low fat kadaknath chicken nuggets.

Keywords: Kadaknath, chicken nuggets, gaur gum, quality attributes.
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(FTF 06)

Effect of nisin on qualitative and sensory aspects of cured *Vawksa Rep* - a traditional pork product of Mizoram

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Abstract

Vawksa rep is the most popular ethnic meat product of Mizoram. However, the product has a bland taste as nothing is applied to it except light smoking of pork chunks. This study was taken up to determine the effect of *Nisin*, a bacteriocin produced by *Lactococcus lactis subsp lactis* and curing ingredients (salt, polyphosphate, sodium nitrate and nitrite and spices) on the shelf life and sensory attributes of *Vawksa rep*. *Nisin* was applied @25ppm of meat mass. The investigation was carried out for four different treatment groups viz. T1- comprising of the control group, T2- comprising of *Vawksa rep* sprayed with *Nisin*, T3- Cured *Vawksa rep* and T4 – *Nisin* and cured *Vawksa rep.* The antimicrobial activity of the bacteriocin as well as the curing ingredients was studied against a few selected micro-organisms related to *Vawksa rep*. It was observed that *Nisin* had a strong antagonistic effect against *Listeria monocytogenes*, *Staphylococcus aureus*, but not very effective against gram negative bacteria viz. *Salmonella*, *Escherichia coli* and *Pseudomonas*. However, the combined effect of curing and addition of culture exhibited pronounced effect on reducing the bacterial population and product was rated to be superior compared to the other treatment groups in terms of sensory attributes viz. appearance, texture, juiciness, flavour and overall palatability. This study demonstrated that *Nisin* can be used effectively as a biopreservative agent for smoked pork product and combined effect of curing and *Nisin* was very pronounced in extending the shelf life of *Vawksa rep* upto 22 days under refrigerated storage at 4±1°C and also to develop a superior product in terms of sensory ratings.

Keywords: *Smoked pork, nisin, curing, biopreservation.*

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(FTF 07)

Effect of different cooking methods on lipid oxidation, microbiological and sensorial quality of chicken tikka under refrigeration storage

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Abstract

A study was conducted to evaluate the effect of charcoal barbeque, air fryer and Oven Toaster Griller (OTG) cooking methods on lipid oxidation, microbiological and sensorial quality of chicken tikka under refrigeration storage. Chicken tikka were prepared and analysed at regular intervals of 5 days from the date of processing to spoilage of the product under refrigeration condition. The different cooking methods significantly affected the lipid oxidation of chicken tikka under refrigeration condition. The chicken tikka which were prepared by OTG was found to have the maximum lipid oxidation when compared to air fryer and charcoal barbequing. There was no significant difference between the treatments in case of microbiological quality of chicken tikka during storage. The product was microbiologically safe upto 15 days of storage as the microbial count didn't exceed the maximum limit in all the three cooking methods. Charcoal barbequed chicken tikka was found to have better sensory score compared to air frying and OTG cooking. At the end of storage period (15 days), the chicken tikka processed under three different conditions were having a sensorial score of more than 6.5 on a 8 point hedonic scale and microbiologically safe upto a period of 15 days.

Keywords: Chicken tikka, lipid oxidation, quality quality, refrigeration storage, shelf life.

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(FTF 08)

Studies on chicken seekh kabab incorporated with citrus fruit by-products

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Abstract

The present investigation is aimed at utilizing spent hen chicken for the preparation of kababs with citrus fruit by-products as a source of dietary fibers and to assess their physico-chemical properties and storage stability. Chicken kababs were prepared using lean meat with two sources of dietary fibers (orange and mosambi pomace) at 4, 8 and 12 % level. The control was prepared in a similar manner except that spent hen meat was substituted by broiler meat. The sensory evaluation revealed that 4 % orange and 8 % mosambi pomace incorporated kababs were adjudged as the most acceptable. The products were packed with or without vacuum using PET (polyethylene terepthalate) and stored at refrigeration temperature (4±10C) for 21 days. The samples were drawn periodical for every 3 days interval and subjected for sensory attributes, physico-chemical characteristics and microbiological profile. The sensory attributes such as flavour, body & texture, colour & appearance, juiciness and overall acceptability decreased significantly ($p \leq 0.05$) under both the packaging conditions. It was observed that vacuum packaged kababs had better sensory scores as compared to the product packed without vacuum. The vacuum packed product was acceptable upto 18 days as compared to product packed without vacuum (15 days) at refrigeration temperature (4±1°C).

Keywords: Kabab, spent hen meat, vacuum packaging, citrus fruit byproducts.

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(FTF 09)

Quality and economics of corn starch incorporated low fat buffalo calf meat sausages

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Abstract

The present study was envisaged to evaluate quality and cost of production of corn starch incorporated low fat buffalo calf meat sausages in comparison to control with 20% vegetable oil. Three male buffalo calves (10-12 months) were slaughtered, portioned into standard primal cuts and manually deboned after overnight chilling (4±1°C). The meat was stored at -20oC after the removal of fascia, external fat and other connective tissue till further analysis. Pre-

standardized level of corn starch i.e. 6% was used for the development of buffalo calf meat sausages and were evaluated for quality attributes as well as cost economics of the product. Cooking yield along with moisture and protein content of treated low fat sausages were found to be significantly higher in comparison to that of high fat sausages, however vice-versa for shear force value and fat content. The developed product was more oxidative stable and was more relished by sensory panellists. Further, the calorie content of the developed product was 43% lower in comparison to high fat product. Perusal of economic study calculated by taking into account their average cooking yield, cost of product formulation and overhead cost revealed the final cost per unit (1kg) as Rs.139 and 116, respectively for high fat and developed corn starch incorporated low fat sausages. Further, the product was found to be economical by 17%. Thus, study concluded that corn starch incorporated sausages were nutritious as well as economical and may be exploited for marketing the product in domestic and foreign market to fetch better revenues.

Keywords: Buffalo calf meat, low fat, corn starch, sausages, quality attribute.
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(FTF 10)

Textural, sensory and nutritional quality of pork nuggets incorporated with different sea weeds as functional ingredient

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Abstract

The present study was carried out to develop functional pork nuggets incorporated with different sea weeds collected from coastal areas of Gujrat viz. Ulva lectuca, *Kappaphycus alvarezii* and Sargassumtenerum. On the basis of preliminary trials and relevant literature, three different levels of incorporation i.e. 3%, 4% and 5% were tried replacing lean meat in formulation. The product was evaluated and compared for various quality parameters and sensory attributes. A significant ($p<0.05$) difference in cooking yield and emulsion stability was observed in treated products as compared to control. Textural attributes of hardness and chewiness of the nuggets with added seaweed were better ($p<0.05$) than control samples. Overall product colour profile was affected ($p<0.05$) depending upon type of seaweed incorporated. On nutritional analysis, a significant ($p<0.05$) increase in total dietary fiber amongst treated products was observed. The sensory attributes showed a decreasing trend with sea weed addition in pork nuggets, however, the scores for color, flavour, juiciness and overall acceptability at 4% level of *Kappaphycus alvarezii* were comparable with control. It can be concluded that sea weeds have a potential for development of functional meat products with high fiber content, lower cooking losses, salt replacement and improved textural properties with reduction in total cost of production.

Keywords: Sea weeds, *Kappaphycus alvarezii*, *Ulva lectuca*, Sargassumtenerum, pork nuggets, dietary fiber

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(FTF 11)

Quality characteristics of dietary fiber rich chevon nuggets incorporated with combination of wheat and oat bran

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Abstract

Dietary fiber rich chevon nuggets were developed by incorporating combination of wheat and oat bran (WOB) at 1:1 proportion in chevon meat emulsion, added at T-1: 3%; T-2: 6 and T-3: 9% levels. The developed chevon nuggets were subjected to quality evaluation viz. physico-chemical, sensory, color and textural attributes. It was found that cooking yield increased significantly (P<0.05) with incorporation of WOB. Instrumental color profile, lightness (L*) and yellowness (b*) increased while redness (a*) decreased (p<0.05) with addition of WOB from 3 to 9%. Instrumental textural properties of chevon nuggets showed that increasing level of incorporation combination of wheat and oat bran combinations (WOB), hardness, chewiness and gumminess showed increasing trend, whereas springiness, stringiness, cohesiveness and resilience were lower in developed chevon nuggets as compared to control. All the sensory properties decreased significantly (P<0.05) with the addition of combination of wheat and oat bran, but sensory panel ranked T-3 as a best between T-1 and T-2. It was concluded that fiber enriched chevon nuggets can be successfully developed with the incorporation of 9% of combination of wheat and oat bran added at 1:1 ratio.

Keywords: Chevon nuggets, Wheat bran, Oat bran, fiber rich meat products.

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(FTF 12)

Development and quality assessment of fibre enriched Kadaknath chicken patties

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Abstract

The study was carried out to develop fiber enriched kadaknath chicken patties using black gram hull. Efficacy of black gram hull at three different levels (3%, 6% & 9%) was assessed to increase the fibre content in kadaknath chicken patties. Moisture content decreased gradually and showed a significant (P<0.05) difference at 6 % and 9 % incorporation of black gram hull. The fibre content in kadaknath chicken patties was increased significantly (P<0.05) with the increasing level of black gram hull. Moisture retention of black gram hull incorporated kadaknath chicken patties also differ significantly (P<0.05). Hardness value was increased gradually with the increasing level of gram hull and become significant (P<0.05) at T-2. There was a significant (P<0.05) difference between control and T-3 in the adhesive force as well as cohesiveness value of fibre enriched kadaknath chicken patties. There was a non–significant

(P>0.05) lower gumminess value was recorded for the product prepared with 3% black gram hull as compared to control. Further, gumminess value in the treatment increased as the level of gram hull in the product is increased. Patties with 9% gram hull indicated significantly (P<0.05) lower flavor and texture scores compared to control. The mean score value for overall acceptability showed that the score for T-3 was significantly (P<0.05) lower compared to control. However, score for T-2 was comparable to control. Hence, T-2 (6% gram hull) was finally selected for development of fibre enriched kadaknath chicken patties.

Keywords: Kadaknath, chicken patties, black gram hull, quality attribute.

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(FTF 13)

Optimization of formulation and pre-cooking methods for development of chicken pickle

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Abstract

The present study was conducted to optimize the formulation and pre-cooking method for development of chicken pickle. Several preliminary trials were conducted to standardize the formulation and appropriate processing technology for the preparation of chicken meat pickle. Three different pre-cooking methods of marinated chicken meat *viz*. steam cooking (without pressure), frying and microwave cooking for 10, 15 and 20 minutes were used for the preparation of product separately under three sub experiments. Three processing conditions, one from each pre cooking method viz. steam cooking (without pressure) for 15 minutes (S); frying for 15 minutes (F) and microwave cooking at 540 MHz for 10 minutes (M) were selected on the basis of sensory evaluation and further compared for various physico-chemical and sensory properties to select the best quality chicken pickle. The pH and titrable acidity values of S were significantly (P<0.05) higher and lower respectively than F and M. Moisture content of S and M was significantly (P<0.05) higher than F, whereas F had significantly (P<0.05) higher protein and fat content than other two treatments. *L**, *a** and shear force values also showed significant (P<0.05) difference among the treatments. There was no significant difference in saltiness and sourness among the treatments, however colour and appearance, flavor, texture, juiciness and overall acceptability scores of S were significantly (P<0.05) higher than other treatments. Therefore, S- steam cooking (without pressure) of marinated chicken meat for 15 minutes was found optimum and selected as the best method for development of chicken pickle.

Keywords: Chicken pickle, steam cooking without pressure, frying, microwave cooking, optimization, pre cooking, marination.

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(FTF 14)

Effect of bioactive compounds from selected fruits on *Wallago attu* fish nuggets

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Abstract

This study evaluated the antioxidant and antimicrobial effects of guava powder (GP), bael pulp powder (BPP) and dragon fruit peel powder (DFPP) on physicochemical and textural properties, sensory qualities and storage stability of fish nuggets during 10-day refrigeration storage (4 ± 1°C) period. The GP, BPP and DFPP were analyzed for dietary fibre, total phenolics, total carotenoids, vitamin C and proximate composition. Fish emulsions were analyzed for pH, emulsion stability and cooking yield and nuggets were analysed for pH, proximate composition, thiobarbituric acid value (TBA), microbiological parameters, texture profile and sensory qualities. DFPP showed highest dietary fibre then GP and BPP. The highest phenolics were observed in BPP followed by GP and DFPP. The highest total carotenoids and Vitamin C were reported in GP as compared to BPP and DFPP. The pH of fish emulsion did not differ significantly ($p>0.05$), there was significant ($p<0.05$) increase in emulsion stability and cooking yield and on the other hand, the fruit powder incorporated nuggets showed significant difference ($p<0.05$) on pH, moisture, fat, and ash content in fish nuggets. Treated nuggets had significantly ($p<0.05$) lower TBA values as well as TPC, psychrophilic count, and coliform count than control indicating antioxidant and antimicrobial potential of GP, BPP and DFPP. Nuggets with different fruit powder had significantly ($p<0.05$) lower textural profile than control. Treated fish nuggets had significantly ($p<0.05$) lower appearance, flavour, texture, tenderness and juiciness scores in comparison to control. Overall, the acceptability of control fish nuggets was significantly ($p<0.05$) higher than other treatment groups. Microbial count, texture profile analysis and sensory qualities of fish nuggets were within the acceptable level up to 10th day at 4±1◦C. Therefore, as the values of the major parameters studied are within the range of standard values, the fish nuggets are also nutritionally sound and acceptable.

Keywords: *Wallago attu*, fish nuggets, dragon fruit powder, total carotenoids, vitamin C

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(FTF 15)

Bioactive peptides from meat muscles and their health benefits

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Abstract

Biologically active or bioactive peptides are unique amino acid sequences found encrypted in food proteins. These are protein fragment containing usually 2–30 amino acids sequences in

length that impart a positive health effect to the consumer when ingested. Peptides within the sequence of their parent proteins are usually inactive. They have been identified from a range of foods, including milk and muscle sources including beef, chicken, pork and marine muscles. A numerous methods have been utilized to release bioactive peptides from muscle protein i.e. ultra filtration membrane system, ion exchange, gel filtration technologies, liquid chromatography, reverse phase liquid chromatography, but enzymatic hydrolysis of protein is the most commonly used technique. Bioactive peptides have various functional properties like antidiabetic, Cholesterol-Lowering, antihypertensive, anti-Cancer, antimicrobial, antithrombotic, immunostimulant activity, angiotensin-1-converting enzyme inhibitory, antioxidant and could play a role in the prevention of diseases associated with the development of metabolic syndrome and mental health diseases. These bioactive peptides can be used as a functional food ingredients, or nutraceuticals and pharmaceuticals to improve human health and prevent disease. Scientific substantiation of safety and efficacy of bioactive peptides is an important aspect that can significantly impact the approval of health claims of bioactive peptides for market release. Bioactive peptides have attracted a lot of scientific interest due to their purposive biofunctional attributes.

Keywords: Bioactive peptide, diseases, meat.

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(FTF 16)

Development of shelf stable pork momo: an ethnic food of Himalayan cuisine

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Abstract

An investigation was carried out on the development of pork momo with addition of orange peel powder to increase the shelf life of the product. The orange peel powder serves as an alternative to chemical or synthetic antimicrobials and antioxidants to counter the spoilage organisms, inhibiting lipid oxidation and thus extend the shelf life of the product. Pork was purchased from the college farm and was minced. The minced pork was allotted to three different group's namely-T1 (control group), T2 (added with vegetable viz-cabbage), T3 (added with 1% orange peel powder). All the steam cooked momo samples were packed in LDPE bags and kept at frozen temperature at <-18°C. The samples of pork momo were examined at regular interval to monitor the change in the keeping the quality of the product through laboratory tests in terms of physico-chemical, microbial quality, sensory quality and the treated momos can be well preserved upto 40th day of frozen storage whereas the control samples were found to be unacceptable on 20th day onwards. The momo treated with the orange peel powder were well accepted by the panelists and the mean panel rating of the momo for taste, flavour and overall acceptability was found to be as high as 7.55 ± 0.23, 7.40 ± 0.24 and 7.30 ± 0.12, respectively.

Keywords: Shelf stable, pork momo, ethnic food, quality attributes, storage study.

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(FTF 17)

Development of dietary fiber rich chicken meat patties using wheat and barley bran

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Abstract

By integrating wheat and barley bran into chicken meat at 5, 10 and 15 percent levels, dietary fiber rich chicken meat patties were made. Barley bran contained more soluble dietary fibers (SDFs) and unsaturated fatty acids (USFAs) than wheat bran, whereas total dietary fibers (TDFs), insoluble dietary fibers (IDFs) and saturated fatty acids (SFAs) were lower in wheat bran. Bran incorporation improved the water holding capacity (WHC) and emulsion stability (ES) significantly. Barley bran showed better effect on WHC and ES than wheat bran. Bran introduction resulted in significant increases in cooking yield, firmness, TDF, USFA and decreases in sensory attributes, humidity, protein, fat and cholesterol content. IDF was lower for wheat bran added patties and for barley bran added patties for SDF and SFA / USFA ratio. It is concluded that for the preparation of baked and steamed chicken patties, barley and wheat bran can be added up to 10 and 15 percent.

Keywords: Dietary fiber, chicken meat patties, water holding capacity, unsaturated fatty acids

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(FTF 18)

Functional foods: opinion, technology and potential health promotion

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Abstract

Food traditions are changing day by day due to hasty urbanization, availability of diversity of food products, changes in eating habits and new technologies. Due to increased cost of health-care and lifestyle related diseases; the consumers are shifting towards the functional foods for health promotion and disease prevention. Functional foods as foods that are "whole, fortified, enriched, or enhanced," but more importantly, states that such foods must be consumed as a part of varied diet on a regular basis, at effective levels for consumers to reap their potential health benefits. With the expansion of food industry, the use of functional foods in healthcare is increasing day by day and consumers are now health-conscious and preferring functional foods as a first line of defense against diseases rather than the pharmaceuticals. So the consumers are changing their mindset towards "Prevention is better than cure". Many functional compounds have been reported for prevention and curing of these diseases. Omega-3 fatty acids, conjugated lenoleic acid (CLA), soluble and insoluble dietary fibers, plant sterols, β-lactoglobulin, lactoferrin, probiotics are few of the examples of functional food ingredients and

may appear to induce anti-inflammatory responses which inhibit carcinogenesis and also improve the biological defense mechanisms. Functional foods represent one of the most intensively investigated and widely promoted areas in the food and nutrition sciences today. However, it must be emphasized that these foods and ingredients are not magic bullets or panaceas for poor health habits. Diet is only one aspect of a comprehensive approach to good health.

Keywords: Functional food, health, varied diet.
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(FTF 19)

Development in Functional meat product

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Abstract

The concept of functional meat products was introduced over 20 year ago in Japan. It is modified by adding ingredients considered beneficial for health or by reducing components that are considered harmful. Meat has saturated fat, excess salt and calories that are related to the incidence of coronary heart diseases, hypertension and obesity. So it is important to develop functional meat products which prevent various nutrition related diseases. Functional meat products are developed by production practices, post harvest techniques and reformulation techniques. Among there reformulation is most commonly used. It can help to avoid undesirable component and obtain palatable composition. Most early development of functional foods were those of fortified with vitamins and minerals such as vitamin E, vitamin C, folic acid, zinc, iron and calcium. Than the focus shifted to the food fortified with micronutrients such as omega-3 fatty acid, phytosterol and soluble fiber to promote good health. In recent time develop food products is offer multiple health benefits in a single food. The process of creating new meat products of functional properties is complex but those components have a significant effect on human health maintenance.

