वार्षिक प्रतिवेदन

ANNUAL REPORT

2018-19

भा.कृ.अनु.प.-राष्ट्रीय माँस अनुसंधान केंद्र

ICAR - National Research Centre on Meat

Chengicherla, Boduppal Post, Hyderabad - 500092

ISO 9001:2015 and ISO/IEC 17025:2005 Certified Organization

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CONTENTS

PREFACE

It gives me great pleasure to interact through the current Annual Report of ICAR-National Research Centre on Meat, Hyderabad for the year 2018-19. I consider this as the most eventful year for witnessing the inauguration of "Grand Auditorium" of ICAR-NRC on Meat on 18th January, 2019 in the hands of Dr. Trilochan Mohapatra, Hon'ble Secretary, DARE and Director General, ICAR in presence of Dr. Joykrushna Jena, Deputy Director General (Animal Science) and Dr. Ashok Kumar, ADG (AH). I am elated to mention that, the "Meat speciation" laboratory of NRC on Meat has been accredited by National Accreditation Board for Testing and Calibration Laboratories and awarded with "ISO/IEC 17025:2005 certificate".

The Centre has continued its research efforts on authentication of meat species and animal tissues through genomic, transcriptomic and proteomic approaches. To augment these work, we have recently procured Digital droplet PCR and Gel-Free Electrophoresis unit and planning to develop field usable kits for meat speciation to cater to the needs of various stakeholders. Development of animal muzzle based traceability system and work on cell cultured meat has been initiated. The Institute is also addressing safety issues in meat value chain with a "One Health Concept" through collaboration and networking with FSSAI, Medical professionals, Veterinarians and Meat industry personnel. A workshop on "One Health: Unprecedented Opportunities and Challenges" was also organized to create awareness among scientific community. Surveillance of meat borne zoonotic diseases, evaluating health status of meat industry personnel, screening of meat and meat products for the presence of polycyclic aromatic hydrocarbons (PAH) and antimicrobial agents are being undertaken. Developing natural plant based dye and nano-particle conjugated sensors which indicate the freshness of meat has been carried out. The Centre has designed super-chilling cabinet with an accurate temperature and humidity control for enhancing the shelf-life of chicken and mutton. Natural

antioxidants, essential oil and packaging mediated strategies are being developed to ensure increased safety and shelf-life of meat and meat products.

I am elated to mention that, the Centre is successful in generating significant amount of funds through extra-mural research projects and currently has 11 grants from DBT, MoFPI, FSSAI, DADF, and ICAR, besides one contract research project. To increase the effectiveness of the research findings and to reach a wider audience, the Institute has successfully conducted an ICAR sponsored 21 days summer-school on "Innovations in livestock sector for doubling farmer's income: Strategies and opportunities in meat value chain". The Institute has also organised training programme on "DNA Techniques in forensic food analysis" for Animal Husbandry officials from different State Governments. Three Front Line Demonstration Programs on 'Scientific sheep and goat production and value addition to meat' was organized in aspirational districts at Khammam, Mulugu, Asifabad in collaboration with Society for Eradication of Rural Poverty (SERP), Govt. of Telangana. Two off-campus trainings were organized on "Safe meat production, processing and value addition" at Veterinary College, Shivamogga and Veterinary College, Hassan. Five hands-on entrepreneurship development programmes were organized and trained 78 entrepreneurs. Twenty two youths were trained in two skill development programmes on "Hygienic meat production and processing".

The ITMU and Agri-Business Incubation (ABI) Centre of NRC on Meat has successfully signed 6 MoUs for providing Technical Know-How and consultancy with different start-up entrepreneurs. More than six outreach activities through showcasing of our technologies at various exhibitions/melas were carried out at Hyderabad, Bangalore and Delhi. Besides aforesaid activities, the Institute has celebrated numerous programmes viz. World Soil Day, Independence Day, Vigilance Awareness Week, International Yoga Day, Hindi Diwas, Republic day, Institute foundation day, Swachhta Pakhwada etc.

I sincerely acknowledge the support of all the staff of NRC on Meat, DG, ICAR, DDG (AS) and ADGs at the Animal Science Division of ICAR, RAC and IMC members. "Together we can" encourages us to adopt present-day challenges and fulfill our responsibilities to our stakeholders. We will continue to focus on creating positive change and prosperity for all our stakeholders in order to ensure sustainable development to take NRC Meat to ever higher horizons of growth.

S. Vaithiyanathan
Acting Director

प्रस्तावना

भा.कृ.अनु.प.-राष्ट्रीय मांस अनुसंधान केंद्र, हैदराबाद की वर्तमान वर्ष **2018-19** की वार्षिक रिपोर्ट को आपके समक्ष प्रस्तुत करना मेरे लिये अत्यंत हर्ष का विषय है। मैं डॉ. त्रिलोचन महापात्र, माननीय सचिव, डेयर एवं महानिदेशक, भा.कृ.अनु.प., नई दिल्ली के कर-कमलो द्वारा डॉ. जॉयकृष्ण जेना, उप महानिदेशक (पशु विज्ञान) और डॉ. अशोक कुमार, सहायक महानिदेशक (पशु स्वास्थ्य) की गरिमामयी उपस्थिति में १८ जनवरी, २०१९ को भा.कृ.अनु.प.-राष्ट्रीय मांस अनुसंधान केंद्र के नवनिर्मित भव्य सभागार का उद्घाटन कार्यक्रम को इस वर्ष का सबसे अधिक महत्वपूर्ण कार्यक्रम मानता हूं। मैं ऊत्साह पूर्वक यह उल्लेख करना चाहुंगा कि संस्थान की "मीट स्पेसिएशन" प्रयोगशाला को परीक्षण और अंशांकन प्रयोगशालाओं के लिए राष्ट्रीय प्रत्यायन बोर्ड द्वारा मान्यता प्राप्त हुई है और "आई.एस.ओ./आई.ई.सी. १७०२५:२००५ प्रमाणपत्र" से सम्मानित किया गया है।

संस्थान ने जीनोमिक, ट्रांसक्रिपटोमिक और प्रोटिओमिक दृष्टिकोण के माध्यम से मांस प्रजातियों और जानवरों के ऊतकों के प्रमाणीकरण पर अपने शोध प्रयासों को जारी रखा है। इन कार्यों को बढ़ाने के लिए, हमने हाल ही में डिजिटल ड्रापलेट पीसीआर और जेल-फ्री इलेक्ट्रोफोरोसिस यूनिट की खरीद की है और विभिन्न हितधारकों की जरूरतों को पूरा करने के लिए मांस की पहचान/जांच के लिए क्षेत्र प्रयोज्य किट विकसित करने की योजना बनाई है। पशु थूथन **(muzzle)** आधारित ट्रेसबिलिटी सिस्टम का विकास और सेल संवर्धित मांस पर काम शुरू किया गया है। संस्थान भारत का खाद्य सुरक्षा और मानक प्राधिकरण, चिकित्सा पेशेवरों, पशु चिकित्सकों और मांस उद्योग के कर्मियों के साथ सहयोग और नेटवर्किंग के माध्यम से "एक स्वास्थ्य" की परिधारणा के आधार पर मांस मूल्य श्रृंखला से सम्बंधित सुरक्षा मुद्दों पर विशेष ध्यान दे रहा है। वैज्ञानिक समुदाय के बीच जागरूकता पैदा करने के लिए "एक स्वास्थ्य: अभूतपूर्व अवसर और चुनौतियां" शीर्षक पर एक कार्यशाला का भी आयोजन संस्थान द्वारा किया गया। मांस जनित ज़ूनोटिक बीमारियों की निगरानी, मांस उद्योग के कर्मियों की स्वास्थ्य स्थिति का मूल्यांकन, पॉलीसाइक्लिक एरोमैटिक हाइड्रोकार्बन (पीएएच) और रोगाणुरोधी एजेंटों की उपस्थिति के लिए मांस और मांस उत्पादों की जांच की जा रही है। मांस की ताजगी के संकेतन हेतु प्राकृतिक वनस्पति आधारित डाई और नैनो-कण संयुग्मित सेंसर विकसित करना का विकास संस्थान द्वारा किया गया है। संस्थान ने चिकन और मटन के अचल-जीवन (**shelf-life**) को बढ़ाने के लिए एक सटीक तापमान और आर्द्रता नियंत्रण के साथ सुपर-चिलिंग कैबिनेट डिजाइन किया है। मांस और मांस उत्पादों की बढ़ती सुरक्षा और शेल्फ जीवन को सुनिश्चित करने के लिए प्राकृतिक एंटीऑक्सिडेंट, आवश्यक तेल और पैकेजिंग आधारित रणनीतियों का विकास किया जा रहा है।

मुझे यह उल्लेख करने में अत्यंत हर्ष हो रहा है कि, संस्थान अतिरिक्त-वित्त पोषित अनुसंधान परियोजनाओं के माध्यम से बडी-धनराशि जनित करने में सफल रहा है और वर्तमान में एक अनुबंध अनुसंधान परियोजना के अलावा, जैव प्रौद्योगिकी विभाग, खाद्य प्रसंस्करण उद्योग मंत्रालय, भारत का खाद्य सुरक्षा और मानक प्राधिकरण, डेयरी और मत्स्य पालन विभाग, और भा.कृ.अनु.प. से **11** अनुदानित परियोजना पर कार्य हो रहे हैं। शोध के निष्कर्षों की प्रभावशीलता बढ़ाने और एक व्यापक लोक-प्रसार, जन जन तक पहुचाने के लिए, संस्थान ने

सफलतापूर्वक एक भा.कृ.अनु.प. प्रायोजित "किसानों को दोगुना करने के लिए पशुधन क्षेत्र में नवाचार आय: रणनीतियाँ और मांस मूल्य श्रृंखला में अवसर" पर केंद्रित **21** दिवसिय ग्रीष्मकालीन स्कूल का सफलतापुर्वक आयोजन किया गया है। संस्थान ने विभिन्न राज्य सरकारों के पशुपालन अधिकारियों के लिए "फॉरेंसिक फूड एनालिसिस में **DNA** तकनीकों का उपयोग" पर प्रशिक्षण कार्यक्रम भी आयोजित किया गया था। "भेड़ और बकरी उत्पादन और मांस मूल्यवर्धन" पर तीन फ्रन्ट लाइन प्रदर्शन कार्यक्रमो का आयोजन खम्मम, मुलुगु, असिफाबाद में ग्रामीण गरीबी उन्मूलन संस्था, तेलंगाना सरकार के सहयोग से किया गया। पशु चिकित्सा महाविद्यालय, शिवमोग्गा और पशु चिकित्सा महाविद्यालय, हासन में "सुरक्षित स्वच्छ मांस उत्पादन, प्रसंस्करण और मूल्य संवर्धन" पर दो ऑफ-कैम्पस प्रशिक्षण आयोजित किए गए। पांच हैंड्स ओन उद्यमिता विकास कार्यक्रम आयोजित किए गए और **78** उद्यमियों को प्रशिक्षित किया गया। "स्वच्छ मांस उत्पादन और प्रसंस्करण" पर दो कौशल विकास कार्यक्रमों द्वारा बाईस युवाओं को प्रशिक्षित किया गया था।

संस्थान के संस्थान प्रौद्योगिकी प्रबंधन इकाई और कृषि-व्यवसाय ऊष्मायन (ABI) ने अलग-अलग स्टार्ट-अप उद्यमियों के साथ तकनीकी ज्ञान और परामर्श प्रदान करने के लिए 6 समझौता ज्ञापनों पर हस्ताक्षर किए। हैदराबाद, बैंगलोर और दिल्ली में विभिन्न प्रदर्शनियों / मेलों में हमारी प्रौद्योगिकियों के प्रदर्शन के माध्यम से छह से अधिक आउटरीच गतिविधियाँ की गईं। उपरोक्त गतिविधियों के अलावा, संस्थान ने विश्व मृदा दिवस, स्वतंत्रता दिवस, सतर्कता जागरूकता सप्ताह, अंतर्राष्ट्रीय योग दिवस, हिंदी दिवस, गणतंत्र दिवस, संस्थान स्थापना दिवस, स्वच्छ पखवाड़ा आदि कई कार्यक्रमों का ऊत्साह पुर्वक आयोजन किया।

मैं संस्थान के सभी कर्मचारियो-अधिकारियो, माननीय महानिदेशक, उपमहानिदेशक, सहायक महानिदेशक, पशु विज्ञान प्रभाग, भा.कृ.अनु.प., नई दिल्ली, संस्थान की अनुसंधान सलाहाकार समिति (आर.ए.सी) और संस्थान प्रबंधन समिति के सभी सदस्यो के उत्कृष्ठ सहयोग और सहभागिता के लिये सादर आभार व्यक्त करता हूं। "एकसाथ हम कर सकते है" का मूल मंत्र हमें वर्तमान चुनौतियों का सामना करने और अपने हितधारकों के लिए अपनी जिम्मेदारियों को पूरा करने के लिए प्रोत्साहित करता है। मैं आपको आश्वस्त करता हूँ कि संस्थान को विकास के उच्चतर क्षितिज पहुचाने के लिये हम अपने सभी हितधारकों के लिए सकारात्मक परिवर्तन और उन्हे अधिक समृद्ध बनाने पर ध्यान केंद्रित करना जारी रखेंगे।

एस. वैद्यनाथन

कार्यकारी निदेशक

EXECUTIVE SUMMARY

ICAR-National Research Centre on Meat, Hyderabad is undertaking research and development projects, entrepreneurship development, consultancy, transfer of technologies, skill development, awareness programmes, exhibitions, contract research, workshops, stake-holders meeting, MoU/Agreements and several other activities to augment sustainable meat animal production, meat processing, value addition and ensuring safety of muscle foods. Four new external funded projects were initiated and several new equipment were procured. Grand auditorium of ICAR-NRC on Meat was inaugurated on 18th January, 2019 in the hands of Dr. Trilochan Mohapatra, Hon'ble Secretary, DARE and Director General, ICAR. The Centre has interacted with various State Government and Central Government organisations, line Departments and other stakeholders to identify the problems and missing links in the meat value chain to formulate new projects. The Institute has successfully conducted one ICAR sponsored summer school, one customised training, one workshop, 10 entrepreneurship trainings, 2 trainings for butchers, three trainings to sheep farmers under NLM project, three front-line demonstration programmes, two off-campus trainings and six MoUs were signed with entrepreneurs. Successfully organised the IRC, IMC and RAC meetings.

The summary of the Institute's activities during the period from April 2018 to March 2019 is presented below:

Research and development

Meat animal production

- Comparison of muscle proteome of sheep slaughtered after electrical stunning or by traditional halal method without stunning by 2D-DIGE and MALDI-TOF/TOF MS analysis revealed 46 significant differentially expressed proteins/peptides that correlated with meat texture and pre-slaughter stress. Peroxiredoxin-6, a potential marker of tenderness in meat was detected in non-stunned samples.
- External auditing of organic sheep unit by APEDA accredited certifying agency "One Cert Asia" has been completed and organic scope certificate has been issued for sheep by the certifying agency.
- About 150 animals of two different farms have been enrolled for promoting traceability in the field.

Meat quality and shelf-life

- The protocol for the preparation of sticker-type sensor from anthocyanin-curcumin-gold nanocomposite coated onto nitrocellulose membrane strips was standardized and the color change in the sensor (pink-colourless-light blue) was compared with the meat quality changes during refrigerated storage (4±1°C).
- Designed superchilling cabinet with temperature and humidity control to optimize the superchilling condition for dressed carcass or meat in order to improve their quality and storage stability.

- Inactivation of meat borne bacteria and inactivation kinetics by ozone were studied.
- Microencapsulation of thymol essential oil by Emulsion Extrusion method was optimized for production of emulsion based chicken meat product.

Meat safety and authentication

- Micro RNA extraction from different tissues of chicken and sequencing for miRNA profiling completed for 5 tissues from chicken and 6 tissues each from cattle and buffalo. Unique, common and differentially expressed miRNAs were identified to develop tissue specific diagnostic assays.
- Chicken tissue specific miRNAs have been identified and validation is being undertaken.
- Haleem meat samples (89 Nos.) were tested using LCD meat array and found misrepresentation of 44 samples.
- Droplet digital PCR assay has been standardized to detect cow and buffalo DNA as well as vegetable DNA in the commercial ghee without having to use known DNA samples.
- Meat samples from 202 slaughtered buffaloes were collected and examined grossly for sarcocysts. No visible sarcocysts were observed.
- The serum samples collected from abattoir associated personnel were tested for brucellosis, leptospirosis and Q fever using ELISA. A total of 4.1%, 14.48% and 16.66% samples were positive for antibodies against leptospirosis, brucellosis and Q fever, respectively by ELISA.
- A total of 205 samples of buffalo meat, and other samples were collected for isolation of *Listeria* sp. and nine samples were found positive.
- The RP-HPLC assay was standardized with LOQ:11.10 µg/Kg for oxytetracycline and 18.20 µg/Kg for chlortetracycline residues with Linearity Accuracy:> 0.999; Linearity range :25-200 µg/Kg.
- Standardization of method for extraction, purification, identification and quantification of PAH compounds from meat products has been completed.

Meat processing and value addition

- Creation of facilities for processing of Haleem-a traditional delicacy of Hyderabad and process optimization for development of chicken and mutton Haleem was carried out.
- Refining of process for preparation of chicken and mutton pickle and seekh kebabs.
- Process optimization for production of dried emu meat.

Training/Workshop/ Entrepreneurship Development Pogrammes Organised

- Training programme on DNA Techniques in forensic food analysis was conducted at the Institute during 2 to 9 July, 2018. A total of 23 officials participated in this training.
- ICAR sponsored Summer School programme on "Innovations in livestock sector for doubling farmers Income: Strategies and opportunities in meat value chain" was organised from 25 July to

14 August, 2018. A total of 15 participants of various SAUs and ICAR institutes from 5 states of the country participated in the training programme.

- During 2018-19, a total of ten hands-on entrepreneurship training programmes and or/ skill development programmes on safe meat production and entrepreneurship development on value added meat products processing were organized. Around 100 entrepreneurs from different states were trained.
- One day Workshop on "One Health: Unprecedented Opportunities and Challenges" was organised on 17th December, 2018 in collaboration with Society for Research on *Listeria* and Indian Meat Science Association. A total of 52 participants attended the workshop.
- Two off-campus trainings were organized on safe meat production, processing and value addition at Veterinary College, Shivamogga and Veterinary College, Hassan during 12-13, March, 11-12, March 2019, respectively.

Contract Research, Consultancy, MoUs and Extension activities

- Three Front Line Demonstration Programmes on, 'Scientific sheep and goat production and value addition to meat' was organized at Khammam, Mulugu and Asifabad on 20 to 21 July, 24 to 25, July and 1 to 2 August, 2018, respectively for Women Self Help Groups of the district. About 214 women participated in the events.
- A contract research project on "Development of traceability model for Indian buffalo meat industry for quality assurance and augmenting exports" was signed with M/s. Clonoid Pvt. Ltd., Hyderabad.
- Six MoUs for providing Technical Know-How and consultancy with different start-up entrepreneurs were signed.
- MoU for research and extension was signed with Chhattisgarh Kamdhenu Viswavidyalaya, Durg.
- Six outreach activities through showcasing of technologies at various exhibitions/melas were carried out at Hyderabad, Bangalore and Delhi.

Infrastructure

The newly constructed auditorium was inaugurated.

Primary poultry processing plant with capacity to process 150 birds per hour has been established under ICAR NAIF –ABI scheme.

Major Achievements

The "Meat speciation" laboratory of ICAR-NRC on Meat has been accredited by National Accreditation Board for Testing and Calibration Laboratories and awarded with "ISO/IEC 17025:2005 certificate"

विशिष्ट सारांश

भा.कृ.अनु.प.–राष्ट्रीय मांस अनुसंधान केंद्र, हैदराबाद मांस पशु उत्पादन, मांस प्रसंस्करण, मूल्य संवर्धन और मांसल खाद्य पदार्थों की सुरक्षा सुनिश्चित करने के लिए अनुसंधान और विकास परियोजनाओं, उद्यमिता विकास, परामर्श, प्रौद्योगिकियों के हस्तांतरण, कौशल विकास, जागरूकता कार्यक्रमों, प्रदर्शनियों, अनुबंध अनुसंधान, कार्यशालाओं, हितधारकों की बैठक, समझौता ज्ञापन / समझौतों और कई अन्य गतिविधियों का संचालन कर रहा है।

चार नए बाह्य वित्त पोषित परियोजनाओं की शुरुआत की गई और कई नए उपकरणों की खरीद की गई। भा.कृ.अनु.प.–राष्ट्रीय मांस अनुसंधान केंद्र के भव्य सभागार का उद्घाटन 18 जनवरी, 2019 को माननीय डॉ त्रिलोचन महापात्र, सचिव, डेयर और महानिदेशक, भा.कृ.अनु.प. के कर– कमलों द्वारा किया गया।

केंद्र ने विभिन्न राज्य सरकार और केंद्र सरकार के संगठनों, लाइन विभागों और अन्य हितधारकों के साथ बातचीत की है ताकि नई परियोजनाओं के निर्माण के लिए मांस मूल्य श्रृंखला में समस्याओं और लापता लिंक की पहचान की जा सके। संस्थान ने सफलतापूर्वक भा.कृ.अनु.प. प्रायोजित एक ग्रीष्मकालीन स्कूल, एक प्रायोजित प्रशिक्षण, एक कार्यशाला, 10 उद्यमिता प्रशिक्षण, 2 कसाई प्रशिक्षण, एनएलएम परियोजना के तहत भेड़ किसानों को तीन प्रशिक्षण, तीन फ्रंट–लाइन प्रदर्शन कार्यक्रम, दो ऑफ–कैंपस प्रशिक्षण और छह उद्यमियों के साथ समझौता ज्ञापन पर हस्ताक्षर किए गए। संस्थान अनुसंधान परिषद, संस्थान प्रबंधन समिति और अनुसंधान सलाहकार समिति बैठकों का सफलतापूर्वक आयोजन किया।

अप्रैल 2018 से मार्च 2019 की अवधि के दौरान संस्थान की गतिविधियों का सारांश नीचे प्रस्तुत किया गया है:

अनुसंधान एवं विकास:

मांस पशु उत्पादन:

- बिजली की तेजस्वी के बाद या तेजस्वी के बिना पारंपरिक हलाल विधि से मारे गए भेड़ों की मांसपेशियों के proteome की 2D & DIGE और MALDI & TOF / TOF एमएस विश्लेषण द्वारा तुलना में 46 महत्वपूर्ण विभेदित प्रोटीन / पेप्टाइड्स का पता चला है जो मांस की बनावट और पूर्व–वध तनाव से संबंधित हैं। बिना अचेत नमूनों में मांस में कोमलता के संभावित मार्कर पेरोक्सीरेडॉक्सिन –6 का पता चला है।
- एपीडा द्वारा मान्यता प्राप्त प्रमाणित एजेंसी "वन सर्ट एशिया" द्वारा ऑर्गेनिक भेड़ इकाई का बाहरी लेखा–परीक्षण पूरा कर लिया गया है और प्रमाणित एजेंसी द्वारा भेड़ों के लिए ऑर्गेनिक स्कोप सर्टिफिकेट जारी कर दिया गया है।
- ट्रेसबिलिटी को बढ़ावा देने के लिए दो अलग–अलग खेतों के लगभग 150 जानवरों को नामांकित किया गया है।

मांस की गुणवत्ता और शेल्फ–लाइफः

- नाइट्रोसेल्यूलोज झिल्ली स्ट्रिप्स पर लेपित एंथोसायनिन–करक्यूमिन–गोल्ड नैनोकम्पोजिट से स्टीकर–प्रकार के सेंसर की तैयारी के लिए प्रोटोकॉल को मानकीकृत किया गया और सेंसर में गुलाबी रंग–रहित–हल्के नीले रंग की तुलना रेफ्रिजरेटेड (4 ± 1°C) भंडारण के दौरान मांस की गुणवत्ता में बदलाव के साथ की गई।
- गुणवत्ता और भंडारण स्थिरता में सुधार करने के लिए तैयार चिकन या मांस की सुपरचिलिंग स्थिति का अनुकूलन करने, उनकी तापमान और आर्द्रता नियंत्रण के साथ सुपरचिलिंग कैबिनेट बनाया गया है।
- ओजोन द्वारा मांस जनित बैक्टीरिया और निष्क्रियता कैनेटीक्स के निष्क्रियता का अध्ययन किया गया ।
- इमल्शन एक्सट्रूज़न विधि द्वारा थायमॉल आवश्यक तेल के माइक्रोएन्कैपुलेशन को पायस आधारित चिकन मांस उत्पाद उत्पादन के लिए अनुकूलित किया गया।

मांस की सुरक्षा और प्रमाणीकरणः

- चिकन के विभिन्न ऊतकों से माइक्रो आरएनए निष्कर्षण और चिकन से 5 ऊतकों तथा मवेशी और भैंस से 6 ऊतकों के लिए miRNA सीक्वेंसिंग पूरा किया गया। ऊतक विशिष्ट नैदानिक परख विकसित करने के लिए अद्वितीय, आम और अलग–अलग व्यक्त miRNA की पहचान की गई।
- चिकन ऊतक विशिष्ट miRNA की पहचान की गई है और सत्यापन किया जा रहा है।
- हलीम मांस के नमूनों (89 नं) का परीक्षण एलसीडी मांस सरणी का उपयोग करके किया गया और 44 नमूनों का गलत विवरण मिला।
- ज्ञात DNA नमूनों का उपयोग किए बिना व्यावसायिक घी में गाय और भैंस डीएनए के साथ–साथ वनस्पति डीएनए का पता लगाने के लिए ड्रॉप्लेट डिजिटल पीसीआर परख को मानकीकृत किया गया है।
- वध किए गए भैंसों के 202 से मांस के नमूने एकत्र किए गए थे और उनकी जांच की गई थी। कोई दृश्यमान सरकोसिस्ट नहीं देखा गया।
- कसाई खाने से जुड़े कर्मीयो से एकत्र किए गए सीरम के नमूनों को एलिसा का उपयोग करके ब्रुसेलोसिस, लेप्टोस्पायरोसिस और क्यू बुखार के लिए परीक्षण किया गया। एलिसा द्वारा क्रमशः 4.1%, 14.48% और 16. 66% नमूने लेप्टोस्पायरोसिस, ब्रुसेलोसिस और क्यू बुखार के खिलाफ एंटीबॉडी के लिए सकारात्मक थे।
- लिस्टेरिया के अलगाव के लिए भैंस के मांस के कुल 205 नमूने, और अन्य नमूने एकत्र किए गए थे। और 9 नमूने सकारात्मक पाए गए।
- आरपी–एचपीएलसी परख मानकीकृत किया गया : ऑक्सीटेट्रासाइक्लिन और क्लोरेटेट्रासाइक्लिन अवशेषों के लिए 11.10 और 18.20 µg/Kg।
- मांस उत्पादों से पीएएच यौगिकों के निष्कर्षण, शोधन, पहचान और मात्रा का ठहराव के लिए मानकीकरण पूरा हो गया है।

मांस प्रसंस्करण और मूल्य संवर्धनः

- हलीम – हैदराबाद की पारंपरिक सौगात के प्रसंस्करण के लिए सुविधाओं का निर्माण और चिकन और मटन हलीम के विकास के लिए प्रक्रिया अनुकूलन किया गया।
- चिकन और मटन अचार और सीक कबाब तैयार करने के लिए प्रक्रिया को परिष्कृत किया गया।
- सूखे ईमू मांस के उत्पादन के लिए प्रक्रिया अनुकूलन किया गया।

प्रशिक्षण / कार्यशाला / उद्यमिता विकास च्वहतंउउमे आयोजन :

- 2–9 जुलाई, 2018 के दौरान संस्थान में फोरेंसिक खाद्य विश्लेषण में डीएनए तकनीकों पर प्रशिक्षण कार्यक्रम आयोजित किया गया था। इस प्रशिक्षण में कुल 23 अधिकारियों ने भाग लिया था।
- आईसीएआर द्वारा प्रायोजित ग्रीष्मकालीन स्कूल कार्यक्रम "किसानों को दोगुना करने के लिए पशुधन क्षेत्र में नवाचार आयः रणनीतियाँ और मांस मूल्य श्रृंखला में अवसर" 25 जुलाई से 14 अगस्त, 2018 तक आयोजित किया गया। 5 राज्यों के विभिन्न एसएयू/ आईसीएआर संस्थानों के कुल 15 प्रतिभागियों ने देश ने प्रशिक्षण कार्यक्रम में भाग लिया।
- 2018–19 के दौरान, सुरक्षित मांस उत्पादन पर कुल दस हाथ–उद्यमिता प्रशिक्षण कार्यक्रम और कौशल विकास कार्यक्रम और मूल्य वर्धित मांस उत्पादों के प्रसंस्करण पर उद्यमिता विकास का आयोजन किया गया। विभिन्न राज्यों के लगभग 100 उद्यमियों को प्रशिक्षित किया गया।
- " एक स्वास्थ्यः अनपेक्षित अवसर और चुनौतियां" एकीकृत स्वास्थ्य पर एक दिवसीय कार्यशाला 17 दिसंबर, 2018 को सोसाइटी फॉर रिसर्च ऑन लिस्टेरिया और भारतीय मांस विज्ञान संघ के सहयोग से आयोजित की गई थी। कार्यशाला में कुल 52 प्रतिभागियों ने भाग लिया।
- क्रमशः 12–13, मार्च, 11–12, मार्च 2019 के दौरान पशु चिकित्सा महाविद्यालय, शिवमोग्गा और पशु चिकित्सा महाविद्यालय, हासन में सुरक्षित मांस उत्पादन, प्रसंस्करण और मूल्य संवर्धन पर दो ऑफ–कैम्पस प्रशिक्षण आयोजित किए गए।

अनुबंध अनुसंधान, परामर्श, समझौता ज्ञापन और विस्तार गतिविधियाँः

- आईसीएआर – राष्ट्रीय मांस अनुसंधान केंद्र, हैदराबाद द्वारा खम्मम, मुलुगु और आसिफाबाद जिले के महिला स्वयं सहायता समूहों पर केंद्रित में क्रमशः 20 से 21 जुलाई, 24 से 25 जुलाई, और 01–02 अगस्त, 2018 तक ' भेड़ और मांस के उत्पादन और मूल्य वर्धन' पर तीन सीमावर्ती प्रदर्शन कार्यक्रम आयोजित किए गए। आयोजन में लगभग 214 महिलाओं ने भाग लिया।
- मेसर्स क्लोनॉइड प्रा. लिमिटेड, हैदराबाद के साथ "भारतीय भैंस के मांस उद्योग के लिए ट्रेसबिलिटी मॉडल का विकास, गुणवत्ता आश्वासन और निर्यात बढ़ाने के लिए अनुबंध अनुसंधान परियोजना" पर हस्ताक्षर किए गए।
- विभिन्न स्टार्ट–अप उद्यमियों के साथ तकनीकी ज्ञान और परामर्श प्रदान करने के लिए छह समझौता ज्ञापनों पर हस्ताक्षर किए गए।
- छत्तीसगढ़ कामधेनु विश्वविद्यालय, दुर्ग के साथ अनुसंधान और विस्तार के लिए समझौता ज्ञापन पर हस्ताक्षर किए गए।

- हैदराबाद, बैंगलोर और दिल्ली में विभिन्न प्रदर्शनियों / मेलों में प्रौद्योगिकियों के प्रदर्शन के माध्यम से छह आउटरीच गतिविधियाँ की गईं।

आधारभूत संरचना व्यवस्थाः

- नवनिर्मित सभागार का उद्घाटन किया गया है।
- आईसीएआर राष्ट्रीय कृषि नवाचार परियोजना के तहत प्रति घंटे 150 पक्षियों को संसाधित करने की क्षमता वाले प्राथमिक पोल्ट्री प्रसंस्करण संयंत्र की स्थापना की गई है।

प्रमुख उपलब्धियां

भा.कृ.अनु.प.–राष्ट्रीय मांस अनुसंधान केंद्र, हैदराबाद में "मांस पहचान" प्रयोगशाला को परीक्षण और अंशांकन प्रयोगशालाओं के लिए राष्ट्रीय प्रत्यायन बोर्ड द्वारा मान्यता प्राप्त हुई है और "आईएसओ / आईईसी 17025: 2005 प्रमाण पत्र" से सम्मानित किया गया है।

INTRODUCTION

The livestock sector in India contributes 4.11% of National GDP and 25.6% of total Agricultural GDP and about 20.5 million people depend upon livestock for their livelihood. Urbanization and financial empowerment of consumers in India have brought a marked shift in food habits of people towards milk products, meat and eggs with resultant increase in demand of total livestock products. There is a clear structural shift in consumption from food grains, particularly cereals, to high-value commodities comprising mainly livestock-based foods. To meet this burgeoning demand, in the year 2017-18, India has produced 7.7 million tonnes of meat and has the distinction of producing largest amount of buffalo meat in the world (42.15%). It is also the second largest producer of goat meat in the world. However, per capita consumption of meat in India still remains relatively low at less than 6.5 kg/person/annum.

