Technologies for commercialisation

Certified Organic Sheep Production

Inventors/Developers: Dr. P. Baswa Reddy, Dr. D.B.V Ramana, Dr. Pankaj, Dr. C. Ramakrishna and Dr. M. Muthukumar

Brief description about the technology

The technology involves the establishment of a model organic livestock production unit comprising a certified organic fodder unit and a certified organic sheep unit, developed in accordance with National Programme for Organic Production (NPOP) guidelines. This initiative addresses challenges in organic livestock production in India, such as lack of awareness, absence of practical production standards, non-availability of accredited certification agencies, and high certification costs.

For this, a project in collaboration with ICAR- CRIDA has been taken up to rear sheep for meat purpose and certify it under organic protocols as per NPOP guidelines. Since feeding of certified organic fodder is an essential component of rearing organic sheep, an area of 0.8 ha was developed into organic fodder unit. The land has initially passed through the required conversion period and the fodder produced in this unit is certified as organic with compliance as per guidelines under NPOP by accredited certifying agency. The fodder produced in the certified fodder unit is used for organic sheep rearing. After due conversion period, the sheep unit was organically certified under NPOP guidelines for the first time in India through accredited certifying agency.

This farm serves as model demonstration unit for farmers and entrepreneurs, showcasing practical protocols for organic livestock production and certification. Regular awareness programmes and training sessions are conducted to promote adoption of organic livestock practices in the country.


Scope Certificate
Certificate No. ORG/SC/1704/000010
ICAR- NRC on Meat and ICAR-CRIDA
India's National Programme for Organic Production Standards
For the following process,
Livestock
this Certificate is issued.
This certificate is valid from
ORG/SC/1704/000010 A.

For further details please contact:

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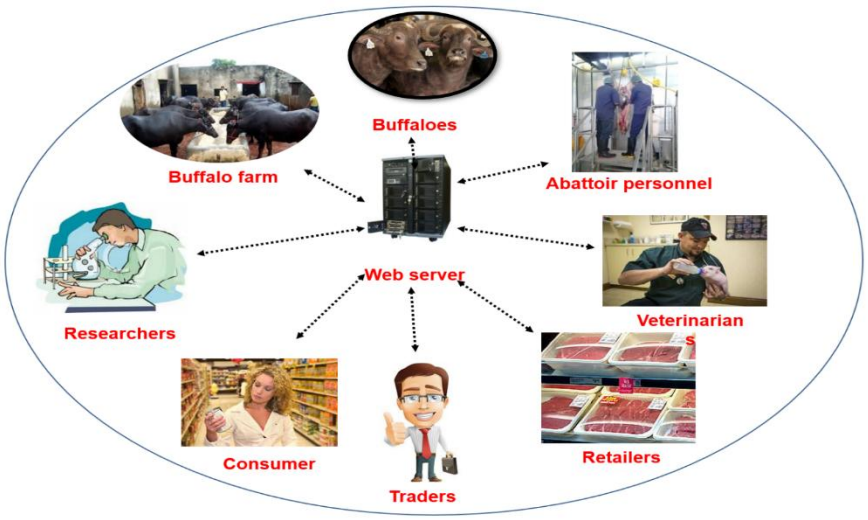
Methodology for Meat Traceability

Inventors/Developers: Dr. Girish Patil. S., Dr C. Ramakrishna and Dr S. B. Barbuddhe

Brief description about the technology: Livestock traceability is the ability to, and the mechanism designed for tracing of an animal product along all steps in the production chain back to the holding of origin of the live animal from which the product was derived. The emergence of traceability concept is the consequence of a long line of developments in improving food quality and safety management. In recent times, it has emerged as a new index of quality and basis for trade. Identification of animals, registration of premises like farms and abattoirs, database for uploading of traceability information and provision for retrieval of information as and when required are the important requirements for meat traceability. Steps in the developed protocol involve method for identification of livestock, a system for storing of information, method for recording the traceability data during slaughter and protocol for labelling of meat for achieving the traceability. A copyrighted web-based database was developed for achieving farm-to-fork traceability. Further a block chain-based database was developed in collaboration with M/s Chainflux Pvt Ltd. The database was linked with Information Network for Animal Productivity and Health (INAPH) for getting the live animal information from the field.