Keywords: Functional foods, beneficial ingredients, health effects.
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(FTF 20)

Traditional meat products and its commercialisation

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Abstract

Meat products with high sensory quality, usually with high nutritional value, produced in a small scale, using ingredients and procedures from ancient times are called Traditional Meat Products. A variety of food products of indigenous taste are being prepared and consumed in India, and these products vary from region to region. Traditional processing of various meat

products with locally available specific ingredients has resulted in the development of products with unique sensory attributes. Nowadays, these products are becoming popular and their demand for such products is increasing day-by-day. Diversity in tradition and culture among different communities in India has resulted in a large variety of traditional meat products. Varieties of products are being prepared from meat and fish with locally available vegetables, herbs, and spices. Among them, indigenously produced blood sausage, animal by-products with rice flour, maize, or fruits, dry meat powder with herbs, and special preparation from animal fats preserved in dry gourd or bamboo containers are important. The knowledge on the preparation method is generally passed on from one generation to the other through practice and word of mouth. However, the native meat handlers are ignorant about the importance of maintaining hygiene and quality specifications during the preparation of such traditional products. These factors pose to be as constraints for commercialization in the current scenario. Commercialization of the ethnic meat products and adequate marketing can cater the palette of this population and address to the huge demand for different meat products in various regions of the country. Commercialization of these indigenous meat preparations will help in converting the local market into a global industry which will generate employment and self-sustainability in different regions of the nation.

Keywords: Traditional meat products, commercialization, local market.
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(FTF 21)

Quality characteristics of dietary fiber rich chevon nuggets incorporated with combination of wheat and oat bran

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Abstract

Dietary fiber rich chevon nuggets were developed by incorporating combination of wheat and oat bran (WOB) at 1:1 proportion in chevon meat emulsion, added at T-1: 3%; T-2: 6 and T-3: 9% levels. The developed chevon nuggets were subjected to quality evaluation viz. physico-chemical, sensory, color and textural attributes. It was found that cooking yield increased significantly ($P<0.05$) with incorporation of WOB. Instrumental color profile, lightness (L*) and yellowness (b*) increased while redness (a*) decreased ($p<0.05$) with addition of WOB from 3 to 9%. Instrumental textural properties of chevon nuggets showed that increasing level of incorporation combination of wheat and oat bran combinations (WOB), hardness, chewiness and gumminess showed increasing trend, whereas springiness, stringiness, cohesiveness and resilience were lower in developed chevon nuggets as compared to control. All the sensory properties decreased significantly ($P<0.05$) with the addition of combination of wheat and oat bran, but sensory panel ranked T-3 as a best between T-1 and T-2. It was concluded that fiber enriched chevon nuggets can be successfully developed with the incorporation of 9% of combination of wheat and oat bran added at 1:1 ratio.

Keywords: Chevon nuggets, wheat bran, oat bran, fiber rich meat products.
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(NMF 01)

Nano-sensor for meat quality: development and evaluation

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Abstract

A research work was envisaged to develop a nano-sensor for monitoring the quality and safety of refrigerated chicken meat. The nano-sensor was made from the combination of curcumin-gold nanoparticles and anthocyanin extract of red cabbage which was immobilized on a nitrocellulose membrane by dip coating method through centrifugation. In this experiment, the chicken meat was packaged in polypropylene trays wrapped with polypropylene film and the sensor was attached to the inner side of the overwrap film. The colour change of the nano-sensor was observed using digital photography during the storageof meat at 0, 3, 5, 7 and 9 days at 4±1ºC in a refrigerator. The colour changes that occurred were quantified and analysed using the Image program. The colour of the nano-sensor was dark pink when the meat was in a fresh state while the colour of the sensor showed discoloration when the meat quality deteriorated and finally changed to blue color. The change in colour of the sensor was monitored and compared with the meat quality parameters such as total volatile basic nitrogen, standard plate count and tyrosine value to correlate the sensor for its suitability to predict the meat quality and shelf-life. The results indicated that chemical, microbial and sensory quality changes corroborated with the color changes produced in the nano-sensor due to its reactivity with the volatile amines. Therefore it is concluded that the nano-sensor made up of curcumin-gold nanoparticle-anthocyanin can be successfully used as potential tool for monitoring the quality and safety of refrigerated chicken meat.

Keywords: Nano sensor, curcumin-gold nanoparticle, anthocyanin, chicken meat safety.

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(NMF 02)

Identification of potential RNA biomarkers for tissue level authentication of chicken meat and meat products

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Abstract

The objective of the research work was to identify novel RNA biomarkers to detect the presence of organ/offal meat in meat of skeletal muscle origin from poultry, since all the tissues have exactly the same DNA sequence and which can't be depended upon for declaration of “true to its labelling” within the same species. Deep sequencing of microRNAs was performed for liver, heart, gizzard, muscle & blood collected from broiler chicken using Illumina Nextseq

500. Among total 60 million reads, 11, 25, 9.2, 8.8 & 6.1 million were analyzed for liver, heart, gizzard, muscle & blood. Annotated miRNAs and classified groups as per miRBase 22.2 was found to be 2456 & 264, 3486 & 333, 1695 & 221, 2184 & 265 and 2037 & 238 for liver, heart, gizzard, muscle & blood respectively. Further, two way data analysis were performed for "Unique & tissue specific miRNAs" and "Common but differentially expressed miRNAs" among the tissues studied. 142 groups of miRNAs were found common to the tissues studied, where as muscle showed co-expression of 29, 56 & 45 miRNA groups with gizzard, heart & liver respectively. Blood being a common component in all tissues, miRNA groups co-expressed between blood and other tissues were also analysed. Finally, it was concluded that 11, 3, 32, 10 & 18 miRNA groups were unique to blood, gizzard, heart, liver and muscle. Due to lower expression of unique elements, top twenty common but differentially expressed miRNAs were identified for each tissue to validate in qRT-PCR platform.

Keywords: RNA biomarker, organ/offal meat, microRNA, deep sequencing, miRBase & qRT-PCR.

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(NMF 03)

Identification of tissue of buffalo origin by species-specific simplex and SYBR green based real-time PCR assay targeting mit. gene sequences

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Abstract

The present study was carried out with aim to develop and standardize the protocol for species-specific simplex and real time PCR assays for identification of tissue of buffalo origin. Species-specific primer pair for buffalo was designed. The conditions for simplex and SYBR Green real time PCR were optimized in terms of quantity and concentration of various components of PCR mix and annealing temperature. Both the developed assays were evaluated for its species specificity and sensitivity. Applicability of developed simplex PCR assay was also assessed on samples from known/coded meat samples, meat admixture and samples subjected to diverse heat treatment viz: boiling, autoclave and microwave. The developed species-specific PCR assay resulted in amplification of DNA template of buffalo origin to a PCR product of 339bp. The real time PCR amplification curve and melt curve analysis using same primer pair also revealed buffalo specific amplification with melting temperature (Tm) value of 82°C. Sensitivity of assays showed that absolute DNA content required for successful identification of tissue of buffalo origin was 10ng for simplex PCR and 0.0002ng by real time PCR. Standard curve analysis based on copies no. of DNA (log DNA concentration) and Cq value revealed the slope of -3.171, correlation coefficient (R2) 0.976 and PCR amplification efficiency (E) 106.71%, respectively. Thus, it was concluded that evolved buffalo-specific primer pair is effective in identification of tissue of buffalo origin either by simplex or Real time PCR assay.

Keywords: Identification, Buffalo origin, species-specific PCR, SYBR green, Real-time PCR
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(NMF 04)

Loop Mediated Isothermal Amplification and Lateral Flow Assay (LAMP-LFA) for onsite identification of tissue of buffalo origin

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Abstract

Internationalization of meat production, distribution and increased prices of commercial meat commodities have led to a significant increase in fraudulent practices in meat. Nucleotide amplification assays have always been preferred over protein-based assays for identification of species origin of meat and under these, in order to meet out the criteria of point of care test (POCT), isothermal amplification techniques have evolved. Paper based analytical devices have gained increasing interest as a promising tool for POCT due to their simplicity, cost efficiency, biodegradability and biocompatibility. Here, we have designed a paper buttons and strips for identification of cattle origin of tissue based on its inherent DNA, which is a single-step device for performing onsite amplification using loop-mediated isothermal amplification (LAMP) technique and detection of amplified product by lateral flow. Using self-designed cattle specific LAMP primer sets and suitable paper the component of paper based LAMP reaction mixture such as Bst DNA polymerase, MgSO4, dNTP, betaine and ratio of outer and inner primer pair and thermal protocol were optimized. The optimized paper based LAMP reaction mixture were lyophilized using button shaped paper as a carrying material at a specific temperature and time combination. A pair of LAMP amplicon specific probe was designed one tagged with biotin at 5' end and another fluoresce in at 3' end. The annealing temperature for hybridization of probe with amplified paper based LAMP product was optimized. The concentration of probe, ratio of probes, concentration of anti fluoresce in on test and concentration of biotin on control line, amount of streptavidin-gold nanoparticle on conjugate pad, amount of hybridized paper based LAMP elute, amount of migrating solution and time gap for observation of results were optimized. Analysis of successful amplification was made by visualizing change in color of freeze-dried paper based LAMP amplified product from violet to blue using HNB dye, instant color change in freeze-dried paper based LAMP amplified product (without HNB dye) after addition of SYBR Green I dye from orange to green, red colored test and control line on LAMP-LFA strip and typical ladder like pattern on gel electrophoresis. The efficacy of developed assay was validated on known/coded/meat admixture/processed samples. Cattle-specific LAMP primers showed specificity without any cross reactivity. Results of sensitivity test conducted on 10 fold serially diluted samples of DNA from target species using specific primer sets revealed the lowest level of detection of absolute DNA was 0.0001ng. Laboratory validation carried out on samples from 10 different individuals of cattle, coded samples and binary meat admixture substantiated the accuracy of developed paper based LAMP-LFA assays. Thus it was concluded

that developed cattle specific paper based LAMP buttons assay are very much effective in identification of species origin of tissue from cattle

Unethical acts such as substitution or mixing of flesh of cheaper or undeclared meat to higher priced meat for economic gain is one of the most common meat fraudulent practices. In a similar red meat category, buffalo flesh available at lower price often used as proxy of higher priced chevon and mutton. Identification of correct origin of tissue ensures consumer's trust and promotes healthy trade. Onsite identification based on amplification of inherent DNA, with portable reagents and accessories has been in practices for disease diagnosis but not in food fraudulence. The present paper presents the development of a paper based loop mediated isothermal amplification and lateral flow (LAMP-LFA) assay for identification of tissue of buffalo origin on site. Buffalo specific LAMP primers were designed by homology comparison of mitochondrial cytochrome b gene sequences and based on probable amplicon (222bp) one pair of probe were also designed. The optimized LAMP reaction components were lyophilized over button shaped nitro cellulose paper. The annealing temperature for hybridization of tagged probe along with amplified LAMP product was also standardized. For detection of successful hybridized probe-LAMP product, lateral flow assay was developed by standardizing the design of strip, amount of analytes over test and control line, amount of migrating solution, amount of elute for charging, visualization time gap and inference of observations. The developed assay was evaluated for its specificity by cross reactivity test, sensitivity by using serially diluted DNA templates, utility in identification of buffalo tissue in meat binary admix and diversely heat processed meat samples. Using 5% trehalose (2:1) as cryo-protectant in LAMP reaction components, lyophilization at -40°C for 5 hrs followed by storage under refrigeration were found optimal. Amplified LAMP product were successfully hybridized with tagged probes by denaturation at 95°C for 5 min followed by annealing at 46°C for 3 min. Concentrations (10pM) and ratio (1:1) of probes, amount of streptavidin gold conjugate (6 µl), Anti-FITC antibody(1 mg/ml), Biotin-BSA(1.2mg/ml), pore size of NCM (5µm), NFW migrating solution (75µl), paper LAMP elute (7.5µl) and visualization time (6 min) were standardized for detection of LAMP product by LFA. The amplification reaction using buffalo specific LAMP primers showed specificity without any cross reactivity. Results of sensitivity test conducted on 10 fold serially diluted samples of DNA from target species using specific primer sets revealed the lowest level of detection of absolute DNA as 0.0001ng. Laboratory validation carried out on samples from binary meat admixture and processed meat samples substantiated the accuracy of developed paper based LAMP-LFA assays and were capable of detection of 1% of buffalo tissue in binary admixture. As point of care test, the LAMP assay using developed paper buttons as carrier of LAMP reagents successful isothermal amplification was also achieved in thermos flask with hot water at 64°C. Thus it was concluded that developed assay is effective in identification of tissue of buffalo origin.

Keywords: LAMP-LFA, onsite identification, buffalo tissue, hybridization, paper based, isothermal amplification techniques, meat mixtures.

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(NMF 05)

Draft genome sequence analysis of antibiotic resistance MRSA reveals potential virulence genes

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Abstract

Staphylococcal species are part of normal flora in human and animals, but in recent years, the presence of virulent and Methicillin resistant *Staphylococcus aureus* (MRSA) in clinical, animal and environmental settings play a significant role in causing of infections worldwide. Coagulase positive MRSA are internationally acknowledged as zoonotic multidrug-resistant responsible for nosocomial and community acquired infections. Multidrug-resistant *S. aureus* strains are rather common in hospitals and farms but are also detected in food animals, chicken, milk and fishery products in Europe, United States, and Asia. The incidence of MRSA in fish and seafood was recently noted. The Whole Genome sequence (WGS) of this strain contains 2,797 protein coding genes and 80 RNAs within the 2.85-Mb genome. The number of paired-end reads was approximately 7 billion short-read sequences in pairs of 300 bp, the number of bases (Mb) was 1,447.5, and there was 35.11% GC content. The majority of the top BLASTX hits belonged to *Staphylococcus* species (top 15 organisms). The total number of Gene Ontology annotations identified for molecular functions was 870, with 586 annotations related to biological process and 236 annotations belonged to with cellular components. We predicted 80 tRNA genes from the contigs using tRNAscan-SE and is submitted in NCBI with the accession number NBZX00000000. The MRSA virulence gene profiles was analysed by VirulenceFinder 2.0 from whole genome sequence (illumina HiSeq 2500) to assess the extent of its pathogenicity/ toxins production nature. The ability of *S. aureus* isolates to cause disease depends on the presence of different virulence factors/ genes for adhesion, invasion, and host defense evasion. Generally the virulence of *Staphylococci* is related to the ability to produce a variety of toxins such as cytotoxins (hemolysins, leukotoxins, and leukocidins) and superantigenic toxins (enterotoxins, exfoliative toxins, and toxic shock syndrome toxin). This MRSA strain contains the virulence factor for exoenzyme genes such as aureolysin (aur) and serine protease (splE) with 100% identity at a size of 1530 and 717bp with the accession no. CP009554.1 and BX571856.1, respectively. The toxin genes includes gamma-hemolysin chain II precursor (hlgA), gamma-hemolysin component B precursor (hlgB), gamma-hemolysin component C (hlgC), Panton Valentine leukocidin F component (lukF-PV), Panton Valentine leukocidin S component (lukS-PV), enterotoxin G (seg), enterotoxin I (sei), enterotoxin M (sem), enterotoxin N (sen), enterotoxin O (seo) and enterotoxin U (seu) with 100% identity. So the present study indicates that the rapid emergence and dissemination of MRSA strains combined with several virulence factors in food items pose a serious threat to public health.

Keywords: Fish, Methicillin Resistant *Staphylococcus aureus*, virulence genes, whole genome sequence.

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(NMF 06)

Development and characterization of thyme oil nanoemulsion for storage stability of pork nuggets

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Abstract

In the present study, development of bioactive nanoemulsion from Thyme essential oil was standardized using ultrasonication at varying amplitude and time combinations and thereafter incorporation of selected nanoemulsion in pork nuggets at optimal level was carried out. Antimicrobial and antioxidant potential of thyme essential oil were evaluated by using zone inhibition assay, MIC, DPPH and ABTS. Three different amplitude and time combinations were used for development of nanoemulsion and depending upon its quality parameters, most ideal combination was selected. The standardized bioactive nanoemulsion was incorporated into pork emulsion at three different levels (2, 3 and 4%) replacing ice chilled water in formulation. On the basis of physico-chemical, sensory and instrumental colour analysis, pork emulsion incorporated with (3%) bioactive nanoemulsion from thyme essential oil were found most suitable for development of pork nuggets. The effect of developed bioactive nanoemulsion on different physico-chemical, microbiological and sensory parameters of pork nuggets were investigated under aerobic and MAP (50% CO_2:50% N_2) packaging conditions at 4±1℃ for 35 days. Lipid oxidation indicators and microbial counts were significantly lower ($p<0.05$) for the treated products incorporated with bioactive thyme essential oil nanoemulsion as compared to control. In general, MAP packaged products had better oxidative, microbiological and sensory quality than the aerobic packaged products. It can be concluded that the incorporation of thyme essential oil nanoemulsion can be instrumental in maintaining microbial and oxidative quality of pork nuggets kept under refrigeration (4±1℃).

Keywords: Thyme oil, nanoemulsion, ultra-sonication, packaging, MIC, pork nuggets.

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(NMF 07)

Antimicrobial activity of *Bacopa monnieri* extract enriched emulsion

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Abstract

The objective of the study was to synthesize *Bacopa monnieri* extract enriched emulsion and its stabilization with help of gum arabic; then characterization of stabilized emulsion and its applications as antimicrobial agent. The prepared emulsion was found to be more stable and

selected for further study due to its high stability as compared to treated samples. The gum arabic was used for the stabilization of emulsion due to its poly-anionic nature. Antimicrobial activity against standard strains i.e., *E. coli* (MTCC No.443) and *S. aureus* (MTCC No.96) of microorganisms was determined by agar- well diffused method. The plates were checked after overnight incubation for the presence of inhibition zone around the well loaded with brahmi extract emulsions along with positive (Amoxicillin) and negative control samples. The results illustrate that Brahmi extract enriched emulsion shows comparable antibacterial activity against *E. coli* and *S. aureus* compared to the positive control (Amoxicillin). It is concluded that stable emulsion is prepared at 1% level of olive oil which shows high stability as compared to other which have good antimicrobial activities.

Keywords: *Bacopa monnieri* extract, emulsion, antimicrobial activity, *E. coli, S. aureus*.
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(NMF 08)

Point of Care Test for identification of pig tissue by paper based Loop Mediated Isothermal Amplification - Lateral Flow Assay (LAMP-LFA) targeting CO I gene

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Abstract

The inclusion of tissue of pig origin i.e. pork or its derivatives in food, is regarded as a serious religious offence in some communities. Routinely used DNA amplification methods for meat speciation suffer from limited onsite applications. Compared to other protein or DNA based methods, paper-based isothermal amplification and detection technique appears promising. The present study was envisaged with objectives of development of paper based loop-mediated isothermal amplification-Lateral Flow Assay (LAMP-LFA) for identification of tissue of pig origin, evaluation of specificity and sensitivity of developed assay and ascertain its utility on samples from binary meat mixture and heat processed samples. Self designed pig specific primer pairs based on CO I gene sequences and probes based on probable amplicon of selected primer pairs were used for amplification of DNA and its detection on LFA respectively. Preliminary trials were made to adjudge the suitability of different paper materials to carry out pre-optimized LAMP reaction. Lyophilization protocol for standardized LAMP reaction components over button shaped paper acting as a carrying material for amplification of DNA was optimized. Hybridization of designed and tagged amplicon specific probe with resultant LAMP product was also standardized. A lateral flow assay was developed for detection of this hybridized product by optimization of strip design, amount of migrating solution and detection time and inferences of observation. Analysis of successful amplification was made by using HNB dye, LAMP-LFA strip and also by typical ladder like pattern on gel electrophoresis. The nitro-cellulosic membrane was found best as carrying materials for LAMP reaction components and amplification. Lyophilization at -40°C for 5 hrs with 5% trehalose (2:1) followed by storage under refrigeration were found optimal. Hybridization of amplified product with tagged probes

were standardized as denaturation at 95°C for 5 min followed by annealing at 58°C for 3 min. Concentrations (10pM) and ratio (1:1) of probes, amount of streptavidin gold conjugate (6 µl), Anti-FITC antibody (1 mg/ml), Biotin-BSA (1.2mg/ml), pore size of NCM (5µm), NFW migrating solution (75µl), paper LAMP elute (7.5µl) and visualization time (6 min) were standardized for detection of LAMP product by LFA. Pig-specific LAMP primers showed specificity without any cross reactivity. Results of sensitivity test conducted on 10 fold serially diluted samples of DNA from target species using specific primer sets revealed the lowest level of detection of absolute DNA as 0.00001ng. Laboratory validation carried out on samples from binary meat admixture and processed meat samples substantiated the accuracy of developed paper based LAMP-LFA assays and were capable of detection of 1% of pig tissue in binary admixture. As point of care test, the LAMP assay using developed paper buttons as carrier of LAMP reagents successful isothermal amplification was also achieved in thermos flask with hot water at 64°C. Thus it was concluded that developed assay is effective in identification of tissue of Pig origin.