Meat value chain in India is highly complex and is comprised of various stakeholders viz, livestock/poultry producers and farmers, live animal markets, municipal slaughterhouses, poultry wet-markets, export meat plants, butcher shops, transport and logistics providers, meat processors, retailers, quick service restaurants, convenience stores, super-markets, institutional caterers and consumers etc. Most of these stakeholders work in isolation and are highly unorganized. In order to ensure doubling of farmer's income, the value chain need to be completed and all the livestock industry stakeholders need to be linked. Further, good animal husbandry and meat production practices must be demonstrated to ensure quality and safe production of livestock products including meat and poultry. Assistance to farmers/farms need to be given to build production model in line with global gap for ensuring safe, nutritious, traceable and affordable products to consumers. Obtaining globally recognized quality and safety certificates must be promoted to boost export of livestock produce to developed nations. Value addition and further processing of livestock and poultry products need to be encouraged. Training, skill development and capacity building of various stake-holders need to be undertaken to cater to the fast changing industry demands. Emerging issues related to livestock and poultry sector *viz*, food safety, environmental responsibility, animal health and welfare, social responsibility and traceability need to addressed appropriately.

Considering the changing scenario in the livestock sector especially meat value chain, ICAR-NRC on Meat has taken-up various research, extension and training activities to address different issues right from meat animal production, meat quality, safety to consumption. Important research areas related to organic small ruminants production, traceability in export buffalo meat value chain, authentication of meat species, field level kits for detecting meat adulteration, estimation of chemical residues and

carcinogenic compounds if any, in highly processed meat products, identification and characterization of meat borne zoonotic microorganisms, packaging and preservation methods for enhanced storage and sensor-based detection of meat spoilage are being undertaken. This Institute is providing need based training for scientific, managerial and technical personnel in meat and allied sectors; establishing a liaison with industry, trade, regulatory and developmental organizations operating in meat sector and is providing consultancy services to entrepreneurs. The Institute is also incubating start-up entrepreneurs through its Agribusiness Incubator (ABI) facility for providing incubation support services to the entrepreneurs in meat processing and developing their businesses.

The Institute will make efforts towards building a sustainable livestock production chain through innovative meat production, processing and value addition approaches and providing trained manpower to ensure clean, safe and hygienic meat and poultry products to consumers.

VISION, MISSION and MANDATE

VISION

NRC on Meat as a premier institution of meat research to solve the problems and face challenges of meat and allied sectors development.

MISSION

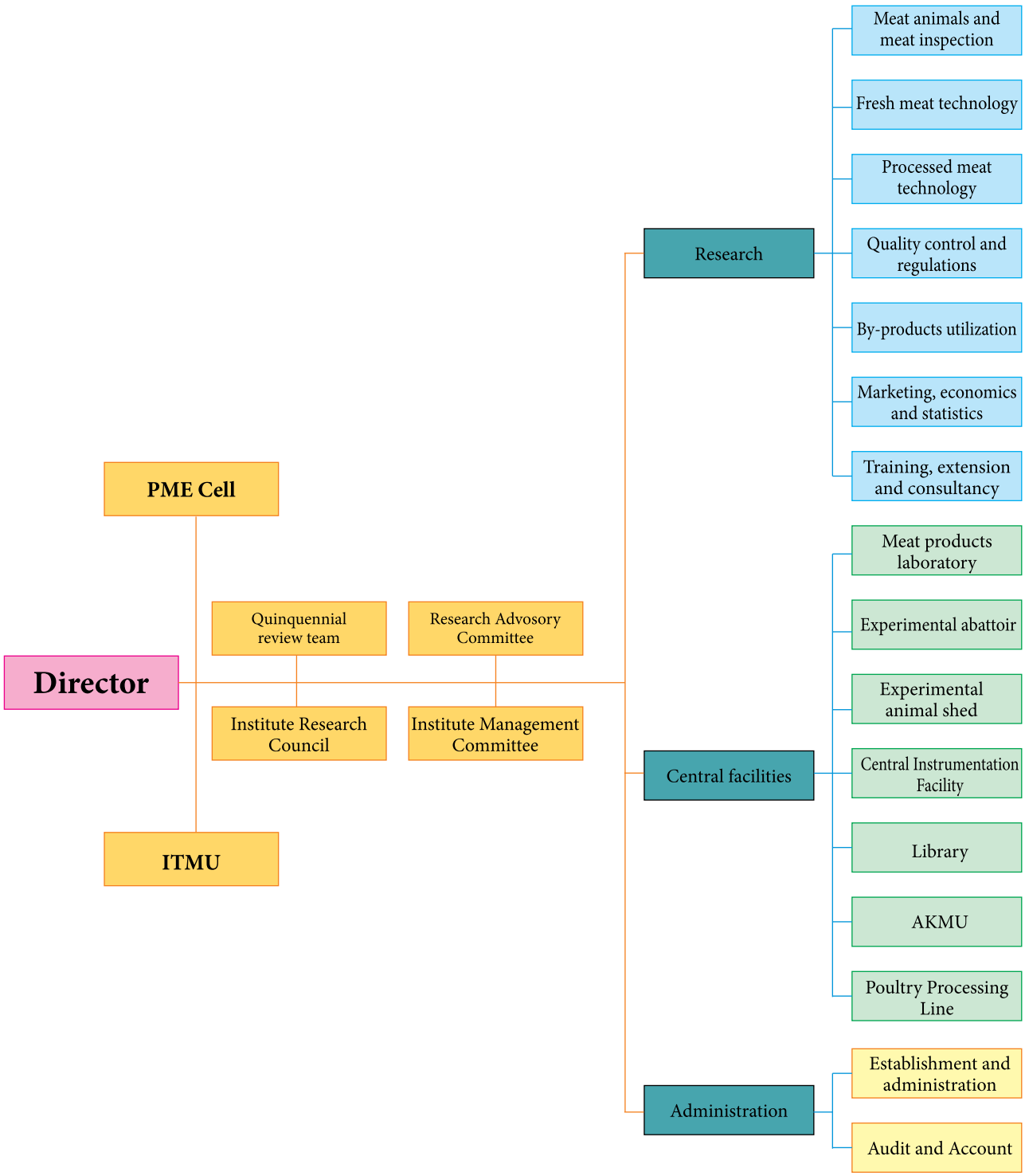
Development of modern organized meat sector through meat production, processing and utilization technologies to serve the cause of meat animal producers, processors and consumers.

MANDATE

- Basic and applied research in meat science and technology for meat production, processing, value addition and utilization
- Capacity development for different levels of personnel in meat sector.
- National repository of information in meat and allied sectors.

ORGANIZATIONAL SET UP

ICAR-NATIONAL RESEARCH CENTRE ON MEAT: ORGANIZATIONAL SET UP



STAFF STRENGTH

Staff	Sanctioned	Filled
Scientific	15	15
Technical	05	04
Administrative	14	07
Skilled Supporting	02	00
Total	36	26

* As on 31st March, 2018

BUDGET

Budget details (In lakhs)

S.No.	Head	Budget	
		Sanctioned	Utilized
1	Establishment	515.00	510.78
2	Contingencies	181.54	181.25
3	Equipment	49.42	48.40
4	Furniture & Fixtures	3.0	3.14
5	Works	91.00	91.00
6	TA	17.00	16.06
7	HRD	3.91	3.91
8	Pension & ORB	49.00	49.00
9	NEH	00	00
	Total	**909.87**	**903.54**

NRCMeat

RESEARCH HIGHLIGHTS

Externally funded research projects

1. Detection and Quantification of Animal Body Fat (Tallow)/Vegetable Fat in Milk Fat/Ghee

Funding agency :	SERB, Govt. of India
Principal Investigator :	Dr. S. Vaithiyanathan
Co-Principal Investigators :	Dr. S. Kalpana and Dr. Rituparna Banerjee

Development of a technique based on PCR assay to detect and quantify animal body fat/vegetable fat in milk fat/ghee in known and unknown samples was envisaged. Under this project, we standardized a method to isolate DNA from fat materials such as milk fat (pure cow ghee), tallow (cattle and buffalo) and vegetable fat. The DNA isolated from milk fat/animal body fat/vegetable fat was not of good quality in terms of A260/A280 ratio. However, the isolated DNA quality was sufficient enough to get amplified by the mitochondrial primers in the PCR assay. In the end point PCR assay using mt D loop and mtCyt b species specific primers, tallow addition above 5% in the milk fat (cow ghee) could be detected (Fig 1). In the Taqman real time PCR assay, DNA from cattle and buffalo tallow could be detected at 1% level. 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. The correlation analysis of DNA content and tallow percentage in the binary mixture showed linear relationship with R2>0.96. The Taqman real time PCR assay for the detection of cattle/buffalo DNA in the unknown tallow samples was validated. A PCR assay has also been standardized to detect vegetable fat in cow milk fat up to 5% using the rbcl PCR assay in the end point PCR assay.

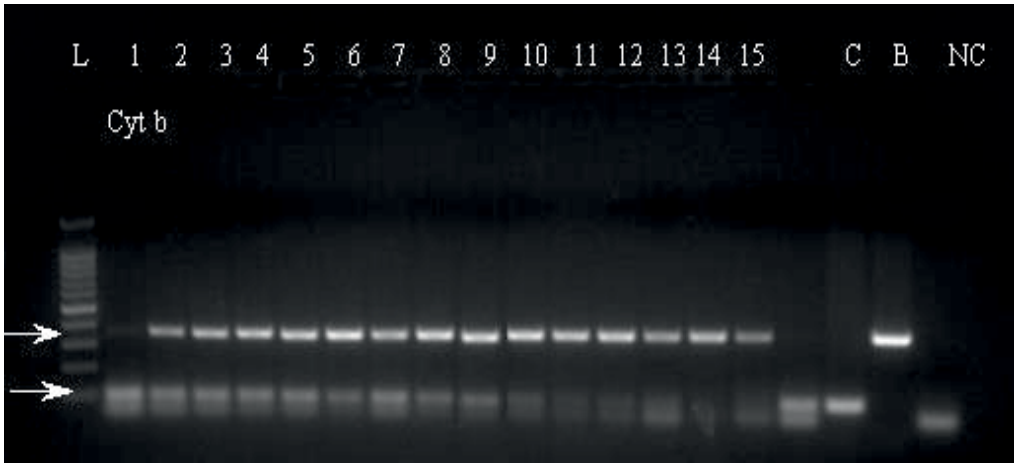


Fig 1. mtCytb duplex (for cattle and buffalo) PCR assay of DNA from binary mixtures

Cow ghee (%) 1=100; 2=95; 3=90; 4=85; 5=80; 6=75; 7=70; 8=65; 9=60; 10=50; 11=40; 12=30; 13=20; 14=10; 15=0

Buffalo Tallow (%) 1=0; 2=5; 3=10; 4=15; 5=20; 6=25; 7=30; 8=35; 9=40; 10=50; 11=60; 12=70; 13=80; 14=90; 15=100; C=cattle and B=buffalo

In order to further improve the accuracy of the DNA based method for the detection of buffalo fat DNA and vegetable fat DNA in cow milk fat, the droplet digital PCR assay system was utilized. Droplet Digital PCR (ddPCR) assay is a method for performing digital PCR that is based on water-oil emulsion droplet technology. A sample is fractionated into 20,000 droplets, and PCR amplification of the template molecules occurs in each individual droplet. The ddPCR technology uses reagents and workflows similar to those used for most standard TaqMan probe-based assays. We have used the mitochondrial cytochrome b gene for cattle and buffalo DNA detection while the chloroplast trnl gene for vegetable (plant) DNA in the ddPCR assay. The massive sample partitioning is a key aspect of the ddPCR technique. Generation of an average of 12000 droplets in a 20µl ddPCR reaction mixture was observed. This sensitive technique has been exploited to detect few copies of the buffalo fat DNA and vegetable fat DNA in cow milk fat. No relationship between DNA concentration and milk fat/body fat/ vegetable fat concentration in a binary mixture (Fig 2) was observed. A total of 22 commercial milk fat (ghee) samples of various brands were collected and subjected to detection for cattle fat DNA/buffalo fat DNA/vegetable fat DNA. Only six samples did not contain vegetable (plant) DNA (Fig 3). Similarly, the ddPCR assay using the cytochrome b gene primers revealed all samples to contain cattle DNA as well as buffalo DNA (Fig 4).

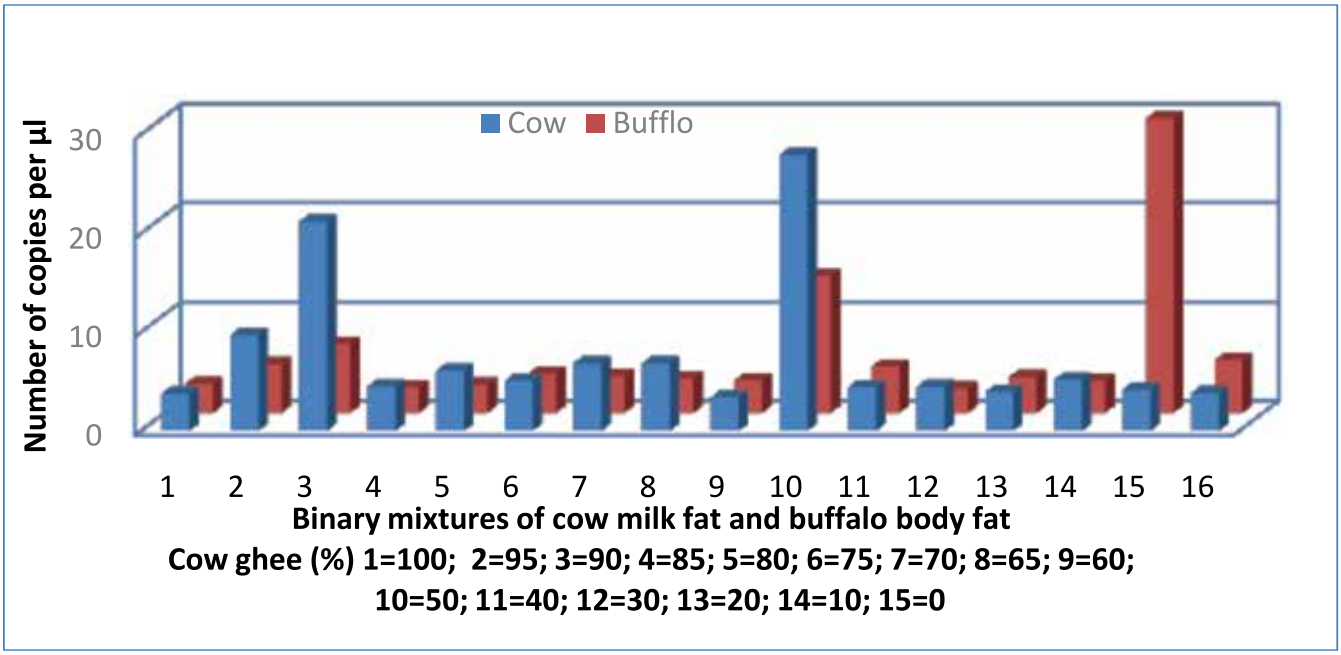


Fig 2. Number of copies of cytochrome b gene per µl detected in the ddPCR assay in the binary mixtures of cow milk fat and buffalo body fat.

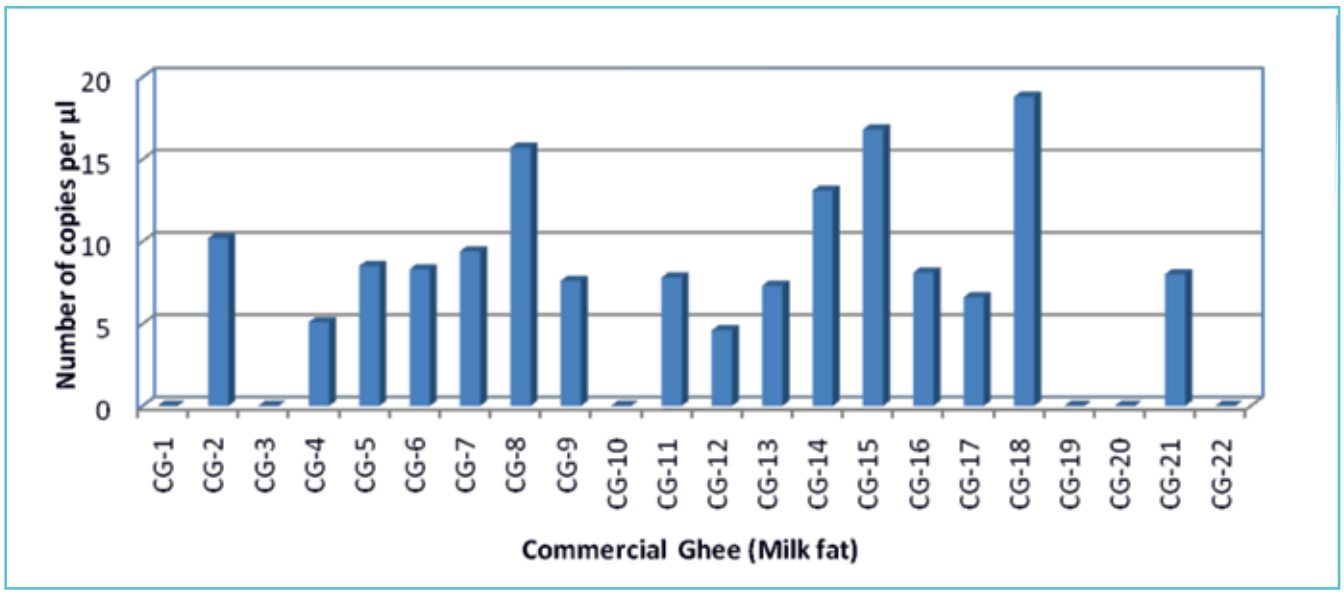


Fig 3. Number of copies of the *trnl* gene per µl detected in the commercial ghee.

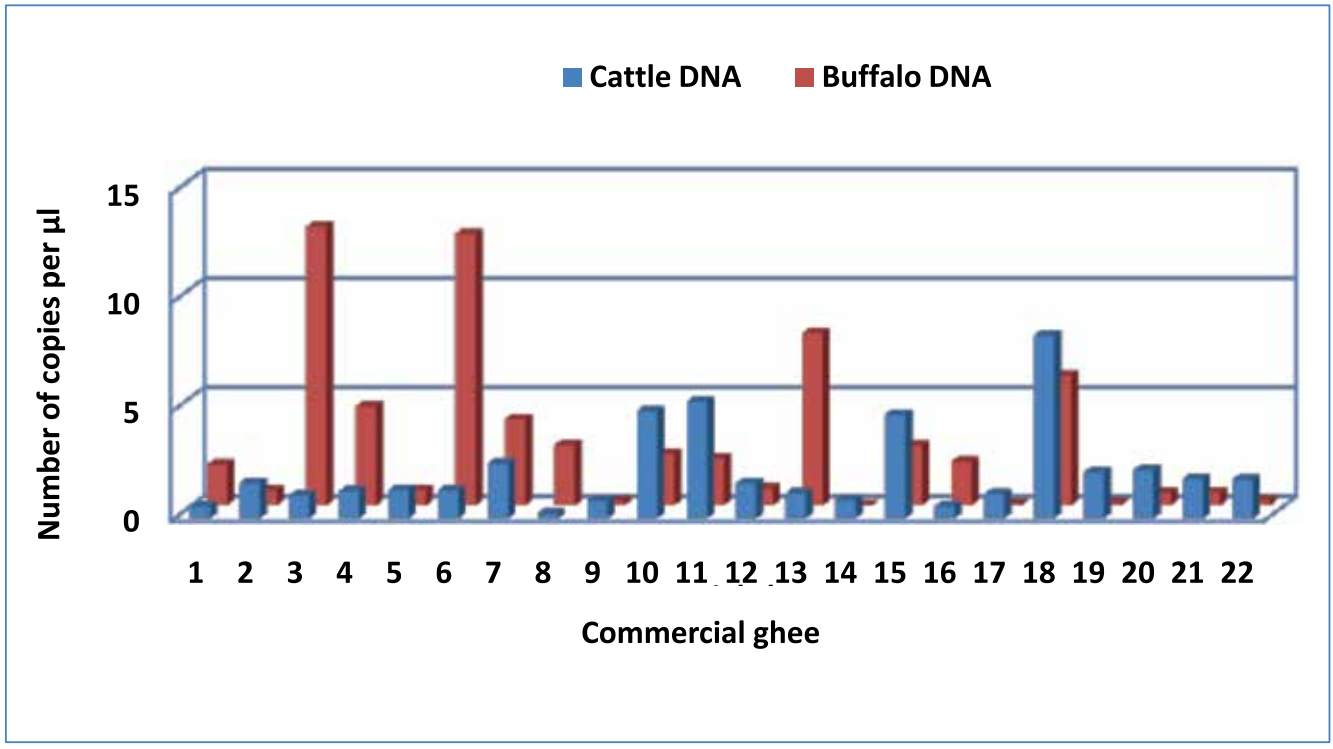


Fig 4. Number of copies of cytochrome b gene per µl detected in the ddPCR assay in the commercial ghee.

2. Species Identification to Check Adulteration of Cheaper Quality Meat in Meat

Funding agency:	FSSAI, Govt. of India
Principal Investigator:	Dr. S. Vaithiyanathan

2.1. Development of real time PCR based method for species identification and for detection of quantity of cheaper quality meat in meat

Real time PCR assays, SYBR green species specific duplex assay and Taqman probe species specific duplex assay were developed. The results of SYBR green species specific duplex assay are presented in the Fig 5 Up to 2 ng and 5 ng of buffalo and cattle DNA could be detected from the binary mixtures.

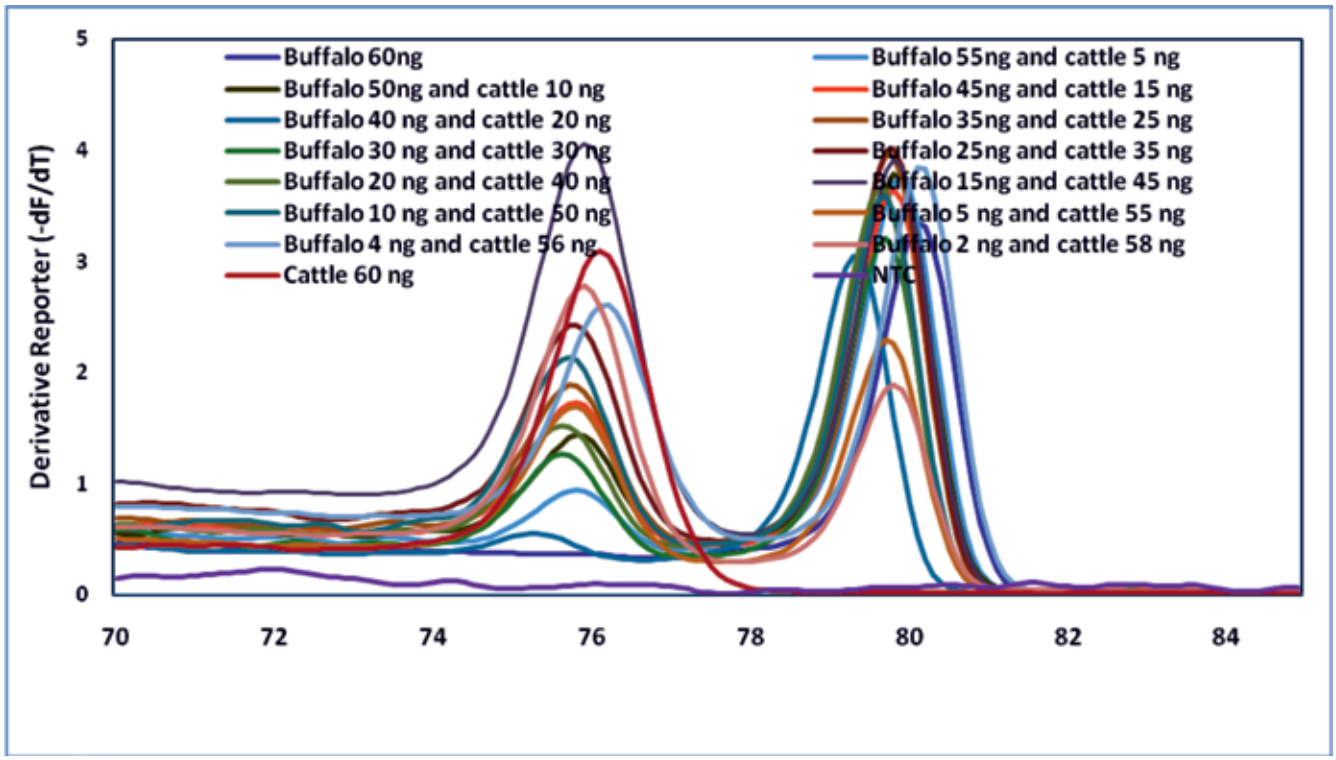


Fig 5. Melt curve analysis of duplex SYBR Green real time PCR Assay using cyt b (cattle and buffalo specific)

In the Taqman probe species specific duplex assay, the FAM and VIC signals successfully amplified on cow and buffalo DNA, respectively, whereas no amplification occurred with DNA from goat and sheep. No FAM signal was observed on buffalo DNA, and no VIC signal was detected on cow DNA, indicating the specificity of the designed assay (Figs. 6 and 7)

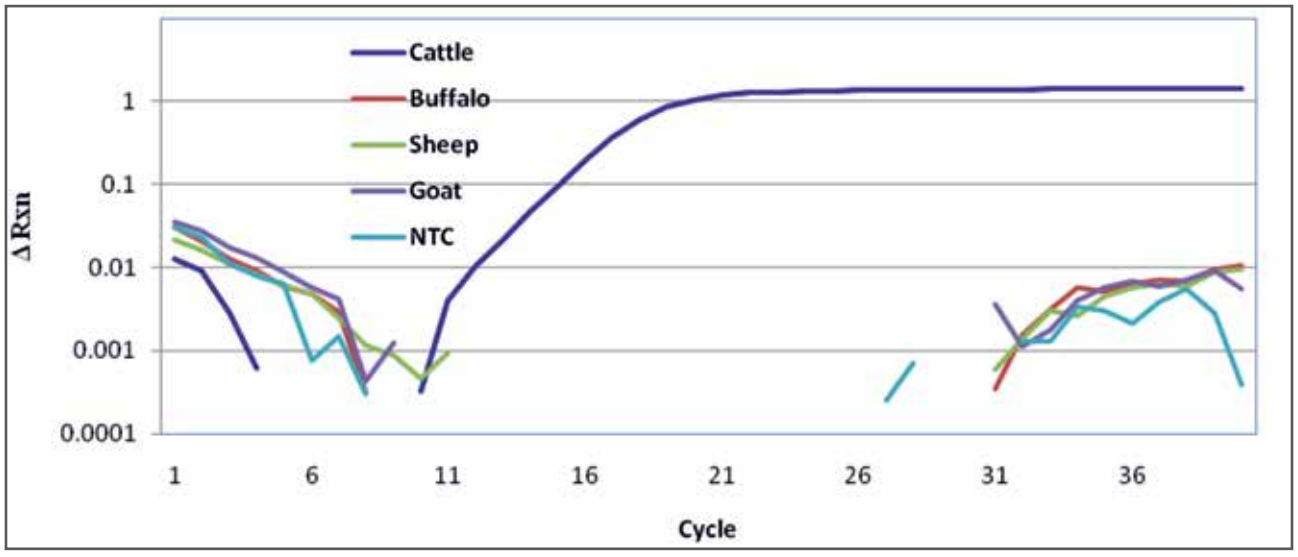


Fig 6. Amplification curves of the multiplex assay on cow, buffalo, goat and sheep pure DNA

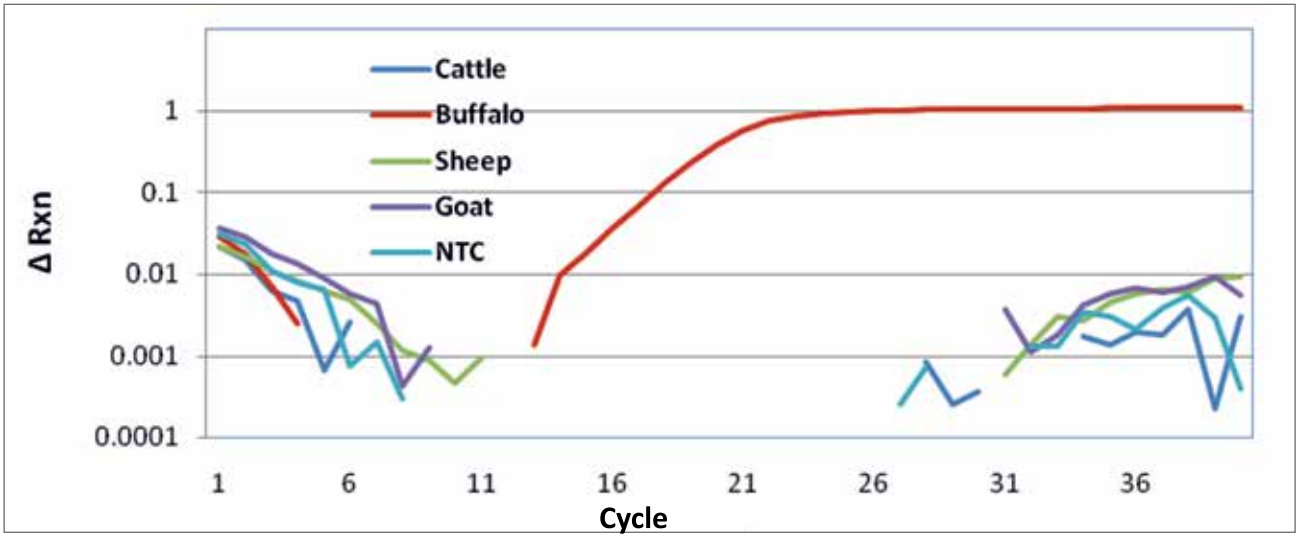


Fig 7. Amplification curves of the multiplex assay on cow, buffalo, goat and sheep pure DNA.