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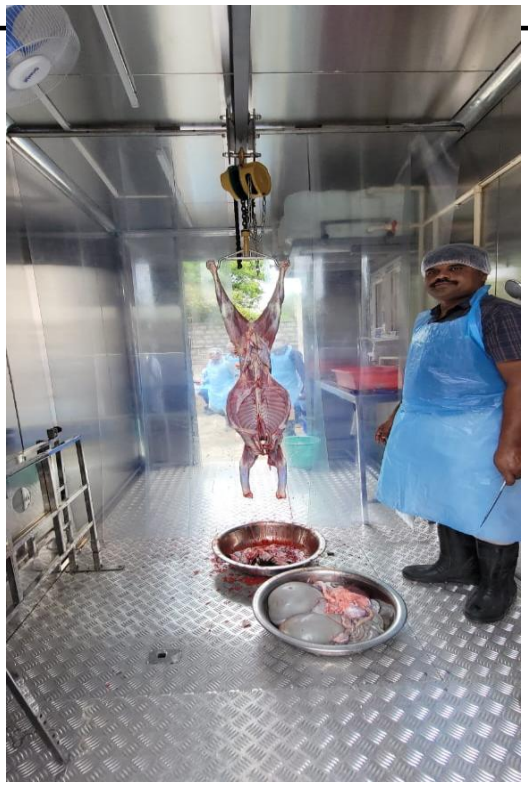
Swachh Meat Hub: A Portable Abattoir Model

Inventors/Developers: Dr. M. Muthukumar, Dr. A.R.Sen, Dr. B. M. Naveena, Dr.Rituparna Banerjee, Dr. Yogesh P. Gadekar and Dr.S.B.Barbuddhe

Brief description about the technology

The exorbitant cost of building civil structure and slaughterhouse machineries and non-availability of small scale meat processing units are resulting in clandestine slaughter at villlages and small towns. Except in few of the larger Municipal corporations and Municipalities, majority of the Gram panchayats need suitable for slaughter of small group of animals. Hence, there is an urgent and imperative need to develop and adopt sustainable, economically viable and environment-friendly technologies suitable for small scale processing.

The Swachh Meat Hub is a compact and cost-effective assembly developed on the principles of good manufacturing and hygienic practices and is suitable for small scale slaughtering of sheep/goat (50 animals/day)/pigs (20 animals/day). The unit has dimension of 12'(L) X 8' (W) X 8' (H) and has all the components required for harvesting and production of meat viz., inbuilt detachable restrainer cum bleeding platform, overhead rail, hoist, knife sterilizer, carcass washing, carcass fabrication table, and containers for holding edible and inedible co-products. The inner wall of the facility is fabricated with food grade stainless steel (SS 304). This unit is designed to be mounted over trailer and could be moved by a tractor or any other suitable vehicle.



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Portable Meat Production and Retailing facility – Multispecies (PMART-M)

Inventors/Developers: Dr. Girish Patil. S, Dr C Ramakrishna and Dr S. B. Barbuddhe

Brief description about the technology

Technology on Portable Meat Production and Retailing Facility – Multispecies (PMART-M) for Sheep and Goats, Pigs and Poultry was designed, developed, tested and validated. PMART-M has been designed for hygienic production of meat as per Food Safety and Standards Authority of India (FSSAI), meeting animal welfare norms of Animal Welfare Board of India (AWBI) and non-polluting and environmental friendly disposal of waste as per Central Pollution Control Board (CPCB) norms. PMART-M is a roomlike structure made of food grade stainless steel (SS304). Floor made of aluminium checker sheet. All four walls made of steel. Roof made of tower fan. PMART-M comprises a) Restrainers b) Portable Slaughterhouse c) Portable meat shop and d) Waste management Facility (Composters and Biodigester). One meat animal (sheep or goat or pig or poultry bird) can be slaughtered at a time. Two operators are required for handling clean and unclean operations. A low-cost electric stunner was designed and developed for each meat animal species. PMART-M has been primarily made up of SS 304 grade stainless steel. A 2 cubic meter capacity biogas plant helps in management of liquid waste and specially designed composters help in management of solid waste generated from slaughter of meat animals.