Keywords: Pig tissue, detection, paper based LAMP, lateral flow assay.

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(NMF 09)

Prevalence and molecular detection of Tetracycline resistant ESBL producing *E. coli* strain from shrimp aquaculture farm

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Abstract

Aquaculture is the fastest growing animal production industry in the world. Resistance to antimicrobials in bacteria derived from aquaculture animals and/or the aquatic environment have been reported in numerous publications in the scientific literature. The present study was carried out to monitor the incidence of an ESBL producing AMR pathogen from aquaculture settings in India and specifically the distribution of Tetracycline resistant genes in ESBL producing *E. coli* from shrimp aquaculture farms by PCR. The ESBL producing *E. coli* strains were isolated in the presence of cefotaxime in Mac Conkey agar after enrichment of the shrimp samples in *E. coli* enrichment broth. The ESBL producers were confirmed as per the CLSI, 2017 guidelines. The ESBL and tetracycline genes screened were CTX-M group 1, 2, 9 & 25, TEM, SHV, OX and tet(A) and tet(B). About 86 number isolates from 66 aquaculture samples were confirmed as *E. coli* by EMB and IMViC tests. All of these isolates were grown on Mac Conkey in the presence of cefotaxime and produce typical dried pink colored colonies. 88.0% of these ESBL producing *E. coli* strains were multi drug resistant (MDR) in disk diffusion assay (Dodecca Enterobacteriaceae 1 and 2, HiMedia, Mumbai). Almost all of these isolates showed higher levels of resistance to more than 5 antimicrobial agents. The distribution of antibiotic resistance genes in the ESBL *E. coli* were CTX-M group 1 (20%), TEM (30%), tet A (40%) and tetB

(10%), respectively from the aquaculture farm shrimp samples. Twenty two strains of ESBL (25.58%) were resistant exclusively to the tetracycline antimicrobial agent and 12 strains (13.95%) showed resistance to both cephems and tetracycline antimicrobial agents. Four ESBL producing *E. coli* strains from an aquaculture farm carried 3 AMR genes viz, CTX-M group 1, TEM and tet (a) genes. Whereas only an ESBL producing *E. coli* strain showed positive for the tet(B) gene in addition to TEM. The persistence and spread of these ESBL *E. coli* in the aquaculture environment poses a threat to exposed human populations. Efforts should be made to more closely monitor and introduce control of antibiotic resistance in aquaculture, as this represents a major reservoir of resistance genes likely to threaten the human use of critical antibiotics in the future.

Keywords: Aquaculture, *E. coli*, ESBL, tetracycline resistance, PCR, shrimp.
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(NMF 10)

A rapid and simple method for species identification of sheep (*Ovis aries*) meat by Loop-mediated isothermal amplification targeting mitochondrial D loop region

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Abstract

Fraudulent substitution of costlier meat with inferior quality meat for economic gains has been reported from across the world. Substitution or adulteration of meat needs to be controlled for ethical, public health and religious reasons. Authentic species identification techniques which are reliable and applicable to meat in various available forms are required to control such fraudulent practices. In this study, we developed a simple and rapid method for identification of mutton which involves Alkaline lysis method of DNA extraction and Loop-mediated Isothermal Amplification (LAMP). For LAMP assay, four primers were designed by targeting mitochondrial D loop region and amplification was carried out under constant temperature 60°C using dry bath. All results were visually detected and confirmed by electrophoresis and flurometric assay. Specificity of the designed sheep specific primers was assessed by performing LAMP assay with the DNA templates isolated from other domestic species *viz.,* cattle, buffalo, pork, goat and chicken. No cross amplification was detected in any other species. Amplification was achieved even in heat treated mutton samples subjected to cooking at 60, 80, 100, 121 °C for 30 min. Sensitivity evaluation showed that the assay can detect 0.5 ng of sheep DNA in the reaction mix. Detection of 0.1% of mutton spiked with 99.9% of beef in binary mixtures is indicative of the sensitivity and robustness of the assay. Results obtained in the present study are repetitive, accurate and reliable, and hence the developed LAMP assay combined with alkaline lysis method of DNA extraction can be handy to food analysts to authenticate mutton both at laboratory and field level.

Keywords: Sheep, species identification, mitochondrial DNA, alkaline lysis.
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(NMF 11)

Antioxidant activity of *Bacopa monnieri* extract enriched emulsion

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Abstract

The objective of the study was to synthesize *Bacopa monnieri* extract enriched emulsion and its stabilization with help of gum arabic; then characterization of stabilized emulsion and assess its antioxidant activities. The gum arabic was used for the stabilization of emulsion due to its poly-anionic nature. Standard ascorbic acid was prepared as 1 mg/ml in methanol. The scavenging activity was compared with ascorbic acid. Antioxidant efficacy of emulsion was evaluated by calculating percentage inhibition of DPPH at concentration i.e. 250µl of the emulsion at room temperature. Results clearly revealed significant ($p<0.05$) difference in the percentage of inhibition with increasing time. It could be due to the formation of small droplets of the emulsion by cavitation process by sonication. Small droplets formed a smooth type of emulsion which did not exhibit release of oil and extract, hence significant ($p<0.05$) difference in the percentage of inhibition was observed. Therefore, it is concluded that the prepared emulsion can be used as stable antioxidant agent in food system.

Keywords: Bacopa monnieri extract, emulsion, antioxidant activity, DPPH scavenging activity.

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(NMF 12)

Species identification of meat samples originated from black buck (*Antilope cervicapra*) by species specific PCR targeting mitochondrial cytochrome c oxidase I

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Abstract

Black buck (*Antilope cervicapra*), also known as Indian black buck is the sole extant member of genus antilope. They are commonly found in India, Nepal and Pakistan. Black buck has religious significance under Hinduism and hence are not harmed in villages of India. Hunting of blackbuck is prohibited under Schedule I of the Wildlife Protection Act of 1972. The blackbuck is listed under Appendix III of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In spite of stringent regulations, black buck are often poached illegally for economic gains especially where the species is sympatric with nilgai. There are about 50,000 black bucks left in India as on 2001. Conservation efforts of the Indian black buck require authentic species identification tools which can stand legal scrutiny so that the culprits can be brought to book. Keeping these issues in view, a species specific polymerase chain reaction was developed which was highly repeatable and authentic. Primers were designed targeting

cytochrome c oxidase I (COI or COX1) gene, found in mitochondrial DNA. Tissue samples required for the analysis were collected from Nehru Zoological Park, Hyderabad. DNA was extracted from the blood sample by following standard protocol. PCR amplification using the novel designed primers was standardized. Amplification yielded 651 bp amplicon in DNA extracted from black buck tissue. No amplification was seen in other closely related species viz., spotted deer (Axis axis), barking deer (*Muntiacus muntjak*)and mouse deer (Moschiola indica). Species specific PCR based method targeting mitochondrial gene for species identification of black buck derived samples was found to be an ideal, authentic and unambiguous qualitative method for meat species identification, thereby providing molecular aid in wildlife forensics and conservation of the species.

Keywords: Species identification, meat, black buck, species specific primer, PCR assay.
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(NMF 13)

Detection of buffalo species in meat and meat products employing DNA based PCR Assay

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Abstract

The study was conducted for the evaluation of DNA based methods for to detect the adulteration of buffalo species in meat and meat products. Molecular method was employed by extracting DNA from different species and oligonucliotide synthesis based on buffalo specific regions of mitochondrial DNA was utilized for PCR amplification. The meat containing different levels of buffalo meat and buffalo meat subjected to different processing condition also has been tested using the assay. Finally the market products from various regions were tested for adulteration. DNA based method was found to be species specific and it detected contamination of buffalo meat at even 1 per cent level with accuracy. Even different processing conditions do not let the adulteration go undetected. The market samples were tested for buffalo meat adulteration and absence of adulteration suggest the food items sold in Himachal Pradesh is free from adulteration of buffalo meat. Conclusively the DNA based method can be applied successfully for quality assurance of food.

Keywords: Buffalo species, meat adulteration, PCR Assay, detection level.
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(NMF 14)

Isolation and identification of *Escherichia coli* from fresh and processed chicken meat and egg

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Abstract

In the present study, prevalence of *E. coli* was assessed in 250 samples of chicken, eggs and their products. Isolation and identification of *E. coli* was done by using cultural, morphological, biochemical and molecular assays. Cultural characterization was done using EMB and MLA media, followed by Gram staining and for biochemical characterization standard biochemical tests were performed. For further confirmation *E. coli* isolates from chicken samples were sent to Central Research Institute, Kasauli for serotyping. Total 22 isolates were confirmed to be *E.* coli on the basis of serotyping and among these 12 isolates belonged to ten different 'O' serogroups *viz*. O2, O8, O11, O13, O17, O21, O23, O35, O66 and O155, while five were rough strains and five were untypable strains. The molecular characterization was done by using multiplex PCR. Ten isolates of *E. coli* revealed the presence of virulence genes, *viz.eae, bfp*A and *stx1/stx2*. The advantage of using multiplex PCR is that it can simultaneously detect and identify different virulence genes and is sensitive as well as specific. The prevalence rate of *E. coli* recorded on the basis of PCR in samples of raw chicken, chicken products, shell eggs and egg products was 6 per cent, 2 per cent, 4 per cent and 6.67 per cent, respectively. The matter of concern is that all the positive isolates were pathogenic belonging to EPEC and STEC pathotypes.

Keywords: Characterization, identification, foodborne pathogens, *E. coli*, chicken meat, eggs.
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(IFP 01)

Structure and properties of novel gelatin based biodegradable films cross-linked by transglutaminase

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Abstract

The gelatin (5%) based biodegradable films were prepared with incorporation of different levels of transglutaminase enzyme (20, 40 and 60U/g of protein). The effect of TGase enzyme on physico-chemical, colour, mechanical, water permeability and oxygen gas barrier properties of developed gelatin films were evaluated. Changes in secondary structure by FTIR, film morphology by SEM and crystallinity by X-ray diffraction patterns were also measured. Thickness, opacity, density, area and energy of films increased whereas moisture content decreased with increase in TGase enzyme as compared to control film. The color of the gelatin film surface affected by decreasing L* values and increasing a* and b* values with addition of TGase enzyme. Tensile strength, elongation at break, penetrability and extensibility of gelatin films were increased by incorporation of TGase enzyme upto 40 U/g of protein however at higher enzyme concentration (60 U/g of protein) these values decrease. Barrier properties of film like water vapour transmission rate and O2 gas transmission rate were improve with addition of TGase enzyme. Total soluble mass decreased after TGase addition at low concentration however at high concentration, TSM increased significantly. Water solubility and swelling index of gelatin film decrease significantly while degree of crosslinking increase significantly with incorporation of TGase enzyme. Scanning electron microscopy (SEM), X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) analysis revealed positive conformational changes in structure of gelatin film due to crosslinking. It is concluded that enzymatic crosslinking by TGase enzyme at 40 U/g of protein can be an effective approach in improving the properties and structure of gelatin film which has great potential for packaging of meat and meat products.

Keywords: Gelatin biodegradable film, crosslinking, Transglutaminase enzyme,

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(IFP 02)

Development of edible active packaging films from natural polyphenol loaded nanosolutions for pork patties

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Abstract

In the present study an attempt was made to develop and evaluate alginate based active edible films with nanoemulsions of polyphenols. Different films were developed using sodium

alginate as the base and with incorporation of polyphenol nanosolutions of Quercetin and Tannic acid to develop active films. The film thickness, grammature, tensile strength, per cent elongation at break, water vapour permeability, water sorption kinetics, light transmission and film opacity, antioxidant activity, antimicrobial activity and total phenol content were evaluated for the above developed films. The thickness and grammature were significantly ($P<0.05$) higher in Quercetin nanoemulsion incorporated films compared to Tannic acid nanosolution incorporated films and control films. The per cent elongation at break, tensile strength, opacity mean values were significantly ($P<0.05$) higher in Tannic acid nanosolution incorporated films compared to Quercetin nanoemulsion incorporated films and control films. The water vapour permeability and water sorption values were found to be lower in Tannic acid nanosolution incorporated films than Quercetin nanoemulsion incorporated films. The antioxidant activity, total phenol content and antimicrobial activity of Tannic acid nanosolution incorporated films were significantly ($P<0.05$) higher than Quercetin nanoemulsion incorporated films. Depending on the analysis of quality parameters of above films, one best film was selected and used to evaluate the efficacy in quality and shelf-life extension of pork patties at refrigerated ($4 \pm 1^{o}C$) storage. Pork patties wrapped in nanosolution incorporated films had significantly ($P<0.05$) better physico-chemical, microbial and sensory attributes than control films.

Keywords: Nano emulsion, pork patties, quercetin, tannic acid, shelf life.

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(IFP 03)

Rheological, physico-mechanical, and microbiological properties of *Manihot esculenta* starch biobased edible packaging film functionalized with caraway (*Carum carvi L.*) essential oil

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Abstract

In this study the rheological, mechanical, barrier, optical and antimicrobial properties of carageenan and *Manihot esculenta* (composite) starch edible film functionalized with incorporation of caraway (*Carum carvi L.*) essential oil were investigated. The MIC of caraway oil against *Bacillus, E. coli, P. aeruginosa* and *S. aureus* were found to be 0.6, 1.4, 1.4 and 0.8 µg/mL respectively. Rheological results showed solid-like visco-elastic behavior of Film Forming Solution (FFS) with increasing concentration of caraway EO. Incorporation of EO caused significant increase in moisture, moisture absorption, bio-degradability in terms of film

solubility, *L* value, total color difference (ΔE), haziness and transparency value however, significantly decreased tensile strength, whiteness index were observed with addition of EO. The zone of inhibition of EO incorporated film against all test bacteria were highly significant ($P<0.01$) than control. No significant change in thickness, density, water activity, swelling, elongation at break, water vapor transmission rate, *a* and *b* value were observed in comparison to control. These results with some good physic-mechanical, antimicrobial and optical characteristics suggest application of such active film into variety of foods with improved food safety and quality.

Keywords: *Manihot esculenta,* caraway, essential oil, composite film, active packaging.
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(IFP 04)

Influence of flax seed flour and flax seed oil on stroage stability of vacuum packaged chicken meat sausages

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Abstract

The present study was carried out to evaluate the effect of 6 per cent of flax seed flour (FF) and 4 per cent of flax seed oil (FO) on storage stability of vacuum packaged omega-3-fatty acid enriched chicken meat sausages during 30 days of refrigerated 4±1°C storage. Chicken meat sausages added with FF (T1) had significantly ($P<0.01$) lower pH, 2-TBARS and per cent FFA values than control and sausages added with FO (T2). As the storage period progressed, a significant ($P<0.05$) increment in pH, 2-TBARS and per cent FFA values were found in both control and treated chicken sausages. The vacuum packaged chicken meat sausages added with FF (T1) had significantly ($P<0.01$) lower total plate counts, total psychrophilic counts, coliform counts, lactobacillus counts and yeast and mould counts than control and chicken sausages added with FO (T2). As the storage period progressed, a significant ($P<0.05$) increment was observed in all microbial counts including yeast and mould counts in both control and treated chicken sausages. The chicken sausages added with FF (T1) had significantly ($P<0.01$) superior colour, flavour, juiciness, tenderness and overall acceptability scores than chicken sausages added with FO (T2) and control sausages. As progression of storage period, there was a significant ($P<0.01$) reduction in sensory scores of both control and treated sausages. The above results indicated that vacuum packaged chicken meat sausages added with FF (T1) had significantly ($P<0.01$) lower pH, 2-TBARS and per cent FFA values, lower microbial counts and superior sensory scores during 30 days of refrigerated storage. Hence, it can be concluded that addition of 6 per cent of flax seed flour had more storage stability during 30 days refrigerated storage than control and chicken sausages added with 4 per cent flax seed oil.

Keywords: Chicken meat sausages, flax seed flour, flax seed oil, quality characteristics.
Acknowledgement: The authors are highly thankful to Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh, India for the financial support to carry out the above research work.
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(IFP 05)

Development of on- package freshness indicator to assess the quality of chicken meat under different storage conditions

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Abstract

Poultry industry is a fast-growing sector with the production of approx 3.22 million tones of meat. India has facing problems in cold storage and packing facilities of meat. The study was designed to develop dye-based freshness indicator for real-time monitoring of chicken meat during storage at 4±1°C, 10±1°C and 37±1°C temperatures. In the present study, four dyes were tried as a freshness indicator based on their colour changing ability. Bromocresol Purple dye-based indicator changed its visible colour from light yellow to purple, Bromothymol Blue from blue to light green, Cresol Red from dark pink to yellow and Cresol Purple from purple to yellow within 7 days, 3 days and 12-24 hr under 4±1°C, 10±1°C and 37±1° C storage conditions. The pH, TBARS value, ammonia, tyrosine value, TVBN, FAA and D-glucose concentration of chicken meat increased significantly ($P<0.05$) while Titrable acidity and ERV decreased significantly ($P<0.05$) with a collateral change in colour of the indicator during different storage conditions. The TVBN concentrations increased from 7.64, 8.55, 8.99 to 20.91, 22.34, 21.95 mg/100g during storage at 4±1°C, 10±1°C and 37±1° C, respectively. The hunter colour values showed a decrease in Redness (a*) and an increase in Yellowness (b*) value in all storage conditions. The changes in Nitrogen (N2) and Oxygen (O2) concentrations in the headspace of chicken meat package were found to be non-significant ($P>0.05$), while Carbon dioxide (CO2) concentrations increased significantly ($P<0.05$) from 0.36, 0.25, 0.26 to 1.60, 3.26, 18.91 %, respectively during storage at 4±1°C, 10±1°C and 37±1° C. All the microbiological parameters viz., Total plate count, Psychrophilic and Pseudomonas count varied significantly ($P<0.05$) with concurrent changes in colour of the indicator. Apart from physico-chemical, instrumental and microbial analysis, the decreasing trends were observed in all the sensory scores with the progression of storage period and concurrent changes in colour of the indicator. A distinct colour change (initial to final) was observed in the case of cresol red (CR) and cresol purple (CP) dye-based indicators, while bromocresol purple (BCP) and bromothymol blue (BTB) dye-based indicators showed a comparatively less distinct colour change during storage of chicken meat. On the basis of visible marked colour change in indictors, Cresol red (CR) and Cresol purple (CP) dyes were found best suited as indicator purpose for assessing chicken meat quality during storage.