2.2. Development of test methods for detection and quantification of tissues (offals) in meat products

Tissue specific microRNA expression analysis in *Gallus gallus*

MicroRNAs (miRNAs) are endogenous, 21–25 nucleotide small noncoding RNAs. Because of their size, abundance, tissue specificity, miRNAs hold promise as unique accessible biomarkers to monitor tissue (offals) incorporation in the meat products. In the present study, the miRNA analysis was performed in the NGS platform (Illumina Nextseq 500) using chicken blood, gizzard, heart, liver and skeletal muscles to quantitatively identify offals in the meat products.

The high-quality reads were processed by extract and count tools after adapter trimming to get the small RNA sequences ranging in length from 15 to 35. Small RNAs ranging in 22 to 25 nt length were present in higher percentage. All extracted small RNAs in each sample were mapped to miRbase database for annotation and identification of miRNAs. Sample wise identified small RNAs are given in the Table 1.

Table 1. Total number of miRNAs annotated in each sample of chicken.

Sr. No.	Sample Name	Annotated miRNA	Grouped miRNA
1	Chicken_Blood	2,037	238
2	Chicken_Gizzard	1,695	221
3	Chicken_Heart	3,486	333
4	Chicken_Liver	2,456	264
5	Chicken_Skeletal muscle	2,184	265

Comparative analysis of miRNAs between tissues

All the miRNAs were compared to find out common and unique miRNAs in different tissue samples. A total of 176 common miRNAs were identified in all samples. In unique comparison, we identified a total of 11 unique miRNAs in chicken blood, 3 unique miRNAs in chicken gizzard, 32 unique miRNAs in chicken heart, 10 unique miRNAs in chicken liver and 18 unique miRNAs in chicken skeletal muscle.

Identification of tissue specific miRNA

Based on the analysed NGS data of the miRNA as well as the criteria laid on the expression analysis in each individual tissue, we have identified 22 tissue specific miRNA (Table 2) and got them custom synthesized for validation of the selected miRNA. MicroRNAs were isolated from different organs/tissues of chicken by using mi-RNA isolation kit method and mi-RNA concentration were measured using a Nano spectrophotometer and observed from 62.56 to 185ng/µL. cDNA concentrations were observed in the range of 290-300ng-µL. Further, mi-RNA samples were converted into c-DNA by using Universal RT-miRNA Kit (c-DNA synthesis kit).

The selected miRNAs were subjected to qPCR analysis and thereafter grouped into three groups based on the expression values in different tissues (Table 2). Subsequently, eight miRNAs from group I were subjected to qPCR expression analysis in different tissues and mixtures of tissues. miR-122-5p expressed at a threshold level of Cq values 36 and below in all the tissues and in the mixtures of tissues. Since no reference gene is available for the miRNA expression analysis, we have considered this specific miRNA as reference gene in our further analysis. Further, out of seven miRNAs remaining in the Group I, two promising candidate miRNAs, namely, miR-148a-3p and 34a-5p were identified for tissue specific identification. Further work is in progress.

Table 2. Identified miRNA selected for different organ or tissue identification based on qPCR expression Cq values.

Sr. No.	Sample Name	Cq Values			
		Liver	Heart	Gizzard	SM
1	has-miR-148a-3p	34.57	42.7	33.01	0
2	gga-miR-122-5P	20.4	30.07	20.58	31.34
3	has-miR-21-5p	23.42	25.33	28.97	0
4	has-miR-454-3p	41.11	36.24	22.48	39.1
5	gga-miR130a-3p	0	0	0	0
6	gga-miR-32-5p	37.72	0	35.68	45.05
7	gga-miR-34a-5p	35.16	39.56	40.23	0
8	mmu-miR-429-3p	35.77	36.94	34.84	37.01
9	has-miR-122-3p	0	37.4	29.63	0
10	has-miR-200a-5p	0	0	42.57	0
11	gga-miR-200b-3p	0	37.38	22.47	0
12	gga-miR-3536	36.92	37.42	42.49	0
13	has-miR-135a-5p	24.57	24.35	28.09	0
14	has-miR-27b-3p	32.64	35.52	0	0
15	has-miR-126-5P	31.08	28.6	34.12	34.56
16	has-let-7b-5p	30.72	30.53	27.71	37.36
17	gga-miR-499-3P	0	27.19	29.32	0
18	has-miR-221-3p	33.47	35.16	35.49	0
19	gga-miR-1a-3p	0	0	0	0
20	has-miR-218-5P	39.61	35.96	20.71	44.32
21	has-miR-490-5P	0	0	31.56	33.75
22	has-miR-205-5p	38.12	36.62	33.56	37.08

3. Setting – up Food Testing Laboratories- Species and Sex Identification of Meat

Funding agency:	FSSAI, Govt. of India
Principal Investigator:	Dr. S. Vaithiyanathan
Co- Principal Investigator:	Dr. Vishnuraj, M.R.

The NABL accreditation process involved conduct of two days transition training program on Laboratory Quality Management System, successful completion of two Proficiency Testing programmes conducted by FAPAS, UK on detection of meat adulteration, calibration of all equipment in the Meat Species Identification Laboratory as per ISO/IEC 17025:2005. And all the processes mandatory for obtaining NABL accreditation were completed and the NABL accreditation as per ISO/IEC 17025:2005 certification was awarded w.e.f 10 October, 2018 to 9 October, 2020.

Technical services offered to clients for the field meat species identification are presented in Table 3.

Table 3. Meat speciation of unknown samples.

Sr. No.	Agencies	No. of forensic evidence samples
1	Police department	34
2	Forest department	1
3	FDA	2
4	Quality assurance	2
5	Animal Husbandry department	9
	Total	48
Type of samples: Horns, bones, skin, slaughterhouse waste, feed sample, organ meat, putrefied meat, vitamin supplements		

4. Development of Technological Interventions for Enhancement of Quality, Shelf-life and Microbiological Safety of Traditional Meat Product- Hyderabadi Haleem

Funding agency:	Ministry of Food Processing Industries, Govt. of India
Principal Investigator:	Dr. Suresh K. Devatkal
Co- Principal Investigator:	Dr. Naveena B.M.

A research project has been initiated in January 2019 with the objectives to develop pilot scale production technology for Hyderabadi Haleem, to enhance the quality, shelf-life and microbial safety Hyderabadi Haleem through new processing/packaging interventions and demonstration and transfer of technologies related to traditional meats to entrepreneurs/industries for further commercialization.

5. Enabling Technologies in Mammalian Cell Culture towards Cultured Meat

Funding agency:	Department of Biotechnology, Govt. of India
Principal Investigator –	Dr. Girish Patil, S.
Co-Principal Investigator:	Dr. S. Vaithiyanathan

Cultured meat is the meat produced by *in vitro* cultivation of animal cells rather than slaughtering of the meat animals. This technology allows meat to be cultured from cells in a fermentor or a bioreactor rather than harvested from livestock on a farm. Cultured meat will help to meet the animal protein requirement of the ever increasing population. In India, no research work has been undertaken in this direction. To fill this gap, the research project was conceptualized in collaboration with CSIR - Centre for Cellular and Molecular Biology, Hyderabad. This is the first research project in the country in the area of cultured meat production with an outlay of Rs 427 lakh funded by DBT. Procurement of equipments and establishment of the Cell culture laboratory is in progress.

6. E-Varaha: Information System for Safe Pork Production in North Eastern India

Funding agency :	Information Technology Research Academy, Govt. of India
Associate :	Dr. Girish Patil, S.

This was the first research project in India focusing on utilizing Information Technology tools for quality meat production. Following IT tools were developed under the project to aid safe meat production.

- Database for traceability and for study of routes of pig-to-pork: Database for traceability was conceptualized for implementing traceability in pig value chain. For this purpose, information was collected for achieving traceability, formats were developed and labelling requirements were finalized. Based on the inputs, traceability database was developed by Indian Institute of Technology, Guwahati.

- Decision Support System (DSS) for effective antemortem and post-mortem inspection: Decision Support System for ante mortem inspection (AMI) and post mortem inspection (PMI) in pigs was developed by documenting etiology, symptoms and decision to be taken. Details of important 66 pig diseases were tabulated for developing DSS. All symptoms were binary coded (0,1) and DSS software was designed. Based on the information tabulated DSS was developed with the support of Manipur University, Imphal, Manipur.

- Image based fecal analysis system for examination of presence of parasites and eggs: Image based fecal examination system for detection of Ascaris eggs was developed. For this purpose, images of Ascaris eggs (n= 1008), non Ascaris eggs (n = 409) and only background without any eggs (n= 417) were used. Positive samples used in the study were checked by using standard microscopy based techniques. Software for detecting the images was developed using Artificial Neural Network (ANN) and Multi-Class Support Vector Machine (MC-SVM) by Tejpur University, Tejpur, Assam.

- Infrared Thermal imaging system for rapid examination of health status of pigs: Infrared Thermal (IRT) Camera was used for undertaking the studies. To study the temperature differences between different body parts of the pigs, IRT images were captured from about 250 pigs during different periods of the day (Fig. 8). IRT images were also collected from different breeds of pigs viz., Hampshire, Ghungaroo and Rani (Hampshire X Ghungaroo). In addition, IRT images were captured in pigs affected with lameness and different diseases like lameness, Foot and Mouth Disease (FMD) and porcine reproductive and respiratory syndrome (PRRS). Images were collected from pig farm of ICAR – National Research Centre on Pig, Guwahati, ICAR – Research Complex for North Eastern Region (RC NEH), Barapani, Meghalaya. Data of the temperature recorded using IRT camera is given in Table 4. Data revealed that temperature of lameness affected legs was significantly ($p<0.05$) higher than animals head, chest and back which clearly indicated probable diseases of the legs. This non-invasive and non-restraining approach indicated possible pathology associated with animal during the AMI. Such animals can be segregated for further detailed AMI by the veterinarian in abattoir.

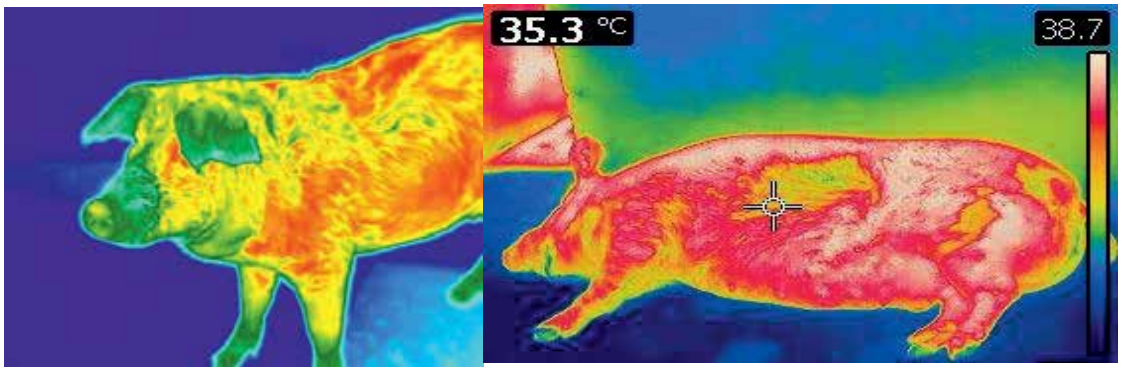


Fig 8. Infrared thermal imaging of pigs.

Table 4. Infrared thermal image pattern in pigs suffering from lameness.

	Head	Chest	Back	Affected leg	Overall
Morning	31.07±0.43[a]	31.88±0.41[a]	30.84±0.63[a]	34.55±0.30[b]	31.26±0.50
Afternoon	33.10±0.35[c]	33.67±0.49[c]	32.91±0.52[c]	35.90±0.31[d]	33.23±0.46
Evening	32.56±0.51[c,e]	32.75±0.64[a,c,e]	32.90±0.43[c,e]	35.95±0.39[d]	32.74±0.52
Overall	32.24±0.48	32.77±0.54	32.22±0.58	35.46±0.37	

7. Development of Rapid Immunochromatographic Assay Kit for Field Level Detection of Meat Adulteration

Funding agency:	Department of Biotechnology, Govt. of India
Principal Investigator:	Dr. B.M. Naveena
Co- Principal Investigator:	Dr. S. B. Barbuddhe and Dr. Rituparna Banerjee

This project is proposed to design and develop simple, cheap and sensitive gold nanoparticle conjugated immunochromatography kits enabling a qualitative, rapid, specific detection of meat adulteration based on detecting selected marker peptides using lateral flow assays and highly specific antibodies. The project is also proposed to develop new, high throughput extraction procedures adequate for the development of immunochromatographic strip-based kits which can be used at producer, wholesaler, exporter, retailer and at consumer level for authentication of meat species.

8. Mapping of Skeletal Muscle Proteins from Important Buffalo Breeds of India using High-throughput Proteomic Tools

Funding agency:	ICAR-LBSYSA
Principal Investigator:	Dr. B.M. Naveena

The *Longissimus dorsi* muscles of Murrah buffalo breed were obtained from GHMC, Amberpet, Hyderabad. Muscles were subjected to evaluation of physico-chemical parameters and proteome characteristics. The pH (5.88±0.15), WHC (15.75±0.98%), myoglobin content (4.22±0.08 mg/g), sarcoplasmic protein extractability (65±2.98 mg/g protein), myofibrillar protein extractability (105±3.87 mg/g protein), collagen content (0.89±0.05 mg/g tissue), collagen solubility (41.85±2.89%), muscle fibre diameter (44.22±2.34 μ), Warner-Bratzler Shear Force (43.85±3.5 N) were evaluated. Proteome analysis using SDS-PAGE and 2-Dimensional Gel Electrophoresis were carried out. 2-DE gels resolved more than 1000 proteins from LD muscles in 3 technical replicates (Fig 9). Further studies on identification of proteins using tandem mass spectrometry will be carried out.

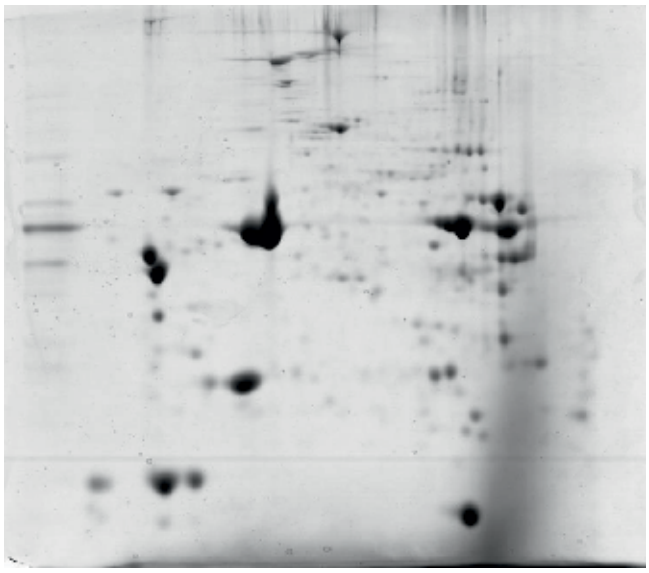


Fig 9. Representative 2-DE gel from *Longissimus dorsi* muscles of buffalo indicating separation of 976 skeletal muscle protein spots

9. Estimation of Carcinogenic and Mutagenic Compounds in Meat Products

Funding agency:	FSSAI, Govt. of India
Principal Investigator:	Dr. M. Muthukumar
Co-Principal Investigator:	Dr. Rituparna Banerjee

Literature collection, recruitment of JRF, procurement of consumables viz., standards (PAH and HCA), solvents, columns, and equipment (rotary evaporator, nitrogen evaporator) and standardization of methodology for extraction, identification and quantitation of PAH and HCA compounds have been carried out (Fig 10). The samples are being collected from market and analysed to quantify the level of PAH and HCA compounds in meat products.

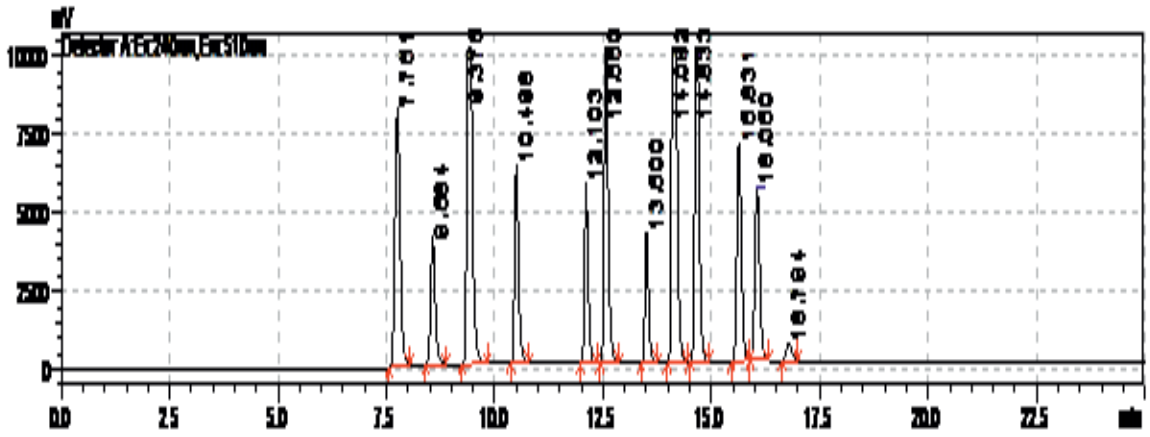


Fig 10. Chromatogram of PAHs standards.

10. National Agriculture Innovation fund (Agribusiness incubator (ABI) & ITMU)

Funding agency:	ICAR, New Delhi
Principal Investigator:	Dr. M. Muthukumar
Co-Principal Investigators:	Dr. Suresh K. Devatkal, Dr. Naveena, B. M., Dr. Girish Patil, S., Dr. Kandeepan, G., Dr. Rituparna Banerjee and Dr. Vishnuraj, M.R.

Under the component I (Institute technology management unit), the intellectual properties generated in the institute are being protected through filling patents/copy right. The technologies developed at the centre are disseminated through participations in various exhibitions/melas. During the year 2018-19, one application was filed for copyright protection and one Patent application entitled "Novel loop mediated isothermal amplification assay primers for species identification of beef" is under process. Further, the technologies and activities of the Institute were displayed at 6 different exhibitions across the country.

Under the component II, the Agribusiness Incubation centre is being established with the objective to generate employment opportunities and promote viable enterprises in meat / poultry processing. During the year 2018-19, ten training programmes on clean meat production and value added meat products processing were organized and a total of 183 participants were given hands on training on clean meat production and value added meat products processing. Six MoUs were signed with entrepreneurs for providing advisory consultancy for establishment of slaughterhouse and value added meat products processing units and one contract research project. Further, poultry processing unit of 150 birds capacity costing about Rs. 50 lakh, semi-automatic label printer for marketing value added meat products, renovation of experimental abattoir and procurement of probe pH meter were carried out for entrepreneurs' training and establishment of incubation centre. Books on "NRC on Meat Technologies for meat production, processing and authentication" and "Business prospects in meat production and processing – An entrepreneurial handbook" were published to disseminate the technologies.

I. Management of IP portfolio

- Copyright application entitled "Database for meat traceability" was filed.
- Patent application entitled "Packaging process for improving the shelf life of meat" (2334/CHE/2012 dated 12-06-2012) First examination report filled on 13 September, 2018.
- Patent application entitled "Process for preparation of chicken-gongura pickle & chicken soup" (3502/CHE/2012 dated 12-06-2012). First examination report filled on 17 September, 2018.
- Patent application entitled "Novel loop mediated isothermal amplification assay primers for species identification of beef" is under process.

II. Training programmes organized

S. No.	Name of Programme	Date of Programme	No. of Participants
1	Assessment of physical, chemical and microbial quality of meat for food safety	2 -7 April, 2018	5
2	Entrepreneurship development programme on value added meat products processing	24 - 27 April, 2018	19
3	Entrepreneurship development programme on value added meat products processing	17-21 July, 2018	20
4	Entrepreneurship development programme on value added meat products processing	10 -15 Sept, 2018	17
5	Skill development training in hygienic meat production and processing practices	29 October – 3 November, 2018	10
6	Entrepreneurship development programme on value added meat products processing	30 October – 3 November, 2018	6
7	Skill development training in hygienic meat production and processing practices	12 - 17 November, 2018	12
8	Entrepreneurship development programme on value added meat products processing	18 - 22 February, 2019	9
9	Safe meat production, processing and value addition	11-12, March 2019	40
10	Safe meat production, processing and value addition	12-13, March 2019	40

III. Commercialization of technologies

S. No.	Name of Technology / Know-How	Name of Contracting Party	Mode of Partnership	Date of Licensing	Revenue Earned (₹)
1	Establishment of value added meat products processing unit	M/s. Hamsana Group, Hyderabad	Incubatee	18-12-18	55,000/-
2	Establishment of value added meat products processing unit	M/s. Thakwa Foods, Tolichowki, Hyderabad	Incubatee	18-09-18	55,000/-
3	Establishment of value added meat products processing unit	M/s. Triusha Foods, Secunderabad	Incubatee	09-08-18	55,000/-

S. No.	Name of Technology / Know-How	Name of Contracting Party	Mode of Partnership	Date of Licensing	Revenue Earned (₹)
4	Establishment of slaughterhouse for goat/sheep	M/s. Magnus Sheep Park Pvt. Ltd. Madhapur, Hyderabad	Consultancy	01-06-18	52,000/-
5	Establishment of value added meat products processing unit	Shri. SidhartaNallu, Hyderabad	Incubatee	27-04-18	52,000/-
6	Establishment of value added pork meat products processing unit.	M/s. Farm Fresh Pork Pvt. Ltd., Vijayawada, Andhra Pradesh	Consultancy	16-02-2019	25000/-

IV. Outreach Activities

S. No.	Programme Organized / participated for Technology Transfer	Date of Programme	No. of Participants	Venue of Event
1	Meat Tech Asia 2018, Bangalore	31 August – 2 September, 2018	More than 1000	BIEC, Bangalore
2	Agri-Startup & Entrepreneurship Conclave, 2018, New Delhi	16-17 October, 2018	More than 1000	ICAR, New Delhi
3	Meat Tech, 2018, Hyderabad	2 November, 2018	More than 100	Hyderabad
4	Poultry Expo 2018, Hyderabad	28-30 November, 2018	More than 1000	Hyderabad
5	NUMAISH 2019, Hyderabad	1 January to 15 February, 2019	More than 20 lakh	Hyderabad
6	ASC- AgriTech Expo 2019	20-23 February, 2019	More than 500	IARI Mela Ground, New Delhi

V. Contract Research

S. No.	Name of Project	Name of Contracting party	Date of Licensing	Revenue Earned (₹)
1	Development of traceability model for Indian buffalo meat industry for quality assurance and augmenting exports	M/s Clonoid Pvt. Ltd., 405, Swathi Apartments, Ameerpet, Hyderabad 500 016	25-01-2019	71,000/-

VI. Revenue generated

S. No.	Type of service	Number	Revenue Earned (₹)
1.	Consultancy	5	2,69,000/-
2.	Contract Research	1	71,000/-
3.	Trainings	10	8,41,250/-
4.	Analytical services	123	4,09,000/-
5.	Sale of meat products		93,950/-
Total			16,84,200/-

VII. MoU with University / Institution

Name of Institution	Type of Agreement	Date
Chhattisgarh Kamdhenu Viswavidyalaya, Durg	MoU for research and extension	22-02-2018

Hon. Minister of State for Agriculture Shri. Gajendra Singh Shekhawat and Director General ICAR, Dr. Trilochan Mohapatra at the NRCM stall at Agri-Startup & Entrepreneurship Conclave held at NASC Complex, New Delhi during 16-17 October, 2018.

Entrepreneurship development programme on Value Added Meat Products Development

M/s Takhwa Food Products Pvt. Ltd., Hyderabad signed MoU with NRC on Meat for providing consultancy to establish value added meat processing unit

The outlet of M/s Trishua Foods, Secunderabad, who signed MoU with NRC on Meat to establish meat processing unit.

Primary Poultry processing unit established under ICAR NAIF –ABI scheme

Agri-startup & Entrepreneurship conclave, ICAR, New Delhi conducted during 16-17 October, 2018

Participated in the NUMAISH Exhibition 2019 Hyderabad during 1 January to 15 February 2019.

11. Training and Capacity Building in Sheep and Goat Value Chain

Funded agency:	National Livestock Mission, DADF, Govt. of India
Principal Investigator:	Dr. P. Baswa Reddy
Co-Principal Investigator:	Dr. M. Muthukumar

Training and capacity building programmes as well as frontline demonstrations (FLDs) were conducted for the stake holders of sheep and goat value chain under the National Livestock Mission (NLM) funded project.

During the year under report, a total of five programmes for women Self Help Group (SHG) members and meat handlers were conducted. The details are as follows.

I) Two days awareness, frontline demonstration cum training programme was conducted for the members of women Self Help Groups (SHGs) and women Pashumitras of Khammam district on 20 and 21 July, 2018 at Training and Technology Development Centre (TTDC), Khammam in coordination with Society for Eradication of Rural Poverty (SERP) and District Rural Development Agency (DRDA) of Khammam district. The programme was attended by a total of 104 participants from different parts of the district. Front Line Demonstrations and hands on training was given to the participants on preparation of different value added meat products like chicken nuggets, meat balls, meat idlies, meat croquets (meat pakodis), chicken cutlets, chicken kebabs, chicken pickle etc.

ii) Frontline demonstration cum training programme was conducted for the members of women Self Help Groups (SHGs) of Jayashankar Bhupalpally district on 25 and 26 July, 2018. The programme was organized at Youth Training Centre (YTC) at Mulugu in coordination with SERP and DRDA of Jayashankar Bhupalapally district. The programme was attended by a total of 61 participants from different parts of the district.

iii) Awareness cum Frontline demonstration programme for the members of women Self Help Groups (SHGs) and women Pashumitras of Komuram Bheem Asifabad district was organized at Training and Technology Development Centre (TTDC), Adilabad on 1 and 2 August, 2018 in coordination with SERP and DRDA of Adilabad and K B Asifabad districts. The programme was attended by a total of 61 participants from different parts of the district.

iv) After organizing three field level awareness programmes cum FLDs for the women Self Help Groups (SHGs) in three aspirational districts (Khammam, JS Bhupalpally and KB Asifabad) of Telangana in association with SERP, as a continuum to these programmes, 26 women participants were selected from these three districts to further refine their skills in meat products processing and establishment of small scale business units.

A training programme of five days duration was conducted for the members of women SHGs at NRCM, Hyderabad from 23 to 27 October, 2018. A total of 26 participants attended the programme. As a part of the programme, class room sessions as well as intensive practical sessions were conducted with major emphasis on hands on training and practicing of hygienic meat production and preparation of different value added meat products. The scope of taking up meat products processing as a business proposition for income generation was also explained. The project details with economics of establishing a small scale meat

products processing unit were provided to the participants. Smt. Pousumi Basu, CEO, SERP interacted with the participants and assured them to provide financial assistance in the form of loan to the participants, if they come forward for establishing the units.

Training programme for women SHGs from aspirational districts

v) In collaboration with Greater Hyderabad Municipal Corporation (GHMC) and Boduppal Municipality, one day awareness cum training programme was conducted for the meat handlers at NRC on Meat on 6 November, 2018. A total of 99 personnel from different divisions of GHMC and Boduppal municipality attended the programme.

Training programme for meat handlers

12. Development of Smart Packaging Nano-sensor for Monitoring Quality and Safety of Meat

Funding agency:	Dept. of Biotechnology, Govt. of India
Principal Investigator:	Dr. Kandeepan. G.
Co-Principal Investigators:	Dr. Suresh K Devatkal and Dr. Vishnuraj M.R.

The project was aimed to develop a strip-type indicator for detecting volatile amines released from chicken meat during refrigeration storage. The levels of anthocyanin, curcumin, sodium tetrachlroaurate, aqueous sodium hydroxide, and distilled water were standardized to develop a chromogenic solution that changes color on reaction with metabolites released from stored meat. Green synthesis of gold nanoparticle was done by following the standardized protocol with suitable modifications. The size of nanoparticles was analyzed through Atomic Force Microscopy. The heights of the particles showed a range of 20-200 nm (Fig. 11). The sensor strip was made of nitrocellulose membrane coated with a nanocomposite solution containing anthocyanin from red cabbage and curcumin-gold nanoparticle. The indicator strip (3.5x1.5 sq.cm) was first tested for its efficacy in an indicator-metabolite model, consisting of 20 microliter ammonia as meat metabolite. The test revealed that the strip changed color from dark pink to pale blue on contact with volatile ammonia. Evaluation of the response of the sensor was studied in chicken meat system. The ready to use strip was used as on-package sticker-type indicator in chicken meat packaged in polypropylene trays with polypropylene over wrap. The samples were stored in the refrigerator (4±1°C) and the response of the strip-type indicator with the volatile amines released from chicken meat was studied. Different meat quality and safety parameters were analyzed at suitable intervals to correlate the colour change in indicator sensor at refrigeration (4±1°C) storage (Fig 12). The samples for analysis were drawn on alternate days during refrigeration storage. The results indicated that the color of the strip-type indicator changed from

dark pink to whitish pale pink to bluish during the storage period with ΔE declining significantly from 39.79 to 18.53. The rate of discoloration increased as the concentration of volatile amines released from chicken meat increased from 6.46 mg% to 26.16 mg% during the progressive storage period. Simultaneous determination of quality parameters like total volatile basic nitrogen, free amino acid, tyrosine value, ammonia and pH in chiller stored chicken meat showed a significantly elevated levels of 22.59 mg%, 43.08 mg%, 4.36 mg%, 18.84 mg% and 5.94, respectively causing onset of deterioration of meat quality from day 7 (Fig 13). The color value ΔE significantly decreased to 18.99. Whereas, the standard plate, psychrophilic and Pseudomonas counts of the microbial quality also indicated significantly increased levels of 6.19 log cfu/g, 6.03 log cfu/g and 5.79 log cfu/g, respectively from the initial load (Fig 14). Meanwhile, the sensory quality of the chilled chicken meat declined significantly to an appearance score of 3.48, color score of 4.08, odour score of 2.72 and sliminess score of 4.50 on a 5-point descriptive scale. The correlation analysis indicated a significantly positive correlation of microbial load and physicochemical quality parameters (r=0.81). In conclusion, anthocyanin-gold-curcuminnano composite based strip-type indicator developed could be successfully used for real-time monitoring of quality and safety of refrigerated chicken meat.