Portable Meat Production and Retailing Facility with biomethanation plant for waste disposal

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Portable Meat Production and Retailing Facility for Sheep and Goats (P-MART)

Inventors/Developers: Dr. C. Ramakrishna, Dr Girish Patil, S. and Dr S. B. Barbuddhe

Brief description about the technology

Technology on Portable Meat Production and Retailing Facility (P-MART) for Sheep and Goats was designed, developed, tested and validated. PMART has been designed for hygienic production of meat. P-MART comprises a) Resting Facility b) Slaughter facility c) Meat cutting & Packaging Facility d) Retailing Facility and e) Waste management Facility (Composters and Biodigester). One sheep or goat can be slaughtered at a time. Two operators are required for handling clean and unclean operations. A low cost electric stunner was designed and developed. P-MART has been primarily made up of SS 304 grade stainless steel. A 2 cubic meter capacity biogas plant helps in management of liquid waste and specially designed composters help in management of solid waste generated from slaughter of sheep / goats.

Overview of Portable Meat Production and Retailing Facility for Sheep and Goats

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Frozen mutton Haleem balls: Novel product and process for the preparation.

Inventors/Developers: Dr. Suresh K. Devatkal, Principal Scientist, ICAR-NMRI

Brief description about technology

Haleem, a traditional dish originated during the Mughal period and remained an integral part of Hyderabad during the rule of Nizams. Hyderabadi Haleem is particularly consumed in the Islamic month of Ramadan during Iftar (the evening meal that breaks the day-long fast) as it provides instant energy and is high in calories. In recognition of its cultural significance and popularity, in 2010 with efforts from ICAR-NRC on Meat, Hyderabad, it was granted Geographical Indication status (GIS) by the Indian GIS registry office, making it the first non-vegetarian dish in India to receive this status. Frozen haleem ball technology addresses the technology gaps of standardization, storage, transportation and convenience and thus augment commercial applications of traditional knowledge on Haleem.

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A process for making uniform, smooth and succulent seekh kebabs

Inventors/Developers: Dr. M. Muthukumar, Dr. Naveena B. Maheswarappa, and Dr. Rituparna Banerjee

Brief description about the technology

The novel method was developed employing sausage stuffer for preparation of seekh kebab with uniform thickness and smooth exterior. This also reduce the preparation time. This method also allows moist cooking of the seekh kebab. The moist cooking prevents case hardening and also ensure adequate cooking. This also reduce cooking loss. It ensures kebab of uniform thickness and smooth exterior (whereas uneven surface and varying thickness is a common in traditional kebab making). This method of kebab preparation prevents contamination of kebab until moist cooking (until peeling off casing). It also ensures even and adequate cooking of centre core of kebab (whereas undercooking of centre core of kebab is a common problem in traditional kebab making as well as kebab made with automated kebab making machine due to case hardening). The novel method ensures cooking yield of 85-90% (whereas the cooking yield in traditional / automated kebab making is around 70-80%). The product is cooked over char coal either with or without skewer for a duration of 2 minutes for the development of unique flavor (smoke), colour (browning) and texture.

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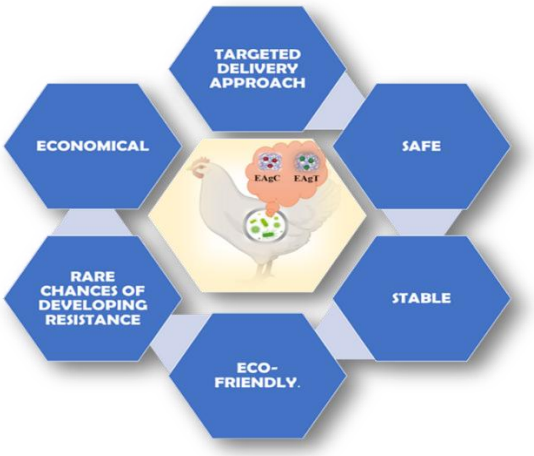
Green Nano -Antibacterial Technology: Chitosan encapsulated nanosilver entrapped cinnamaldehyde and thymol to combat multi-drug-resistant bacteria

Inventors: Dr. Deepak B. Rawool, Dr. S. B. Barbuddhe, Dr Jess Vergis and Dr Nitin V. Kurkure