Keywords: Freshness indicators, chicken meat, quality changes, dye based.
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(IFP 06)

Antagonistic activity of whey protein based films loaded with protective culture in a model meat system

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Abstract

Lactic acid bacteria (LAB) organisms are termed as protective cultures, which inhibit the growth of food spoilage and pathogens through competition for nutrients and with the production of bacteriocins, organic acids, proteolytic and antimicrobial enzymes. The whey protein concentrate (WPC; 6%) was used to develop biodegradable films as per the method casting method standardized in our laboratory. The known protective cultures viz. *L. acidophilus* (LA), *L. bulgaricus* (LB), *L. lactis* (LL), *L. plantarum* (LP) and *L. rhamnosus* (LR) combination or cocktail (LM) of all the cultures with a cell count of 105 cfu/ml were incorporated in the film matrix material and uniformly distributed before developing the films. The developed films along with control (whey protein films without any protective culture) were used to wrap the chevon meat chunks weighing 10g and microbial challenge testing was carried out against *E. coli, S. aureus, L. monocytogens* and *S. typhimurium*. The test organisms were inoculated in the meat system at the rate of 103 cfu/ml. The meat was stored for 18h at refrigeration temperature 4±2°C. After incubation, the quantitative assessment of test organisms clearly indicated the significant inhibition of test oragnisms. The biodegradable films with *L. plantarum* are able to inhibit all the test organisms upto 80%. The inhibition rate followed as per the pattern LP>LR>LM>LL>LB>LA. *L monocytogenes* was inhibited maximum by LR whereas *S. typhimurium* was inhibited highest by LP. On the basis of results, the biodegradable films loaded with protective cultures can be recommended for the packaging of raw meat to combat the issues of food safety.

Keywords: *L. plantarum*, antagonistic cultures, *L. rhamnosus*, food pathogens, lactic acid bacteria.

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(IFP 07)

Milk protein based bioactive biodegradable films for the storage stability of fresh poultry chunks

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Abstract

Bioactive biodegradable films were developed from 6% whey protein concentrate (72% protein) and impregnated with plantaricin (PLNT) and nisin (NIS) 0.5% w/v and a combination

of both Nisin (0.5%) and plantaricin (0.5%) (NIS-PLNT). The fresh poultry breast chunks (PBC) were packaged in the developed films and stored under aerobic conditions at refrigeration temperature (4±1°C) for 9 days. The storage quality of the PBC packaged in bioactive biodegradable films was compared with for was compared with PBC wrapped in biodegradable films without any preservative and PBC packaged in LDPE pouches (CON). The samples were drawn on alternate days i.e. 1, 3,5,7,9 and analyzed for various physicochemical (pH, titratable acidity, TBARS, PV, FFA) microbiological (SPC, Psychrophiles, coliforms, salmonella and yeast & mold), instrumental color profile and sensory parameters. Oxidative stability parameters were increased with storage period in all the products. TBARS value was measured (P<0.05) lowest in NIS-PLNT and highest (0.50±0.06) for CON on 9th day of storage. TBARS, PV and FFA varied as per pattern CON<NIS<PLNT<NIS-PLNT. SPC and psychrophiles were significantly lower in NIS-PLNT and PLNT than all other treatments throughout storage. SPC was more than 3 log cycle lower in NIS-PLNT than control on the last day of storage. Yeast and mold were not detected in any sample throughout the study. Instrumental color profile (L*, a*, b*) was better maintained in the PBC wrapped in protein based biodegradable films throughout the storage period than LDPE packaged PBC. Sensory quality attributes also followed a decreasing trend with the increase in storage days. The control products developed off odour and sliminess on 5th and 7th day of storage, respectively. Results concluded that the raw poultry beast chunks can be stored successfully for 9 days at refrigeration temperature on packaging with whey protein based bioactive films impregnated with 0.5% each of Nisin and plantaricin, with acceptable physico-chemical, sensory and microbiological quality characteristics.

Keywords: Shelf life, quality, microbial quality, bioactive films, bacteriocins.
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(IFP 08)

Effect of edible coating incorporated with natural antimicrobials on quality and shelf-life of chicken patties

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Abstract

Indiscriminate use and increased awareness regarding the harmful effects of synthetic preservatives has compelled the researchers to develop natural methods of preservation of meat and meat products. The present research work was undertaken for the extension of shelf-life and enhancement of quality of chicken patties using edible coatings incorporated with essential oil. Chicken patties were coated with chitosan incorporated with clove essential oil and kept in aerobic packaging at frozen storage (-18±1ºC) and evaluated for physico-chemical and microbiological parameters and sensory characteristics for a period of 120 days. The study

revealed that control (T1) and only chitosan-coated chicken patties (T2) had significantly ($P<0.05$) higher ($P<0.05$) tyrosine value, TVBN concentration, TBARS value, pH and lower DPPH value than chicken patties coated with chitosan and clove oil (T3). The microbiological study revealed that T3 had significantly lower ($P<0.05$) aerobic plate count, coliform count, yeast and mold count and *Pseudomonas* count than T1 and T2. Sensory evaluation revealed no significant difference ($P<0.05$) among freshly prepared patties but the scores were significantly higher ($P<0.05$) in T3 during the advanced stage of storage. Thus, from the present study, it was concluded that the edible coating of chitosan incorporated with clove essential oil can be successfully used for the enhancement of quality and shelf-life of chicken patties.

Keywords: Essential oils, natural antimicrobials, shelf-life extension.
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(IFP 09)

Quality, sensory and shelf life investigation of chicken nuggets wrapped in Tapioca starch based edible film containing different essential oils at refrigeration (4±1°C) storage

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Abstract

The aim of the study was to evaluate chemical, microbiological and sensory changes during storage at 4±1°C of chicken meat nuggets wrapped with tapioca starch based edible films prepared with incorporation of anise, caraway and nutmeg essential oils (Eos). In consideration of the minimum inhibitory concentration (MIC) and sensory examination, a total of 3 groups of different EOs along with 2 controls were investigated. The result of analysis showed that the pH, peroxide, FFA and TBA value of treatments were significantly ($p < 0.05$) lower than both the controls. The treated products revealed significantly ($p < 0.05$) higher DPPH activity. The total plate count, psychrophilic and yeast and mold count were significantly ($p < 0.01$) lower in treatment groups, whereas, coliforms were not detected throughout the storage period. Among treatment groups, the general arrangement of effect of essential oils on microbial count was in the order Nutmeg > Anise > Caraway. All sensory attributes except saltiness of samples were significantly influenced by the storage time ($p < 0.05$). The treated samples were found well acceptable during whole storage period of 15 days however the control C showed to be the most perishable group during the storage. Reduction in overall acceptability with storage time was much pronounced in control than C1, T1, T2 and T3. Thus, the application of edible film in meat product was found proficient in confining the products quality and sensory attributes

throughout refrigeration storage.

Keywords: Essential oils, chicken nuggets, storage study, edible film, tapioca starch.
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(IFP 10)

Storage stability of functional Kadaknath chicken patties under different packaging

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Abstract

Fibre enriched low fat functional kadaknath chicken patties were developed and packaged aerobically as well in vacuum condition and evaluated for storage stability under refrigeration. The pH, TBA and FFA values of fibre enriched low fat kadaknath chicken patties were lower as compared to control throughout the storage. A progressive and significant ($P<0.05$) increment in the pH, TBA and FFA values of control as well as fibre enriched low fat kadaknath chicken patties were observed with the advancement of storage in aerobically as well as in vacuum packaged kadaknath chicken patties . The total plate count (TPC) followed a significantly ($P<0.05$) increasing pattern from 0 to 12 day (in aerobic packaging) and from 0 to 28 day (in vacuum packaging) in control as well as fibre enriched low fat kadaknath chicken patties. Psychrotropic counts as well as Yeast and Mold count under aerobic packaging were not detected upto 9 day of storage either in control or in fibre enriched low fat kadaknath chicken patties and these were detected on 12 day of storage. However, psychrotropic counts under vacuum packaging were detected from 14th day of storage and Yeast and Mold were not detected during the entire period of storage. Coliform were not detected during the entire period of storage in either of packaging. Sensory attributes under storage study did not have any significant ($P>0.05$) difference between control and fibre enriched low fat kadaknath chicken patties on all storage days in either of packaging. The mean scores for all the sensory attributes for both control as well as fibre enriched low fat kadaknath chicken patties decreased gradually with increasing storage period. From the study it was concluded that the fibre enriched low fat kadaknath chicken patties may be considered as health full product which was very well stable and accepted up to 12 day (in aerobic packaging) and for a period of 28 days (in vacuum packaging) under refrigeration.

Keywords: Low fat, fibre enriched, kadaknath, microbiological quality, sensory attribute, packaging methods.
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(IFP 11)

Extending the shelf life of paneer coated in edible film treated with essential oils

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Abstract

The present study was conducted to evaluate shelf life of paneer wrapped with essential oil treated edible packaging film. CMC and starch based edible packaging film was prepared and treated with 0.5% concentration of essential oil of clove and oregano. Freshly prepared paneer was wrapped with essential oil treated edible film and evaluated for the shelf–life at refrigeration temperature (4°C) till spoilage. During storage different physico-chemical parameters like pH, titratable acidity, TBA and tyrosine value was evaluated. At the same time microbial examination of total plate count, psychrophilic count, yeast and mould count and coliform count was done at the interval of 3 days. Sensory evaluation was also done at the interval of 5 days, on the parameters like appearance, juiciness, flavour, texture and overall acceptability. Control sample was failed in sensory evaluation on 5th day of storage and microbiologically found unfit on 9th day of storage. The paneer packed in clove and oregano essential oil treated edible packaging film was found unattractive on 10th day of sensory evaluation. But found microbiologically sound at 12th day of storage. The result, shows paneer packed in edible film treated with clove and oregano essential oil were found to increase the shelf –life of paneer for at least by 4 days.

Keywords: Paneer, edible packaging, essential oils, shelf life, microbial quality.

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(IFP 12)

Advanced packaging technology for preservation of meat

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Abstract

Meat is perishable commodities and to prevent it from spoilage, pathogen contamination, many of modern packaging techniques are being used. Freshly slaughtered meat is virtually sterile, it generally becomes contaminated with microorganisms - feces from hides and skins, germs on tools, hands or in rinsing water - during subsequent cutting and processing stages. Food borne illnesses associated with pathogens, toxins, and other contaminants pose serious threat to human health. Spoilage microorganisms including bacteria, yeast and molds, and pathogenic micrograms, specifically *Salmonella spp., Staphylococcus aureus, Listeria*

monocytogenes, Clostridium perfringens, Clostridium botulinum, and *Escherichia coli* O157:H7 are of major concern. Active packaging refers to the active materials, such as moisture absorbent, scavengers, antimicrobial and antioxidants releasing systems that are used in the food surrounding environment to enhance the performance of packaging system. Active and intelligent packaging solutions are showing great promise for the improvement of packaging functionality and will enable extended shelf life, higher quality and greater safety of packed meat. Microbial contamination and lipid and protein oxidation are major concerns for meat and meat products in terms of food safety and quality deterioration. The meat quality and safety properties are highly dependent on packaging materials and technologies. Antimicrobial packaging is one of the most important concepts in active packaging of meat. This is because meat provides excellent nutrients for the potential growth of microorganisms, therefore careful attention needs to be given to minimizing bacterial proliferation in order to deliver safe, wholesome meat to the consumer.

Keywords: Modern packaging, antimicrobial packaging, protein oxidation.
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(IFP 13)

Storage stability of fibre enriched egg kofta wrapped in soy protein based bioactive biodegradable films under different packaging conditions

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Abstract

In the present study, shelf life of fibre enriched egg kofta (FEK) wrapped in soy protein isolate (SPI) biodegradable films was ascertained by evaluating the changes in product quality and storage stability under different packaging conditions. As per previous studies carried out, a formulation mixture of 4% w/v SPI with sodium alginate and glycerol at a drying temperature of 45̊C for 7-8 hrs was standardized for development of SPI films impregnated with 2 % (v/v) licorice extract as a natural antioxidant and antimicrobial. FEK packed in developed bioactive biodegradable SPI film under different packaging conditions were evaluated. Different treatments viz. aerobic packaged product (T-1), product packaged in MAP conditions (T-2), product packaged in vacuum(T-3), product wrapped in developed films and packaged under aerobic conditions(T-4), product wrapped in developed films and packaged under MAP conditions (T-5) and product wrapped in developed films and packaged under vacuum conditions(T-6) kept under refrigeration (4±1 ºC) **were assessed for various physiochemical, microbiological parameters and** sensory attributes. The pH was significantly ($P<0.05$) lower in T-5 than all other treatments. The bioactive film wrapped products (T-4, T-5) had significantly ($P<0.05$) lower peroxide values as well as TBARS value than the unwrapped products (T-1, T-2, T-3). In general, microbiological parameters viz. SPC, Psychrophilic and Yeast and Mold count of the wrapped products was significantly ($P<0.05$) lower than unwrapped at the end of the storage period. Coliforms were not detected in any of the treatments except in T-1 that too on

28th day of storage, however, *Salmonellae* were completely absent in all the treatments throughout the storage period. The results concluded that developed FEK wrapped in developed SPI based bioactive biodegradable films can be successfully stored under modified atmosphere packaging conditions at refrigerated temperature (4±1℃) for 35 days without any adverse effect on oxidative stability, microbiological and sensory quality attributes.

Keywords: Fiber enriched egg kofta, biodegradable film, soy protein isolate, vacuum packaging, storage life, modified atmosphere packaging .
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(IFP 14)

Intelligent packaging: an enzyme substrate based TTI for monitoring the quality of frozen chicken in supply chain

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Abstract

Poultry industry is highly organised nearly 70% and growing rapidly among the livestock sector. There is no system available for monitoring the temperature abuse spoilage of increasing supply of frozen chicken in the storage. A Gel type TTI encased in LDPE film was developed by optimizing the levels of enzyme-substrate (Laccase-Guaiacol) and carrier (Agarose). The indicator was attached to packaged frozen chicken meat and exposed to three different temperature abuse conditions i.e. 37±1℃ for 2h, 4h, 6h, 8h, 25±1℃ for 3h, 6h, 9h, 12h, and 4±1℃ for 12h, 24h, 36h, 48h respectively. The TTI based on Laccase-Guaiacol complex changed from colourless to light brown and finally dark brown colour. These colour changes indicated the deterioration in meat quality and safety as a result of temperature abuse. The simultaneous analysis of pH, extract release volume, total volatile basic nitrogen, free amino acids, D-glucose, FDA hydrolysis, instrumental colour, shear force value, total plate count, psychrophilic count, Pseudomonas count, yeast and mold count and various sensory attributes indicated that the changes in quality parameters were well comparable with the colour change in the TTI. Colourless, light brown and dark brown TTI colour indicated that there was no temperature exposure, short duration and longer duration exposure to frozen meat hence meat is highly acceptable and unacceptable respectably. It was observed that changes in meat quality parameters were rapid at higher temperature abused chicken meat samples compared to lower temperature abused samples. Exposure of chicken meat to 37°C for 4h or 25°C for 6h or 4°C for 24h continuously makes the meat unacceptable. It is concluded that enzyme- substrate based TTI can be successfully used for monitoring meat quality and safety during temperature abuse of frozen chicken meat in the supply chain.

Keywords: Intelligent packaging, enzyme substrate, TTI indicator, frozen chicken.
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(IFP 15)

Studies on microbiological qualities of electron beam irradiated modified atmosphere packaged raw chicken at refrigeration temperature

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Abstract

The present study was undertaken to determine combined effect of Modified Atmosphere Packaging (MAP) and Electron Beam Irradiation (EBI) on microbiological qualities of raw chicken at refrigeration temperature. The raw chicken samples were purchased from HACCP accredited chicken processing plant in and around Mumbai city. All the samples were divided into 5 separate groups, one control group, second MAP control and remaining three groups were exposed to 1.0, 2.0 and 3.0 kGy EBI doses and stored at refrigeration temperature. All the raw chicken samples were analyzed to determine its TVC, differential counts and sensory qualities. The average total viable count for the control and MAP control samples on 0 day was found to be 4.70±0.11 and 4.45±0.33, respectively, whereas for samples irradiated at 1.0, 2.0 and 3.0 kGy the count was 3.70±0.06, 2.47±0.08 and 2.22±0.14, respectively. Microbiological analysis of irradiated raw chicken samples packaged in MAP showed significant reduction in TVC, average S. aureus, E. coli and yeast and mould counts with increasing electron beam irradiation doses. However, electron beam irradiated and raw chicken control and MAP control samples did not contain *Salmonella* spp., *Pseudomonas* spp., *Listeria* spp. and *Bacillus* spp. throughout the period of storage. Color measurements showed reduced Hunter a* and b* values and increased L* value of electron beam irradiated raw chicken samples. Thus, the study concluded that electron beam irradiation dose at 3.0 kGy was found to be more effective in control of microbial load of raw chicken samples packaged in MAP at refrigeration storage.

Keywords: MAP, electon beam irradiation, microbiological quality, raw chicken, refrigeration.

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(PMPQ 01)

Effect of essential oils and their combination on the quality attributes of chicken nuggets

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Abstract

The effect of oregano, thyme essential oils, and their combination on the quality of chicken nuggets stored under refrigeration (4±1ºC) temperature were studied along with control. The products were analysed for physico-chemical, microbiological and sensory parameters of chicken nuggets were determined. The result showed that incorporation of essential oils either alone and their combination significantly ($P<0.05$) had higher DPPH scavenging activity than that of the control samples throughout the storage period. Also, essential oil incorporated chicken nuggets showed that reduction in TBARS and tyrosine value. Incorporation of essential oil and their combination significantly ($P<0.05$) reduced the total viable count, psychrophillic count, yeast and mould count over the control samples. Coliforms were not detected in the essential oil incorporated chicken nuggets throughout the storage period. Essential oil incorporated chicken nuggets received acceptable sensory scores over control samples. The study indicated that chicken nuggets incorporated with essential oils either alone and their combination retained acceptable physico-chemical characteristics, microbial counts and had good to very good sensory ratings when stored under refrigeration at 4 ± 1ºC for 35 days but the control samples got spoiled after 28 days of storage. Hence, it was concluded that essential oil incorporated chicken nuggets in this study could be safely stored up to 35 days 4±1ºC without any marked loss of physico-chemical, microbiological quality but slightly lower but acceptable sensory quality.

Keywords: Chicken nuggets, essential oils, incorporation, quality attributes, acceptability.

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(PMPQ 02)

Antioxidant effects of extracts of orange peel and Moringa oleifera leaves on chicken meat sausages

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Abstract

To overthrow the detrimental effect of synthetic antioxidants, the present study was undertaken to investigate the antioxidant effects of extracts of orange peel powder and Moringa oleifera leaves on chicken meat sausages. The effect of these extracts on sensory

evaluation, instrumental colour, moisture content, pH, TBARS, FFA and microbial counts of sausages stored at frozen temperature (-18°C) for 100 days was evaluated. The results revealed that extracts treated sausages showed better sensory scores. There was no negative effect on the instrumental colour, moisture content and pH of the control and treated sausages. TBARS, FFA and microbial counts indicated significant differences as compared to control sausages which had higher values of the respective parameters. Thus, it was concluded that the orange fruits by products powder and Moringa leaves have the potential to be used as natural antioxidants.

Keywords: natural anti oxidants, orange peel, Moringa oleifera, lipid oxidation and TBARS
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(PMPQ 03)

Studies on production and shelf life of chicken nuggets incorporated with whole egg liquid

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Abstract

Study was undertaken with a view to develop an acceptable quality chicken nuggets with inclusion of whole egg liquid and bread crumps. Emulsion prepared by blending of minced and chopped meat of broiler, spent hen and its combination with or without non meat ingredients was used for preparation of chicken nuggets. Results indicated that the nuggets made from broiler meat exhibited significantly higher scores for juiciness, texture and overall palatability as compared to that of spent hen meat. Similarly, the emulsion stability and cooking yield of chicken nuggets improved significantly when prepared from broiler meat. As far as binders are concerned, whole egg liquid was found helpful in improving the sensory quality as well as other quality attributes of chicken nuggets. Nuggets made with incorporation of 15 per cent WEL scored optimum for all the sensory attributes and ranked superior with regard to emulsion stability and products yield. Incorporation of bread crumps did not show remarkable improvement in quality attributes of chicken nuggets. Storage study revealed that the scores of all the sensory attributes declined gradually with the progress of storage. Similarly, the pH, TBA number, tyrosine value and microbial counts increased considerably at the end of 20 days storage but, the counts were within the spoilage limit. It is concluded that chicken nuggets with or without WEL or bread crump's could be stored safely in HDPE pouches for 20 days under refrigerated storage (4±1°c).