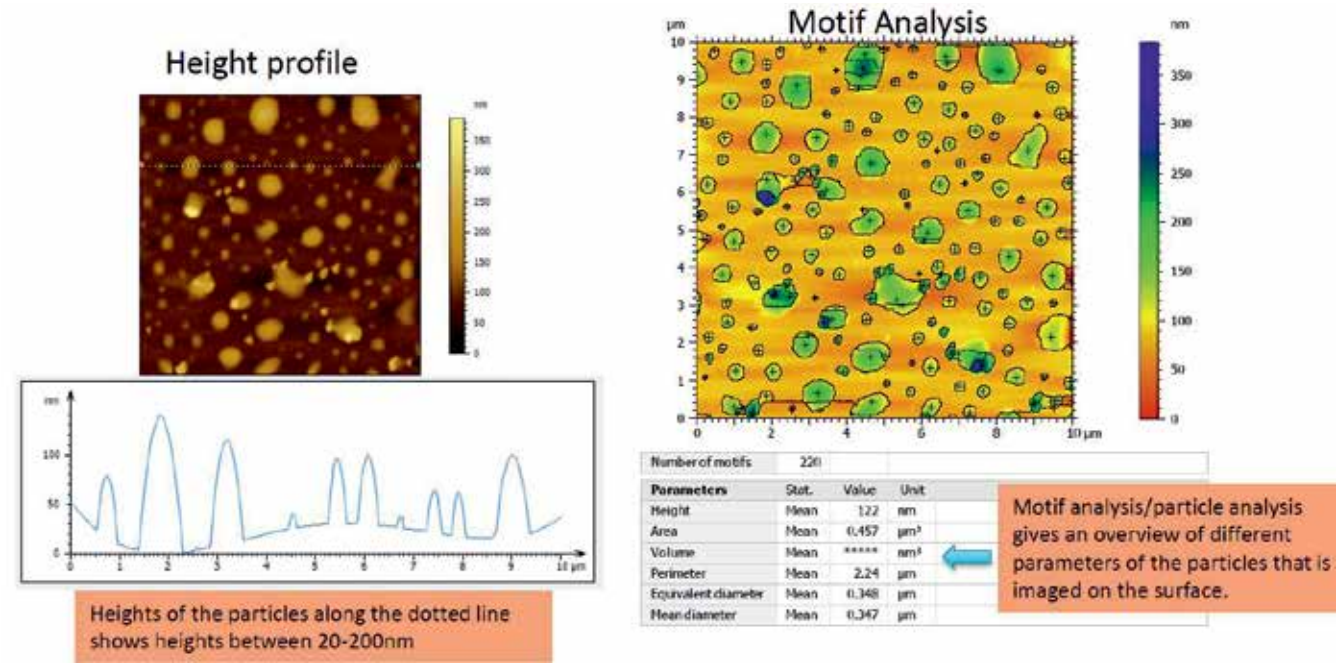


Fig 11. Gold nanoparticle size analysis in Atomic Force Microscopy using mountain map commercial software.

Day1 Day3 Day5 Day7 Day9

Fig 12. Colour change in sticker-type sensor (anthocyanin-curcumin-gold nanocomposite) during refrigerator storage of chicken meat.

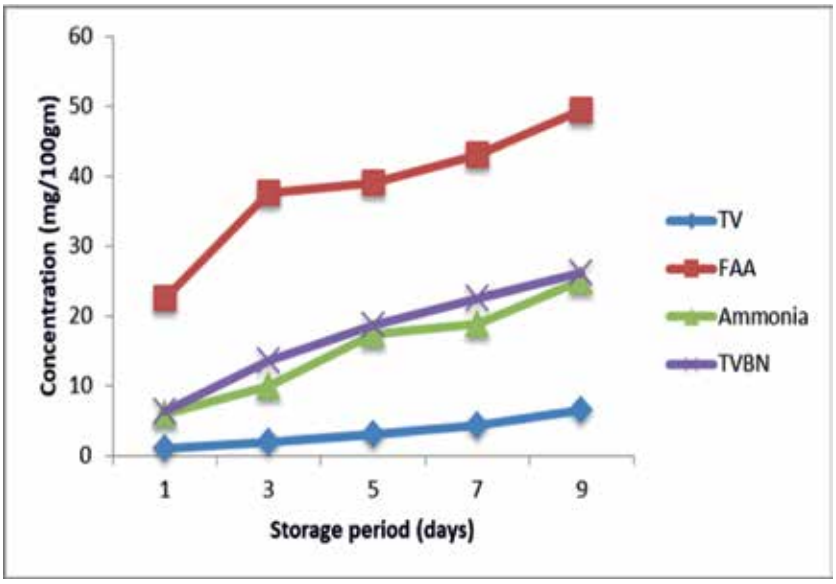


Fig 13. Physicochemical quality changes of chicken meat during refrigerated (4±1°C) storage.

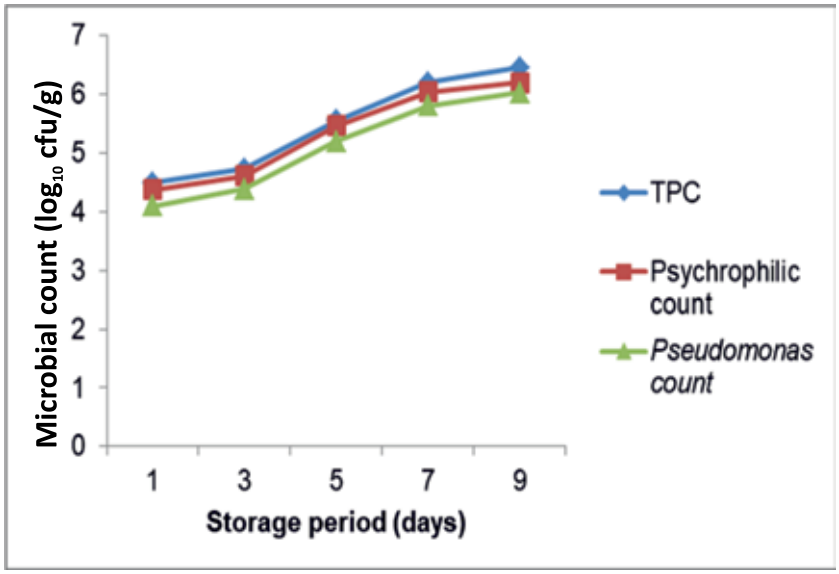


Fig 14. Microbial quality changes of chicken meat during refrigerated (4±1°C) storage.

Institute funded research projects

1.Assessment of the Occupational Health Hazards and Food Safety Risks Associated with Abattoir Personnel

Principal Investigator:	Dr. S. B. Barbuddhe
Co-Principal Investigators:	Dr. L. R. Chatlod and Dr. Sunil Pal Singh

The research proposal envisaged to assess the seroprevalence of important occupational health hazards namely, brucellosis, leptospirosis and Q fever and food safety risks among butchers and slaughterhouse workers. The risk factors related to these diseases among these individuals were also evaluated.

During the year, a total 76 serum samples were collected from occupationally exposed individuals namely, abattoir associated personnel and veterinarians (36) and from case of pyrexia of unknown origin (40) as control. Thus, a total of 168 samples were collected during two years. Data on personal hygiene and other epidemiological data were also collected. Two awareness programmes were organized for abattoir associated personnel. The serum samples were tested for brucellosis, leptospirosis and Q fever using serological tests. A total of 5.79%, 14.66% and 13.04% samples were positive for antibodies against leptospirosis, brucellosis and Q fever, respectively by ELISA. None of the abattoir associated personnel were using proper hygienic precautions and protective gears. Further collection of samples and their testing for various occupational hazards are under progress.

Awareness programme for meat handlers

2. Development and Validation of Rapid Assays for Detection of *Listeria monocytogenes* in Foods

Principal Investigator:	Dr. S. B. Barbuddhe
Co-Principal Investigator:	Dr. L. R. Chatlod

A research project on validation of rapid assays for detection of *Listeria monocytogenes* in foods has been initiated with objectives to develop cost-effective and rapid diagnostic assays for *L. monocytogenes* and to validate the assays for detection of *L. monocytogenes* in meat. Synthetic peptides coupled with latex beads shortlisted from leads from earlier grants have been planned to be validated. Samples (n=205) from various levels of buffalo production chain (soil, farm manure, skin swabs, faecal samples, meat samples from retail shops) were collected and screened for isolation of *Listeria spp.* A total of nine presumed isolates were isolated. Further validation of assay in spiked meat samples is in progress.

3. Effect of Encapsulated Essential Oils for Enhancing Safety and Quality of Emulsion Based Chicken Meat Products

Principal Investigator:	Dr. Y. Babji
Co-Principal Investigators:	Dr. S. Vaithiyanathan, Dr. G. Kandeepan, Dr. S. Kalpana and Dr. P. Baswa Reddy

Standardization of emulsion extrusion technique for production of microspheres:

(i) Standardization of emulsion extrusion technique for thymol microspheres

Emulsion extrusion technique was standardised for thymol essential oil using a 2% sodium alginate solution and a 0.5% of calcium chloride solution. The sodium alginate solution was left at refrigeration temperature (4±1˚C) for 24 h to disengage bubbles before use. Afterwards, to a 37.5 ml out of 50 ml of sodium alginate, 12.5 ml of thymol essential oil was added, and the mixture (3:1) was sonicated at 300 rpm for 45 min using a magnetic stirrer. Then the thymol mixed sodium alginate was taken into a 50 ml syringe and prepared microspheres by passing through a 21.5 G needle by maintaining a constant distance of 2.5 cm between the tip of the needle to the surface of calcium chloride solution. The resulting microspheres were allowed to harden in the calcium chloride solution for 20 min. The thymol EO loaded alginate beads were collected from the cross linking solution using a nylon sieve. The microbeads, then were rinsed twice with distilled water. The dried microcapsules were stored at refrigeration temperature until use in glass bottle.

ii) Standardisation process of emulsion extrusion technique for cinnamon essential oil

Emulsion extrusion technique was standardized for cinnamon essential oil using a 0.5% sodium alginate in a beaker by stirring for over 15 min until it completely dissolved and appeared clear, then the sodium alginate solution was kept at refrigeration temperature for 24 h to disengage bubble before use. After 24 h, a 30 ml out of 100 ml sodium alginate was taken in to a 200 beaker, which was kept on stirred by a magnetic stirrer at 300 rpm for 45 min. Then a 10 ml cinnamon EO was slowly added to the sodium alginate solution

without losing a drop of essential. A 0.125 % calcium chloride solution was prepared by dispersing 125 mg calcium chloride in 100 ml distilled water. Then slowly microcapsules were prepared by passing 50 ml of sodium alginate cinnamon essential oil by a syringe (22G needle) in to the 0.125 % calcium chloride solution slowly and observed formation of microspheres by maintaining a 2.5 cm distance between the tip of the needle and surface of the calcium chloride solution.

The cinnamon essential oil loaded microbeads were collected from calcium chloride cross linking solution by passing through a nylon sieve .The resultant microbeads were allowed to harden at the bottom of the calcium chloride solution for 20 min. The cinnamon essential oil loaded microcapsules were collected from the cross linking solution using a nylon sieve and microcapsules were rinsed twice with distilled water and excess water was removed using tissue paper. The dried microcapsules were stored at refrigeration temperature until further use.

(iii) Effect of microencapsulated essential oils (Thymol and Cinnamaldehyde essential oil) on physico-chemical, proximate, sensory and bacteriological attributes of freshly prepared emulsion based chicken nuggets.

The pH of control (no microencapsulated cinnnamon) and treated (0.1% cinnamon microencapsulated essential oil) chicken nuggets on 0 day were 6.55 and 6.4 respectively, whereas TBA values (mg-mda/kg meat) were 0.067 and 0.0715 for control and treatment, respectively. The moisture contents of control (no microencapsulated cinnnamon) and treatment (0.1% cinnamon microencapsulated essential oil) were 63.62% and 62.07%, respectively on 0 day.

The total plate counts (TPC) of control sample on 0 day was 2.11 $\log_{10}$ cfu/g whereas in treated sample (0.1% cinnamon microencapsulated essential oil) the TPC were 1.6 $\log_{10}$ cfu/g on 0 day. The (0.1% cinnamon microencapsulated essential oil) treated chicken nuggets showed a reduction of 0.51 $\log_{10}$/cfu of TPC after treatment on 0 day. *E. coli*, *Salmonella*, *Listeria* and *Staphylococcus aureus* counts in cinnamon treated samples as well as in control samples on day 0 were not observed.

Sensorially both control and 0.1% cinnamon treated (microencapsulated) chicken nuggets were highly acceptable. However, the latter exhibited cinnamon odors, although acceptable to the panelists. The yield of the control was 94.69% whereas, the yield of treatment was 94.37%.

Control Nuggets

Treatment (0.1% cinnamaldehyde EO) Nuggets

Emulsion based chicken nuggets

Process development /protocols for microencapsulation of thyme and cinnamon essential oils were standardized using a 2% sodium alginate and 0.5% calcium chloride; 0.5% sodium alginate and 0.125% calcium chloride by an emulsion extrusion technique, producing thymol and cinnamon essential oil sodium alginate microspheres, respectively for enhancing bacteriological safety besides producing an emulsion based chicken meat product with acceptable sensorial attributes.

4. Development of Ozone (O3) based Decontamination Technology for Poultry and Sheep/Goat Carcasses

Principal Investigator:	Dr. Suresh K. Devatkal

In this project, efforts are being made to develop an ozone based decontamination method/technology for poultry and small ruminant carcasses. Initial studies were conducted to know the lethal effect of ozone on different bacteria isolated from meat and meat products. Isolated bacteria were identified and confirmed by 16S rRNA gene sequencing. These pure cultures were utilized for microbial death kinetics studies. Bacterial cultures suspended in sterile water were exposed to known concentration of ozone for different time interval and survival was counted using plate count method. Results showed a 15 min treatment with 200ng/hr ozone reduced about 4-6 log bacteria of different species (Fig. 15).

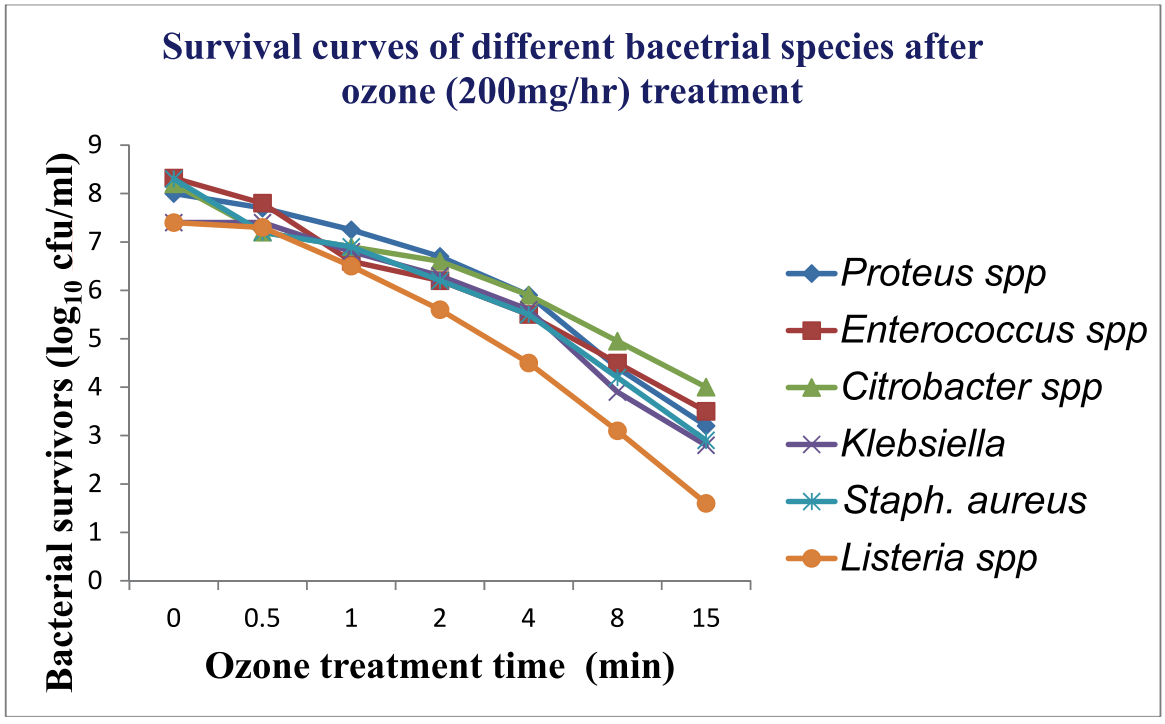


Fig 15. Kinetics of bacterial inhibition during ozone treatment.

5. Development of Traceability based Quality Assurance Methods for Wholesome Meat Production

Principal Investigator:	Dr. Girish Patil, S.
Co-Principal Investigator:	Dr. S. B. Barbuddhe, Dr. S. Vaithiyanathan and Dr. C. Ramakrishna

Development of guidelines/ standards for implementation of meat traceability in India

The concept of traceability was presented before Agriculture and Processed Food Products Export Development Authority (APEDA), New Delhi. Based on the inputs and after referring to International traceability standards, developed draft National livestock traceability which includes all the details including implementation model, method of identification of animals, information to be stored, database for storage of information, retrieval mechanism, mode of control and traceability certification methodologies. Draft standards will be put before APEDA and Dept of Animal Husbandry, Dairying and Fisheries (DAHD & F), Govt. of India in 2019-20 to elicit their feedback.

Development of species traceability of buffalo meat by AL – LAMP technique

Techniques for species authentication of buffalo meat is an important requirement in view of huge export prospects, ban of export of beef and incidence of adulteration of buffalo meat with beef for financial gains. Several DNA based techniques have been developed for detection of buffalo meat of which Polymerase Chain Reaction (PCR) based techniques are commonly used by the food analysts. Loop Mediated Isothermal Amplification (LAMP) overcomes the drawbacks associated with traditional PCR techniques. LAMP obviates the requirement of high cost equipments, process is rapid and result is easy to interpret. Here, a method for detection of buffalo meat has been developed by designing a novel set of primers targeting mitochondrial D loop gene (Fig 16). Further, a quick method for DNA extraction involving Alkaline Lysis (AL) method has been adapted which makes the process of DNA extraction and amplification simple. Both require only dry bath and involve simple chemicals hence can be undertaken in laboratory with minimum resources.

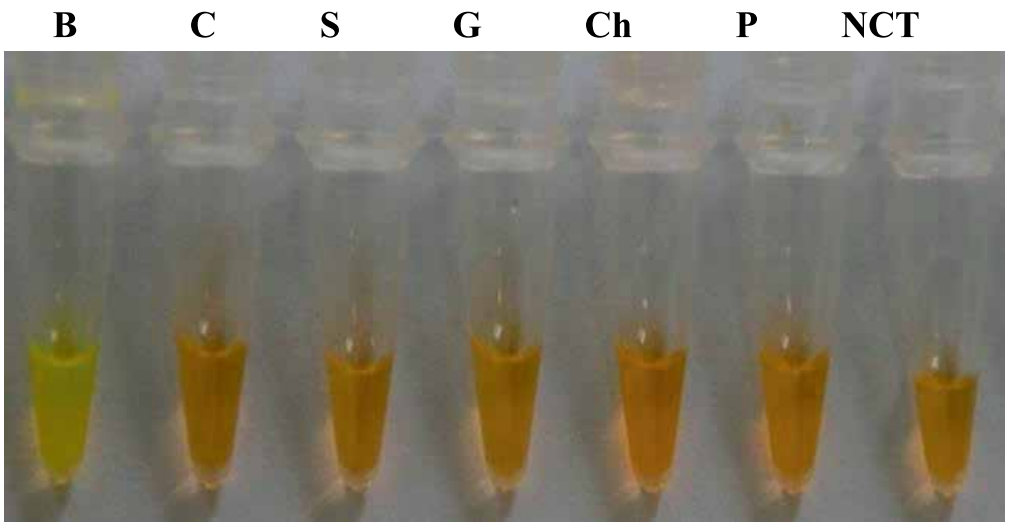


Fig 16. Cross amplification of buffalo meat specific LAMP test.
B: Buffalo; C: Cattle; S: Sheep meat; G: Goat meat; Ch: Chicken; P: Pork; NCT: Negative control

Development of individual identification of buffalo meat by microsatellite genotyping

Microsatellite genotyping : Microsatellite markers for buffaloes (*Bubalus bubalis*) were selected based on the PIC (Polymorphism Information Content) score of different markers recommended by ISAG - FAO (International Society for Animal Genetics -Food and Agriculture Organization) advisory group panels of microsatellite markers for buffalo species (FAO, 2011). The selected microsatellite markers were custom synthesized, PCR amplification of the 30 microsatellite markers was undertaken by following standard protocol using DNA extracted from buffalo meat. Out of the 30 markers used, 28 markers gave good amplification of expected amplicon size. Further, amplification in more individual buffalo DNA samples is in progress.

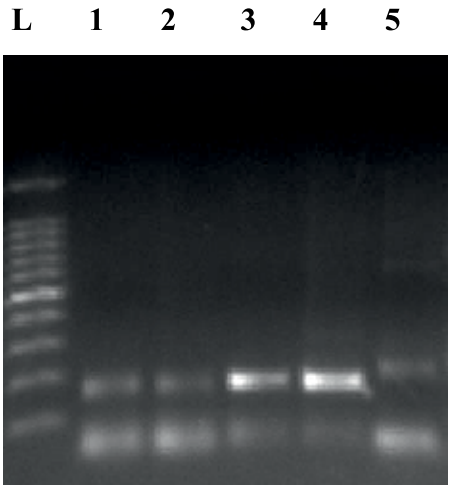


Fig 17. PCR amplification of microsatellite markers (CSSM046, CSSM013 & DRB3)
Lane L: 100 bp Ladder; Lane 1 and 2: CSSM046 (152 – 160 bp); Lane 3 and 4: CSSM013 (162 - 172 bp); Lane 5: DRB3 (142 – 198)

Undertaking field studies in implementation of meat traceability

Interactions were held with different stakeholders for adopting traceability system. Animal identification (Fig. 18) based on the National animal identification system of DAHD & F, Govt. of India and enrollment in livestock traceability database (www.livestocktraceindia.in) has been initiated in following farms: (i) Instructional Livestock Farm Complex, Veterinary College, SPVNRTSVU, Hyderabad and (ii) Narender Farm, Chengicherla, Hyderabad.

Fig 18. Twelve digit bar coded ear tags used for identification of buffaloes

6. Identification of Important Bioactive Peptides from Meat and Slaughterhouse By-products

Principal Investigator:	Dr. B.M. Naveena
Co-Principal Investigators:	Dr. Suresh K. Devatkal and Dr. Rituparna Banerjee

In this study, we attempted to use ginger as a natural source of protease in comparison with other commercially available enzymes to extract and characterize antioxidant and antihypertensive hydrolysates from water buffalo liver, a protein rich offal. Hydrolysis of sarcoplsmic protein extracts from buffalo liver using proteinase-K, pronase-E and ginger protease significantly increased the % degree of hydrolysis and generated low-molecular weight peptides evident from SDS-PAGE. Enzyme treated hydrolysates exhibited significantly higher DPPH radical scavenging activity and ACE inhibitory activity (Figure 19). Mass spectrometric analysis (MALDI-TOF MS) of selected gel-filtered fractions identified the proteins that possess strong antioxidant activity. Present findings indicate the efficacy of ginger protease in generating protein hydrolysates from water buffalo liver with significant antioxidant and antihypertensive activity.

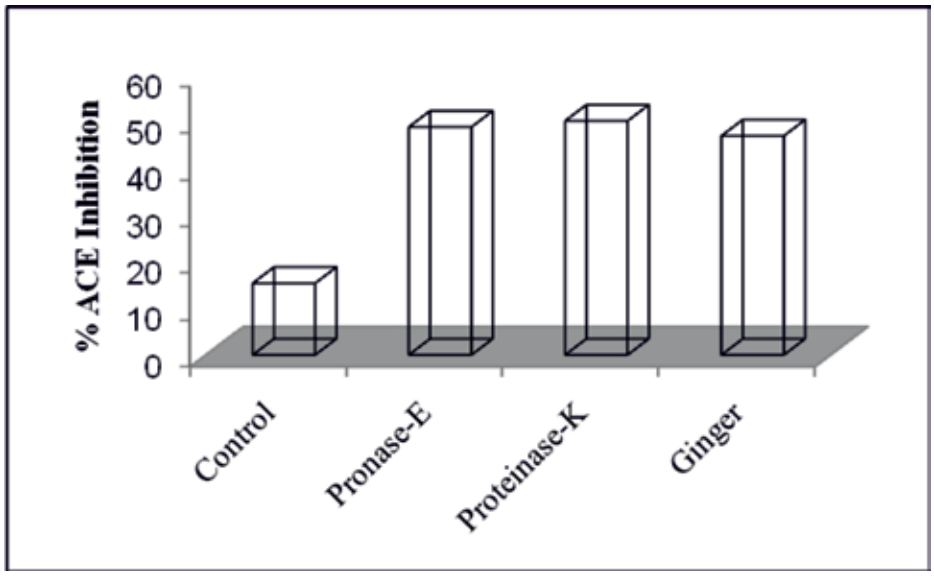


Fig 19. Percent angiotensin-I converting enzyme (ACE-I) inhibitory activity of hydrolyasates from buffalo liver(n = 3).

7. Species Identification of Sarcocysts in Buffalo Meat

Principal Investigator:	Dr. C. Ramakrishna
Co-Principal Investigators:	Dr. Girish Patil, S. and Dr. S. Kalpana

A total of 202 meat samples were collected from slaughtered buffaloes. All the 202 meat samples were examined grossly for the presence of visible Sarcocysts. No visible Sarcocyst was observed in any of the 202 meat samples. DNA was isolated from all the 202 meat samples and the DNA was subjected to PCR for amplification of the target gene. However, no amplification was observed.

8. Organic Meat Production System for Sustainable Sheep Husbandry and Promotion of Consumer Health

Principal Investigator:	Dr. P. Baswa Reddy
Co-Principal Investigators:	Dr. D.B.V. Ramana, Dr. Pankaj, Dr. C. Ramakrishna and Dr. M. Muthukumar

A collaborative research project is being carried out in collaboration with ICAR-CRIDA, Hyderabad at Hayatnagar Research Farm. Under this project for feeding to the sheep under organic system, organic fodder is being produced in an area of 0.8 hectares. Organic fodders of CO-4, hedge lucerne, stylo, subabul are produced under organic production guidelines as per NPOP requirements. Organic certification of fodder has been carried out through APEDA accredited certifying agency, Aditi Organic Certification Pvt. Ltd, Bengaluru. After due inspection and auditing, organic scope certificate for the year 2019-20 has been awarded for the fodder as per the NPOP standards of India.

Breeding stock of sheep are being reared under cut and carry system with organically produced fodder (Fig. 20). The feeding, health care and other animal rearing practices as per the norm under NPOP guidelines are being followed. The renewal audit of organic livestock (sheep) has been carried out and the organic scope certificate has been issued the APEDA accredited organic certifying agency 'OneCert Asia' (Fig 21). The renewal audit for organic sheep certification for 2019-20 has been initiated .

The yield of CO4 fodder was 69 tons/ ha with a crude protein content of 8.6%. The total flock strength of the organic sheep unit as on 31 March 2018 was 38 including eight lambs. The average daily weight gain (ADG) in lambs in the organic unit during the reporting period was 52 ±7.3 g, while, the ADG in the regular flock was 54 ± 9.6g.

Fig 20. Organically certified sheep and fodder

Scope Certificate
Certificate No. ORG/SC/1704/000010

Accreditation No. under NPOP
NPOP/NAB/008

ICAR- NRC on Meat and ICAR-CRIDA
Chengicherla, Boduppal (PO),
Hyderabad Telangana- 500092

This is to certify that the product(s) and areas(s) of the mentioned organisation inspected by OneCert International Private Limited are in accordance with requirements of

India's National Programme for Organic Production Standards

For the following process,
Livestock
this Certificate is issued.

This certificate is valid from
11/06/2019 until 21/03/2020

This certificate is valid for those product(s) and area(s) that are specified in the annexe ORG/SC/1704/000010 A.

The validity of this certificate solely depends on the continued compliance with the required standards and is subject to annual surveillance inspections.

Authorised By:

Sandeep Bhargava
Director
Issued Date: 14/06/2019

OneCert International Private Limited H-8, Mansarovar Industrial Area, Mansarovar, Jaipur – 302 020 (Rajasthan) India
Phone: (91) 141 2400602 :: PBX: (91) 94140 46706 :: Email: info@onecertinternational.com : Website: www.onecertasia.in

Note : For all & complete information, term and conditions for certification, kindly refer to cover letter and annexures.

Fig 21. Organic Livestock (sheep) certificate

9. Simultaneous Quantitative Determination of Oxytetracycline and Chlortetracycline Residues in Buffalo Meat Samples Using RP-HPLC

Principal investigator:	Dr. S. Kalpana
Co-Principal Investigator:	Dr. M. Muthukumar

An RP-HPLC method was standardized for simultaneous determination of oxytetracycline and chlortetracycline residues with a linearity range of 25-200 ppb, limit of detection (LOD) 3.66 µg/Kg and limit of quantification (LOQ) 11.10 µg/Kg for oxytetracycline; LOD 6 µg/Kg and LOQ 18.20 µg/Kg for chlortetracycline. For monitoring purpose, about 110 buffalo meat samples were collected from in and around Hyderabad city for monitoring and extracted for analysis of oxytetracycline and chlortetracycline residues. About 110 extracted samples were injected and analyzed in triplicate using RP-HPLC and none of the samples had the said residues at or above MRL (200 µg/Kg).

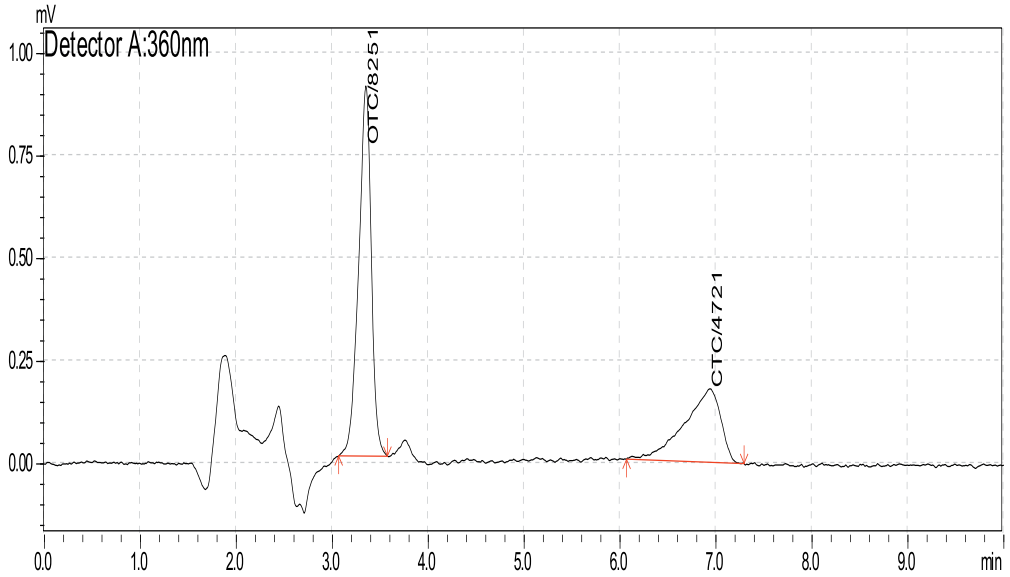


Fig 22. Optimized representative chromatogram of oxytetracycline and chlortetracycline.

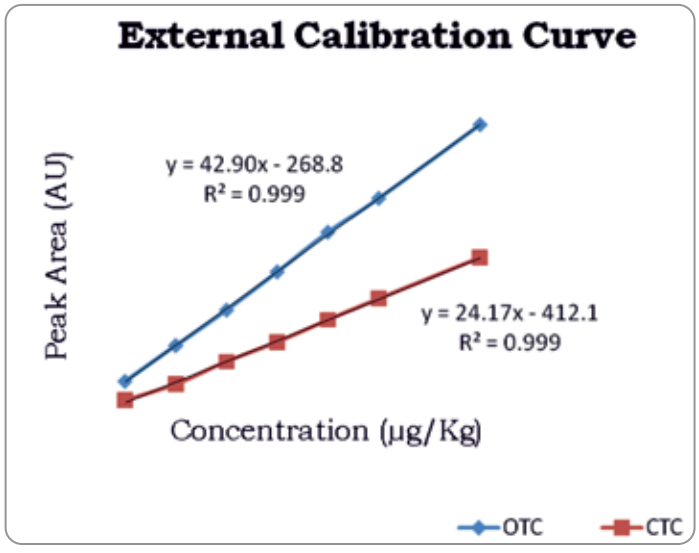


Fig 23. External Calibration Curve in the range 25-200µg/Kg

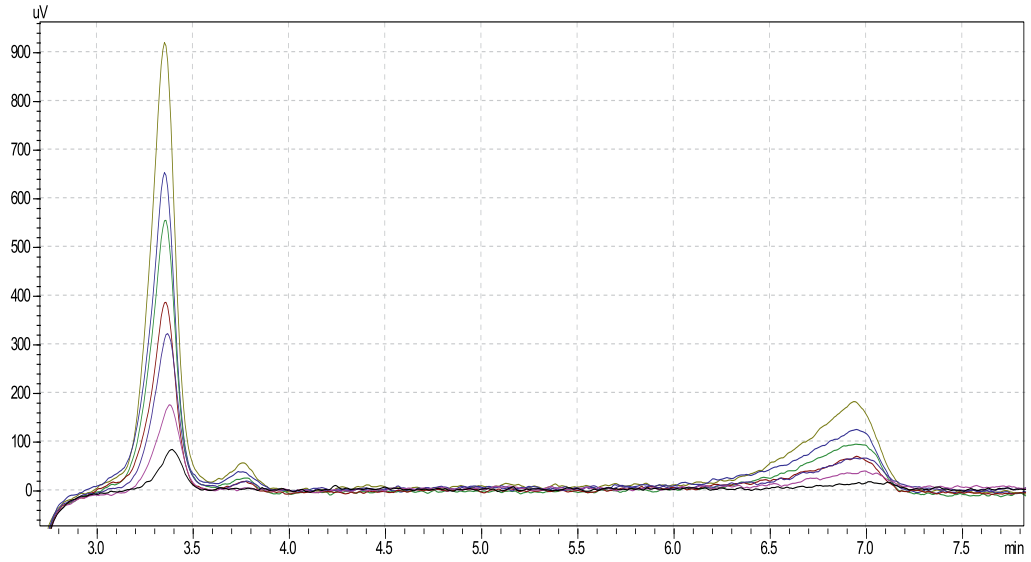


Fig. 24. Linearity overlay oxytetracycline and chlortetracycline.

10. Effect of Superchilling and Cryoprotectants on Quality and Storage Stability of Meat

Principal Investigator:	Dr. Rituparna Banerjee
Co- Principal Investigator:	Dr. B. M. Naveena

Standardization of the superchilling conditions for enhancing the shelf-life of meat and to observe its effects on quality and storage stability of meat were attempted. A superchilling cabinet has been developed with respect to temperature and humidity to optimize the superchilling condition of dressed carcass or meat in order to improve their quality and storage stability. The cabinet has been provided with a digital display which shows the temperature and humidity of the cabinet. Superchilling storage (-2 to -3 ˚C) was able to extend the shelf-life of dressed chicken carcasses up to 35 days in comparison to the 7 days storage life of chilled samples. Scanning electron microscopy (SEM) revealed organized structure with compact fibres on day 0, however, superchilled sample revealed small gaps between muscle fibres and variation in the fibre diameter on 30 d. In comparison, frozen sample showed disintegration of fibre structure with larger inter-fibre spaces on day 30.

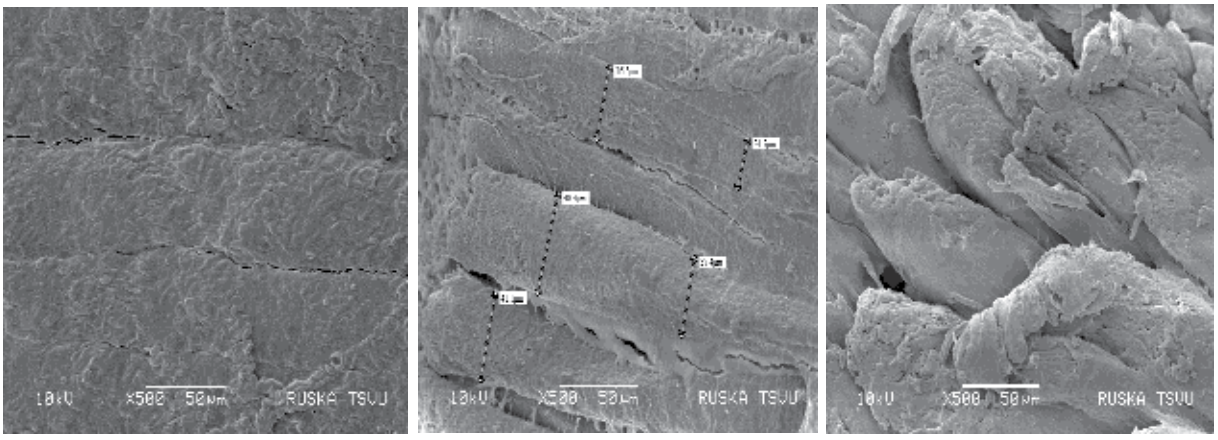


Fig 25. Scanning electron microscopy of muscle fibres.

Experiments were also conducted on superchilling storage (-2˚to -3 ˚C) of sheep carcasses, cut-up parts and boneless meat and analysed for pH, WHC, cooking yield, TBA value, instrumental color (L*, a* and b* value), % metmyoglobin, shear force value, total plate count (TPC) at an interval of 7 days, i.e. 0, 7, 14….upto 42nd day.

Fig 26. Superchilling (-2° C) of sheep carcass cut-up parts

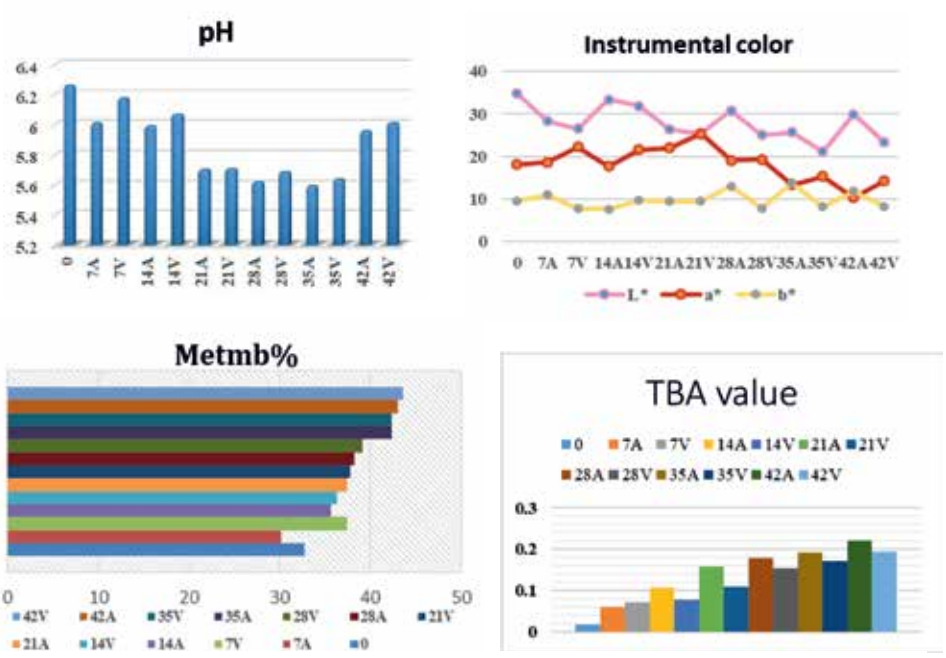


Fig 27. Changes in pH, Instrumental color (L*, a*, b*), Metmyoglobin% and TBA value of mutton during superchilled (-2°C) storage

11. Development of miRNA Based Methods for Authentication of Meat and Meat Products with Respect to Organ Meats

Principal Investigator:	Dr. Vishnuraj M. R.
Co-Principal Investigators:	Dr. S. Vaithiyanathan, Dr. Suresh K. Devatkal and Dr. Kandeepan G.

Development of a technique based on miRNA- RT-qPCR platform to detect the presence of organ meat in meat and meat products has been attempted. Under the present study, the sequencing of miRNAs of chicken (5 tissues), cattle and buffalo (6 tissues each) using Illumina Nextseq platform with single end 75 nt read length had been completed.

Depths of NGS sequencing were > 6 million reads for chicken, > 20 million reads for cattle and > 18 million reads for buffalo and every sequence was analyzed for its length distribution, quality distribution, GC content and ambiguous bases and the data analyses were performed as per the objectives of the study. Unique miRNAs between tissues were identified as per Venn diagram analysis (Fig. 28) and common but differentially expressing miRNAs between tissues were identified through heat map analysis (Fig. 29).

Complete panels of 22 miRNAs were selected for downstream applications; miRNA primers against each selected miRNAs were procured and validated in chicken liver, heart, gizzard and skeletal muscle using RT-qPCR platform. Further, the miRNAs were classified as reference miRNAs and Rank I, Rank II & Rank III based on the suitability for using in meat organ mixtures. Various raw as well as cooked, meat-organ mixtures were prepared for chicken heart, gizzard and liver with skeletal muscle at 5, 25 and 50% organs in muscle meat, all Rank I primers along with reference miRNAs were validated for differential expression using RT-qPCR platform and dd-PCR platforms (Fig. 30). Promising results in terms of miRNA tissue specificity were observed from the experiment to develop tissue specific diagnostic platform that can detect the presence of organ meat/tissues in skeletal meat. Further, the validation of miRNA platform in commercial meat products is in progress.

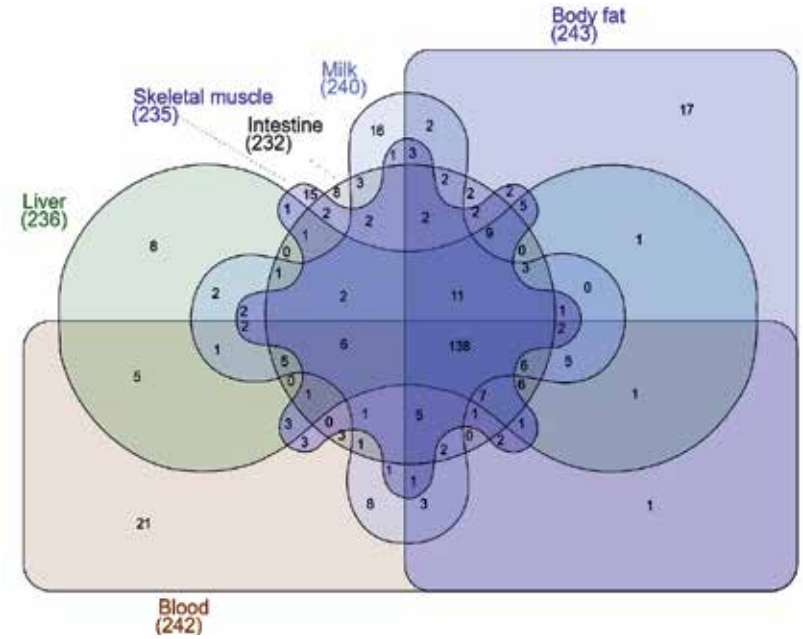


Fig 28. Venn diagram analysis for unique miRNAs among various organs/tissues from cattle.

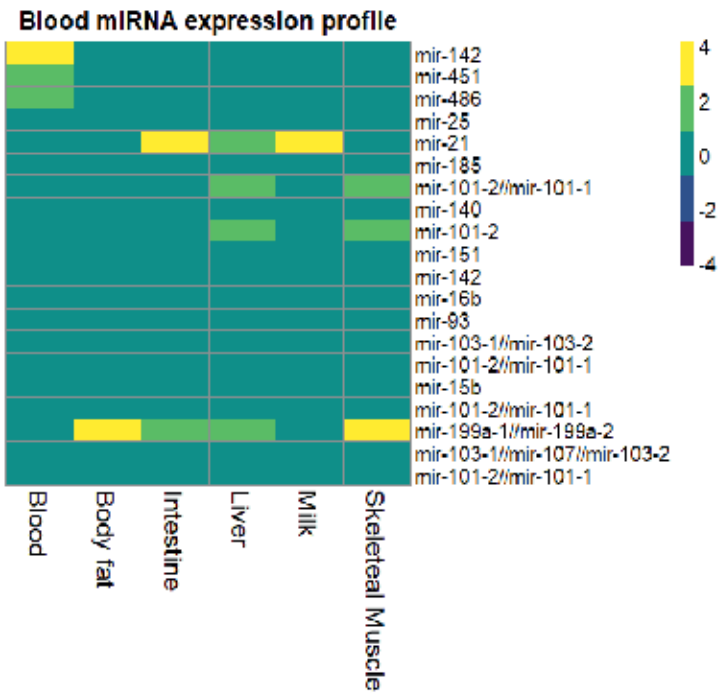


Fig 29. Heat map analysis for common but differentially expressed miRNAs among various organs/tissues from buffalo.

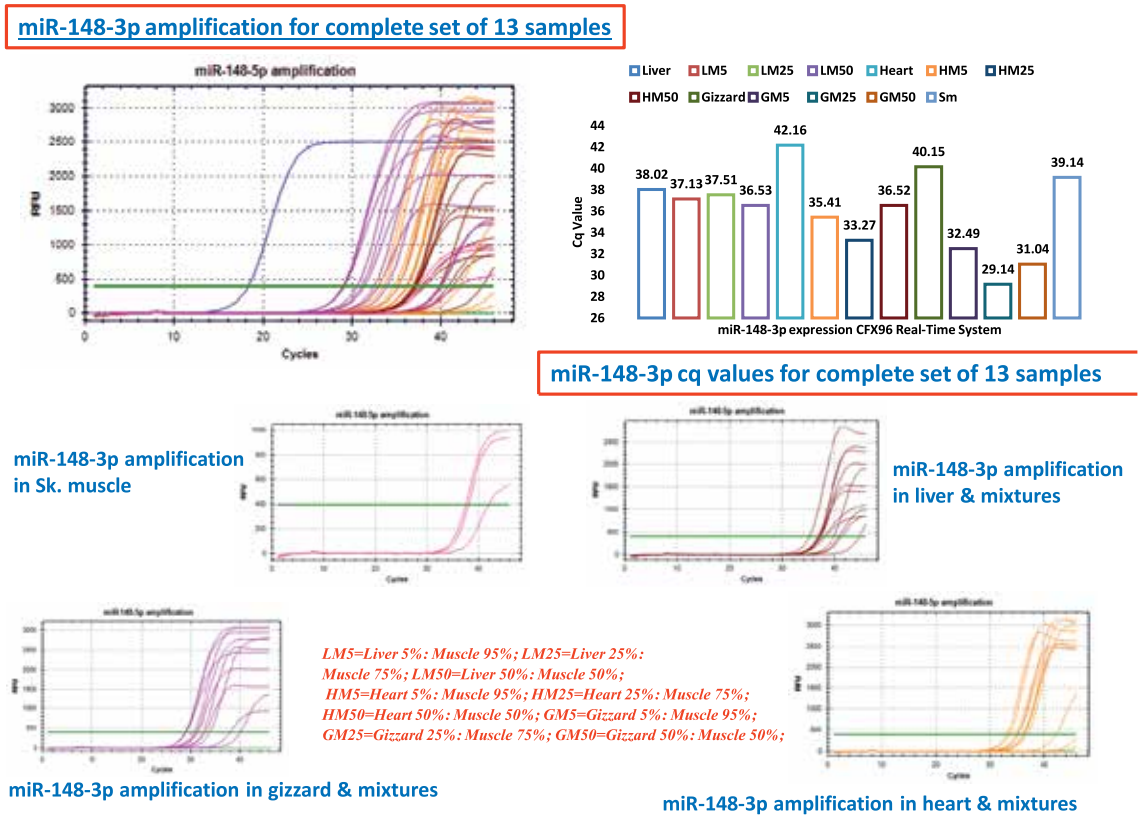


Fig 30. Differential expression (in terms of Cq values) of Rank I primer (miR-148-3p) in various meat-organ mixtures from chicken.

12. Prevalence and Characterization of Important Foodborne Pathogens in Buffalo Meat Production Chain

Principal Investigator :	Dr. L. R. Chatlod
Co-Investigator :	Dr. S. B. Barbuddhe

During the year a total of 217 samples were collected from different sites of buffalo meat production chain (abattoir and retail outlets) to study the prevalence of *Escherichia coli* and *Salmonella spp.* Samples were collected by adopting the standard aseptic measures and transported to laboratory under chilled condition and immediately processed for isolation.

Samples were inoculated in enrichment broths. Enriched inoculum was streaked on selective agar. Characteristic colonies were picked up on nutrient agar. Confirmation of the suspected isolates was done by biochemical tests.

Screening of 217 samples from buffalo meat production chain indicated the occurrence of *E. coli* and *Salmonella* spp in 21.19 % and 3.22 % of samples, respectively. Further studies are in progress.

13. Impact of Meat Research on Livestock Sector Development–Role of Public Investment

Principal Investigator:	K. Varalakshmi

The impact of NRCM research on research community data on research papers was assessed. Citations were collected and analysed by using WOS software for the period 2007-2017. The results of bibliometric analysis of NRCM are summarized below in the following heads

1. General Bibliometric Characteristics of NRCM research output

NRCM has published 152 research papers of which 50.66% (#77) are first author papers and 49.34% (#75) are co author papers where the NRCM researchers are co authors in the papers of other institutes like ICAR institutes, SVU and also other international institutes. Both FA and RA articles have contributed equally to the research output / bibliometric output of the institute.

- To analyse the visibility and impact of NRCM research, we have carried out bibliometric analysis of the NRCM research output by using WOS software where we could recover 85 research articles out of 152.
- Only half of the articles (55.92%) produced have been published in peer reviewed journals where FA (58.44%) have slightly more visibility compared to RA articles (53.33%).
- Top five authors according to visibility in WOS (including both FA and RA) are Naveena B.M (29.41%), Anjaneyulu A.S.R (14.12%), Girish Patil. S (10.59%) Chatlod L.R (7.06%) Vaithyanathan. S. (7.06%). These authors contributed for 68.24% of peer reviewed articles as seen in WOS. Almost 80% of articles are recovered in WOS for these authors.
- Total citation count of NRCM articles was 513 where in 261 are for FA articles and 252 are for RA articles.

- Overall highest citations are the contributions of B. M. Naveena (55.56%) followed by Anjaneyulu A.S.R (15.59%), Girish Patil. S. (13.65%).
- 52.94% of FA articles contributed for 50.88% of citations where as 47.06% of RA articles contribute for 49.12% of citations. Average citations per paper were more for RA articles (6.3) compared to FA articles (5.8). Average citations per paper is 6.04.

2. Trend in NRCM publications

I) General Trend of publications

- Overall the highest number of articles were published in 2014-15 (15.29%) followed by 2009-10, 2010-11 with 12.94% each.
- Out of 513 citations of all articles, 25.15% were cited in 2015-16 followed by 2016-17(22.81%), 2014-15(15.01%).
- In case of papers published in a particular year, the highest number of citations were taken by the papers produced in 2008-09 (174) followed by 2010-11(93), 2011-12(86) with 33.92%, 18.13%, 16.76% of all papers citations.

ii) Growth rate of NRCM publications

- Trend in NRCM publications was analyzed by estimating the growth rates like Annual Average Growth Rate (AAGR) and Compound Annual Growth Rate (CAGR)
- Publication trend showed that NRCM publications have grown at Annual average growth rate of 51.15% and CAGR of 7.75% during 2007-08 to 2016-17

3. Journal wise analysis of NRCM research output

- International journals have increased the visibility of NRCM research compared to national Indian journals.
- Regarding average citations again Meat science has ranked the first with 20.13 citations per paper followed by Food chemistry (18), International Journal of Food science and technology (16), Small Ruminant Research (14), Journal of Agriculture and Food chemistry (8), Poultry Science (8) and European Journal of Food Research and Technology (6).
- Overall Meat science has topped in the preferred journals for increasing visibility of NRCM research due to its international appearance.

4. Inter Institutional /International Collaboration of NRCM

To work out the institutional/ International collaboration of NRCM with respect to research article production, we have taken only co-authored articles where first author was from other institute/ country and NRCM authors were co authors.

- NRCM has collaborated with about 10 institutes from India and abroad out of which 2 are international institutes and 8 are within India. Out of 10, 5 are ICAR institutes and 2 are state universities, 2 are international universities and 1 is other institute.

- University of Connecticut, Storrs, IVRI, G. B. Pant University of Agriculture and Technology, Pantnagar have been in top collaborating institutes list in respect of all three parameters i.e., papers, citations and average citations.
- Overall degree of collaboration institutional collaboration is 0.47 with the highest in 2009-10 (0.73). Though NRCM is good at institutional collaboration its collaboration with other countries is less as evident by least international CC of 0.06 with highest CC in 2012--13(0.25)
- Though the degree is less, international collaboration has helped to increase the visibility of NRCM in meat research. It emphasizes the need to collaborate with other countries to leave its footprint in the world meat research.

5. Author wise analysis of NRCM research output

Author analysis was done to know the effect of multiple authors on the article visibility, to estimate the degree of author collaboration and also to estimate the individual author productivity to delineate the top productive authors of the institute.

i) NRCM Author Collaboration with other researchers

Articles were categorized into different categories according to number of authors and analysed for their bibliometric characteristics.

- One paper was with single author and the rest were multi author papers. Degree of author collaboration was 0.99.
- It was concluded that 62% of articles and citations were accounted by the articles with authors upto 5 and 38% come from multi author articles with more than 5 authors i.e., the highest number of articles and citations were accounted by less number of authors.

ii) Individual Author Analysis

- Bibliometric analysis of authors showed that the top five authors were B.M. Naveena, A.S.R. Anjaneyulu, S. Vaithyanathan, Girish Patil. S and M. Muthukumar in respect of all parameters i.e., number of papers, citations and average productivity per paper. Estimates of these parameters for these 5 authors were 25, 12, 6, 9, 5 papers and 285, 80, 41, 80, 13 citations and 11.4, 6.67, 6.83, 7.78, 2.6 citations per paper, respectively.

6. Citation wise Analysis of NRCM research output

Citation analysis was carried out to find out low cited papers, average papers and highly cited papers by categorizing the papers by number of citations.

- It was evident from the results that 31.76% of papers did not have citations out of which first author articles account for 63% (#17). 15.29% papers have single citations.
- Since average citation rate is 6.04 per paper for NRCM articles (#85), citation categorization is given as <6 , 6 , >6
- While more papers are less cited and less papers are more cited with 70.58% of papers with 15.2% of citations and 27.06% of papers with 82.46% of citations.

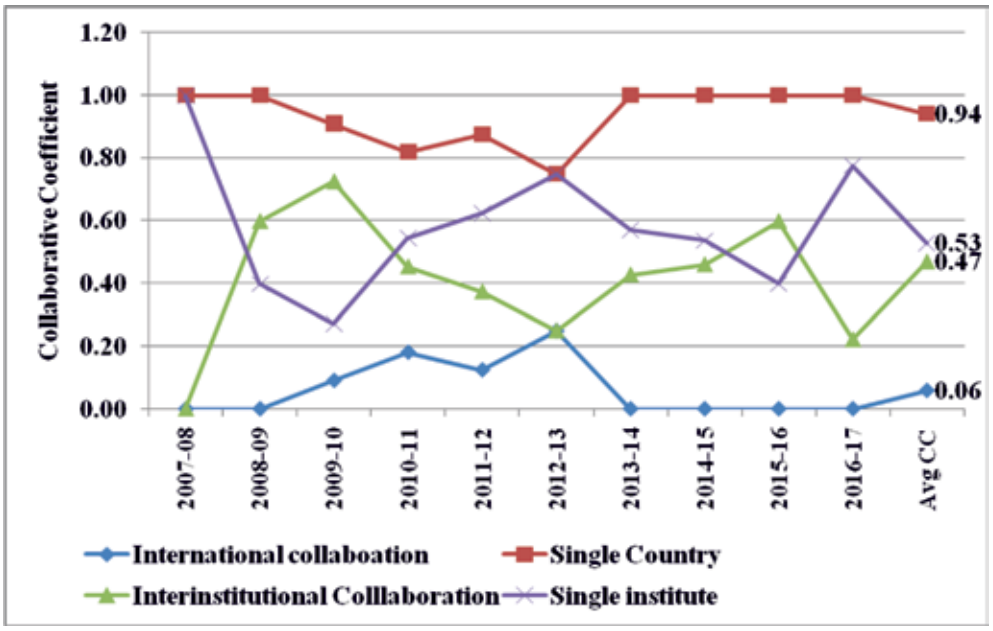


Fig 31. Collaborative coefficient of NRCM with other institutes or countries.

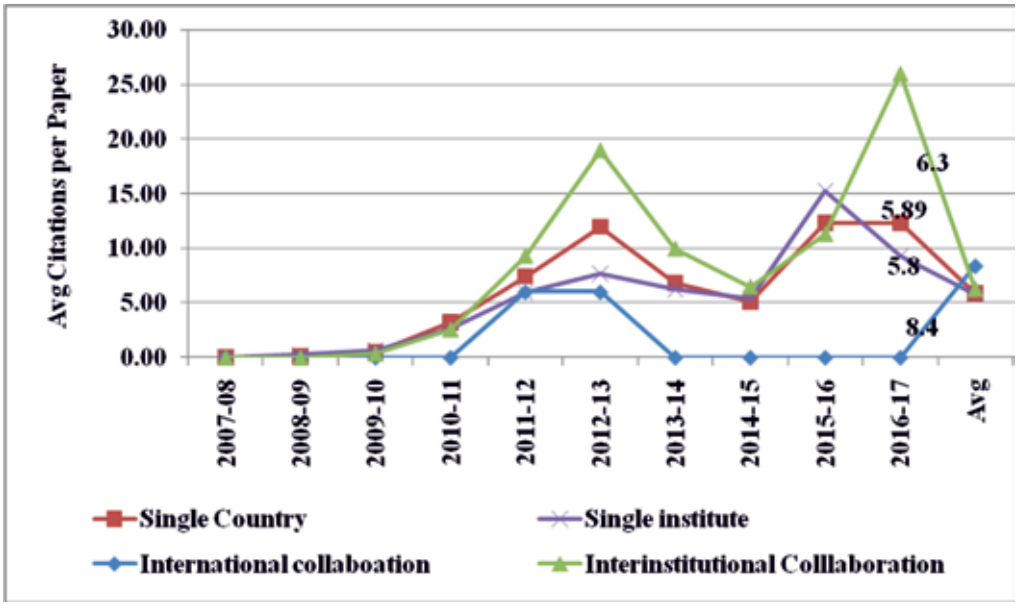


Fig 32. Effect of collaborations on article visibility.

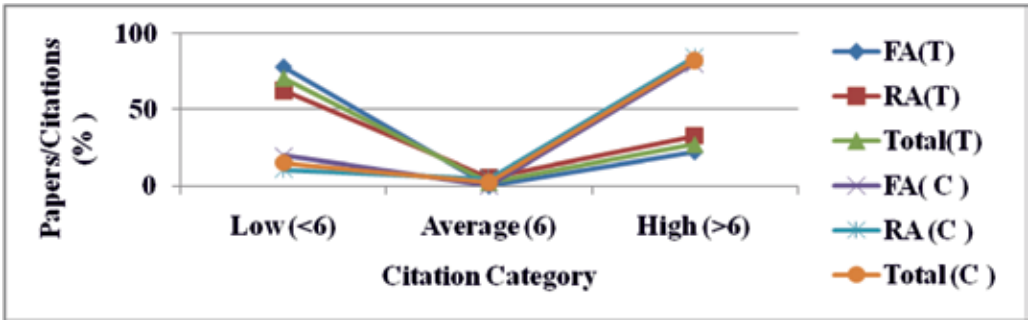


Fig 33. Citation categorization of papers.

Contract Research Project

Artificial intelligence based muzzle recognition technology for individual identification of animals

Funding agency: Clonoid Pvt Ltd., Hyderabad

Principal Investigator:	Dr. Girish Patil, S.

A simple method of individual animal identification by muzzle imaging using mobile app (Gomukh) developed by Clonoid Pvt Ltd is being validated and mode of integration of the technology with livestock traceability system is being developed. Muzzle images were captured in ILFC, Veterinary College, Hyderabad and Livestock Research Station, Mamnoor, Warangal. The validated muzzle image based methodology is expected to bring down the cost and time required for individual identification of animals.

Fig 34. Muzzle imaging for validating artifiicial intelligence based individual identificaiton technology.

PUBLICATIONS

1. Research Papers

Akhunji, B., Bhate, R., Pansare, N., Chaudhari, S.P., Khan, W., Kurkure, N.V., Kolte, S.W. and Barbuddhe, S.B. (2019). Distribution of *Orientia tsutsugamushi* in rodents and mites collected from Central India. Environmental Monitoring and Assessment 191(2): 82.

Banerjee, R., Naveena, B.M. and Muthukumar, M. (2018). Microstructural and physico-chemical properties of seekh-kebabs during grilling, roasting and smoking. Fleischwirtshaft International. 3: 50-54.

Barman, K., Konwar, D., Banik, S., Girish, P.S., Gokuldas, P.P., Thomas, R. and Rajkhowa, S. (2018). Effect of supplementation of Azolla (*Azolla carolini*) meal on performance of crossbred (Hampshire × Ghungroo) pigs. Indian Journal of Animal Nutrition 35 (4) : 469-472.

Bhattacharya, D., Kandeepan, G. and Chauhan, P. (2018). Development and evaluation of chicken meat nuggets enriched with date palm fruit (*Phoenix dactylifera L.*). International Journal of Livestock Research 8(07): 287-295.

Choudhary, B.K., Choudhary, M., Bera, B.C. and Barbuddhe, S.B. (2018). Emergence of multidrug-resistant *Raoultella ornithinolytica* associated with Indian major carp. Current Science 114: 1818-1821.