Keywords: Chicken nuggets, whole eggs, bread crumps, HDPE, quality attributes.
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(PMPQ 04)

Storage stability of emulsion based chicken sausages incorporated with blends of essential oils at refrigeration temperature (4±1℃)

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Abstract

This work explores the efficacy and potential of four different blends of essential oils as bio-preservative for enhancement of shelf life of emulsion based (ready-to-eat) chicken sausages. Chicken sausages were prepared by incorporating optimum level of blends of various essential oils (clove oil, holy basil oil, cassia oil, thyme oil, ajowan oil and beetle oil) viz, Blend-1 (0.25%), Blend-2 (0.25%), Blend-3 (0.25%) and Blend-4 (0.125%). Refrigerated and aerobically packaged products were analysed for various parameters at 7 days interval for 42 days. It was found that blend of essential oils (EOs) had no significant effect (P>0.05) on proximate composition of emulsion based chicken sausages. However, significant increase (P<0.05) in pH of both control and treatment samples occurred upto day 14 of storage period followed by decrease in values. TBARS increased significantly (P<0.05) in all the products at each interval of storage period. Increase in TBARS was found to be least in case of Blend-2 products. Regarding anti-oxidant activity, it was found that control products had significantly lower (P<0.05) total phenolics content and DPPH activity than treatment products. Among treatments, Blend-2 products were observed with significantly higher (P<0.05) values for both the parameters. Further, Blend-1 and Blend-2 products were observed with significantly lower (P<0.05) microbial count; however, Blend-4 products received slightly higher sensory scores than Blend-2. It was found that Blend-1, 2 and 3 (each at 0.25%) and Blend-4 (0.125%) enhanced the shelf life of chicken sausages by 13-14 days, 16-17 days, 10-11 days and 6-7 days, respectively.

Keywords: Chicken sausages, essential oils, food safety, anti-oxidant activity, microbial quality, storage stability.

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(PMPQ 05)

Efficacy of mango peel as fat replacer for development of low fat functional chicken patties

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Abstract

The study was aimed to study the efficacy of mango peel powder as fat replacer for development of low-fat functional chicken patties. Low fat chicken patties were developed by incorporating mango peel powder separately at 1.0, 2.0 and 3.0% level to replace 50% vegetable oil in formulation. The formulation of emulsion was maintained by addition of water accordingly. There was a significant difference (P<0.05) between control and treatments for all physicochemical properties except product pH and protein content. The emulsion pH, emulsion stability, water activity, fat and cholesterol content of mango peel treated chicken patties was significantly (P<0.05)lower, however cooking yield, moisture content, fat retention and moisture retention values was significantly (P<0.05) higher than control. All mineral content decreased significantly (P<0.05) in treatments except potassium and phosphorous content. Scores for all sensory attributes were decreased significantly (P<0.05) in treatments except juiciness, however there was no significant difference between sensory score of MP1 and MP2. Therefore it is concluded that 2% mango peel powder cold be extended as fat replacer in the development of low fat emulsion based meat products.

Keywords- Emulsion based products, low fat, functional chicken patties, mango peel, fat replacer.

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(PMPQ 06)

Development of low fat emulsion based chicken products by incorporation of oat flour

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Abstract

This study was conducted develop low fat emulsion based chicken products by replacing meat with oat flour in standard emulsion. The standard formulation for emulsion was optimized based on preliminary study and used for the current study. In standard emulsion formulation meat is replaced with oat at 5, 10 and 15 percent level and evaluated for physico-chemical, proximate, textural and sensory attributes in both raw emulsion and cooked nuggets. Significant (P<0.05) improvements in emulsion stability, water holding capacity, cooking yield, moisture retention and fat retention were observed with incorporation of oat flour. The protein, fat and ash content decreased with incorporation of oat flour with significant (P<0.05) increase in crude fibre with addition of oat flour. Because of larger moisture absorption and moisture retention during cooking properties of oat soluble fibre maintains the textural integrity of the emulsion without fat addition. Texture profile analysis revealed significant (P<0.05) reduction in hardness force and hardness stroke with no significant (P>0.05) differences in adhesive force among all treatments. Sensory evaluation for attributes like appearance, flavor, texture and overall acceptability revealed that acceptability of 15% oat incorporated product was significantly lower (P<0.05) compared to other treatments. From the results obtained in this study, it was concluded that oat flour can be used successfully as a fat substitute in low-fat emulsion based chicken product without deteriorating the product quality at 10% level with better sensory acceptability.

Keywords: Low fat, emulsion based, chicjen products, oat flour, quality attributes.

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(PMPQ 07)

Effect of green tea extract on quality attributes of chicken meatballs during refrigerated storage

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Abstract

The aim of present study was evaluate the antioxidant property of green tea (Camellia sinensis) extract to prevent lipid oxidation in chicken meatballs during refrigerated storage. In the preliminary trials, standardization of the meat and potato with three different levels 5, 10, 15% were prepared and compared for sensory properties. The meatballs having 65% meat and 15% potato was found to be better over other two treatments for sensory parameters. For standardization of the pearl millet flour, product with 0.5, 1 and 1.5% flour were tried and compared for sensory properties where treatment with 1.5% pearl millet flour was found superior over other. To examine antioxidant property of chicken meatballs were prepared by as control (without green tea), green tea extract at different concentrations levels as 0.25%, 0.5%, and 0.75% levels. During storage of chicken meatballs the moisture, protein and fat declined significantly while pH, TBA, tyrosine values increased significantly ($p<0.05$). The difference in sensorial properties between the control and treatment and all the products were acceptable up to 20th day of storage. Similarly, the total plate count, psychrophilic count increased significantly ($P<0.05$) during 20 days storage but were within the spoilage limit. However, *Coliform* spp, *Clostridium* spp, yeast and mould were not detected through-out study period. Thus, based on the observations, it is concluded that green tea extract may be utilized as a natural antioxidant in cooked meatballs.

Keywords: Green tea extracts, meat balls, refrigeration storage, antioxidant properties, shelf life.

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(PMPQ 08)

Comparative physicochemical and sensory quality of meat in commercial native chicken, backyard native chicken, commercial broiler and spent layer chicken

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Abstract

Back yard native chickens are becoming popular along with the commercial native chicken. A study was planned on the physicochemical quality of meat in commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC). An experiment was conducted on 12 birds of either sex in each class. Birds were purchased form commercial farms in and around Namakkal, Tamil Nadu slaughtered by Jatka method. Physico-chemical parameters, of each group were studied for sexes and breast and leg meat separately. A meat product nugget was prepared to assess the sensory quality. WHC was significantly higher (P<0.01) and muscle fiber diameter and collagen content were significantly lower ((P<0.01) in CB than BNC and SLC. Shear force values for fresh and cooked meat were significantly lower in CB and highest in SLC. The collagen content was significantly higher in males than females and in thigh meat than breast meat. The chewability in the cooked thigh meat was better than breast meat. The overall acceptability of nugget for CB was significantly higher (P<0.01) than CNC, BNC and SLC. The study revealed that commercial broiler meat was better than commercial native chicken, backyard native chicken and spent layer chicken in overall physicochemical and sensory quality in terms of low collagen content, better tenderness, water holding capacity, juiciness and overall acceptability.

Keywords: Meat quality, native chicken, backyard poultry, spent layer, chicken nugget, sensory quality.

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(PMPQ 09)

Standardization of formulation and processing conditions for the development of extruded chicken meat puffs

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Abstrat

Snack foods are important part of diet as a source of nutrients and energy supply in between the regular meals. In the present study the formulation and processing conditions for the development of meat based snack foods i.e. chicken meat puffs were standardized. The selected ingredients for the preparation of meat puffs was: chicken meat powder, rice flour, corn flour, chicken fat, water, salt, spice mix and food grade colour. The dried ingredients were mixed in the mixer for 5 minutes. The mix was filled in the feeder of the extruder. After starting the oil pump and heater of machine, then main motor was started and waited till the speed of barrel reaches to the frequency of 35 and temperature reaches to 120°C (heater area 3), then started the feeder motor and waited till good quality extruded products comes out. Then cutter motor was started at the speed of 9 runs. The prepared chicken meat puffs was collected in the large vessel. The developed product was analysed for the physicochemical, instrumental colour, texture profile, proximate and sensory quality evaluation. The developed extruded

chicken meat puffs had acceptable physico-chemical and sensory properties.

Keywords: Extruded, ingredients, snack, puffs.
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(PMPQ 10)

Quality evaluation of dried, shelf stable and ready-to-fry/microwavable spent hen meat based chips and their production economics

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Abstract

Effective utilization of tough and fibrous meat from spent hen and breeding stock used for production of both broiler and layer chicks, is a pertinent problem and requires alternate solutions to meet the demands of consumers. Increasing market demand for convenient, nutritious and economical food products has instigated the research drive for production of nutritionally superior products from little valued tough meat from spent birds. In recent past, microwaving has evolved as a fast and convenient cooking method, which can prepare nutritious dishes with less quantity of fat. Therefore, present study was designed to evaluate quality of dried, shelf stable and ready-to-fry or microwavable spent hen meat based chips, prepared by using tapioca starch, corn flour and potato starch. After conducting a range of experiments with combinations of different flours, starches, meat levels and processing conditions, the final product was selected based on high sensory acceptability using frying as cooking technique. Comparison of frying and microwaving as cooking methods revealed higher sensory acceptability for deep fat fried product as compared to microwaved, although microwaved product also showed good acceptability on 9-point hedonic scale. Flavour (7.06±0.12) and texture (7.00±0.10) scores were much better in frying than microwaving for which corresponding values were 6.22±0.14 and 6.53±0.15, respectively. Due to higher sensory acceptability, frying was selected as cooking technique. The protein content of fried ready-to-eat chips was 16.26±0.35 percent and the value was significantly higher than control (0.48±0.04) in which no meat was added. Texture profile analysis for Hardness (22.19±1.43 N for Control and 24.47±1.59 N for treatment) and Fracturability (0.086±0.003 N for control and 0.098±0.006 N for treatment) did not revealed any significant difference. The suggested retail price for 1Kg of ready-to-fry spent hen meat based chips was calculated at Rs 500/kg i.e. each 100 g packet can be sold at retail price of Rs.50. However, margin of profit can be substantially increased by using commercial equipments and increasing per-day production. Therefore, this product with high protein content could be an alternative to starch based snacks and potato chips available in the market.

Keywords: Spent hen meat, shelf stable, ready to eat, quality evaluation, acceptability.
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(PMPQ 11)

Physico - chemical and sensory attributes of apricot enriched dietetic egg albumen nog

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Abstract

The study was carried out to develop a healthy drink with best quality proteins having no added sugar. In this study efforts were made to develop dietetic egg albumen nog with the incorporation of different levels of apricot. The developed products were evaluated for different physic-chemical and sensory attributes. The dried apricot and eggs were purchased from the local market of R.S. Pura, Jammu. Apricot were boiled in water and finely chopped to obtain the pulp. Simultaneously eggs were disinfected with 2% sodium hypochlorite solution and pasteurized at 64°C for 2.5 min. Thereafter albumen is separated and beaten with blender till it obtained a frothy consistency. The fresh cow milk was procured from the dairy farm of SKUAST-J and adjusted to 3.5% fat and 8.5% SNF. Milk is boiled and cooled. All the ingredients are added in a mixer such as milk, beaten albumin, apricot pulp, artificial food grade colour, gelatine and aspartame (sugar free) and mixed. Three levels of apricot i.e. 15%, 20% and 25% were incorporated and 20% apricot pulp was optimized on the basis of sensory evaluation and physic-chemical parameters. The following observation were noted Moisture – 85%, Fat – 2.75%, Protein - 4.42% , Ash – 1% and Dietary fibre – 1.03%, carbohydrate - 5.8%. Thus 20% level was chosen on the basis of physic-chemical and sensory attributes. The developed product can be used in constipation and diabetes as it contains fibre and no sugar respectively.

Keywords: Egg nog, dietetic, apricot, egg albumen.

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(PMPQ 12)

Process standardization and quality attributes of dietetic fig enriched egg albumen nog

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Abstract

In present study, protocol was optimized for preparation of fig enriched egg albumen nog with the incorporation of different levels of fig and thereafter physico-chemical and sensory characteristics were analyzed. Fresh eggs were procured from local market of R.S Pura, Jammu and were subjected to disinfection with 2% sodium hypochlorite solution. Eggs were pasteurized at 64^{o}C for 2.5 minutes. Egg albumen was separated from egg yolk and beaten with

blender till foamy consistency was attained. Dried figs obtained from local market were hydrated by boiling in water and triturated to obtain pulpy consistency. Fresh cow milk obtained from Faculty of Veterinary Sciences and Animal Husbandry dairy farm adjusted to 3.5% fat and 8.5% SNF milk was boiled and on cooling it was blended with other ingredients. The ingredients added including foamy egg albumen, pulp of fig, gelatin, aspartame (sugar free) were blended in mixer and food grade color was incorporated to provide pleasing appearance. Three levels of fig were used i.e. 5%, 10%, 15% to formulate egg albumen nog. On basis of different physico-chemical and sensory attributes, 10% level was selected as optimum. The selected egg nog was having -Moisture-80.7%, Protein-4.6%, Fat-2.9%, Ash-0.9%, Crude fibre-0.2%, Carbohydrate-10.7%. Overall acceptability was highest for egg nog prepared with the incorporation of 10% fig. Developed product is a good source of high quality protein. The product can be consumed by persons suffering from diabetes as this is free from added sugar.

Keywords: Egg albumen, Dietetic, Fig, Egg Nog
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(PMPQ 13)

Nuggets prepared from fresh and cured broiler chicken meat

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Abstract

Nuggets were prepared from fresh and cured meat of spent broiler chicken, packed in polyethylene bags and stored for 12hr at -18 ± 2°C. Thawed nuggets were fried with refined olive oil on a hot pan and the product quality was apprise. Olive oil consists mainly of oleic acid (up to 83%) with smaller amounts of other fatty acids including linoleic acid (up to 21%) and palmitic acid (up to 20%). Nuggets from cured chicken had lower moisture and higher fat contents and lower weight loss on frying compared to fresh meat nuggets and reduction in the product diameter. With the exception of pulpiness, sensory performance ratings of cured meat nuggets were significantly higher than fresh meat nuggets. Cured chicken meat produced better nugget products compared to fresh meat as indicated by lower FFA and TBA values and better sensory quality and texture. Products packed in polyethylene bags can be stored at -18 ±2̊C for up to 4 months without marked deterioration in product quality.

Keywords: Olive oil, chicken curing, TBA value, free fatty acids.
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(PMPQ 14)

Effect of guar gum incorporation on quality of low fat kadaknath chicken patties

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Abstract

Low fat patties were prepared by incorporation of three different levels of guar gum (T-1 0.5%, T-2 1% and T-3 1.5%) by replacing added fat. The emulsion stability was found to be increased initially from control to T-2 and then decreases with the further increasing level of guar gum. There was a significant ($P<0.05$) difference in the cooking yield and moisture content of kadaknath chicken patties between control and treatments. Guar gum added low fat kadaknath chicken patties had significantly ($P<0.05$) lower fat content compared to control. Moisture retention was significantly ($P<0.05$) lower in control as compared to guar gum incorporated kadaknath chicken patties. Fat retention was significantly ($P<0.05$) increased with the increasing level of guar gum from control to T-2 and thereafter a non-significant ($P>0.05$) increment was noticed. Hardness, cohesiveness and gumminess values of guar gum incorporated kadaknath chicken patties differed significantly ($P<0.05$). However, no significant difference in the adhesive force was noticed. Sensory attributes of guar gum incorporated fibre enriched low fat kadaknath chicken patties indicated that there were non-significant ($P>0.05$) difference in the mean scores of general appearance, mouth coating, saltiness and juiciness. Flavor and texture scores at T-1 and T-2 were comparable to control although scores were significantly ($P<0.05$) lower for T-3. Sensory panelists rated T-2 similar to control for texture attributes. Overall acceptability revealed that there was significant ($P<0.05$) variations among different guar gum incorporated fibre enriched low fat kadaknath chicken patties. A significant ($P<0.05$) lower score were observed for T-1 and T-3. However, score for T-2 was comparable to control. Hence, patties with 1% guar gum (T-2) was found superior and most acceptable by the sensory panelists and finally selected as fibre enriched low fat kadaknath chicken patties.

Keywords: Kadaknath, low fat, fibre enriched, chicken patties, guar gum, quality attribute.

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(PMPQ 15)

Effect of Incorporation of Oregano oil on the quality attributes of chicken nuggets

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Abstract

Lipid oxidation and protein oxidation are the important problems that may affect the quality and shelf life of the poultry meat products. Hence, an experiment was conducted to study the quality attributes of chicken nuggets by incorporation of oregano oil. Chicken nuggets were prepared by incorporating oregano oil at three different levels (0%-control, 0.05% - treatment I, 0.1% - treatment II, 0.25% treatment III). The products were evaluated for various physico-chemical parameters and sensory parameters to find the optimum level of incorporation of oregano essential oil in the chicken nuggets. The result showed that the emulsion pH, product pH, emulsion stability, product yield, shear force value, moisture and fat retention did not show any significant difference between the treatments and control. The DPPH scavenging activity of oregano essential oil was observed to be significantly (P<0.05) increasing with increasing concentrations, highest value being observed in 0.25%. Sensory evaluation of the nuggets revealed significant (P<0.05) difference in flavour, spiciness and overall acceptability between treated and control nuggets. Thus it can be concluded that 0.1% level of inclusion of oregano oil can be effectively used for preparation of chicken nuggets of an acceptable quality.

Keywords: Chicken nuggets, oregano oil, shelf life, quality attribute.
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(PMPQ 16)

Effect of incorporation of curry leaves extract and powder on the sensory attributes of chicken patties during refrigerated storage

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Abstract
Aim of this study was to find out the effect of incorporation of curry leaves extract and powder in chicken patties on sensory attributes during refrigerated storage. The chicken patties prepared by incorporation of curry leaves extract at the level of 1% (E1), 2% (E2) and powder at 0.4% (P1), 0.6% (P2) were assessed at a regular interval of 5 days upto 20 days under refrigerated storage (4±10C). The mean appearance scores of control and powder groups were non-significantly decreased with advancement of storage period. The mean flavour scores of all groups were non-significantly decreased with advancement of storage period upto 20 days of storage except for E1 and P2 groups. The overall study revealed that the patties of all groups showed a declining trend for juiciness during the storage being highest for 0 day and lowest for 20th day. The mean values for tenderness score of all groups were non significantly decreased during the advancement of storage period except for E1, E2 and P2 groups were decreased significantly (p<0.05). The extract groups showed slightly higher overall acceptability as compared to powder groups. A decreasing trend was recorded for the score offered for all sensory parameters of chicken patties with the advancement of storage period. It can be concluded that the chicken patties incorporated with 2% curry leaves extractor 0.6% powder can be stored upto 20 days at refrigerated temperature without significant effect on the sensory attributes.

Keywords: Chicken patties, sensory evaluation, curry leaves extract and curry leaves powder.
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(PMPQ 17)

Development of chicken meat patties by using lychee pericarp aqueous extract

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Abstract

The study was conducted with an objective to evaluate the effect of lychee pericarp extract on quality characteristics of chicken meat patties. The extract was prepared after overnight soaking of 10gm lychee pericarp powder in 100 ml distilled water and then by filterating with whatman filter paper. The chicken meat patties were prepared with incorporation of 5%, 10%, 15%, 20% of the extract after the sensory evaluation selected level of lychee pericarp aqueous extract is 15% and the nutritional and physico-chemical characteristics of product is studied. The extract addition showed significantly increase in shelf life and it also decreased the fat and free fatty acid content as compared to control sample. The emulsion stability and cooking yield were also higher. The addition of lychee pericarp aqueous extract resulted in lower thiobarbituric acid content as compared to control. It is concluded that addition of lychee pericarp aqueous extract chicken meat patties at 15 % level improved the nutritional and physico-chemical properties of chicken meat patties.

Keywords: Lychee pericarp, chicken patties, physiochemical properties.

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(PMPQ 18)

Comparative nutritive value of meat in commercial native chicken, backyard native chicken, commercial broiler and spent layer chicken

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Abstract

Back yard native chickens are becoming popular along with the commercial native chicken. A study was planned on the nutritive value of meat in commercial native chicken (CNC), backyard native chicken (BNC), commercial broiler (CB) and spent layer chicken (SLC). An experiment was conducted on 12 birds of either sex in each class. Birds were purchased form commercial farms in and around Namakkal, Tamil Nadu slaughtered by Jatka method. Nutritional composition and protein quality of each group were studied for breast and leg meat separately. Protein quality (biological value, true digestibility and net protein utility) of meat was studied by precision feeding trial in adult cockerels. Cholesterol content was significantly lower in CB and CNC. The true digestibility, biological value and net protein utility in SLC were significantly lower than other categories. Biological value and net protein utility was significantly higher ($P<0.01$) in CB than CNC, BNC and SLC. The lipid and cholesterol content were significantly higher in thigh

than breast meat. The study revealed that over all nutritive value of commercial broiler meat was better than commercial native chicken, backyard native chicken and spent layer chicken.

Keywords: Nutritive value, native chicken, backyard poultry, spent layer, cholesterol content, protein quality.
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(PMPQ 19)

Emu meat as an alternative of conventional meat and beneficial effect in daily human diet

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Abstract

The demand for so-called functional food has greatly increased over the last decade with greater attention paid to the quality of products consumed. Emu is the second largest bird species after ostrich and is native to Australia. Their meat is low-fat, low-cholesterol, iron-rich also rich in protein, B vitamins, and creatine. Emu meat is dark, cherry red in colour with significantly higher myoglobin content and the myoglobin is more prone to oxidation as evidenced by higher initial metmyoglobin percentage. Cholesterol content in ratite meat is generally low as in emu it is 58 mg/100 g. The concentration of iron in emu meat is around 4 mg/100 g. Protein value is around 22%. As regards the physical characteristics of meat, colour is the first feature inspected by the consumer in selection of any meat; Emu meat is classified as dark red meat which is darker than beef. It can be explained by a high pigment content ranging between 3.2 and 5 mg of Fe/100g versus 2 mg of Fe/100g in beef. Emu meat is also characterised by relatively high final pH values (6.0) that cause dark colour, high water-holding capacity. The abundance of bioactive compounds, e.g. polyunsaturated fatty acids, makes emu meat highly susceptible to oxidation so there is need of intelligent packaging system in order to prevent oxidation of these elements

Keywords: Emu meat, nutritional value, dietary, biological value, physical characteristics
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(PMPQ 20)

Augmentation of Chitosan-Essential oils combinations as biopreservatives in Sweet and Sour Chicken Meat Spread

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Abstract

The effect of chitosan and essential oils (oregano and cassia) on storage quality attributes of sweet and sour chicken meat spread was evaluated in the present study. MIC of the essential oils of oregano and cassia against standard test bacterial culture of *Staphylococcus aureus* and *E coli* was determined. Sweet and sour chicken meat spread was developed using the optimized formulation. Combination of 0.5% chitosan and 0.125% of each EOs (oregano and cassia) were selected to be incorporated in the product based on various sensory trials. Product storage studies revealed that control had significantly higher (P<0.05) pH and TBAR Sand TV than treatment products whereas, total phenolics and DPPH activity was significantly lower (P<0.05) in control throughout the storage period. *Staphylococcu*s, psychrophilic as well yeast and mold count were significantly (P<0.05) lower in the treatments whereas, coliforms were not detected throughout the storage period. Sensory acceptability of chitosan + Oregano was highest (P<0.05) among all the treatments. Application of natural antimicrobials in combination considerably enhanced antioxidant as well as microbial quality of chicken meat spread.

Keywords: Biopreservation, essential oil, *Staphylococcus Aureus, E. coli*, chitosan.

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(PMPQ 21)

Shelf life extension of chicken spread with incorporation of natural essential oils

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Abstract

The present study was attempted to extend the shelf life of chicken spread with incorporation of essential oil *viz.* anise, clove and oregano at 0.1% 0.2% and 0.3% levels separately. Chicken spread incorporated with anise at 0.2% (AN), clove at 0.1% (CL) and oregano at 0.1% (OR) level were selected on the basis of sensory evaluation. These selected treatments along with control (C) were stored at 4±20C and evaluated for physico-chemical, microbiological and sensory properties at every 5 days interval. Overall highest pH was observed in C followed by OR>CL>AN. The mean TBARS and FFA values of control were significantly (P<0.05) higher than treatments on all storage days. The lowest TBARS and FFA values were observed in OR>CL>AN. pH, TBARS and FFA values of control and treatments increased significantly (P<0.05) with progression of storage period. Total plate count, psychrophilic count and yeast and mould count of control were significantly (P<0.05) higher than treatments, whereas yeast and mould and psychrophilic growth was not detected on 0 day in treatments. Overall highest microbial count was observed in C>CL>OR>AN. *Coliform* count was not detected throughout the storage period. All sensory attributes, color and appearance, flavor, texture, juiciness, saltiness, mouth coating, meat flavor intensity, spreadability and overall acceptability scores decreased significantly (P<0.05) with progression of storage. The control was not evaluated after 25th day due to microbiological spoilage and rejection by sensory panelists, whereas treatments were

evaluated up to 35th day due to presence of slime on surface and foul smell with further storage. Among the treatments, AN had significantly (P<0.05) higher overall acceptability scores till the end of study. It could be concluded that shelf life of chicken spread might be extended with incorporation of anise essential oil at 0.1% level and the product was very well acceptable up to 35th day of storage under refrigeration from microbiological and sensory point of view.

Keywords: Chicken spread, anise, clove, oregano, natural essential oil, shelf life.
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(PMPQ 22)

Antioxidant and antimicrobial effect of oregano essential oil on shelf-life of chicken patties

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Abstract
The present study was envisaged to study the antioxidant and antimicrobial potential of oregano essential oil (OEO) in processed meat model (chicken patties, CP). Three treatments were prepared as control (CP without CEO), T-1, T-2 and T-3 containing 0.125%, 0.25% and 0.5% OEO, respectively and aerobically packaged. The samples were evaluated for different quality attributes. Results pointed out that the T-3 product had the highest oxidative and antimicrobial potential out of all products as predicted by lowest thiobarbituric acid reacting substances and highest 1, 1 diphenyl-2 picrylhydrazyl radical scavenging activity with lowest microbial load followed by T-2, T-1 and control. on the other hand, sensory scores of T-3 were lesser than that of others, showing some pungency. The control product got spoiled on 21st, T-1 and T-2 on 25th and T-3 on 30th day of storage. In conclusion, 0.125% OEO can be efficiently incorporated in products without affecting sensory attributes.

Keywords: Oregano essential oil, antimicrobial effect, antioxidant effect, sensory.
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(PMPQ 23)

Application of food extrusion process to develop chicken meat-based extruded products

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Abstract

Food extrusion provides a great versatility for the development of low-cost, high-nutritive and convenient food products such as cereal-based snacks and food products. Extrusion processing is widely used in the food industry for restructuring starchy and proteinaceous ingredients. A variety of extruded food products like noodles, pasta etc. are produced by manipulation of composition and process variables. Extruded snacks are gaining importance nowadays due to their peculiar taste, texture and convenience. Extruded products contain low levels of protein, which makes it necessary to fortify them with protein-rich diets. One of the possible ways for alleviating this problem is to utilize meat and meat proteins to enrich cereal-based extruded products. In the meat industry most of the spent hen meat is not properly utilized for human consumption due to its negative impact on eating quality attributes. Extrusion technology provides a method to utilize such a tough meat recovered from spent hens and other underutilized meat cuts. The application of this technology has been demonstrated, however, a systematic study of the physico-chemical changes occurring in meat tissues or developed extruded meat products during extrusion and the interrelationship between process variables, reaction kinetics, and rheology of meat needs to be undertaken before the full potential of the technology can be realized.

Keywords: Food extrusion, spent hen meat, value addition.

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(ABWM 01)

Studies on characterization of slaughter house waste

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Abstract

The present study was undertaken to characterize the slaughterhouse waste water and to identify the possible treatment alternatives to minimize the impact of the discharge to the environment. The wastewater collected from two slaughter houses (Slaughter house-I (S.H-I with a capacity of > 300 sheep and goat per day) and Slaughter house-II (S.H-II with a capacity of <100 sheep and goat per day) was characterized in terms of physico-chemical, organic and microbiological characteristics. The waste water collected from S.H-II had significantly (P<0.05) higher temperature and pH than waste water collected from S.H-I. The higher turbidity values in S.H-I waste water was correlated with the total dissolved solids values. The waste water collected from S.H-I had significantly (P<0.05) higher electric conductivity than waste water of S.H-II. The waste water collected from S.H-I had significantly (P<0.05) higher total dissolved solids and lower total suspended solids values than waste water from S.H-II. An inverse relationship was found between the total dissolved solids values and total suspended solids values of slaughter house waste water. The waste water collected from S.H-I had significantly (P<0.05) higher dissolved oxygen, BOD and COD values than waste water collected from S.H-II. Both BOD and COD values are highly correlated with microbial populations of slaughter house waste water. A considerable higher total viable count and total coliforms count was found in the waste water of S.H-I. The results of the present investigation indicated that the wastewater coming out from slaughter houses which are not maintaining any treatment facilities, thus causing the heavy pollution to the nearby environment, as the waste water was having the pollutant loads much higher than the effluent discharges standards recommended by various central and state pollution control boards.

Keywords: Slaughter house waste, physical characteristics, BOD, organic characteristics.
Acknowledgement: The authors are highly thankful to Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh, India for the financial support to carry out the above research work.
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(ABWM 02)

A study on the effect of physico-chemical characteristics, palatability and storage quality of pet food incorporated with buffalo liver meal

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Abstract

The pet food industry is an important portion of the food and feed industries in the world. The pet foods were prepared by as control (soya protein), buffalo liver meal (BLM) at different concentrations levels as 10, 20 and 30% levels. On the basis of sensory evaluation and dog palatability experiment, dry pet foods containing 30% BLM was found superior over other variants. Digestibility trial was conducted to evaluated for their digestibility against the control. Blood was collected individual dogs on 0 and 15th day of the feeding trial. The physico-chemical and microbiological attributes of pet foods were assessed on 0, 15, 30, 45 and 60 days in vacuum and aerobic packaging. There was a highly significant effect (P<0.01) of incorporation of BLM on the crude protein digestibility and ether extract digestibility than control. However, The NFE digestibility of product containing BLM (90.03±1.34%) was significantly lower than control. Hemoglobin, total protein and cholesterol level of treatment was significantly higher than control. Significant changes were seen in physico-chemical and microbial parameters of BLM containing pet food during storage at ambient temperature under vacuum and aerobic packaging condition. However, *Coliform* spp, *Clostridium* spp, yeast and mould count were not detected throughout the study period in any of packaging. The cost of production of pet foods with 30% BLM and soya flour was estimated to be Rs 82.90 and Rs 91.80 per kg. Hence, the pet foods (whole meal) developed by incorporating 30% BLM in the present study will have a good market potential.

Keywords: Pet foods, buffalo liver, microbial quality, packaging.
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(ABWM 03)

Quality assessment of functional sorpotel burger developed by using finger millets

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Abstract

Recently, ready-to-eat meat products have grown in popularity. Therefore, the main objective of the present study was to develop a ready-to-eat goat meat by-products based product, with improved nutritional value and stability. Another idea was to launch a product into market which would facilitate composing a quotidian diet without necessity of changing eating habits or giving up favourite meals. So a study was undertaken to develop functional sorpotel burger by utilizing the goat by-products i.e lungs, liver, heart, viscera etc. and finger millets. So that most of the nutrients available in these waste materials can be make available to the human beings in cheaper price. Standardized protocol was developed for sorpotel burger with prolong shelf life. The evaluation of product was done in terms of nutritional, microbiological and sensorial values using the standard protocols prescribed for foods of animal origin. Nutritionally and sensorial basis sorpotel burger were at par to the meat burger. However, significantly higher level of fat and moisture were reported in the developed product. Microbiologically sorpotel burger were showing standardized limit of total plate count and no

Staphylococcus as well as *Coliform* was found in the product. Sorpotel burger were also found quit stable nutritionally and microbiologically upto 10 days of refrigeration storage.

Keywords: Sarcopatel, burger, shelf life, storage, nutritional quality, sensorial quality, microbiological quality.
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(ABWM 04)

Effect of different rendering regime over physicochemical, nutritional and microbiological characteristics of rendered poultry skin fat

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Abstract

High consumption of poultry meat in the country leads to a considerable amount of poultry sleeves as a waste, which causes serious environmental problems. Skin is one of the underutilized poultry byproducts and can be good source of quality fat. The present study was made with objective to evaluate the effect of different rendering process viz. dry, wet and microwave on physico-chemical, nutritional and microbiological characteristics of rendered poultry skin fat. De-feathered poultry skin obtained after customized processing of poultry sleeves were subjected to dry and wet rendering for two hrs at temperature 50°, 60° and 70°C; and for microwave rendering at 180W micro power level for 4, 5 and 6 min. The quality of rendered poultry skin fat was evaluated in terms of physico-chemical, nutritional and microbiological characteristics. There was no significant difference ($p>0.05$) in peroxide values and refractive index of rendered fat subjected to different rendering temperature (dry and wet) and time (microwave). The TBARS, p-ansidine, acidity index and free fatty acid values were highest in fat rendered at 50°C, showed significantly lower ($p<0.05$) values at 60°C, but again increased in fat rendered at 70°C under dry and wet methods. However, in fat rendered by microwave, these values increased with increase in rendering time. The moisture content continuously decreased while iodine values and unsaponified matter of rendered fat increased with increase in rendering temperature or time. There was decrease in L* value but increase in a* or b* values as the rendering temperature or time was increased. The proportion of UFA, MUFA, PUFA, ω-3 and ω-6 increased as the rendering temperature (dry and wet) or time (microwave) were increased. TPC was present only in fat rendered at temp of 50°C, otherwise TPC, *Coliform* count, *Salmonella* count, *Staphylococcus* count, Yeast and Mould count were not detectable in either of the rendered fat. Thus, it was concluded that rendering regime had significant effect on physicochemical, nutritional and microbiological characteristics of rendered fat. Rendered poultry skin fat from either dry, wet or microwave rendering were acceptable on fat quality parameters and can be alternate source of good quality fat.

Keywords: Rendering, poultry skin, fat quality, microbiological quality.
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(ABWM 05)

Storage stability of chicken liver powder incorporated dog biscuits at ambient temperature (25 °C)

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Abstract

The dog biscuits was developed after the incorporation of chicken liver powder at 30% level and dicalcium phosphate at 2% level. The developed dog biscuits were packed under aerobic and MAP conditions and stored at ambient temperature (25°C) for 80 days. The samples were analyzed on 1, 20, 40, 60 and 80 days of storage. The storage quality was evaluated on the basis of various physico-chemical (pH, water activity, moisture, TBARS, PV, FFA) microbiological (TPC, PC, coliforms count, yeast and mold counts), water activity and sensory analysis (5- point descriptive scale).The pH values showed significantly($P<0.05$) decreasing trend whereas the water activity followed increasing trend with the advancement of storage period. Similar to the water activity, moisture content of stored dog biscuits also followed significantly ($P<0.05$) increasing trend in both treatment dog biscuits. TBARS values and Free fatty acid content also followed increasing trend throughout the storage period, but the rate of increase was significantly ($P<0.05$) lower in MAP than aerobic packaging. Total plate count (TPC) and Yeast and mold counts for control as well as treatment products of both packaging methods increased significantly ($P<0.05$) at each subsequently storage interval. The scores for all the sensory parameters showed declining trend in products of both aerobic and MAP with the progress of storage period but decline in the scores for MAP products was significantly ($P<0.05$) slower than aerobic packaging. The dog biscuits can be stored for 80 days without any marked loss in physico-chemical, microbiological and sensory qualities.

Keywords: Dog biscuits, aerobic, MAP, storage stability, sensory evaluation.

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(ABWM 06)

Storage stability of fiber enriched pork loaves incorporated with blood and liver protein hydrolysates under different packaging condition at refrigeration temperature (4±1℃)

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Abstract

Present study explored changes in quality attributes of pork loaves during storage at refrigerated temperature under different packaging system prepared with inclusion of porcine blood and liver hydrolysates in pork loaves (T-1: 0.00, T-2: 0.09 blood hydolysate and T-3: 0.09 % liver hydrolysate under aerobic packaging condition and T-4: 0.00, T-5: 0.09 blood hydolysate and T-6: 0.09 % liver hydrolysate under modified atmospheric packaging condition) and compared with control (without hydrolysates T-1 and T-4). Changes in physico-chemicals, lipid oxidation, instrumental textual parameters, colour profile, microbial quality and sensory attributes were evaluated for all groups. Results indicated that all evaluated parameters (physico-chemicals, lipid oxidation, instrumental textual parameters, colour profile, microbial quality and sensory attributes) for porcine blood hydrolysate packed under modified packaging condition were comparatively ($P < 0.05$) maintained better than control and aerobic packaging condition. Tested groups packaged under aerobic packaging condition were stored up to 28 days storage while those under modified packaging condition were stored up to 42 days. Outcome of the present study was concluded that protein hydolysate of pork blood and liver is good source of unconventional substance for preservation of meat products with lower oxidation, microbial proliferation rate and maintained comparatively better sensory attributes throughout storage than control. Among assessment of packaging system modified packaging condition was better than aerobic packaging during entire storage.

Keywords: Physico-chemical characteristics, lipid oxidation, colour profiles, microbial quality, sensory attributes.

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(ABWM 07)

Effect of chicken gizzard blend containing oat flour and isolated soy-protien on quality characteristics of chicken patties

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Abstract

The present study was undertaken to prepare an optimized chicken gizzard blend (CGB) containing oat flour and to study the effect of its incorporation at varying levels on quality attributes of chicken patties and their storage stability at 4±1°C for 15 days. Three levels of oat flour 5% (Tr1), 10% (Tr2) and 15% (Tr3) containing CGB were formulated with control containing no oat flour and patties were prepared and evaluated. All the treatments (Tr1, Tr2 and Tr3) exhibited higher ($P<0.05$) cooking yield (CY) than control. Treatments showed higher ($P<0.05$) fat retention as compared to control. Dimensional shrinkage showed higher ($P<0.05$) among treatments. Texture Profile Analysis (TPA) revealed that Tr3 showed highest ($P<0.01$) hardness values while control, Tr1 and Tr2 did not differ significantly. Springiness was found to be highest ($P<0.01$) in control and lowest in Tr3. Cohesiveness showed higher ($P<0.05$), and chewiness were not significantly ($P<0.05$) different among treatments. Sensory evaluation revealed significantly ($P<0.01$) higher flavor and juiciness scores and overall acceptability in Tr2.

Therefore CGB containing 10% oat floar was considered to be optimum for chicken gizzard blend.

Keywords: Chicken gizzard, chicken patties, quality attributes, oat floar.