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Dhaka, P., Malik, S.V.S., Yadav, J.P., Kumar. M., Baranwal, A., Barbuddhe, S.B. and Rawool, D.B. (2018). Seroprevalence and molecular detection of coxiellosis among cattle and their human contacts in an organized dairy farm. Journal of Infection and Public Health 12(2): 190-194.

Doijad, S.P., Poharkar, K.V., Kale, S.B., Kerkar, S., Kalorey, D.R., Kurkure, N.V., Rawool, D.B., Malik, S.V.S., Ahmad, R.Y., Hudel, M., Chaudhari, S.P., Abt, B., Overmann, J., Weigel, M., Hain, T., Barbuddhe, S.B. and Chakraborty, T. (2018). *Listeria goaensis* sp. nov. International Journal of Systematic and Evolutionary Microbiology 68(10): 3285-3291.

Girish, P.S., Lipika, N., Thomas, R., Rajkumar, V. and Alam, T. (2018) Development of shelf stable Ready-to-eat pork curry using retort processing technology. Journal of Packaging Technology and Research 2: 61 – 66.

Kalleshamurthy, T., Shekar, R., Niranjanamurthy, H.H., Natesan, K., Shome, B.R., Bambal, R.G., Sairiwal, L., Barbuddhe, S.B., Sahare, A., Kilari, S., Rahman, H., Shome, R. (2018). Assessment of fluorescence polarization assay: a candid diagnostic tool in *Brucella abortus* strain 19 vaccinated areas. Microbiology and Immunology 62(11): 694-701.

Kalleshamurthy, T., Yaranna, C., Shekar, R., Natesan, K., Sahay, S., Shome, B.R., Rahman, H., Barbuddhe, S.B., Barman, N.N., Das, S.K. and Shome, R. (2018). Fluorescence polarization assay: Diagnostic evaluation for porcine brucellosis. Journal of Microbiological Methods 156: 46-51.

Kiran, M., Naveena, B.M., Smrutirekha, M., Reddy, B.P., Banerjee, R., Praveen, K.Y., Venkatesh, C. and Rapole, S.N (2019). Traditional halal slaughter without stunning versus slaughter with electrical stunning of sheep (*Ovis aries*). Meat Science 148: 127-136.

Kiranmayi, C.B., Krishnaiah, N., Muthukumar, M., Subhashini, N., Srinivasa Rao, T. and Madhava Rao, T. (2018). Detection of organochlorine, organophosphorus and synthetic pyrethroid residues in pork, chicken, fish and fishpond water samples. The Pharma Innovation Journal 7(12): 13-16.

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Ramakrishna, C., Vaithiyanathan, S., Muthukumar, M., Chatlod, L.R., Lavanya, P. and Kulkarni, V.V. (2019). Molecular approaches in species identification of Sarcocysts in Indian buffalo meat. Indian Journalof Animal Research 53(3): 388- 393.

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Sahu, R., Kale, S.B., Vergis, J., Dhaka, P., Kumar, M., Choudhary, M., Jain, L., Choudhary, B.K., Rawool, D.B., Chaudhari, S.P., Kurkure, N.V., Malik, S.V.S. and Barbuddhe, S.B. (2018). Apparent prevalence and risk factors associated with occurrence of *Coxiella burnetii* infection in goats and humans in

Chhattisgarh and Odisha, India. Comparative Immunology, Microbiology and Infectious Diseases 60: 46-51.

Sarvadnya, R.G., Kokane, R.D., Dange, A., Gadekar, Y.P. and Girish, P.S. (2018). Process standardization for puffed product from spent hen meat. The Pharma Innovation Journal 7 (7) : 69 – 74.

Sarvadnya, R.G., Kokane, R.D., Kharate, A., Dange, A., Gadekar, Y.P., Girish, P.S. and Mukartal, S.Y. (2018). A study on the shelf life of the spent hen meat puffed product (SHPP) stored at ambient temperature. Journal of Experimental Zoology, India 21 (2): 1235-1240.

Shome, R., Kalleshamurthy, T., Natesan, K., Jayaprakash, K.R., Byra Reddy, K., Mohandoss, N., Sahay, S., Shome, B.R., Hiremath, J., Rahman, H. and Barbuddhe, S.B. (2018). Serological and molecular analysis for brucellosis in selected swine herds from Southern India. Journal of Infection and Public Health 12(2): 247-251.

Singh, B. P., Kandeepan, G., Vishnuraj, M. R., Shukla, V. and Verma, S.K. (2018). Evaluation of coconut water and coconut milk as ice flake substitute in chicken nuggets. Journal of Animal Research 8(4): 651-657.

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Vergis, J., Pathak, R., Kumar, M., Sunitha, R., Malik, S.V.S., Barbuddhe, S.B. and Rawool, D.B. (2018). A comparative study for detection of extended spectrum β-lactamase (ESBL) production by enteroaggregative *Escherichia coli* (EAEC) strains using double disc, nitrocefin and PCR assays. Journal of Microbiological Methods 151: 57-61.

2. Review/Technical/Popular articles

Kapgate, S.S., Kumanan, K., Vijayarani, K. and Barbuddhe, S.B. (2018). Avian parvovirus: classification, phylogeny, pathogenesis and diagnosis. Avian Pathology 24:1-10.

बिनोद कुमार चौधरी, ममता चौधरी एवं बारबुद्धे, एस. बी 2018 वैज्ञानिक तकनीक से मत्स्यपालन एवं उनका जैनिक स्ट्रेस प्रत्रिका जलचरी, अंक-23, (2017- 2018) भा.कृ.अनु.प. - केन्द्रीय मात्सिकी शिक्षा संस्थान, मुंबई., द्वारा प्रकाशित.

Devatkal, S.K. and Naveena, B.M. (2018). Innovations in modern meat retailing and e-commerce applications. Processed Food Industry 22 (1): 13-17.

Varalakshmi, K. (2018) Opportunities in meat processing in India with special reference to A.P and Telangana". In telugu magazine "Pashunestham" (తెలంగాణ మరియు ఆంధ్రప్రదేశ్‌లో మాంస పరిశ్రమలకు గల అవకాశాలు).

3. Presentations in Conferences/Symposia/Seminar/workshop/trainings

a. Lead papers/invited lectures

Babji, Y., Kandeepan, G., Ambedkar, Y.R., Kalpana, S., Vaithiyanathan, S and Girish, P. S. (2019). Meat safety assurance microbial risk analysis across the supply chain. Lead paper presented in IV Convention of Association of Meat Scientists and Technologists & National Seminar on "Food Sovereignty; Innovation at Intersection of Technology, Quality & Production held at NTR College of Veterinary Science, Gannavaram, 6-7 February, 2019.

Babji, Y., Kandeepan, G., Kalpana, S. and Vishnuraj, M.R. (2018). Meat food safety assurance risk management in supply chain. International Symposium and 8th Conference of Indian Meat Science Association (IMSACON), West Bengal University of Animal and Fisheries Sciences, Kolkata, November 22-24, 2018.

Banerjee, R., Muthukumar, M. and Naveena, B. M. (2018). Recent advances in chilling and freezing techniques for meat processing. ICAR Sponsored 21 days CAFT training on "Emerging Food Processing and Packaging Technologies: A Drive for Economic Opportunities" held at Center for Advanced Faculty Training – Home Science, Post Graduate & Research Center, PJTSAU, Rajendranagar, Hyderabad, 11-31 July, 2018.

Banerjee, R., Naveena, B.M and Devatkal, S. (2018). Development of functional meat products for catering to health conscious consumers. ICAR sponsored 21 days Summer School on Innovations in Livestock Sector for Doubling Farmers Income: Strategies and Opportunities in Meat Value Chain held at ICAR-NRC on Meat, Hyderabad, 25 July-14 August, 2018.

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Barbuddhe, S B., Muthukumar, M and Sahu, R. (2018). Red meat and colon cancer: Points to Ponder. Paper presented at the on Seminar on One Health: Unprecedented Opportunities and Challenges, held at ICAR-National Research Centre on Meat, Hyderabad, 18 December, 2018.

Barbuddhe, S. B. and Rawool, D.B. (2019). Antimicrobial resistance: issues and alternative approaches. Invited talk presented in 7th Pan Commonwealth Veterinary Conference on "The Role of veterinarians in addressing the global challenges to the lives of our pets, livestock, wildlife, humans and our environment" held at ICAR-NIANP, Bangalore, 3-7 March, 2019.

Barbuddhe, S.B., Choudhary, M., Chaudhari, S.P. and Rawool, D.B. (2019). Agroecology and zoonoses. Paper presented in National conference on "Challenges and Opportunities for tackling Veterinary Public Health Issues at the Human, Animal & Environment Interface" organized by Nagpur Veterinary College, Nagpur, 26-27 February, 2019.

Barbuddhe, S. B. and Rawool, D. B. (2018). Antimicrobial resistance and its impact on livestock and poultry production and human health in India. ICAR sponsored Summer School on "Innovations in

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Barbuddhe, S.B. and Choudhary, M. (2018). Impact of biotic stresses on livestock productivity. ICAR sponsored winter school on "Climate change led abiotic and biotic stresses in farm animals and amelioration with nutritional and physiological approaches" organized by ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru. 1-21 November, 2018 pp. 97-102.

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Barbuddhe, S.B. (2018). ICMSF standards and sampling plans for meat and meat products. Skill Development Program on "DNA Techniques in Forensic Food Analysis" (Strategies to combat economically motivated adulterations and frauds in foods of animal origin) organized by ICAR–National Research Centre on Meat, Chengicherla, Hyderabad, 2 July to 9 July, 2018.

Barbuddhe, S.B. (2018). Innovative technologies available for commercialization in Meat Sector. Training program on "Technology innovation and commercialization: Agriculture and Allied Sectors" at MANAGE on 17 May, 2018.

Barbuddhe, S.B. (2018). Recent concepts of One Health in Veterinary Perspective on occasion of One Health Day at College of Veterinary and Animal Sciences, Udgir on 3 November, 2018.

Barbuddhe, S. B. (2019). The concept of One Health to counter zoonoses. Training program on "Recent advances in livestock sector" for the extension functionaries of State Department of Animal Husbandry, Tamilnadu at MANAGE, Hyderabad on 31 January, 2019.

Baswa Reddy, P. (2019). Sheep and goat production approaches and strategies to enhance meat production and productivity. Paper presented in Fourth Annual Convention of Association of Meat Scientists and Technologists and National Seminar on "Food Sovereignty: Innovations at intersection of Technology, Quality and Production" at NTR College of Veterinary Science, Gannavaram, 6-7 February, 2019.

Chatterjee, R.N., Banerjee, R. and Naveena, B. M. (2018). Scope for poultry meat production and processing in the world vis-a-vis India: Strategies for doubling farmers' income. Lead paper presented in VIII Conference of Indian Meat Science Association Conference and International Symposium on 'Technological Innovations in muscle food processing for nutritional security, quality and safety' organized at Veterinary College, Kolkata, 22 to 24 November, 2018.

Devatkal, S. (2018). High pressure related technologies as emerging technologies to improve quality and safety factors in poultry meat. Lead paper presented at Indian Poultry Science Conference and Symposium, ICAR-CARI, Port Blair, 15-17 November, 2018.

Doijad, S., Barbuddhe, S.B and Chakraborty, T. (2019). Translational genome sequencing in public health microbiology. Paper presented in National conference on "Challenges and Opportunities for tackling Veterinary Public Health Issues at the Human, Animal & Environment Interface" organized by Nagpur Veterinary College, Nagpur, 26-27 February, 2019. Gannavaram, 6-7 February, 2019.

Girish, P.,S. (2018). ICT application in Animal Husbandry' at NAARM, Rajendrangar, Hyderabad in the training program on, 'ICT application in agriculture' on 10 September 2018.

Girish, P. S. and Kulkarni, V.V. (2019). Approaches for doubling farmers income in North eastern India through meat Production and processing. Paper presented in International Conference on, 'Animal agriculture for doubling farmers income – Technology, policy and strategy options' organized at Veterinary College, AAU, Guwahati, 27- 28 February, 2019.

Girish, P. S. and Kulkarni,V.V. (2018). Meat science research and education in India: Issues, challenges and priorities. Lead paper presented in VIII Conference of Indian Meat Science Association Conference and International Symposium on 'Technological Innovations in muscle food processing for nutritional security, quality and safety' organized at Veterinary College, Kolkata, 22 to 24 November, 2018.

Girish, P. S., Das, P. J. and Nagappa K. (2018). Recent advances in application of IT in muscle food sector. Lead paper presented in VIII Conference of Indian Meat Science Association Conference and International Symposium on 'Technological Innovations in muscle food processing for nutritional security, quality and safety' organized at Veterinary College, Kolkata, 22 to 24 November, 2018.

Kalpana, S. (2019). Antimicrobial residues in foods of animal origin: existing regulations and guidelines for rational use. Lead paper presented in National seminar on "Food sovereignty: Innovations at intersection of technology, quality and production" held at NTR college of Veterinary Science, Gannavaram, 6-7 February, 2019.

Kandeepan, G., Babji, Y., Kalpana, S. and Gouthami, B.P. (2019). Recent developments in packaging for proficient marketing of meat and meat products. Lead paper presented in IV Convention of Association of Meat Scientists and Technologists and National Seminar on "Food sovereignty: Innovations at intersection of technology, quality and production. Dept. of LPT, NTR College of Veterinary Science, Gannavaram,6-7 February, 2019.

Kandeepan, G., Shivaji, A. and Swaroopa, G. (2018). Development of smart packaging time-temperature indicator for monitoring quality of chicken meat at different temperature abuse conditions. Lead paper presented in VIII Conference of Indian Meat Science Association Conference and International Symposium on 'Technological Innovations in muscle food processing for nutritional security, quality and safety' organized at Veterinary College, Kolkata from 22 to 24 November, 2018.

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Kandeepan,G., Swaroopa, G. and Shivaji, A. (2018). Smart packaging indicator developed from anthocyanin-silver-titanium oxide nanocomposite for monitoring quality and safety of chicken meat under refrigeration storage. Lead paper presented in 8th International Food Convention IFCON 2018 on "Holistic approaches for start-ups, human resource training for agriculture and food industry gemmation" CSIR-CFTRI, held at Mysore, 12 to 15 December, 2018.

Muthukumar, M., Kanchana, K. and Divya. (2018). Chemical residues of concern in chicken meat and meat products". In: the manual of the ICAR sponsored training programme on "Exploring the technological approaches for enhancing the nutritive value and marketing of poultry products" at Veterinary College and Research Institute, Namakkal, 28 November to 18 December, 2018. Pp. 118–127.

Muthukumar, M. (2018). Buffalo meat in Indian economy. National brainstorming workshop on "Role of Buffalo in Indian Economy", Central Institute for Research on Buffaloes, Hissar, 20 July, 2018.

Muthukumar, M. (2018). Challenges and opportunities for meat sector development in Telangana. MEAT-TECH 2018 Conference on "Technology Trends & Opportunities in Meat and Allied Industries for a new pink revolution, CII, Hyderabad, 2 November, 2018.

Muthukumar, M. (2018). Current status of meat sector in India. Meeting on Processing characteristics of crops/commodities and their availability for commercial sale and value addition, ICAR, NASC Complex New Delhi, 15 May, 2018.

Muthukumar, M. (2018). Innovative processing technologies for meat value chain. Training programme on "Emerging Food processing and packaging technologies : A Drive for economic opportunities", held at Centre for advanced faculty training in home science, Faculty of Home Science, Professor Jayashankar Telangana State Agriculture University, Hyderabad, 11- 31 July, 2018.

Muthukumar, M. (2018). Risk, health concerns and management of chemical residues of concern in meat and meat products. Lead paper presented in VIII Conference of Indian Meat Science Association Conference and International Symposium on 'Technological Innovations in muscle food processing for nutritional security, quality and safety' organized at Veterinary College, Kolkata, 22 to 24 November, 2018.

Muthukumar, M. (2018). Sustainable buffalo production through salvaging unproductive buffaloes for meat production and meat export. Lead paper presented in VIII Conference of Indian Meat Science Association Conference and International Symposium on 'Technological Innovations in muscle food processing for nutritional security, quality and safety' organized at Veterinary College, Kolkata, 22 to 24 November, 2018.

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Vaithiyanathan, S. and Vishnuraj, M.R. (2018). DNA based molecular techniques for detection of meat adulteration. Recent developments in small ruminant rearing, meat quality control and value addition under National livestock mission project, held at ICAR-NRC on Meat, Hyderabad, 20-23 December, 2018.

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b. Abstracts

Banerjee, R., Naveena, B. M., Muthukumar, M. and Devatkal, S. (2018). Development of superchilling process for shrink wrapped chicken carcasses. Paper presented at International Symposium and eighth conference of Indian Meat Science Association on "Technological innovations in muscle food processing for nutritional security, quality and safety" held at West Bengal University of Animal and Fishery Sciences, Kolkata, West Bengal, 22-24 November, 2018.

Banerjee, R., Naveena, B. M., Praveen,Y., Muthukumar, M., Devatkal, S. and Padmaja, T. (2018). Shelf-life extension of meat using superchilling (-2°C): Protein degradation, microbial growth and physic-chemical properties. Paper presented at International Conference on "Recent Advances in Food Processing Technology" held at IIFPT, Thanjavur, 17-19 August, 2018.

Baswa Reddy, P., Ramana, D.B.V. and Muthukumar, M. (2019). Production of selenium enriched functional meat through supplementation of different sources of Selenium in Total Mixed Rations (TMR) of sheep. Paper presented in fourth Annual Convention of Association of Meat Scientists and Technologists and National Seminar on "Food Sovereignty: Innovations at intersection of Technology, Quality and Production" held at NTR College of Veterinary Science, Gannavaram, 6-7 February, 2019.

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Devatkal, S. (2018). Post-harvest processing and value addition to poultry. Paper presented at International training on "Feed the future-Indian Triangular training Programme Held at ICAR-DPR, Hyderabad, 1 -15 May, 2018.

Devatkal, S. (2018). Sensory qualities, consumer preference and meat quality characteristics of slow and fast growing chicken genotypes. Paper presented at Indian Poultry Science Conference and Symposium, held at ICAR-CARI, Port Blair, 15-17 November, 2018.

Girish, P. S., Barbuddhe, S.B., Kumari, A., Nagappa, K. and Rawool, D. B. (2018) Rapid method for halal authentication of meat using lamp based molecular technique. Paper presented in XVI Annual Symposium of Indian Association of Veterinary Pubic Health Specialists (IAVPHS) and National Conference on "Challenges and opportunities for tackling Veterinary Public Health issues at the human, animal and environment Interface" held at Veterinary College, MAFSU, Nagpur, 26 -27 November, 2018.

Girish, P. S., Saikia,T., Nandi, S., Sen, A., Karabasanavar, N., Ranbir Singh, K., Singh, R., Sarma, N., Dutta, T. and Das, P. J. (2018). Development of infrared thermal imaing based technique for efficient ante-mortem inspections in pigs. Paper presented in VIII Conference of Indian Meat Science Association Conference and International Symposium on 'Technological Innovations in muscle food processing for nutritional security, quality and safety' held at Veterinary College, Kolkata, 22-24 November, 2018.

Girish, P.S., Barbuddhe, S.B., Kumari, A., Devatkal, S. and Rawool, D. B. (2018) AL – LAMP: A simple, rapid and economical method for identification of meat species and detection of meat adulteration. Paper presented in VIII Conference of Indian Meat Science Association Conference and International Symposium on 'Technological Innovations in muscle food processing for nutritional security, quality and safety' held at Veterinary College, Kolkata, 22 - 24 November, 2018.

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Kalpana, S. and Muthukumar, M. (2018). Liquid chromatographic determination of residual FQ in meat using fluorescent detectors. Paper presented at International symposium and eighth conference of Indian Meat Science Association on "Technological innovations in muscle food processing for nutritional security, quality and safety" held at West Bengal University of Animal and fishery Sciences, Kolkata, West Benga, 22-24 November, 2018.

Kalpana, S. and Muthukumar, M. (2018).Quantitative determination of residual enrofloxacin in field buffalo meat samples using RP-HPLC. Paper presented in National symposium on "One health: Veterinary Pharmacology and Toxicology approaches" held at College of Veterinary sciences and animal husbandry, Anand Agriculture University, Anand, Gujarat, 5-7 December, 2018.

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Muthukumar, M., Priyanka, V.S., Nadeem Fairose, Md., Naveena, B.M., Wilfred Ruban, Girish, P.S. and Sudharshan (2018). Quality attribute and shelf life evaluation of retort processing cereal based chicken stew. In: Proceedings International Conference on Recent Advances in Food Processing Technology organized by Indian Institute of Food Processing and Technology, Thanjavur, 17-19, August, 2018.

Naveena, B. M., Banerjee, R. and Devatkal, S. (2018). Angiotensin-I-converting enzyme (ACE-I) inhibitory activity of protein hydrolysates obtained from water buffalo (*Bubalus bubalis)* liver. Paper presented at International symposium and eighth conference of Indian Meat Science Association on "Technological innovations in muscle food processing for nutritional security, quality and safety" held at West Bengal University of Animal and Fishery Sciences, Kolkata, West Bengal, 22-24 November, 2018.

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Vaithiyanathan, S., Vishnuraj, M. R., Sowmya, M. and Uday Kumar, R. (2018). Establishing forensic evidences from animal/abattoir by-product (horn) through DNA techniques: a case study from ICAR-NRC on meat. Paper presented at International symposium and eighth conference of Indian meat scientist association on "Technological innovations in muscle food processing for nutritional security, quality and safety" held at West Bengal University of Animal and fishery Sciences, Kolkata, West Bengal, 22-24 November, 2018.

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Vaithiyanathan, S., Vishnuraj, M. R., Srinivas, K., Narender Reddy, G., Kalpana, S., Banerjee, R. and Prakash, B. (2018). Simultaneous detection of beef and buffalo tallow using multiplex real time PCR. Paper presented at 19th World Congress of Food Science and technology held at CICDO exhibition centre, Mumbai, 23-27 October, 2018.

Vaithiyanathan, S., Vishnuraj, M. R., Srinivas, K.,Narender Reddy, G. and Sowmya, M. (2018). Application of DNA techniques in food fraud analysis: A two year long surveillance study on Haleem samples. Paper presented at 19th World Congress of Food Science and Technology held at CICDO Exhibition Centre, Mumbai, 23-27 October, 2018.

Yadav, J.P., Dhaka, P., Vergis, J., Vijay, D., Kumar, M., Pathak, R., Bhoomika, S., Kumar, A., Malik, S.V.S., Barbuddhe, S.B. and Rawool, D.B. (2018). A comprehensive study of genetic diversity and antibiogram profile of human and animal enteroaggregative *Escherichia coli* isolates from India. Paper presented at FSSAI-ICMSF-CHIFSS International Symposium on "Microbiological Food Safety Sampling and Testing in Food Safety Management" organized by FSSAI, ICMSF and CHIFSS held at Delhi, 9-10 October, 2018.

4. Training manuals

Babji, Y., Girish, P.S. and Kandeepan, G. (2018). Entrepreneurship development programme for small and medium scale meat processing, ICAR-NRC on Meat, Hyderabad.

Babji, Y., Kandeepan, G. and Vishnuraj, M.R. (2018). Entrepreneurship development programme on Value added meat products processing, ICAR-NRC on Meat, Hyderabad.

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Barbuddhe, S.B., Chatlod, L.R., Banerjee, R. and Muthukumar, M. (2018). Assessment of microbial and physical quality of meat. ICAR-NRC on Meat, Hyderabad.

Barbuddhe, S.B., Muthukumar, M. and Chatlod, L.R. (2018). One Health: Unprecedented Opportunities and Challenges, ICAR-NRC on Meat, Hyderabad.

Girish, P.S. and Muthukumar, M. (2019). Safe meat production, processing and value addition. ICAR-NRC on Meat, Hyderabad.

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Girish, P.S., Muthukumar, M., Naveena, B.M., Devatkal, S.K. and Banerjee, R. (2018). Value added meat product processing. ICAR-NRC on Meat, Hyderabad.

Muthukumar, M., Naveena, B.M. and Girish P.S. (2019). Value added meat products processing for entrepreneurship training on value added meat products processing. ICAR-NRC on Meat, Hyderabad.

Muthukumar, M., Naveena, B.M. and Girish, P.S. (2019). Entrepreneurship training on value added meat products processing. ICAR-NRC on Meat, Hyderabad.

Naveena, B.M., Muthukumar, M. and Banerjee, R. (2018). Innovations in Livestock Sector for Doubling Farmers Income: Strategies and Opportunities in Meat Value Chain. ICAR-NRC on Meat, Hyderabad.

Naveena, B.M., Muthukumar, M., Banerjee, R. and Phand, S. (2018). Entrepreneurship Development in Meat Value Chain: A Drive for Sustainable Animal Production and Employment Generation. MANAGE and ICAR-NRC on Meat, Hyderabad.

Vaithiyanathan, S and Vishnuraj, M. R. (2018). DNA techniques in forensic food analysis. Strategies to combat economically motivated adulteration and frauds in foods of animal origin. ICAR-NRC on Meat, Hyderabad.

5. Folders/Brochure

Devatkal, S.K., Naveena, B.M., Muthukumar, M. and Girish, P.S. (2018). Technical bulletin/brochure on online meat retailing: New business models for young technology entrepreneurs. ICAR-NRC on Meat, Hyderabad.

Devatkal, S.K., Naveena, B.M., Muthukumar, M. and Girish, P.S. (2018). Online meat store: Business and revenue model. Devatkal, S.K., Naveena, B.M., Muthukumar, M. and Girish, P.S. (2018). ICAR-NRC on Meat, Hyderabad.

Muthukumar, M., Naveena, B.M., Banerjee, R., Girish, P.S., Suresh, K. Devatkal, Reddy, P.B., Kandeepan, G., Babji, Y. and Ramakrishna, C. (2018). Technologies for meat production, processing and authentication. ICAR-NRC on Meat, Hyderabad.

Reddy, P.B., Girish, P.S. and Muthukumar, M. (2018). Booklet in telugu on 'Chinna taraha mamsa utpattula tayari- vyapara namuna. ICAR-NRC on Meat, Hyderabad.

Vaithiyanathan, S. and Vishnuraj, M. R. (2018). Skill development program on DNA techniques in forensic food analysis. Strategies to combat economically motivated adulteration and frauds in foods of animal origin. ICAR-NRC on Meat, Hyderabad.

Vaithiyanathan, S. and Vishnuraj, M. R. (2019). Meat species identification laboratory (MSIL). Dos and dont's while collecting and forwarding samples for meat species identification to MSIL, Meat species identification laboratory, ICAR-NRC on Meat, Hyderabad, 30 March, 2019.

6. Books/Book Chapters

Girish, P.S., Muthukumar, M, Naveena, B.M., Devatkal, S.K. and Vaithiyanathan, S. (2018) Business Prospects in Meat Production and Processing - An Entrepreneurial Handbook. ICAR – National Research Centre on Meat, Hyderabad (ISBN No. 978-93-5351-599-7).

Girish, P.S. and Karabasanavar, N.S. (2019). Molecular techniques for speciation of meat. In: Meat Quality Analysis – Advanced evaluation methods, techniques and technologies, 1st Edition, Academic Press, Elsevier, USA.

Girish, P.S. and Barbuddhe, S.B. (2019). Meat traceability and certification in meat supply chain. In: Meat Quality Analysis – Advanced evaluation methods, techniques and technologies, 1st Edition, Academic Press, Elsevier, USA.

Muthukumar, M., Girish, P.S., Naveena, B.M.,Kandeepan, G., Banerjee, R. and Devatkal, S.D. (2019). NRC on Meat Technologies for meat production, processing and authentication. Institute Technology Management unit, ICAR-NRC on Meat, Hyderabad.

Rawool, D.B., Bhoomika, S., Vergis, J., Pathak, R., Satyaprakash, K., Gourkhede, D., Yadav, J.P., Malik, S.V.S. and Barbuddhe, S.B. (2018). Antimicrobial peptides: An alternative approach to tackle antimicrobial resistant pathogens. Current topics in veterinary public health and zoonoses. College of Veterinary and Animal Sciences. G.B. Pant University of Agriculture & Technology, Pantnagar- 263145, Uttarakhand, India, ISBN No. 978-93-84970-06-2.

Rawool, D.B., Malik, S.V.S., Kumar, M., Yadav, J.P., Bhoomika., Pathak, S.R., Ujjwal, D.and Barbuddhe, S.B. (2018). Newer approaches for poultry processing in disease scarce conditions. Technological

Advances in Value Addition as well as Production of Green and Safe Poultry Products. ICAR Sponsored Summer School organized by ICAR-Central Avian Research Institute, Izatnagar-243122, Bareilly (UP) India during 04-24 September, 2018, pp 3. ISBN no. 978-93-5311-841-9.

Rawool, D.B., Malik, S.V.S., Kumar, M., Yadav, J.P., Bhoomika.,Pathak, S.R., Ujjwal, D. and Barbuddhe, S.B.(2018). Assessment of antimicrobial resistance profile of bacterial pathogens of poultry origin: Recent approaches. Technological Advances in Value Addition as well as Production of Green and Safe Poultry Products. ICAR Sponsored Summer School organized by ICAR-Central Avian Research Institute, Izatnagar-243122, Bareilly (UP) India during 04-24 September, 2018, pp 3. ISBN no. 978-93-5311-841-9.

Banerjee, R., Verma, A.K., Naveena, B.M. and Kulkarni, V.V. (2018). Processing, Storage and Transportation of Meat and Meat Products. In: Animal Sourced Foods for Developing Economies: Preservation, Nutrition, and Safety. Muhammad Issa Khan, Aysha Sameen (Eds.). World Food Preservation Center Book Series. CRC Press. ISBN 9781498778954.

Banerjee, R., Verma, A.K., Naveena, B.M. and Kulkarni, V.V. (2018). Processing, Storage and Transportation of Meat and Meat Products. In: Animal Sourced Foods for Developing Economies: Preservation, Nutrition, and Safety. Muhammad Issa Khan, Aysha Sameen (Eds.). World Food Preservation Center Book Series. CRC Press. ISBN 9781498778954.

Thota, C.K. and Muthukumar, M. (2018). The taste of India: Value added meat products processing and exports despite FMD. Lambert Academic Publication. ISBN No. 9786139859702.

PARTICIPATION IN TRAINING/SEMINAR/ CONFERENCES/ SYMPOSIA/WORKSHOP

Dr. B. M. Naveena attended 3 months specialized training in the area of "Meat quality and safety" at Oklahoma State University, USA during March 2018 – July 2018.

Dr. B. M. Naveena attended Food Safety Preventive Control Alliance workshop conducted by International Food Protection Institute, USA and certified as "Preventive control qualified individual (PCQI)" at Oklahoma State University, USA in April, 2018.

Dr. B. M. Naveena attended workshop on "Produce Safety Alliance Grower Training Course" at Oklahoma State University, Tulsa, USA on 5 April, 2018.

Dr. P. Baswa Reddy participated as expert member in the Scientific Advisory Meeting of KVK- CRIDA at Hayatnagar Resarch Farm, Hyderabad on 8 April, 2018.

Dr. S. B. Barbuddhe and Dr. Y. Babji participated in Regional Consultation on Climate Smart Agricultural Policies, Strategies and Agricultural Development programmes towards climate change adaptation and mitigation" on 17 April, 2018 at ICAR-NAARM, Hyderabad.

Dr. B. M. Naveena attended Basic Training-Entrepreneural Workshop at Oklahoma State University, Stillwater, USA on 19 April, 2018.

Dr. L. R. Chatlod attended training programme on Hospitality Management, at ICAR-NAARM, Hyderabad from 20-25 April, 2018.

Dr. Suresh Devatkal attended "Postharvest processing and value addition to poultry" during International training on "Feed the furure-Indian Triangular training programme held at ICAR-DPR, Hyderabad during 1-15 May, 2018, Hyderabad.

Dr. Girish Patil, S. participated in meeting on, 'Revision of ICAR model act on higher education in agriculture' organized at ICAR - Indian Institute of Millets Research, Rajendranagar, Hyderabad on 14 May 2018.

Dr. M. Muthukumar attended the meeting on Processing characteristics of crops/ commodities and their availability for commercial sale and value addition, ICAR, NASC complex New Delhi on 15 May 2018.

Dr. P. Baswa Reddy participated as subject matter expert for the Annual Action Plan workshop of KVKs of Telangana organized by ATARI, Zone-X and PJTSAU at CRIDA, Santoshnagar, Hyderabad during 31 May to 1 June, 2018.

Dr. Girish Patil, S. participated in Management Development Program (MDP) organized at National Academy of Agricultural Research Management (NAARM), Rajendranagar, Hyderabad from 4 to 15 June, 2018.

Dr. B. M. Naveena attended Training on "Internal Auditor Course" at Oklahoma State University, USA on 19 June, 2018.

Dr. S. B. Barbuddhe participated in 24th Meeting of Regional Committee II at CIFA, Bhubaneshwar during 22-23 June, 2018.

Dr. B. M. Naveena attended 71st Reciprocal Meat Conference-The Annual Meeting of American Meat science Association (AMSA)" held at Kansas City, Missouri USA from 24 to 27 June, 2018.

Dr. Girish Patil, S. participated in Group meeting of Hyderabad based Institutes on 'ICAR - ICT Road map' at the ICAR - Indian Institute of Millets Research, Rajendranagar, Hyderabad held on 6 July, 2018.

Dr. M. Muthukumar attended the National brainstorming workshop on "Role of Buffalo in Indian Economy" held at Central Institute for Research on Buffaloes, Hissar in collaboration with National Academy of Dairy Science (India) on 20 July, 2018.

Dr. Girish Patil, S. participated in meeting of scientific panel of FSSAI on 'Meat and meat products including poultry' held on 16 August, 2018.

Dr. S. Kalpana attended seminar on "Food safety and quality: challenges & solutions" at Hitec City, Hyderabad, Telangana on 22 August, 2018.

Dr. Girish Patil, S. participated in Half-yearly review meeting of the project entitled "e-Varaha: Information System for Safe Pork Production in North East India" held at Kalyani Govt. Engineering College, University of Kalyani, West Bengal on 05 September, 2018.

Dr. B. M. Naveena attended the workshop on "Saving the Harvest" held at NASC Complex, New Delhi on 26 September, 2018.

Dr. S. Vaithiyanathan participated 5 days training on Laboratory Assessors Course as per ISO 17025: 2017 at CIFT, Cochin during 26-30 September, 2018.

Dr. M. Muthukumar attended the 7th QRT meeting as a special Invitee at NAARM, Hyderabad on 24 October, 2018.

Dr. Girish Patil, S. participated in Interactive meeting on 'Clean meat' at Department of Biotechnology, New Delhi on 25 October, 2018.

Dr. M. Muthukumar participated in the MEAT-TECH 2018 Conference on "Technology Trends & Opportunities in Meat and Allied Industries for a new pink revolution" organized by CII at Hyderabad on 2 November 2018.

Dr. L. R. Chatlod and Vishnuraj, M. R attended ICAR Sponsored 21 days summer school on "Innovations in Livestock sector for doubling farmers income: strategies and opportunities in meat value chain" at ICAR-NRC Meat from 25 July to 14 August, 2018.

Dr. Rituparna Banerjee attended International Conference in Recent Advances in Food Processing Technology at IIFPT, Thanjavur from 17-19 August, 2018.

Dr. Vishnuraj, M. R. attended 2 days training on "Transition training on Laboratory Quality Management System as per ISO 17025:2017" organized by BIS, Hyderabad during 25-26 September, 2018.

Dr. S. B. Barbuddhe participated in FSSAI-ICMSF-CHIFSS International Symposium on Microbiological Food Safety Sampling and Testing in Food Safety Management jointly organized by FSSAI and ICMSF held in New Delhi during 9-10 October, 2018.

Dr. Vishnuraj, M. R. participated in the conference on "The global food safety and regulatory developments and food safety validation and verification". 19th World Congress of Food Science and Technology at CICDO exhibition centre, Mumbai during 23 -28 October, 2018.

Dr. Vishnuraj, M. R. participated in 5 days Short Term Mission on Better Training for Safer Food (BTSF) mission of European Union (EU) in India on Risk Assessment at FSSAI HQ, New Delhi during 12-16 November, 2018.

Dr. S.Vaithiyanathan and Dr. M. Muthukumar attended a meeting convened by Bureau of Indian Standards (BIS) for the Government labs on 15 November 2018 at Chennai.

Dr. Suresh Devatkal attended Indian Poultry Science Conference and Symposium on "Sensory qualities, consumer preference and meat quality characteristics of slow and fast growing chicken genotypes" at ICAR-CARI, Port Blair held during 15-17 November, 2018.

Dr. S.Vaithiyanathan, Dr. Y. Babji, Dr. S. Girish Patil, Dr. B.M. Naveena, Dr. M.Muthukumar Dr. G. Kandeepan, Dr. S. Kalpana, Vishnuraj, M. R and Dr. Rituparna Banerjee participated in 8th Conference of Indian Meat Science Association & International Symposium on Technological innovations in muscle food processing for nutritional security, quality and safety organized by IMSA and West Bengal University of Animal and Fishery Sciences, Kolkata during 22 - 24 November, 2018.

Dr. G. Kandeepan participated in National conference on "Revisiting agricultural research and monitoring system for developing innovations: To meet the newer challenges" organized jointly by ARSSF and ICAR-CIWA, Bhuvaneshwar durinh 24-25 November, 2018.

Dr. B. M. Naveena attended one day Brainstorming and Stakeholder meeting held at NAAS complex, New Delhi on 26 November, 2018.

Dr. Girish Patil, S. participated in Krishi Nodal Officers meeting held at New Delhi during 4-5 December, 2018.

Dr. S. Kalpana participated in National symposium on "One health: Veterinary Pharmacology and Toxicology approaches" held at College of Veterinary sciences and animal husbandry, Anand Agriculture University, Anand, Gujarat, during 5-7 December, 2018.

Dr. G. Kandeepan participated in 8th International Food Convention IFCON 2018 on Holistic approaches for start-ups, human resource training for agriculture and food industry gemmation, CSIR-CFTRI, Mysore during 12 - 15 December, 2018.

Dr. B. M. Naveena attended National Conference on "Innovative Biotechnological Approaches for Improving Animal Health and Productivity" held at NRC on Mithun, Medziphema, Nagaland from 13-15, December, 2018.

Dr. Girish Patil, S. participated in Sensitization program of stakeholders on 'E Varaha' and 'Image DGP' project organized at ICAR – RC for NEH Region, Barapani on 21 December 2018.

Dr. S.Vaithiyanathan, Dr. S. B. Barbuddhe, Dr. Y. Babji, Dr. C. Ramakrishna and Dr. P. Baswa Reddy attended seminar on "Sustainability of small farmers in changing Agricultural scenario" organized by Retired ICAR employees association and Prof. Jayasankar Telangana State Agricultural University at Seminar Hall, PJTSAU, Rajendranagar, Hyderabad on 22 December, 2018.

Dr. S. Vaithiyanathan participated 2 days training on "Transition training on Laboratory Quality Management System as per ISO 17025:2017" dated at BIS Chennai during 6-7 January, 2019.

Dr. S. Kalpana participated in SCAFi sponsored "World brackishwater aquaculture conference 2019" held at ICAR-Central institute of Brakishwater aquaculture, Chennai,Tamil Nadu during 22-25 January, 2019.

Dr. Rituparna Banerjee attended 19th Indian Veterinary Congress, XXVI Annual Conference of IAAVR and National Symposium entitled "Innovative progress in animal health and production for safe and secured food under One Health perspective" at Kolkata during February 1-2, 2019.

Dr. S. Vaithiyanathan attended the meeting on "Roadmap for Utilization of Bio resources towards Bio economy" 'Meat and Dairy Animals' at Indian National Science Academy (INSA), New Delhi during 4 - 5 February, 2019.

Dr. L. R. Chatlod attended Hindi workshop at ICAR-NAARM, Rajendranagar on 5 February, 2019.

Dr. S. Vaithiyanathan, Dr.Y. Babji, Dr. P Baswa Reddy, Dr. G. Kandeepan, Dr. S. Kalpana and Vishnuraj, M. R participated in IV Convention of Association of Meat Scientists and Technologists and National Seminar on "Food sovereignty: Innovations at intersection of technology, quality and production organized by AMST and NTR College of Veterinary Science, Gannavaram during 6-7 February, 2019.

Dr. M. Muthukumar attended the National Agri-business Entrepreneurship Conclave held at ICAR Research Complex for NEH region, Umiam, Meghalaya during 9 to 11 February, 2019.

Dr. P. Baswa Reddy attended the DST sponsored training programme on 'Emotional Intelligence at work place for the scientists and technologists' at Centre for Organization Development (COD), Hyderabad during 18-22 February, 2019.

Dr. Vishnuraj, M. R. participated in 14th Agricultural Science Congress (ASC) and Agri Tech at National Agricultural Science Congress, New Delhi during 20-23 February, 2019.

Dr. S. B. Barbuddhe and Dr. Girish Patil, S. participated in XVI Annual Symposium of Indian Association of Veterinary Pubic Health Specialists (IAVPHS) and National Conference on "Challenges and opportunities for tackling Veterinary Public Health issues at the human, animal and environment interface" organized at Nagpur Veterinary College, MAFSU, Nagpur during 26- 27 February, 2019.

Dr. M. Muthukumar and Dr. Vishnuraj, M.R. attended the 6th Meeting of Empowered Committee for Strengthening of Food Testing System in the Country at FSSAI, HQ, New Delhi on 22 February, 2019.

Dr. S. B. Barbuddhe participated in 7th Pan Commonwealth Veterinary Conference on "The Role of veterinarians in addressing the global challenges to the lives of our pets, livestock, wildlife, humans and our environment" held at ICAR-NIANP, Bangalore during 3-7 March, 2019.

Dr. B. M. Naveena attended Lead Auditor training with SGS India, Hyderabad on FSSC22000 certification from 4-8 March, 2019.

Dr. Girish Patil, S. participated in Interactive meeting-cum-workshop of Scientists in IT/Computer Application of all ICAR Research Institutes/ NRCs/ PDs/ ATARIs held at New Delhi at NASC Complex, New Delhi on 6 March, 2019.

Dr. Girish Patil, S. participated in meeting of Scientific panel on 'Meat and meat products including poultry' of FSSSAI held on 15 March, 2019.

Dr. M. Muthukumar, Senior Scientist undergone training on "Laboratory quality system management and internal audit as per ISO/IEC – 17025 : 2017" at National Institute of Plant Health and Management, Hyderabad during 25 to 29 March, 2019.

AWARDS AND RECOGNITIONS

- Certificate of Appreciation for the Institute from the Council for proactively implementing ICAR Research Data Management Guidelines in KRISHI portal.
- Dr. S. B. Barbuddhe, Principal Scientist was selected as a Member, National Academy of Sciences (NASI), India in 2018.
- Dr. B.M. Naveena, Principal Scientist was conferred with the FELLOWSHIP of Indian Meat Science Association (IMSA) since 2018.
- Dr. B.M. Naveena, Principal Scientist was Visiting Faculty/Adjunct Faculty at Dept. Livestock Products Technology, Guru Angad Dev Veterinary & Animal Science University (GADVASU) from 22-28h March, 2019.
- Dr. B.M. Naveena, Principal Scientist, Member: Scientific panel on "Meat and Meat Products including Poultry Products" at Food Safety and Standards Authority of India (FSSAI), New Delhi.
- Dr Girish Patil, S., Principal Scientist, Member: Scientific panel on, 'Meat and meat products including poultry' at Food Safety & Standards Authority of India, New Delhi.
- Dr. B.M. Naveena, Principal Scientist, Editor: Journal of Meat Science (ISSN 0975-5209), an official publication of Indian Meat Science Association (IMSA).
- Dr Girish Patil, S., Principal Scientist worked as Associate Editor of 'Journal of Meat Science' published by Indian Meat Science Association, Hyderabad.
- Dr Girish Patil, S., Principal Scientist elected as Treasurer of Indian Meat Science Association at 8th Conference of Indian Meat Science Association (IMSACON VIII) held at West Bengal University of Animal and Fishery Sciences, Kolkata during November 22-24, 2018.
- Dr. M. Muthukumar, Senior Scientist was reelected as Secretary of Indian Meat Science Association at 8th Conference of Indian Meat Science Association (IMSACON VIII) held at West Bengal University of Animal and Fishery Sciences, Kolkata during November 22-24, 2018.
- Dr. M. Muthukumar, Senior Scientist was nominated as Regional Coordinator for National Agri-business Entrepreneurship Conclave held at ICAR Research Complex for NEH region, Umiam, Meghalaya during 9 to 11 February 2019.
- Dr. Vishnuraj, M. R., Scientist has qualified the Junior Food Analyst Examination -2018 conducted by FSSAI as per the Food Safety and Standards Act, 2006.

- Best Oral presentation (First) award to Dr. Girish, P S. Principal Scientist and others at VIII Indian Meat Science Association Conference and International Symposium at West Bengal University of Animal and Fisheries Sciences, Kolkata, 22-24 November, 2018.
- Best oral presentation (second) award to Dr. Vishnuraj M. R. Scientist at VIII Indian Meat Science Association Conference and International Symposium at West Bengal University of Animal and Fisheries Sciences, Kolkata, 22-24 November, 2018.
- Best Poster Presentation to Yadav, J.P., Dhaka, P., Vergis, J., Vijay, D., Kumar, M., Pathak, R., Bhoomika, S., Kumar, A., Malik, S.V.S., Barbuddhe, S.B. and Rawool, D.B for the paper "A comprehensive study of genetic diversity and antibiogram profile of human and animal enteroaggregative Escherichia coli isolates from India" at FSSAI-ICMSF-CHIFSS International Symposium on "Microbiological Food Safety Sampling and Testing in Food Safety Management" organized by FSSAI, ICMSF and CHIFSS held in Delhi, 9-10 October, 2018.
- Best Oral Presentation award to Girish, P.S., Barbuddhe, S.B., Aparna, K., Nagappa, K. and Rawool, D.B. for the paper "Rapid Method for Halal Authentication of meat using LAMP based molecular technique" at National conference on "Challenges and Opportunities for tackling Veterinary Public Health Issues at the Human, Animal & Environment Interface"" organized by Nagpur Veterinary College, Nagpur during 26-27 February, 2019.
- Best Oral Presentation award to Vergis, J., Pathak, R., Kumar, M., Sunitha R., Malik, S.V.S, Barbuddhe S.B. and Rawool D.B. for the paper "Efficacy of Lactoferricin (17-30) against biofilm forming multi-drug resistant Enteroaggregative *E. coli* (MDR-EAEC) at International Conference on "Advanced Functional Materials for Energy, Environment and Health Care (AFMEEHC)" at Centre for Materials Science and Technology (CMST), University of Mysore on March 18-20, 2019.
- Best Oral Presentation award (First) to Kandeepan, G., Swaroopa, G., Gouthami, B., Babji, Y. and Shivaji, A. at the IV Convention of Association of Meat Scientists & Technologists and National Seminar on "Food Sovereignty: Innovations at intersection of Technology, quality and Production" organized by the Dept. of LPT, NTR College of Veterinary Science, Gannavaram from 6-7 February, 2019.
- Certificate of Appreciation to Dr. Kandeepan G. and Swaroopa G. for excellent oral presentation of research paper "Real-time monitoring of chicken meat quality through smart indicator developed from natural extract" at National conference on "Revisiting Agricultural Research and monitoring system for developing innovations: To meet the newer challenges" organized by Agricultural Research Scientists Forum and ICAR-Central Institute for Women in Agriculture at Bhubaneshwar, 24-25 November, 2018.
- Oral presentation award (First) to Dr. Kandeepan G. and others for the paper "Development of smart packaging condition" at the International Symposium on "Technological Innovations in Muscle food

processing for nutritional security, quality and safety" and 8th Conference of Indian Meat Science Association, organized by West Bengal University of Animal & Fishery Sciences, Kolkata, November 22-24, 2018.

- Oral Presentation Award (First) to S. Kalpana for the paper on "Quantitative determination of residual enrofloxacin in field buffalo meat samples using RP-HPLC" received at National symposium on "One health: Veterinary Pharmacology and Toxicology approaches" held at College of Veterinary Sciences and Animal Husbandry, Anand Agriculture University, Anand, Gujarat, 5-7 December, 2018.
- Oral Presentation Award (First) to Dr. S. Kalpana for the paper on "Extraction method for HPLC analysis of enrofloxacin and ciprofloxacin residues in buffalo meat" at the Fourth convention of Association of Meat Scientists and Technologist and National Seminar on "Food sovereignty: Innovations at intersection of technology, quality and production" held at NTR college of Veterinary Science, Gannavaram, 6-7 February, 2019.
- Oral Presentation Award (third) to Dr. S. Kalpana for the paper entitled on "Liquid chromatographic determination of residual FQ in meat using fluorescent detectors" at the International symposium and Eighth conference of Indian Meat Scientist Association held at West Bengal University of Animal and Fishery Sciences, Kolkata, 22-24 November, 2018.
- Best poster presentation award to Ambedkar Y.R, Pandey, A, Shyni, A., and Babji, Y. for the paper "A study on efficiency of natural anti-oxidants on physico-chemical and microbial stability of goat meat (chevon) patties during storage" at Asian Regional Conference on Goats (ARCG) organized by Amity University, Jaipur in collaboration with International Goat Association, October 22-26, 2018.
- Best poster presentation award (Second) to Dr. Rituparna Banerjee at VIII Indian Meat Science Association Conference and International Symposium at West Bengal University of Animal and Fisheries Sciences, Kolkata, 22-24 November, 2018.
- Young Scientist Award to Dr. Rituparna Banerjee received at 19th Indian Veterinary Congress and XXVI Annual Conference of IAAVR for presentation on "Superchilling concept enabling shelf life extension of meat: A potential alternative for chilling and freezing", 1-2 February, 2019.

WORKSHOPS/TRAININGS/ AWARENESS PROGRAMMES ORGANIZED

ICAR sponsored Summer School organized

ICAR sponsored Summer School programme on "Innovations in livestock sector for doubling farmers Income: Strategies and opportunities in meat value chain" was organised at ICAR-National Research Centre on Meat, Hyderabad from 25 July to 14 August, 2018. A total of 15 participants of various SAUs and ICAR institutes from 7 states of the country participated in the training programme.

Release of compendium of training during inaugural session of the programme

Workshop on One Health : Unprecedented Opportunities and Challenges

One-day work shop on "One Health: Unprecedented Opportunities and Challenges" was organised on 17 December, 2018 at NRCM, Hyderabad in collaboration with Society for Research on *Listeria* and Indian Meat Science Association. Dr. Ashok Kumar, Assistant Director General (Animal Health), ICAR, New Delhi graced the occasion as Chief Guest. Dr. S. Vaithiyanathan, Acting Director of the Institute presided over the function. Over 70 veterinarians, medicos, students of veterinary college and staff of NRCM participated in the programme. Dr. S.B. Barbuddhe, Principal Scientist, Dr. M. Muthukumar, Senior

Scientist and Dr. L.R. Chatlod, Scientist coordinated the programme. Speakers from different institutes delivered lectures on opportunities in one health, strategies of one health, medical genetics and alternative approaches to microbial resistance, red meat and colon cancer, environmental health issues, meat safety and traceability and alternate therapy for MDR bacterial infections.

Participants of the workshop on "'One Health: Unprecedented Opportunities and Challenges"

Entrepreneurship Training Programmes

Five entrepreneurship development programmes were conducted at ICAR-National Research Centre on Meat, Hyderabad during 24-27 April, 17-21 July, 10 -15 September, 30 October- 3 November, 2018, 18-22 February, 2019. A total of 78 prospective entrepreneurs participated in the prgrammes. Processing of different value added products like emulsion meat products, restructured products, enrobed products, ground meat products, cured and smoked products were demonstrated. Different packaging and preservation methods, meat handling and cooking techniques were also demonstrated. Necessary information like availability of equipment, their costs, ingredients, product formulation was provided to participants to enable them to start their own enterprise.

Skill Development Programme in hygienic meat production and processing.

Two skill development programmes were conducted at the institute during 29 October – 03 November and 12 – 17 November, 2018. A total of 22 participants were trained. Practical demonstrations on hygienic slaughtering, handling of meat, preparation of different cut-up parts, value added meat products processing were made during the programme. Participants were also educated on good manufacturing practices, food safety management practices, national and international meat standards and regulations pertaining to meat and meat products.

Training programme on safe meat production, processing and value addition

Two trainings were organized on safe meat production, processing and value addition at Veterinary College, Shivamogga and Veterinary College, Hassan during 12-13, March, 11-12, March 2019, respectively. Hygienic slaughtering, handling of meat, preparation of different cut up parts, value added meat products processing were demonstrated to over 80 participants.

Skill development training in Hygienic Meat Production and Processing practices at Veterinary College, Shivamogga, Karnataka

Training programme on DNA Techniques in forensic food analysis

A Skill Development Program on "DNA Techniques in Forensic Food Analysis" was organized during 2 July to 9 July, 2018 at the Institute to impart skill upgradation to the officials involved in the food sector dealing with meat. A total of 23 trainees participated in the programme.

Participants of the Skill Development programme with the staff of the Centre

XII Research Advisory Committee Meeting

XII Research Advisory Committee meeting held on 27 April 2018. The meeting was chaired by Dr J. K. Mallik, Former JD, IVRI, Izatnagar. The members, Dr. B. S. Prakash, ADG (AN&P), ICAR, New Delhi, George T. Oomen, Prof. & Head (Retd.), Dept of LPT, Veterinary College, Pookode,Kerala, Dr. Mineswar Hazarika, Professor & Head, Dept of LPT, Veterinary College, Guwahati, Assam, Dr. U. K. Pal, Professor & Head, Dept. of LPT, Veterinary College, Pondicherry, Dr. S. Vaithiyanathan, Director (Acting), ICAR - NRC on Meat, Hyderabad and the Member Secretary, Dr. S. B. Barbuddhe, I/c PME also participated in the deliberations. Dr. S. B. Barbuddhe presented the Action Taken Report on the recommendations of the previous RAC meeting. It was followed by presentation on progress made in different activities after the last meeting. Chairman and members appreciated the overall activities of the projects including research projects, trainings, technology transfer initiatives and awareness programs being undertaken by the scientists of the Centre.

XII Research Advisory Committee meeting

Institute Research Council Meeting

XIII meeting of Institute Research Council of ICAR – National Research Centre on Meat, Hyderabad was held on 2 May 2018 under the Chairmanship of Dr. S. Vaithiyanathan, Director (Acting). Dr. N. Krishnaiah, Professor and Head, College of Veterinary Sciences, Rajendra Nagar, Hyderabad was invited as an expert and Dr. Rajan Gupta, Principal Scientist, Animal Science Section, ICAR represented the Council. Meeting began with welcome by Dr. S. B. Barbuddhe, Principal Scientist & I/C PME Cell. The Chairman, IRC welcomed the experts and narrated about the the overall progress during the year. It was followed by presentations on different ongoing, new and completed research projects. Dr N. Krishnaiah and Dr. Rajan

Gupta appreciated the quality of the projects and opined that most of the projects were of International standards. Specific inputs were provided for different projects for strengthening the technical program and to make projects relevant to societal needs. Dr Girish Patil, S. and Dr. Laxman Chatlod acted as rapporteurs.

View of the XIII Institute Research Council meeting

XIII Research Advisory Committee Meeting

The XIII Research Advisory Committee meeting of ICAR - National Research Centre on Meat, Hyderabad was held on 18 March 2019. The committee chaired by Dr. A. T. Sherikar, Former Vice Chancellor, MAFSU, Nagpur and the members, Dr. A. S. R. Anjeneyulu, Former Emeritus Scientist, NRC on Meat, Dr. Ashok Kumar, ADG (AH), ICAR, New Delhi, Dr. Meena Kataria, Head, Division of Biochemistry, ICAR –IVRI, Izatnagar, Dr. Nitin V. Kurkure, Professor and Head, Department of Pathology, Nagpur Veterinary College, Nagpur, Dr. Ashwin Raut, Principal Scientist, ICAR-National Institute of High Security Animal Diseases Bhopal, Farmer Members, Sh. Subash Chanderji, and Sh. Ravi Kumar visited various laboratories, meat processing unit and newly constructed auditorium before the start of the meeting. Dr. S. Vaithiyanathan, Director (Acting) welcomed the Chairman and Members of the RAC and apprised the committee about the overall progress made by the Centre in past few years. In his initial remarks, Dr. A.T. Sherikar, Chairman addressed the RAC about its role in shaping the research programmes of the Institute.

Following the remarks, the action taken report on the recommendations of 12th Research Advisory Committee was presented. The ITMU and ABI activities such as the trainings, awareness programmes,

exhibitions, consultancy MoU's/Transfer of technology, services provided, revenue generated etc. were also presented. The Chairman and the members expressed overall satisfaction about the progress of the work particularly initiation of the work in frontier and emerging areas of meat science, and inputs given by all Members especially non-official members. After the detailed deliberations and discussion on the ongoing projects and extra-mural projects recommendations have been made for future programmes.

Chairman and Members of XIII Research Advisory Committee with the Scientists of the Institute

OTHER EVENTS

Vigilance awareness week

In pursuance of the directive issued by the Govt. of India, Vigilance Awareness Week was observed in ICAR-NRC on Meat, Hyderabad from 29 October to 3 November, 2018 on the theme 'Eradicate Corruption – Build a New India' to promote integrity, transparency and accountability in public life. On the first day, Vigilance Awareness Pledge was administered by, Dr. S. Vaithyanathan, Acting Director to all the scientists and staffs of the centre. On 31 October, 2018, all the staff members took Integrity Pledge as a tribute to Shri. Sardar Vallabhbhai Patel to acknowledge his commitment to uphold the highest standards of honesty and

Scientists and staffs of the Centre taking Vigilance Awareness Pledge

integrity. On the third day, as a part of outreach activity and awareness creation, drawing, elocution and essay writing competition was conducted for the students at Government school, Chengicherla. In the valedictory function on 3 November, 2017, Shri. Srinivas. K. Inspector of Police, Cyber Crime wing, Hyderabad gave a talk on the need for awareness against corruption to build up a corruption free and truthful society.

International Yoga Day

ICAR – National Research Centre on Meat, Hyderabad celebrated International Yoga Day on 21 June, 2018. Scientists and staff of the Centre participated in the event. On the occasion Dr. Girish Patil, S., Principal Scientist elaborated the benefits of the Yoga and gave background information and importance of the event. It was followed by demonstration of Yoga steps by Mr Harinath, Patanjali Peeth, Hyderabad. He systematically demonstrated and explained the benefits of each Aasan. He advised all the participants recharge themselves everyday by practicing Yoga and make it a part of their life.

Scientists and staff of the Centre practicing yoga

World Soil Day

World Soil Day was celebrated on 5 December, 2018. All the scientists, technical and administrative staff participated in the programme. Dr. S. Vaithiyanathan, Acting Director welcomed the participants and narrated about the importance of celebrating the World Soil Day. Soil is mother of everything we grow and we eat. Soil embraces three times as much carbon as the atmosphere and can help us meet the challenges of a changing climate. The basic elements in soil, animal and humans are the same. The human health is intriguingly related to soil health and animal health. He also urged to play active role to avoid soil pollution and its degradation. All the scientists also spoke on the occasion and expressed their views. It was suggested to establish composting unit to convert the abattoir waste in compost and treat the effluent scientifically to avoid soil pollution. It was also suggested to test the chemical and biological quality of soil of the surroundings of the slaughter houses.

Inauguration of Auditorium

Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR inaugurated the newly constructed Auditorium of the Institute on 18 January, 2019 in presence of Dr. J.K. Jena, DDG (AS & Fisheries), Ashok Kumar, ADG (AH) and Dr. S. Vaithiyanathan, Acting Director, NRC on Meat. Chief Engineer and other officials from CPWD, Hyderabad, Directors of different ICAR Institutes, Officials from Animal Husbandry Department, Govt. Telangana, Former Directors and staff of NRC on Meat, IMC members, Entrepreneurs and several meat processors were also present during the inauguration. Hon. DG ICAR visited different facilities at the auditorium and interacted with CPWD officials.

During the function, Dr. S. Vaithiyanathan welcomed the Chief-guest and other dignitaries. Dr. J.K. Jena, Guest-of Honour addressed the gathering and complimented all the staff NRC on Meat for the new auditorium and suggested to use the facility in collaboration with Animal Husbandry Dept., farmers, meat processors and other stake-holders to conduct the meetings regularly. Hon. DG, ICAR congratulated the staff of NRC on Meat for the grand auditorium and complimented for the successful NABL accreditation certification. He urged all the scientists for proper sampling, recording, maintainance on par with global requirements and develop alternative technologies for validation of meat species and sex determination methods including development of field usable kits. Later, the "NABL accreditation certificate" awarded to "Meat speciation" laboratory of NRC on Meat; "Technology Booklet" and a brochure published by ABI were released.

12th Foundation day Celebrated

The 12th Foundation day of ICAR-National Research Centre on Meat was celebrated on 22 February, 2019. Shri. Akhil Kumar Gawar, Director, Telangana State Food Processing Society, Department of Industries & Commerce, Govt. of Telangana graced the occasion as Chief Guest and Dr. Asha Martin, Principal Scientist, CSIR-CFTRI, Mysuru was invited as the guest of honour. Dr. S. Vaithiyanathan, Director (Acting), ICAR-

Celebration of the Foundation Day of the Centre

NRC on Meat delivered welcome address and presented a brief on the institute activities completed in the previous year. On this occasion, Dr. Asha Martin, delivered a lecture on "Ensuring Food Quality and Safety" and narrated the importance of foods in nutrition, safety issues associated with them, future foods, role of FSSAI as a regulatory body and its food safety related guidelines and the need for collaborative research work between CSIR-CFTRI, Mysuru and ICAR-NRC on Meat, Hyderabad. The Chief Guest presented training certificates to the trainees who have successfully completed the entrepreneurship training on "Value added meat products processing" held from 18 to 22 February, 2019. Besides, he also presented appreciation certificates to the scientists and technical personnel who have exhibited the institute activities in the Numaish 2019 held at Hyderabad. The Chief Guest, Shri Akhil Kumar Gawar delivered a talk on the future challenges, researchable areas in meat sector and urged the Scientists of ICAR-NRC on Meat for developing burning socio-scientific consumer need based research projects concerning meat quality, meat industry and policy matters. An open day program was also organized for the children from various schools located in Chengicherla and about 350 students participated and interacted with scientists followed by a visit to the different laboratories. The students were also given demonstrations on food safety by mobile unit of FSSAI, "Food safety on wheels" of Telangana State.