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(ABWM 08)

Preparation, storage stability and palatability of buffalo offal meal based pet food

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Abstract

The present investigation was envisaged to effective utilization of offals in pet food because buffalo offals are under utilized in India. Pet foods were standardized by incorporating buffalo lung meal (BLM) and buffalo tripe meal (BTL) at 10, 20, and 30% levels. On the basis of sensory evaluation and dog palatability experiment, dry pet foods containing 20% lung meal (BLM) and 30% buffalo tripe meal (BTL) were selected. The TBARS, Tyrosine value and microbial load did not adversely affect the palatability attributes. Maximum selected pet foods were packaged in LDPE bags for aerobic and in PE/Al foil laminates for vacuum conditions at ambient temperature up to 60 days. The samples were evaluated for physico-chemical parameters and microbial quality at regular intervals of 0, 15, 30, 45 and 60 days of storage. pH, TBARS, Tyrosine value, acid value, free fatty acid and TVC significantly increased with advancement of storage period in both pet food. However the increase in retail price of lung and tripe containing pet food was Rs 82.50 and 97.50 respectively, that was lower to most brands available in market. Thus buffalo lung and tripe meals can be effectively incorporated in dry pet food.

Keywords: Buffalo offals, pet food, palatability, storage study.

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(ABWM 09)

A novel method of salvaging poultry waste through black soldier flies larvae

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Abstract

Poultry sector in India predominantly working on integration model has achieved production efficiency. However, the poultry enterprise has not much progress in the waste management sector. The search for efficient, economical and user-friendly technology for salvaging waste is on. This study was undertaken to generate valuable byproducts from the poultry waste from hatchery, farms and slaughter sites. The different combinations of these were evaluated along with the kitchen waste as control through incorporating BSF larvae as a biological tool. The major findings of the study revealed that the combination of waste from different poultry operations was found to be the best in terms of effective material reduction of 39.95%, highest reduction efficiency of 52.36 % with high bioconversion efficiency of 31.83 % and lowest FCR of 1.24. Further, the pre-pupae biomass harvested (122.72g) was also more, the time taken for material recycling and waste reduction was shorter (24 days) and the residue obtained after larval action was also found to be of high manure value with a C/N ratio of 43.51. The efficiency of waste treatment was dependent on larval activity in the substrate, which in turn was dependent on the moisture and nutritional profile of the substrate. The microbial safety analysis demonstrated that there was a reduction in *Salmonella* spp in the residue which ensured public health concern. Thus, it was concluded that this novel method of salvaging waste was efficient in converting the waste into byproducts of high commercial value.

Keywords: Poultry waste management, BSF larva, material reduction, manure value, microbial safety.

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(AVS 01)

Microbiological assessment of drinking water sources of tribal areas of Himachal Pradesh

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Abstract

A total of 40 water sources from tribal areas of Himachal Pradesh were tested for microbiological quality of drinking water between June 2019 and November 2019. In these areas, water from natural streams originating from mountains is used directly for drinking and other household purposes without any prior treatment. The water samples tested in this study were from Pangi (n=10) region of district Chamba and Lahual (n=12) and Spiti (n=18) regions of district Lahual-Spiti. Water samples were collected aseptically and were kept at 4℃ till processing was done. All the samples were processed within 3 days of collection. Microbiological assessment of the collected water samples was done by determining the counts of indicator coliform group of bacteria by presumptive coliform test. All the samples detected positive in presumptive coliform test were tested for the presence of thermo-tolerant coliform by Eijkman test. In presumptive coliform test, most probable number (MPN) of coliform ranged between 0 MPN/100ml to 1100 MPN/100ml. As per World Health Organization standards, water from only 37.5% (15/40) of tested water sources was found fit for drinking (0 MPN/dl). 60% (6/10), 38.9% (7/18) and 16.7% (2/12) of these potable water samples from Pangi, Spiti and Lahual regions, respectively. None of the 25 contaminated samples was positive for thermo-tolerant coliform by Eijkman test indicating absence fecal contamination of animal or human origin of these water sources. This is the first preliminary investigation and detail studies will be conducted in future on microbiological assessment of drinking water sources of tribal areas of Himachal Pradesh to determine exact contamination levels.

Keywords: Microbiological quality, drinking water, tribal areas, contamination level.

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(AVS 02)

Effect of thermal stress on expression profile of apoptosis related genes in peripheral blood mononuclear cells of transition Karan Fries cows

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Abstract

The present study was conducted in cross bred (Karan Fries) cows during transition period to quantify the effect of thermal stress on the molecular regulation of apoptosisin peripheral blood mononuclear cells (PBMC). The experiment was carried out into two parts on 12 pregnant, dry Karan Fries cows. Experiment- Iwas carried out on 6 cows,during thermoneutral conditions (THI=67.3) andexperiment- II was conducted on another 6 cows duringsummer season (THI=79.9). Blood samples were collected on -15, 0 and +15days with respect to calving where day '0' represents the day of calving. The PBMCwere separated to analyze the mRNA expression level of Caspase-3, BAX, BCL-2, P- 53, Fas ligand and BAK. It was found that there was significant up regulation of Bax/Bcl-2, BAK and CASP-3 on the day of calving during both temperature conditions. Comparison between the two temperature conditions showed that expression of CASP-3, Bax/Bcl-2, BAK and P53 increased during summer as compared to thermoneutral condition in PBMC suggesting the susceptibility of these cells to apoptosis. Contrary to this FAS mRNA expression was increased on 15 day preand postpartum in summer.Based on the above findings it can be concluded that during calving PBMC are more susceptible to apoptosis and summer being more stressful potentiates the apoptosis of PBMC in Karan Fries cows.The study suggests that the animal requires protection during extreme climatic conditions during the climate change scenario.

Keywords: Thermal stress, apoptosis, blood mononuclear cells, Karan fries.
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(AVS 03)

A cross sectional study of seroprevalence and potential risk factors of bovine brucellosis in Punjab, India

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Abstract

Brucellosis is a re-emerging zoonotic disease prevalent in livestock population of developing countries. Most of Indian states, including Punjab are endemic for bovine brucellosis. A cross sectional study was carried out to estimate the seroprevalence and analyze the potential risk factors for bovine brucellosis. A total of 2891 serum samples were collected from cattle and buffaloes belonging to 393 farms followed by analysis with Rose Bengal Plate agglutination test (RBPT) and competitive Enzyme Linked Immunosorbant Assay (C-ELISA). Risk factors were analyzed for their association with seropositivity of farms. The overall (positive by both RBPT and C-ELISA) individual animal seroprevalence was 9.47% (95% CI: 8.40, 10.53), with 12.1% and 17.05% was found in RBPT and C-ELISA, respectively, whereas the herd prevalence was 29.77% (95% CI: 25.25, 34.29). Seropositivity ranged from 5.97% to 20.11% by RBPT and 12.28% to

25.7% by C-ELISA between different districts and vary significantly (p<.0001). Large farms have higher (p=<.0001) seropositive animals than medium and small. Age wise seropositivity vary significantly (p<.0001) then that of species, breed and sex wise. In risk factor analysis, nine variables were found significant (p<0.05) by final multivariable logistic regression model. Of them, lack of screening before purchase (OR=3.27, p=0.0012) was observed to be the principal risk factor. The presence of risk factors on farms underlines the lack of brucellosis control measures followed and calls for the stringent government policy on brucellosis in Punjab.

Keywords: Brucellosis, C-ELISA, RBPT, risk factors, seroprevalence.
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(AVS 04)

Synthetic pyrethroid resistance in *Rhipicephalus (Boophilus) microplus* ticks of goats from north western Himalayas, India

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Abstract
Rhipicephalus (Boophilus) microplus tick is widely distributed among the cattle and goat population of India. At present, tick control in India is based on large scale use of synthetic acaricides of three major classes, namely organophosphates, carbamates and pyrethroids. Their rampant use has led to emergence of acaricidal resistance in tick populations. Monitoring acaricide resistance in field isolates and use of suitable managemental practices are essential for controlling ticks in animals. In the present study, Adult immersion test (AIT) and Larval packet test (LPT) were employed for evaluation of resistance against synthetic pyrethroids in *Rhipicephalus (B.) microplus* ticks. The ticks were collected from the organized and unorganized goat farms of Palampur, Himachal Pradesh, where treatment failures were observed frequently. The mortality slope, LC50, LC95, 95 % confidence limit and resistance factor of field isolates were determined. Results obtained by the AIT showed that *R. (B.) microplus* ticks were resistant to deltamethrin and showed low grade resistance (level I, RF > 5) level whereas LPT revealed moderate grade resistance (level II, RF > 10). To the best of our knowledge, this is the first report from the region and further data on field status of acaricide resistance is essential for strategic use of available acaricides to overcome the development of acaricide resistance and formulating suitable control strategies against goat ticks.

Keywords: *Rhipicephalus (B.) microplus,* goat ticks, acaricide resistance, control strategies.
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(AVS 05)

Validation of HPLC-DAD method for determination of antibiotic residues in bovine milk and human health risk assessment

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Abstract

Milk is considered as a valuable food commodity across the globe. But unfortunately, it is being contaminated by various chemicals.Antibiotics are routinely used in veterinary practices for prevention and control of diseases. But, their frequent, injudicious and sub therapeutic usage and lack of awareness among producers to follow proper withdrawal time may results in the occurrence of antibiotic residues in milk and other foods of animal origin. These antibiotic residues not only contribute to development of antimicrobial resistance among microorganism with significant health risk to consumers but they may also interfere with starter cultures forcheese and other dairy products resulting in economic losses to the producers as well. In this context, High-performance liquid chromatography with photo diode-array detection (HPLC–DAD) was optimized and validated for the determination of oxytetracycline in bovine milk. Thecolumn, mobile phase, temperature and flow rate were optimised to provide the best resolution of targeted analyte. Milk samples were extracted and purified using a hydrophilic-lipophilic balanced solid-phase extraction cartridge and analyzed using HPLC–PDA which measured spectra in the range of 210-400 nm. The chromatography method was performed at 25oC using 0.01 M oxalic acid buffer with methanol and acetonitrile for separation and determination of oxytetracycline residues. The method was validated in compliance with European Commission decision 2002/657/EC and antibiotic was quantitatively determined in spiked milk samples. The limit of quantification values were found to be below MRLs levels established by FSSAI. Five point calibrations showed that the methods were linear with a R2 value of 0.998 for oxytetracycline in the investigated range. The validated method was subsequently employed for screening of randomly collected milk samples in and around Palampur (n = 15). The results of human health risk assessments revealed that EDIs of oxytetracycline are lower than the ADIs. Therefore, it could be assumed that consumer is adequately protected from consumption of such milk at current levels of contamination. However, the results of present study suggests that continuous residue monitoring programs, accompanied by educational programs to milk producers and animal husbandry workers on proper maintaining of the withdrawal period are neededto meet the expectations of food safety and public health.

Keywords: Bovine milk, antibiotic residue, HPLC-DAD method, human health.

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(AVS 06)

Milk derived bioactive peptide as potent nutraceutical to augment health and production through osteoblast interactive pathways

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Abstract

Osteoporosis is a systemic and silent skeletal disease which leads to increased risk of fracture, thereby decreased mobility, decreased feed intake and finally poor health to production quotient. The recovery from bone related injuries is both time consuming and expensive. Current therapies are unable to overcome these shortcomings. There is an emerging requirement to augment current therapies with nutraceuticals or compounds that hasten the healing process and enable full recovery. Bioactive peptides are specific protein fragments that have a positive impact on body functions and these can be future of nutraceuticals. The bio-peptide under investigation was obtained from casein hydrolysis and it exhibits antioxidative, ACE inhibitory, immunomodulatory and osteogenic properties. This bioactive peptide induces osteoblast differentiation through pathways such as Wnt to bring about faster recovery at an efficient pace as was observed in our in-vitro studies. Further as this peptides is bioavailable its administration is both easy and efficient. It can prove to be revolutionary to reduce animal production (meat/milk) and health losses incurred due to deteriorating bone health.

Keywords: Osteoporosis, nutraceuticals, bioactive peptides, bioavalibility.

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(AVS 07)

Optimization of a whey protein concentrate enriched instant powder mix with cocoa powder

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Abstract

The present study was made to enhance a whey protein concentrate enriched instant powder mix with cocoa powder. The two types of instant powder mixes were prepared by spray drying named treatment 1 (T1) and treatment 2 (T2). The liquid mix prepared for spray drying of treatment T1 contained ingredients such as rice extract added WPC (1 %), vitamin A (2500 IU)

and iron (10 mg) and T2 contained rice extract added WPC (1 %), vitamin A (2500 IU), iron (10 mg) and cocoa powder (6%). The physico-chemical properties, microbiological counts and organoleptic evaluation of different instant powder mixes were studied. Higher scores for colour, taste, flavour and overall acceptability of spray dried powder were noticed for T2 due to inclusion of cocoa powder. Moisture per cent of T1 and T2 was similar but per cent of protein, fibre, fat and total ash of T2 were higher than T1. The vitamin A and iron content decreases as storage period increase. The total plate count (cfu × 102 per gm) of T2 was higher than T1 but within the acceptable limit of the Codex or the ICMSF. Coliform count and yeast and mould count were totally absent in T1 and T2 which also meets the required standards of BIS. T2 showed better acceptability in terms of physico-chemical, organoleptic property and microbial counts within limit during storage period of 90 days at room temperature.

Keywords: Whey protein concentrate, instant powder mix, cocoa powder, quality attributes.
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(AVS 08)

Feeding and managemental practices followed by dog owners in Pathankot and Hoshiarpur District of sub-mountainous zone of Punjab

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Abstract
Under the present study 80 dog owners each from District Pathankot and Hoshiarpur were surveyed and data regarding the feeding and management of their pets were collected. Dog owners are giving the food items such as chapatti, milk, curd, pulses, rice, vegetables, meat and meat products, eggs, sweets and fruits to their pets. The data regarding the feeding of dogs in rural and urban areas of both the districts were also compared. 40 dogs from the urban area and 40 dogs from the rural area of Pathankot District were selected. There was significant ($P \leq 0.05$) difference in milk, sweets, dal and meat feeding among the urban and rural dog owners in Gurdaspur district. The average milk consumption of dogs of urban area was significantly ($P<0.05$) higher than the rural areas. The consumption of other food items were comparable among the rural and urban area of District Pathankot. 40 dogs from the urban area and 40 dogs from the rural area of Hoshiarpur district were selected. There was significant difference among feeding of milk, milk product, curd, sweets, chapatti, dal, rice, vegetables, meat, bone and eggs in the diet of dog in urban and rural areas of Hoshiarpur district. The consumption of curd and dal showed a significant decrease in case of rural areas as compared to urban areas. The body condition score of the dogs from district Pathankot is slightly higher than the dogs from district Hoshiarpur.

Keywords: Dog, feeding practices, Pathankot, Hoshiarpur, data.
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(AVS 09)

Physicochemical and sensory characterization of caramel coated chhana confection

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Abstract

The study was designed to develop a chhana (traditional dairy product obtained by acid coagulation of hot milk) based confection by incorporating different levels of mango and pineapple powder @ 2%, 4% and 6% separately in the formulation of chhana base (95g chhana+ 5g whole milk powder) replacing chhana proportionately in formulation which was further cooked at 60º brix sugar syrup concentration (10 min) followed by coating with caramel using silicon moulds. The following treatments (95g chhana+ 5g milk powder(C), 93g chhana+ 5g milk powder+ 2g fruit powder(T1), 91g chhana+ 5g milk powder+ 4g fruit powder(T2), 89g chhana+ 5g milk powder+ 6g fruit powder(T3), were assessed for proximate, physico-chemical and sensory parameters. No significant ($p>0.05$) difference was recorded in the mean values of moisture, fat, protein, ash, lactose, cholesterol and carbohydrate content of all the treatments as compared to control. pH value showed a significant ($p<0.05$) decreasing trend with incorporation of mango and pineapple powder at 4% and 6% level. Titratable acidity was found to be significantly ($p<0.05$) higher in confection with addition of mango and pineapple powder at 6% level as compared to control confection. Water activity increased significantly ($p<0.05$) with addition of pineapple powder at 6% level, however, no significant effect ($p>0.05$) was observed on water activity of samples incorporated with mango powder. No significant difference ($p>0.05$) was recorded in the mean values of cooking yield, coating loss, and weight of coating of mango and pineapple powder treated samples as well as control. Colour analysis was done for all the samples and no significant ($p>0.05$) effect was observed on L* and a* colour values, however b* value increased significantly ($p<0.05$) at 6% level of mango powder incorporation as compared to control. On the basis of sensory attributes, most acceptable confection was prepared by incorporating mango and pineapple powder at 4% level. Such confection is expected to increase nutritional profile of market candies and confection.

Keywords: Caramel coated, chhana confection, mango and pineapple powder, quality attributes.

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(AVS 10)

To study the toxic effect of Oxytetracycline on fish *Cyprinus carpio* using multiple biomarkers

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Abstract

The present study was designed to assess the toxic effect of antibiotic oxytetracyclin (OTC) in

fish *Cyprinus carpio* using multi-biomarker approach. The acute exposure was given up to 96 hours of treatment. Sub-lethal concentration used in the experiment was 60 mg/l of water. Sampling was done after 24, 48, 72 and 96 hours of exposure. Different behavioral alteration like, high pigmentation, high mucus secretions, loss of equilibrium, hyperactivity were seen throughout the exposure. Different nuclear and cytoplasmic alterations were seen under genotoxicity testing in blood cells of fish. The time dependent significant increase was observed for micronucleus, aberrant nucleus, vacuolated cytoplasm, and aberrant cytoplasm when compared to control. Highest value for micronucleated cells, degenerative nucleus and karyolyzed cytoplasm were found to be at 96 hours of exposure. On the other hand cells with aberrant nucleus and aberrant cytoplasm were found to be high at 72 hours and a decrease in the value is observed at 96 hours. Along with behavioural changes and genotoxicity testing morphological alterations in scale structure were also seen. Damage on the scale was observed in both the regions (anterior and posterior). The exposed fish showed significant alterations such as damaged radii, focus, circuli, uprooted and damaged lepidonts and dispersal of chromatophores. The intensity of scale damage was found to be time dependent. These observations strongly suggest that fish scales can be successfully applied to ecotoxicological studies. The results obtained from scale study are evidencing their relevance, reponsivity and complementarity to other bio-indicators.

Keywords: Toxic effect, oxytetracyclin, *Cyprinus carpio,* bio-indicators.
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(AVS 11)

Veterinary drug residues in food-animal products: key concerns

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Abstract

Veterinary drug residueis one of the major global issues covering contamination in animal derived products (meat, milk eggs and honey). Important factors influencing the occurrence of residues in animal products are pharmacokinetic characteristics of the drugs and biological processes of the animals. Extra-label usage of drug and failure to keep the withdrawal period are the main reasons for development of drug residues. The major effects of veterinary drug residues on public health are development of drug resistance, hypersensitivity reaction, carcinogenic, mutagenic, teratogenic effects and disruption of normal intestinal flora. To implement an effective residue avoidance in food animal practice, a veterinarian must be aware of pharmacological principles of many drugs. The main constraint is that the most pharmacokinetic parameters have been determined in healthy animals and not in diseased ones. Thus drug residues can be avoided by a well-planned drug usage program. Guidelines to mitigate or lessen the chances of antibiotic residues (U.S. Drug Residue Prevention Reference Manual 2018), include establishment of a valid Veterinarian-Client-Patient Relationship, record keeping of antibiotic use and identification of all treated animals, implementation of a

preventive animal health program, awareness of drug usage according to labeled recommendations and withdrawal periods, drug residue screening through specific tests before marketing of milk and/or meat from treated animals. There is limited information on veterinary drug residues worldwide, hence, more work is required to be carried out to prevent the occurrence of veterinary drug residues. Moreover, there is urgent need to familiarize all animal health professionals with the knowledge of pharmacokinetics, pharmacodynamics and toxicological effects of pharmaceutical preparations to minimize public health hazards due to drug residues in food-animal products.