Open day seesion at the Centre attended by Children from different schools.

DISTINGUISHED VISITORS

Sri Jupally Krishna Rao, Hon. Minister for Panchayat Raj and Rural Development, Govt. of Telanagana visited the Institute on 4 April, 2018.

Sri Chhabilendra Roul, Special Secretary, DARE & Secretary, ICAR, New Delhi visited the Institute on 25 September, 2018.

Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR visited the Institute on 18 January, 2019.

Dr. J.K. Jena, Deputy Director General (Animal Sciences), ICAR visited the Institute on 18 January, 2019.

Sri Akhil Kumar Gawar, Director, Telangana State Food Processing Society, Department of Industries of Commerce, Govt. of Telengana visited the Institute on 22 February, 2019.

Dr. Asha Martin, Principal Scientist, CSIR - CFTRI, Mysore visited the Institute on 22 February, 2019.

Sri Upendra Pratap Singh, Commissioner, Animal Husbandry & Veterinary Sciences, Govt. of Karnataka visited the Institute on 22 February, 2019.

Dr. Ranjith Ramanathan, Associate Professor, Department of Animal and Food Sciences, Oklahoma State University, USA visited the Institute on 4 January, 2019 and delivered a lecture on *"Advanced Research Tools in Meat Quality and Food Safety"* and highlighted various aspects of livestock production and Industry requirements in developed countries.

PERSONNEL

Scientific		
1	Dr. S. Vaithiyanathan	Acting Director
2	Dr. S. B. Barbuddhe	Principal Scientist
3	Dr. Y. Babji	Principal Scientist
4	Dr. Suresh Devatkal	Principal Scientist
5	Dr. Girish Patil	Principal Scientist
6	Dr. B.M. Naveena	Principal Scientist
7	Dr. C. Ramakrishna	Senior Scientist
8	Dr. M. Muthukumar	Senior Scientist
9	Dr. P. Baswa Reddy	Senior Scientist
10	Dr. Kandeepan, G.	Senior Scientist
11	Dr. S. Kalpana	Senior Scientist
12	Dr. L. R. Chatlod	Scientist
13	Mrs. K. Varalakshmi	Scientist
14	Dr. Rituparna Banerjee	Scientist (On Study leave)
15	Dr. Vishnuraj, M.R.	Scientist
Administrative		
1.	Mr. B.P.R. Vithal	Private Secretary to Director
2.	Mr. Marisetti N.V. Rao	Assistant Finance and Accounts Officer
3.	Mr. Jitender Singh Gaite	Assistant Administrative Officer
4.	Mrs. C. Padmaja	Personal Assistant to Director
5.	Mr. T. Devender	Assistant
6.	Ms. Kola Alekhya	Assistant
7.	Mr. Sri Harsha	Assistant
8.	Mrs. V. Kalpana	Upper Division Clerk

Technical		
1.	Mrs. Kanchana Kommi	Technical Assistant (T-3)
2.	Mr. P. Phani Kumar	Technical Assistant (T-3)
3.	Mr. B.V.D. Srinivasa Rao	Sr. Technician (T-3)
4.	Mr. Mandala Srinivas	Technician (T-2)

Promotions

Scientific Staff

1. Dr. G. Kandeepan, Scientist (SS) was promoted as Senior Scientist.
2. Dr. S.Kalpana, Scientist (SS) was promoted as Senior Scientist.
3. Dr. B.M. Naveena, Senior Scientist was promoted as Principal Scientist.

Technical Staff

Sh. B.V.D. Srinivasa Rao, Senior Technician was promoted to the post of Technical Assistant Grade-III.

New Appointments

Sh. Jitender Singh Gaite has joined as an Assistant Administrative Officer w.e.f 06.09.2018 on deputation.

Transfers

Sh. Shaik Rukman, Junior Accounts officer of the Centre was relieved from the duties on 31.12.2018 to join the post of Assistant Finance & Accounts Officer at ICAR-ATARI, Bengaluru.

COMMITTEES

Quinquennial Review Team

1. Dr. J. Abraham, Consultant Meat Technologist, "Sharon", Santosh Nagar, Mannuthy, Thrissur, Kerala. Chairman
2. Dr. Sarfaraz Wani, Dean, Veterinary College, SKUAST Kashmir, Shuhuma Campus, SrinagarMember
3. Dr. K. N. Selvakumar, Dean, Veterinary College and Research Institute, Orathanadu, Thanjavur, Tamil Nadu, Member
4. Dr. K. C. Varshney, Head, Department of Veterinary Pathology, Rajiv Gandhi Institute of Veterinary Education & Research, Kurumbapet, Puducherry, Member
5. Dr. Chetan Kumar Thota, Director (International Business), Allanasons Ltd, Surya Towers, Block-F,5th Floor, 105 Sardar Patel Road, Secunderabad, Member
6. Dr. Manish Kumar Chatli, Head, Division of LPT GADVASU, Ludhiana, Member
7. Dr. S. Vaithiyanathan, Principal Scientist, ICAR-NRC on Meat, Hyderabad, Member Secretary

Research Advisory Committee

1. Dr. A. T. Sherikar, Former Vice Chancellor, MAFSU, Nagpur, 6, Sherikar Niwas, Atlanta Cooperative Society, Plot No.9, Sector-40, Nerul (Seawoods), Navi Mumbai, Chairman
2. Dr. B.C. Patnayak, Ex-Director, CSWRI, S/30, Maitree Vihar, Phase-I, Chandrashekharpur, Bhubaneshwar, Member
3. Dr. Ashok Kumar, ADG (AH), ICAR, New Delhi, Member
4. Dr. A. S. R. Anjeneyulu, Former Emeritus Scientist, Flat No .113, NRSA colony, Hydernagar, Hyderabad, Member
5. Dr. Meena Kataria, Head, Division of Biochemistry, ICAR –IVRI, Izatnagar, Member
6. Dr. Nitin V. Kurkure, Professor and Head, Department of Pathology, Nagpur Veterinary College, Nagpur, Member
7. Dr. Ashwin Raut, Principal Scientist, ICAR-National Institute of High Security Animal Diseases, Anand Nagar, Bhopal, Member
8. Sh. Subash Chanderji, R/o. H. No. 16-1-289, Saidabad, Hyderabad, Member
9. Sh. Ravi Kumar, R/o H.No.5-8-61, Gadwal House, Station Road, Nampally, Hyderabad, Member
10. Dr. S. Vaithiyanathan, Director (Acting), ICAR-NRC on Meat, Hyderabad, Member
11. Dr. S. B. Barbuddhe, Principal Scientist & I/c PME Cell, ICAR-NRC on Meat, Hyderabad, Member Secretary

Institute Management Committee (IMC)

1. Dr. S. Vaithiyanathan, Acting Director, National Research Centre on Meat, Hyderabad- Chairman
2. Director, Animal Husbandry Department, Govt. of Telengana, Shantinagar, Hyderabad. - Member
3. Director, Animal Husbandry Department, Govt. of Andhra Pradesh.- Member
4. Dr. K. Kondala Reddy, Associate Dean, Sri P.V. Narasimha Rao Telengana State University for Veterinary Animal Fishery Sciences, Administrative Office, Rajendranagar, Hyderabad-500030- Member
5. Dr. S.V. Rama Rao, Principal Scientist, ICAR – Directorate of Poultry Research, Rajendranagar, - Member
6. Dr. Subeer S. Majumdar, Director, National Institute of Animal Biotechnology (NIAB), Miyapur, Hyderabad - Member
7. Dr. Ganesh Kumar, Principal Scientist, ICAR – NAARM, Rajendra Nagar, Hyderabad – Member
8. Dr. Ravishankar C.N., Director, ICAR – CIFT, Cochin - Member
9. Dr. Ashok Kumar, Asst. Director General (AN & P), Indian Council of Agricultural Research, Krishi Bhavan, New Delhi - Member
10. The Controller, ICAR – NAARM, Rajendra Nagar, Hyderabad- Member
11. Shri Jitender Singh Gaite, Assistant Administrative Officer, National Research Centre on Meat, Chengicherla, Hyderabad – Member Secretary

Institute Animal Ethics Committee

1. Dr. S. Vaithiyanathan, Acting Director , ICAR –NRC on Meat, Hyderabad, Chairman
2. Dr. A. Gopala Reddy, PVNR Veterinary University, Hyderabad, Main Nominee
3. Dr. BDP Kalakumar, PVNR Veterinary University, Hyderabad, Link Nominee
4. Dr. Jayashree Chiring Phukon, CSIR- CCMB, Hyderabad, Scientist from outside the Institute
5. Dr. K. Venkaiah, ICMR- National Institute of Nutrition, Hyderabad, Socially Aware Nominee
6. Dr. C. Ramakrishna, ICAR-NRC on Meat, Hyderabad, Veterinarian
7. Dr. Kandeepan Gurunathan, ICAR-NRC on Meat, Hyderabad ,Biological Scientist
8. Dr. Kalpana Starling, ICAR-NRC on Meat, Hyderabad, Scientist from different biological discipline
9. Dr. P. Baswa Reddy, ICAR –NRC on Meat, Hyderabad , Scientist In-Charge cum Member Secretary

Institute Bio-Safety Committee

1. Dr. S. Vaithiyanathan, Director, ICAR-NRCM, Hyderabad, Chairman
2. Dr. Ravikumar G.V.P.P.S, Principal Scientist, NIAB, Hyderabad, DBT Nominee
3. Dr. T. K. Bhattacharya, National Fellow & Principal Scientist, Directorate of Poultry Research, Hyderabad, Outside Expert
4. Dr. K. Madhava Reddy, Consulting Medical Officer, ICAR-NRCM, Hyderabad, Bio-Safety Officer
5. Dr. S.B. Barbuddhe, Principal Scientist, ICAR-NRCM, Hyderabad, Internal Member
6. Dr. Suresh Devatkal, Principal Scientist, ICAR-NRCM, Hyderabad, Internal Member
7. Dr. Vishnuraj M.R, Scientist, ICAR-NRCM, Hyderabad, Internal Member
8. Dr. Girish Patil S, Principal Scientist, ICAR-NRCM, Hyderabad, Member Secretary

Institute Technology Management Committee

1. Dr. S. Vaithiyanathan – Acting Director, ICAR- NRC on Meat, Hyderabad, Chairman
2. Dr. S. B. Barbuddhe, Principal Scientist, ICAR- NRC on Meat, Hyderabad, Member
3. Dr. Girish Patil, S -Principal Scientist, ICAR- NRC on Meat, Hyderabad, Member
4. Dr. P. Baswa Reddy – Senior Scientist, ICAR- NRC on Meat, Hyderabad, Member
5. Dr. S. K. Soam, Principal Scientist, ICAR- NAARM, Hyderabad, Member (IPR Expert)
6. Dr. M. Muthukumar - Senior Scientist, ICAR- NRC on Meat, Hyderabad, Member Secretary

Internal Complaints Committee (ICC)

1. Dr. B. Shobha, Associate Professor, University of Hyderabad, Presiding Officer
2. Smt. C. Padmaja, Personal Assistant, NRCM, Member
3. Shri. B.P.R. Vithal, Private Secretary (PS) to Director, Member
4. Smt. Dheram Usha, President, Abhaya Association for Empowerment of Women, Hyderabad, Member

STUDENTS' CORNER

S. No	Name of the student	Research Project Topic	Members of Advisory Committee
1	Dr. Ranajit Kundu, M.V.Sc. Scholar, Division of Veterinary Public Health, ICAR-IVRI, Izatnagar	Studies on the occurrence and characterization of *Salmonella, Listeria monocytogenes*, and *Escherichia coli* in buffalo meat production chain	Dr. S. B. Barbuddhe, Principal Scientist
2	Dr. Faruk Hussain, M.V.Sc. Scholar, Dept. of Poultry Science, College of Veterinary Sciences, Rajendranagar, Hyderabad	Effect of dietary inclusion of nanozinc oxide in commercial broilers	Dr. P. Baswa Reddy, Senior Scientist
3	Dr. K. Gopi Reddy M.V.Sc Scholar, Dept of V.P.H College of Veterinary Sciences, Rajendranagar, Hyderabad	Studies on the quality of Fresh water and Marine fish sold in and around Greater Hyderabad Municipal Corporation	Dr. L. R. Chatlod Scientist
4	Dr. Rajesh Kumar Sahu Ph.D Scholar, Dept of V.P.H College of Veterinary Sciences, Rajendranagar, Hyderabad	Studies on pesticide and metallic residues in aquatic foods and effect of processing methods on pesticide residues.	Dr. L. R. Chatlod Scientist
5	Dr. Shivaji Arabati, M.V.Sc. Scholar, Dept. of LPT, College of Veterinary Science, Rajendranagar, Hyderabad.	Development of time temperature indicator for monitoring quality of chicken meat at different temperature abuse conditions	Dr. Kandeepan, G., Senior Scientist
6	K.Santosh Kumar, M.V.Sc. Scholar, Dept. of LPT, College of Veterinary Science, Rajendranagar, Hyderabad.	Decontamination of poultry carcass with chlorine dioxide	Dr. M. Muthukumar, Senior Scientist
7	Ms. Mounica, M.V.Sc. Scholar, Dept. of LPT, College of Veterinary Science, Rajendranagar, Hyderabad.	Development of highly specific, rapid and sensitive loop mediated isothermal amplification assay (LAMP) for species identification of mutton	Dr. Girish, P.S., Principal Scientist
8	Dr Jagadish Swamy, Ph.D. Scholar, Dept. of LPT, College of Veterinary Science, Rajendranagar, Hyderabad	Development of PCR based molecular techniques for species identification of important wild animals	Dr. Girish, P.S., Principal Scientist

LIST OF ON-GOING RESEARCH PROJECTS

Institute funded projects

S. No	Project Details	PI	Co-PIs
1	Assessment of the occupational health hazards and food safety risks associated with abattoir personnel	S. B. Barbuddhe	L. R. Chatlod and Sunil Pal Singh
2	Development of Ozone (O_3) based decontamination technology for poultry and sheep/goat carcasses	Suresh K. Devatkal	
3	Development of traceability based quality assurance method for wholesome meat production	Girish Patil S.,	S. B. Barbuddhe, S. Vaithiyanathan and C. Ramakrishna
4	Species identification of Sarcocysts in buffalo meat	C. Ramakrishna	Girish Patil, S. and S. Kalpana
5	Organic meat production system for sustainable sheep husbandry and promotion of consumer health	P. Baswa Reddy	D. B. V. Ramana, Pankaj, Ramakrishna, C. and M. Muthukumar
6	Impact of meat research on livestock sector development-Role of public investment	K. Varalakshmi	B. M. Naveena
7	Effect of superchilling and cryoprotectants on the quality and storage stability of meat	Rituparna Banerjee	
8	Development of miRNA based methods for authentication of meat and meat products with respect to organ meats	Vishnuraj M.R,	S. Vaithiyanathan, Suresh Devatkal and Kandeepan G.
9	Effect of essential oils for enhancing safety and quality of emulsion based chicken meat products	Y. Babji	S. Vaithiyanathan, G. Kandeepan, S. Kalpana and P. Baswa Reddy
10	Development and validation of rapid assays for detection of *Listeria monocytogenes* in foods	S.B. Barbuddhe	L. R. Chatlod

S. No	Project Details	PI	Co-PIs
11	Simultaneous quantitative determination of oxytetracycline and chlortetracycline residues in buffalo meat samples using RP-HPLC	S. Kalpana	M. Muthukumar
12	Prevalence and characterization of important food borne pathogens in buffalo meat production chain	L. R. Chatlod	S. B. Barbuddhe
13	Identification of important bioactive peptides from meat and slaughter house by-products.	B. M. Naveena	Suresh K. Devatkal and Rituparna Banerjee

Externally Funded projects

S. No	Project Details	Funding Agency	PI	Co-PIs
1	Detection and quantification of animal body fat/vegetable fat in milk fat/ghee	MoFPI funded project through DST	S. Vaithiyanathan	S. Kalpana and Rituparna Banerjee
2	Setting – up food testing laboratories-species and sex identification of meat	MOFPI through ICAR	S. Vaithiyanathan	Vishnuraj M.R.
3	Species identification to check adulteration of cheaper quality meat	FSSAI	S. Vaithiyanathan	
4	Mapping of skeletal muscle proteins from different buffalo breeds of India using high throughput proteomic approaches	ICAR LBSYSA	B. M. Naveena	
5	National agriculture innovation fund (ITMU and ABI)	ICAR	M. Muthukumar	Suresh K. Devatkal, B. M. Naveena, Girish Patil, S., Kandeepan, G., Rituparna Banerjee and Vishnuraj M.R.

S. No	Project Details	Funding Agency	PI	Co-PIs
6	Development of smart packaging nano-sensor for monitoring quality and safety of meat	DBT	Kandeepan G.	Suresh K Devatkal and Vishnuraj M.R.
7	Estimation of carcinogenic and mutagenic compounds in processed meat	FSSAI	M. Muthukumar	Rituparna Banerjee
8	Development of rapid immunochromatographic kits for field level detection of meat adulteration	DBT	B. M. Naveena	S. B. Barbuddhe and Rituparna Banerjee
9	Development of technological interventions for enhancement of quality, shelf-life, and microbiological safety of traditional/ethnic meat products	MoFPI	Suresh K. Devatkal	B. M. Naveena
10	Training and capacity building in sheep and goat value chain	National Livestock Mission, DADF	P. Baswa Reddy	M. Muthukumar
11	Enabling technologies in mammalian cell culture towards cultured meat	DBT	Girish Patil, S.	S. Vaithiyanathan

राजभाषा कार्यान्वयन

हिन्दी चैतना सप्ताह - २०१८

भा.कृ.अनु. प राष्ट्रीय मांस अनुसंधान केंद्र में हिन्दी चेतना सप्ताह का आयोजन १४ सितंबर से २० सितंबर २०१८ तक की अवधि के दौरान किया गया। हिन्दी चेतना सप्ताह का शुभारंभ हिन्दी कार्यशाला द्वारा किया गया जिसमें श्रीमति अनीता पांडे, सहायक निदेशक (राजभाषा), राष्ट्रीय ग्रामीण विकास एवं पंचायती राज संस्थान, राजेन्द्रनगर, हैदराबाद मुख्य अथिति रही। हिन्दी चेतना सप्ताह में विभिन्न कार्यक्रमों का आयोजन किया गया जिसका वर्णन इस प्रकार है।

१. हिन्दी विचार गोष्टी एवं हिन्दी कार्यशाला
२. श्रुतलेख
३. हिन्दी में हस्ताक्षर, गायन एवं कविता पाठ जिसमें भारत रन्त स्वर्गीय प्रधान मंत्री अटल बिहारी वाजपेयी जी कविताओं का पाठ किया गया
४. हिन्दी निबंध प्रतियोगिता (शीर्षक-स्वच्छ भारत स्वस्थ भारत)
५. चित्रकारी प्रतियोगिता (बच्चो हेतु)
६. हिन्दी अनुवाद प्रतियोगिता
७. प्रश्नोत्तरी
८. समापन समारोह

प्रतियोगिताओं में संस्थान के सभी वैज्ञानिकों, अधिकारियों, कर्मचारियों, संशोधन सहयोगी, वरिष्ठ संशोधन फेलो, विद्यार्थीगण एवं संपदा कर्मचारियों ने उत्साहपूर्वक भाग लिया और प्रथम, द्वितीय, तृतीय एवं सांत्वना पुरस्कार प्राप्त किए।

हिन्दी कार्यशाला

हिन्दी दिवस १४ सितंबर २०१८ के पावन अवसर पर भा.कृ.अनु.प-राष्ट्रीय मांस अनुसंधान केंद्र में हिन्दी की कार्यशाला का आयोजन किया गया जिसमें राजभाषा हिन्दी का कार्यालयीन अनुप्रयोग के महत्व को समझाया गया। मुख्य अथिति श्रीमति अनीता पांडे, सहायक निदेशक (राजभाणा), राष्ट्रीय ग्रामीण विकास एवं पंचाजती राज संस्थान, राजेन्द्रनगर, हैदराबाद द्वारा राजभाषा हिन्दी का अधिकाधिक कार्यालय कार्यों में प्रयोग हेतु जानकारी दी गई केंद्र के वैज्ञानिकों अधिकारियों एवं कर्मचारियों इत्यादि राजभाषा हिन्दी के सरल अनुप्रयोगों के माध्यम से कार्य करने पर प्रकाश डाल गया और हिन्दी राजभाषा का अधिकाधिक प्रयोग के लिए अभिप्रेरित किया।

संस्थान के सभी वैज्ञानिकों, अधिकारियों एवं कर्मचारियों को हिन्दी में अधिकाधिक टिप्पणी / प्रारूप लेखन हिन्दी शिक्षण योजना के तहत सभी को प्रबोध प्रवीण प्राज्ञ और पारंगत की शिक्षा लेने सभी को हिन्दी में हस्ताक्षर करना सभी मीटिंग्स और ट्रेनिंग में हिन्दी में बातचीत करना, संस्थान के सभी परिपत्र एवं आदेश पत्रों का हिन्दी में रूपान्तरण करने की दिशा में प्रयास हेतु बल दिया गया।

SWACHHTA MISSION

Swachhta Hi Seva

Swachhta Hi Seva campaign was celebrated at National Research Center on Meat, Chengicherla, Hyderabad from 15 September - 2 October, 2018 with great enthusiasm and all the staff members actively participated in the campaign.

NRCM Staff taking Swachhata pledge

Under the Swachhta Hi Seva campaign cleaning activities were undertaken in laboratories, meat processing plant, guest house, trainees hostel and different sections of the office. As a part of Swachhta Hi Seva campaign plantation of trees was done on 25 September, 2018 at the Institute.

Shri Chhabilendra Roul, Special Secretary (DARE) & Secretary (ICAR) planted a sapling on this occasion.

To commemorate the Swachhta Hi Seva Abhiyan an awareness procession was taken out from the Institute to Chengicherla village on 28 September, 2018. Placards-slogans/quotes and banner about Swachh Bharat were displayed by the staff. The procession traversed many streets of the village and all along the roads was swept and trash was collected simultaneously.

Swachhta Pakhwada

"Swachhta Pakhwada" campaign was celebrated at National Research Center on Meat, Chengicherla, Hyderabad from 16 to 31 December, 2018 with great enthusiasm. Dr. S. Vaithiyanathan, Director (Acting), NRC on Meat, administered the Swachhta shapath on 16 December, 2018. All the scientific, technical, administrative and contractual staff took pledge. Every day Shramdaan was performed by all the staff of the Centre throughout the campaign period.

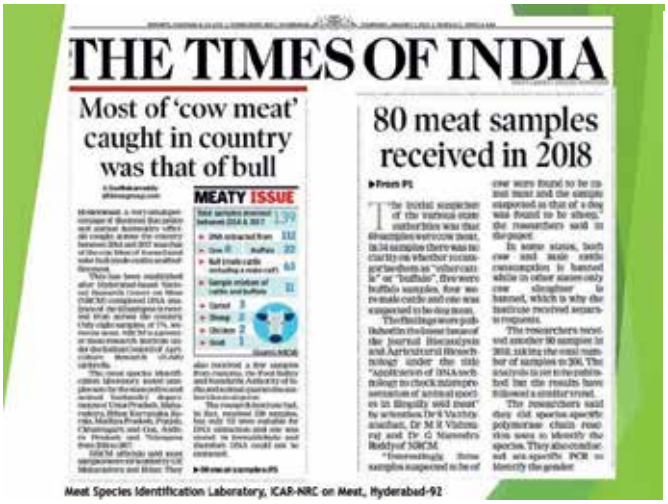
NRCM Staff taking Swachhata pledge

Under the Swachhta Pakhwada campaign cleaning activities were undertaken in Laboratories, Meat processing plant, guest house, trainee's hostel, experimental animal sheds and different sections of the office.

An awareness procession was taken out from NRC on Meat gate to Chengicherla village on 31 December, 2018. All the scientific, technical, administrative and contractual staff participated actively in the awareness programme.

Staff of NRCM in procession at Chengicherla Village

ICAR-NRC MEAT IN NEWS



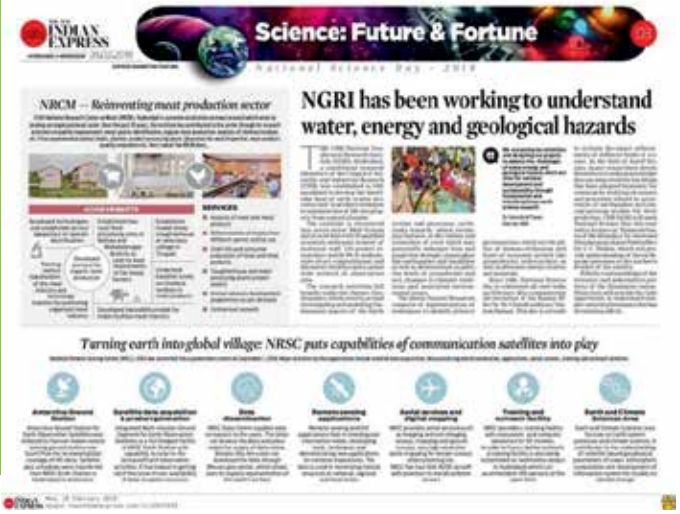
THE TIMES OF INDIA

Most of 'cow meat' caught in country was that of bull

MEATY ISSUE

80 meat samples received in 2018

Meat Species Identification Laboratory, ICAR-NRC on Meat, Hyderabad-92



THE INDIAN EXPRESS

Science: Future & Fortune

NRCM — Reinventing meat production sector

NGRI has been working to understand water, energy and geological hazards

Turning earth into global village: NRSC puts capabilities of communication satellites into play

ICAR-National Research Centre on Meat

AGRI-BUSINESS INCUBATOR

CSIR-National Geophysical Research Institute

CERTIFICATION DILEMMA PLAGUES TELANGANA

The demand for organic chicken has been on the rise in the state. Principal scientist at National Centre for Research on Meat, Dr P Baswa Reddy, says there are several hurdles to get the certification process for organic chicken started. A glut of the dilemma:

- Country chicken sold here is raised through conventional poultry farming without certification
- For organic labelling of livestock, a panel submitted a report to Agricultural and Processed Food Products Export Development Authority (APEDA)
- 'Crescent Agia' in Jaipur and 'Coastal Union' in Bengaluru have been given authorization for giving certification
- Applications of 'Aditya Organic' and 'Vedic Organic' of Hyderabad are pending. If these agencies are certified, a logo and label can be used
- The process will take at least two years, as certification starts with farming practices, how the feed is given and protocol followed. This certificate is valid for exports too

With regard to organic farming, the Peerumpagai Krishi Vikas Yojana, a cooperative of farmers, also provides for self-certification locally. Under this, farmers certify each other

RAINBOW ROOSTER TO THE RESCUE

Rainbow Rooster, or coloured broiler, which is neither a broiler nor country chicken, is now sought after in poultry industry. The reason:

- It grows fast like a broiler and looks and tastes like country chicken
- It is both suitable for backyard rearing and organic production
- In eight weeks, male rainbow roosters weigh at least 2kg

THE HEALTHY WAY: An organic chicken farm at Gundlapochampally

"The birds (organic) are farmed using natural food. We don't use any antibiotics and growth hormones due to which mortality is high when compared to broiler chicken. The response is not great, and we are facing difficulties of certification

Dharmendra Reddy

SILVER LINING ON PESTICIDE FRONT

- The National Research Centre on Meat has found pesticide levels in fish from Kolleru Lake, and districts through which the Godavari passes, are within permissible limits
- A study was carried out for two years after complaints were received over pesticide residue being found in fish supplied from this region to Hyderabad, northern states and abroad

"We have tested for 17 pesticide residues in freshwater fish from Godavari districts and Kolleru. The positives (pesticides) from paddy fields may reach ponds and wetland. However, in samples of fish tested, pesticide residues are within acceptable limits. Following apprehensions from North India, we found that fish from Kolleru, and Godavari districts are safe

Dr P Baswa Reddy | PRINCIPAL SCIENTIST, NATIONAL RESEARCH CENTRE ON MEAT

గొర్రెలు, మేకల పెంపకం, మాంసం ఉత్పత్తిపై శిక్షణ కార్యక్రమాలు

సంక్షేమవిభాగం,జూలై21,ప్రభాతవార్త

గ్రామీణ పేదరిక నిర్మూలన సంస్థ ఆధ్వర్యంలో జాతీయ మాంస పరిశోధన సంస్థల ద్వారా గొర్రెలు,మేకల పెంపకంలో మెళకువలు, పరిశుభ్ర మాసం ఉత్పత్తిపై గత రెండు రోజులుగా నిర్వహించిన శిక్షణ కార్యక్రమంలో మహిళా సంఘ సభ్యులకు అవగాహన కల్పించినట్లు డీఆర్‌డీఏ పీడీ ఇందుమతి తెలిపారు. ఈ అవగాహనతో గొర్రెలు, మేకలు, కోళ్ళ పెంపకంపై స్పష్టమైన అవగాహన, మెళకువలు మహిళలు నేర్చుకున్నారని, దీని ద్వారా వచ్చే మాంస ఉత్పత్తుల తయారీ, విక్రయం, ఆదాయ అభివృద్ధి కార్యక్రమాలను కూడా వారంతా అవగతం చేసుకోవడం జరిగిందని చెప్పారు. ఈ రెండు రోజుల శిక్షణా కార్యక్రమంలో మహిళా సంఘ సభ్యులతో పాటు పశుమిత్రాలు, డైరెక్టర్ వైద్యనాధన్, సెంటిస్ట్ డాక్టర్ బసవారెడ్డి, డాక్టర్ గిరీష్‌పాటిల్, సెర్ప్‌లైవ్ స్టాక్ డైరెక్టర్ అనంతరం, అడిషనల్ డీఆర్‌డీవో జయశ్రీ, డీపీఎం శ్రీనివాస్ తదితరులు పాల్గన్నారు.

వార్త Sun, 22 July 2018
epaper.vaartha.com/c/30678177

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National Accreditation Board for Testing and Calibration Laboratories

(A Constituent Board of Quality Council of India)

CERTIFICATE OF ACCREDITATION

MEAT SPECIES INDENTIFICATION LABORATORY (MSIL)

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2005

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

ICAR-National Research Centre on Meat, Chengicherla,
Boduppal PO, Hyderabad, Telangana

in the field of

TESTING

Certificate Number TC-7992

Issue Date 10/10/2018 **Valid Until** 09/10/2020

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.

(To see the scope of accreditation of this laboratory, you may also visit NABL website www.nabl-india.org)

Signed for and on behalf of NABL

8907697010003000 2037

Anil Relia
Chief Executive Officer

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
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ICAR - National Research Centre on Meat

ISO 9001:2015 and ISO/IEC 17025:2005 Certified Organization

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