Keywords: Drug residues, food-animal, public health, awareness.
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(AVS 12)

Estimation of micro and macro minerals in testis of spiti horses

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Abstract
This paper presents the mineral composition of testis of Spiti horses. The testicular tissue samples were collected from 10 apparently healthy Spiti horses immediately after castration and then dried in hot air oven at 60°C until they attained uniform weight. The tissues (0.5 gm) were digested for quantitative analysis in diacid and the residue left after digestion was reconstituted to known volume with demineralised water (dilution 1: 20) for analysis. Different macro (magnesium, calcium, sodium and potassium) and micro (iron, copper and zinc) minerals were estimated by atomic absorption spectrophotometer and the values of sodium and potassium were estimated by flame photometry.

Keywords: Spiti horses, testicular meat, macro and micro minerals.
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(AVS 13)

Optimization of a whey protein concentrate enriched instant powder mix with cocoa powder and milk powder

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Abstract

The present study was made to optimize a whey protein concentrate enriched instant powder mix with cocoa powder and milk powder. The two instant powder mixes were prepared by spray drying and termed as control group and treatment group. The liquid mix prepared for spray drying of control contained ingredients such as rice extract added WPC (1 %), vitamin A (2500 IU) and iron (10 mg) and treatment contained rice extract added WPC (1 %), vitamin A (2500 IU), iron (10 mg), cocoa powder (6 %) and milk powder (6 %). The physico-chemical properties, microbiological counts and organoleptic evaluation of different instant powder mixes were studied. The protein, fibre, fat and total ash per cent of treatment group were higher than control group whereas both groups were almost similar in moisture per cent. As storage period increase, the vitamin A and iron content decreases in both groups. The total plate count (cfu×102 per gm) of treatment group was higher than control group but within the acceptable limit of the Codex or the ICMSF. Coliform count and yeast and mould count were totally absent in both groups. The scores for colour, taste, flavour and overall acceptability of spray dried powder were observed higher in treatment group due to inclusion of cocoa powder and milk powder. Treatment group showed better acceptability in terms of physico-chemical, organoleptic property and microbial counts within limit during storage period of 90 days at room temperature.

Keywords: Whey protein concentrate, instant powder mix, cocoa and milk powder, quality attributes.

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(AVS 14)

Process optimization of fruit yogurt enriched with dietary fibre

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Abstract

The present study was conducted to optimize the yogurt with different concentration of strawberry pulp and rice bran to study their effects on sensory characteristics, physic-chemical properties and microbial changes during 15 days of storage at refrigeration temperature (4±1°C). Fruit yogurt was prepared by addition of strawberry pulp at different concentration (5%, 10% and 15%). Yogurt with 10% strawberry pulp had higher sensory score than control yogurt and used for further study. Yogurt with 10% strawberry pulp was incorporated with different concentration of rice bran (0.3%, 0.6% and 0.9%) evaluated for sensory score, though addition of rice bran had decreased texture score but appearance, flavour and overall acceptability of 0.9% rice bran was higher than all other treatments. The freshly prepared yogurt samples were analysed for proximate composition. The moisture, protein and fat content of rice bran incorporated strawberry yogurt were lower than control. The fibre content was higher in rice bran incorporated strawberry yogurt than control. The strawberry yogurt incorporated with 0.9% rice bran was sensorically sound and microbiologically safe for

consumption of 15 days at refrigeration temperature.

Keywords: Fruit yogurt, strawberry, physico-chemical quality, microbial quality, storage life.

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(AVS 15)

Shelf life extension of chocolate coated chhana confection at refrigeration temperature of (4±1ºC)

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Abstract

Chhana is a well-known traditional dairy product which is used as a base for production of wide variety of traditional Indian dairy sweets but limited shelf life of chhana and chhana based sweets (three days at 24°C, six days at 10°C and 1 day at ambient temperature) is the major hurdle in their industrial production. Therefore chocolate coated chhana confection has been formulated by incorporating chhana @ 90%, mango and pineapple powder separately @ 4%, milk powder @ 5% and cranberry extract @ 1% level followed by chocolate coating after cooking for 10 minutes at 60° Brix sugar syrup concentration. Storage stability of the confection was studied at refrigeration after wrapping in aluminum foil and packing aerobically in low density polyethylene (LDPE) pouches. The different physico-chemical, proximate, microbiological and sensory properties of cranberry treated samples and control samples (control samples does not contain cranberry) were monitored at 0, 15, 30, 45 and 60 day of refrigeration storage. Significant decrease in pH and water activity and increase in titratable acidity was observed with progress in storage period. Mean TBA and FFA values for all the treated samples were significantly ($P<0.05$) lower at 45 and 60 day of refrigeration storage as compared to control samples. Mean Y&M counts for all the treatments were significantly ($p<0.05$) lower as compared to control at day 45 of refrigeration storage. TPC and Y&M count were found to be above threshold level on day 60 of refrigerated storage in case of control as well as treated samples. Phenolic and flavonoid counts decreased significantly ($p<0.05$) with increase in storage period and the mean values of phenols and flavonoids in case of treatments were comparable to control throughout the storage period. Sensory scores decreased significantly ($p<0.05$) with increase in storage period. Based on the results, chocolate coated chhana confection could be manufactured with storage stability of 60 days at refrigeration temperature (4±1ºC).

Keywords: Shelf life extension, chocolate coated, chhana confection, refrigeration temperature.

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(AVS 16)

Effect of parasitic diseases of western himalayan region on meat quality of animals

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Abstract

The meat quality of animals and poultry is often ruined by multifactorial causes including nutritional, microbial, parasitic and often succumbed to variety of ailments. During necropsy examination of different meat animals in the Department of Veterinary Pathology, a variable range of pathological conditions were recorded and among them the parasitic conditions were more pronounced. In buffaloes, the most prevalent conditions reported included fasciolosis, sarcocystis and cysticercois. In small ruminants (sheep and goats) hydatidosis, hemonchosis, tapeworms, cysticercosis, hepatic distomiasis etc. were commonly encountered. Necropsy conditions presented in poultry revealed intestinal coccidiosis, ascariasis etc. The rabbits presented for necropsy examination revealed the presence of heapticcoccidiosis, encephalitozoon and ear canker. The lesions related to parasitic conditions recorded during gross necropsy examination were further confirmed by histopathological, microbiological and parasitological investigations. These parasites recorded during necropsy examination of different animals species can directly or indirectly influence the growth of animals and often pose a significant threat in terms of economic loss to marginal farmers or meat industries. Many of the parasitic conditions including hydatidosis and cysticercosis can act as a zoonoses to mankind via spill over infections or through meat consumption. The present study puts into record the parasitic conditions recoded during routine necropsy examination, which are although sub-clinical normally.

Keywords: Parasitic diseases, western himalayan region, meat animals, zoonoses, necropsy examination.

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(AVS 17)

Effect of lantadenes on pro-inflammatory cytokines and α-SMA expression

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Abstract

Lantana poisoning in livestock causes jaundice, photosensitization, hepatopathy and nephropathy. The present work was designed to study the effect of lantadenes of Lantana camara on pro-inflammatory cytokines and α-smooth muscle actin (α-SMA) expression during sub-chronic exposure (at the dose of 24 mg/kg bw, orally daily for 90 days) in guinea pigs. The quantitative RT-PCR (qRT-PCR) analysis was done for IL-1, IL-6, TGF-β, TNF-α and Cox-2 cytokines with GAPDH as internal control. The IL-1 and IL-6 mRNA expression in lantadene administered animals was approximately similar to control. The TGF-β mRNA expression in

lantadene group showed approximately 3.5 fold increase as compared to control. The TNF-α mRNA expression in lantadene group showed approximately 1.2 fold increase as compared to control. The expression of COX-2 mRNA in lantadene group revealed approximately 3.6 fold increase as compared to control. After 90 days of lantadene induced toxicity, the α-SMA titre was elevated in lantadene treated group as compared to control, but did not show significant difference.

Keywords: Lantana poisoning, livestock, lantadene induced toxicity.

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(AVS 18)

Studies on strategic interventions for augmenting survival percentage in Gaddi Kids under semi-intensive production system

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Abstract

A study was carried out on survivability of male Kids/Bucklings reared at COVAS campus under AICRP-Gaddi field unit, from the year 2013-16. Study revealed that 12, 6, 9 & 15 bucklings/male kids died out of 30, 25, 39 & 47 reared during the year 2013-14, 2014-15, 2015-16 & 2016-17 respectively. Thus, survivability was recorded as 60%, 76%, 76.9% & 68% respectively. Further investigations revealed that 45.23% of the total deaths occurred during the months of May to August (season of summers and monsoon at Palampur) and 64.28% occurred in animals having body weight of less than 20.5 kgs. Faecal examination of 10 kids in the month of July, 2016 revealed heavy parasitic infestation with epg in nematodal infection reaching as high as 3200 (range 1100—3200). P.M. examination also indicated heavy Nematodal & Cestodal infection. Ectoparasites including ticks were also noticed especially during the summer and monsoon months. Haematological examination of 6 kids died between the months of May to September, 2016, around 4-7 days before death, indicated state of severe anaemia with pale conjunctival mucous membrane and mean Haemoglobin value of 4.43±0.24g/dl & PCV of 15.17±0.83 %. Based upon pattern of deaths, body weight, clinical examination, faecal examination, haematological examination and pasture / environmental conditions, interventions were introduced in the year 2017 and 2018 to save the lives and to increase body weight. Deworming schedule was re-designed (at least 5 dewormings per year) with introduction of drugs not much used before (Fenbendazole + Praziquantel, Closantel etc.). Proper and adequate ectoparasiticidal treatment through Dipping (atleast thrice in a year) was scheduled. Oral haematinic mixture in proper dosage was also introduced. Resultantly, survivability % increased to 95% and 97.5% respectively in the year 2017 & 2018 respectively leading to enhancement of profitability of field units through availability of more number of bucks for genetic improvement of flock.

Keywords: Gaddi kids, survival, semi-intensive, production system, genetic improvement.

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(AVS 19)

Age related biometrical study on prenatal development of heart in Gaddi Sheep

Brij Vanita[1], Rajesh Rajput[2], Virender Pathak[3], Parul Shukla[3] and Divya Gupta[3]

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Abstract

The present study was conducted on the heart of eighteen Gaddi sheep fetuses. The main objective of the research was to investigate the gross anatomy of heart at different gestational stages. The fetuses were procured from local slaughter houses in and around the Palampur region. The prenatal heart samples were divided into three groups based on their age in days viz. group-I (early prenatal period 0-50 days), group-II (mid prenatal period 50-100 days) and group-III (late prenatal period 100-150 days) of gestation. There were n=6 fetuses in each group. The gestational age of Gaddi sheep fetuses was estimated by using the body weight of fetus. The fetuses were dissected open for subsequent biometric analysis of the heart.The maximum gain in weight and volume of the heart occurred in late prenatal period. Whereas, the percentage of heart weight to the weight of fetus decreased with the advancement of the gestational age.

Keywords: **biometrical study, prenatal development, heart, Gaddi Sheep.**

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(AVS 20)

Potential of Goat meat produced under migratory farming in Himalayan region of Himachal Pradesh, India

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Abstract

Worldwide the consumption of chevon (goat meat) has increased owing to its distinct nutritional attributes. Increased awareness of consumers created consumer category demanding healthier food and are ready to pay premium price. Goat husbandry is an integral component of hill farming system. Gaddi and Chegu goat are two indigenous goat breeds of the State. Gaddi, known as “White Himalayan” goat, is predominant goat breed constituting 60-65% of total goats and is primarily reared under migratory system. Contribution of goat to total livestock population of Himachal Pradesh remains more or less same for the past five livestock census, while sheep has shown a clear cut decreasing trend. Compared to cattle, sheep and poultry, less scientific investment has been made towards improving the productivity at

national as well as at state level. Under migratory system goats are mostly farmed under natural grasslands with very little, if any, use of pharmacological agents to increase production efficiency. Thus, these goats and chevon derived from them can be considered as natural/organic “green produce.” It is imperative that this unique quality of such goats and products derived from them be emphasized during marketing. Therefore, the chevon industry can take advantage of the growing demand for organic food. This demand for organic food is mainly motivated by the consumers' health concerns. The adaptability and resilience of goats make them an indispensable resource to safeguard sustainable production and contribute to the increasing protein requirements of the growing human populace. Adoption of migratory unit for improved breeding and management practices revealed that there was significant improvement in body weight at different ages in every unit every year thus highlighting the importance of improved management for goats managed under sub-optimal management in migratory production system. There is huge demand of the chevon from “Gaddi”goats owing to its excellent acceptable meat quality and nearly organic status. Proper sale outlets needs to be created and meat to be sold by a brand name highlighting its production under migratory system. Intervention of the government at its highest level is required to create and provide good marketing infrastructure and eliminating middlemen.

Keywords: Goat meat, migratory farming, Himalayan region, Gaddi goat, meat quality.

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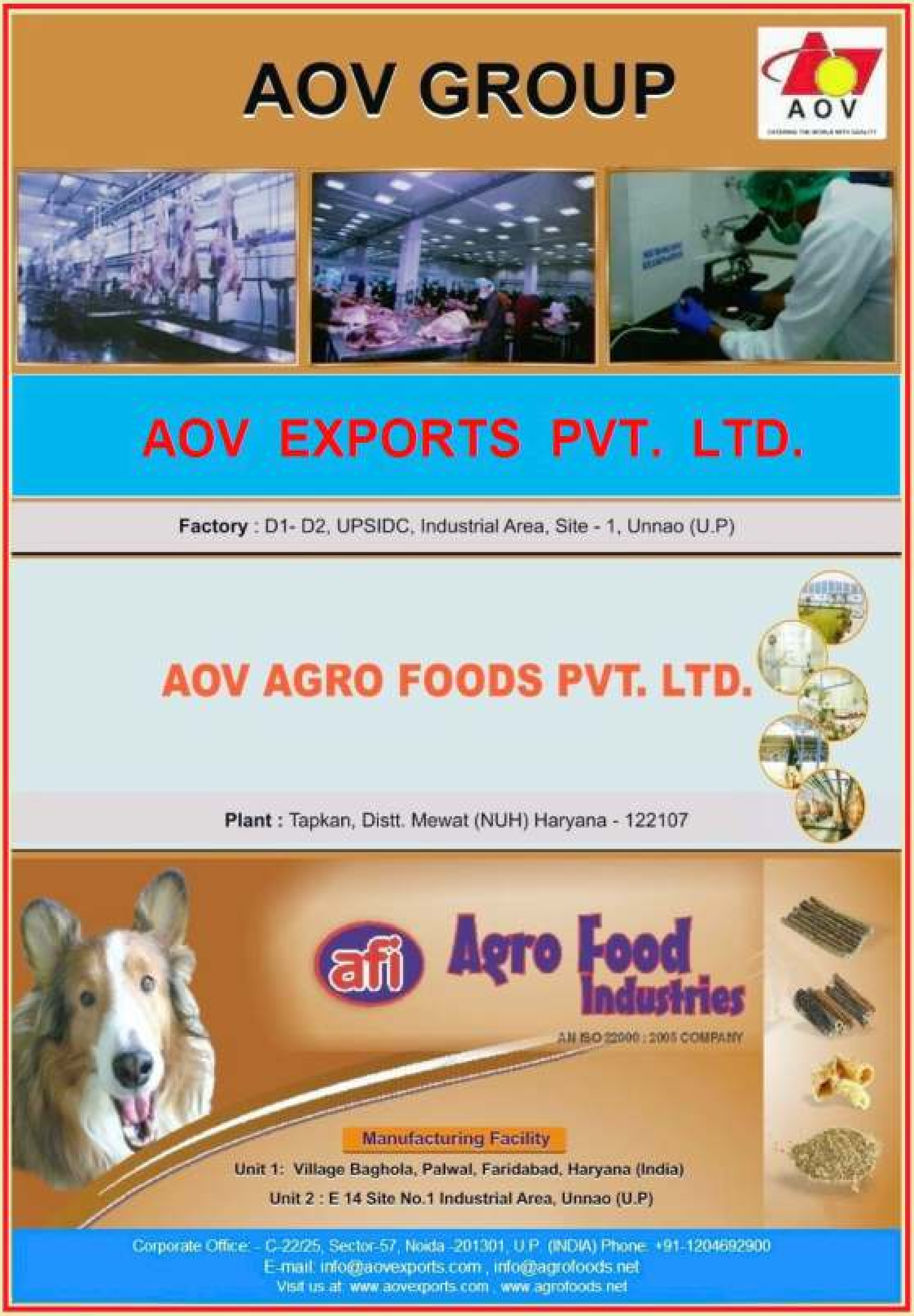
Goat rearing in traditional occupation of pastoralists in Himachal Pradesh, also rearing by small holders is also picking up as a major sustenance for poor farmer. With this aim, the Federation under **Rastriya Krishi Vikas Yojna (RKVY)** is implementing a scheme in the year 2019-20 titled **'Enlarging Production Base of Goats under Conventional Small Holder/Pastoral System,** with the aim to improve the productivity of goats under conventional Small holder/pastoral System in Himachal Pradesh by organizing 150 clusters of 1000 goats each in the districts of Sirmour, Solan, Bilaspur, Hamirpur, Una, Mandi, Kangra and Chamba.

AIMS AND OBJECTIVES :-

1. To provide better healthcare and management facilities to the goats.
2. To provide impetus in production by supplementation of growth promoters particularly during the winters to make up to the scarcity of nutritious grasses/fodder and minerals.
3. To improve economic status of Goat Breeders in the State.
4. Ensuring Long Term Sustainability of the Sector

OUTCOMES (Deliverables): -

1. Improved animal health.
2. Better progeny- Twinning's, triplets.
3. Increase in meat production
4. Decrease in mortality and morbidity rate.
5. Livelihood opportunities to local unemployed youth.
6. Education to breeders for scientific management of flocks.
7. Improved economic status of goat breeders leading to long term sustainability of the sector.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7	143	137	139	17	119	119	0.9	0.75
14	325	286	306	28	196	315	1.0	1.00
21	585	520	553	55	385	700	1.3	1.25
28	910	780	845	85	595	1295	1.5	1.30
35	1300	1105	1203	110	770	2065	1.7	1.35
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49	2340	2015	2178	155	1085	4060	1.9	1.70

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	Weight			Feed Bird		Cumulative		
wks	Males	Females	Average	Per Day	Week	Feed	Fcr	Mortality %
1	110	105	107	15	105	105	0.98	0.75
2	250	220	235	25	175	280	1.19	1
3	450	400	425	50	350	630	1.48	1.25
4	700	600	650	75	525	1155	1.78	1.3
5	1000	850	925	100	700	1855	2.01	1.35
6	1450	1150	1300	125	875	2730	2.1	1.5
7	1800	1550	1675	150	1050	3780	2.26	1.7
8	2200	1900	2750	160	1120	4900	2.28	1.9

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Age at Maturity	140days
Age at 50% Production	154days
Age at Peak Production	190days
Peak Production	93%
Hen Housed eggs to 80weeks	345eggs
Color of Eggs	Dark Brown
Average Egg weight	60gms.
Body weight at maturity	1650gms
Body weight at end	2.2kgs
Feed to 20weeks	7kg
Feed consumption during Lay	120gms/day.

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AGE DAYS	MALES	FEMALES	AVERAGE	FEED/D	FEED/WK	CUM FEED	FCR	MORTALITY
7	69	51	60	10	70	70	1.167	0.75
14	92	68	80	15	105	175	2.188	1
21	161	119	140	25	175	350	2.500	1.3
28	265	196	230	30	210	560	2.435	1.4
35	345	255	300	40	280	840	2.800	1.5
42	495	366	430	50	350	1190	2.767	1.6
49	745	495	620	60	420	1610	2.597	1.7
56	923	697	810	65	455	2065	2.549	1.8
63	1081	849	965	75	525	2590	2.684	1.9
70	1219	901	1060	85	595	3185	3.005	2
80	1357	1003	1180	95	665	3850	3.263	2.1
90	1495	1105	1300	105	735	4585	3.527	2.2
100	1668	1233	1450	110	770	5355	3.693	2.3

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* FY - Financial Year