Brief Description: The unique features of the technology are as follows. (1) The developed technology (compound) can be used for rearing antimicrobial resistance-free broiler birds. (2) The developed compounds (EAgT and EAgC) were found safe as per OECD 425 guidelines, and also stable at room temperature (6 months). (3) The innovative product is intended for targeted delivery (released maximum >80% at alkaline pH i.e. in the intestine), hence dose required would be less and also it reduces overall production costs. (4) No residues of compounds were found in vital organs and breast muscles of treated poultry ensuring consumer safety. (5) The microbes may have a very rare or almost negligible chance of developing resistance against the developed product (EAgT and EAgC). (6) The developed product can be used either as a therapeutic as well as from a preventive perspective in the poultry industry. Routine use of developed compound may aid in the production of antibiotic residue-free chicken from a public health/ food safety perspective



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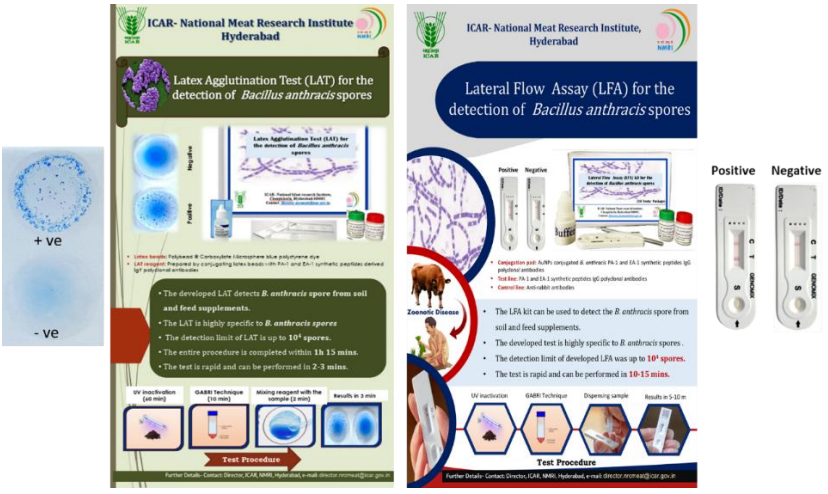
Latex agglutination test and Lateral Flow Assay for the detection of *B. anthracis* spores from soil and feed supplement

Inventor: Dr. Deepak B. Rawool, Dr. S. B. Barbuddhe

Brief Description: PA-1 and EA-1 peptide-oriented IgY/IgG antibody-based LAT/LFA have excellent specificity (highly specific to *B. anthracis* spores and does not cross react with other *Bacillus* spp. viz., *B. subtilis, B. cereus, B. mycodies, B. thurigiensis, B. lichneformis*) and a good sensitivity (detection limit of LAT: 10^5 spores/g of soil/animal feed supplements while LFA can detect 10^3 spores/g of soil/animal feed supplements) when compared with WOAH-recommended PCR assay (10^3 spores/g).

- The developed LAT/ LFA test is meant for rapid and onsite detection of *B. anthracis* spores. Hence the requirement for higher infrastructure, sophisticated types of equipment, trained manpower, and most importantly time can be saved for the detection of *B. anthracis* spores.
- The problems such as cross-reactivity and low specificity available with earlier diagnostic antigens have been solved; as earlier diagnostic antigens (proteins) employed were not stable, however, synthetic peptides identified in this innovation are highly stable, cost-effective, scalable, and reproducible with utmost purity.

Cost of the technology: Rs 10.00 Lakh Plus GST



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Portable UV device for inactivation of *Bacillus anthracis* spores in soil samples

Inventor: Dr. Deepak B. Rawool, Dr. S. B. Barbuddhe, Dr Ramakrishna C., Dr Baswa Reddy, Dr. Laxman Chatlod, Dr. Yogesh Gadekar

Brief Description: The unique features of the developed device are

- The developed device (Portable UV cabinet and Portable battery-operated power supply) will be quite handy to inactivate B. anthracis spores in soil samples at field level.
- The portable UV Aluminum device is safe from operator point of view as UV radiation emitted by UV lamp are blocked by Aluminum device.
- At a time 6 soil samples can be processed for inactivation of B. anthracis spores.
- The fully charged portable battery-operated device can provide a power supply to portable UV Cabinet for at least 14 to 16 h.
- The inactivated B. anthracis spores using this device are quite safe to handle, transport and process in the laboratory for downstream applications such as its detection using molecular tools (PCR or RealTime PCR).

Cost of the technology: Rs 2.0 Lakh + GST

Photo

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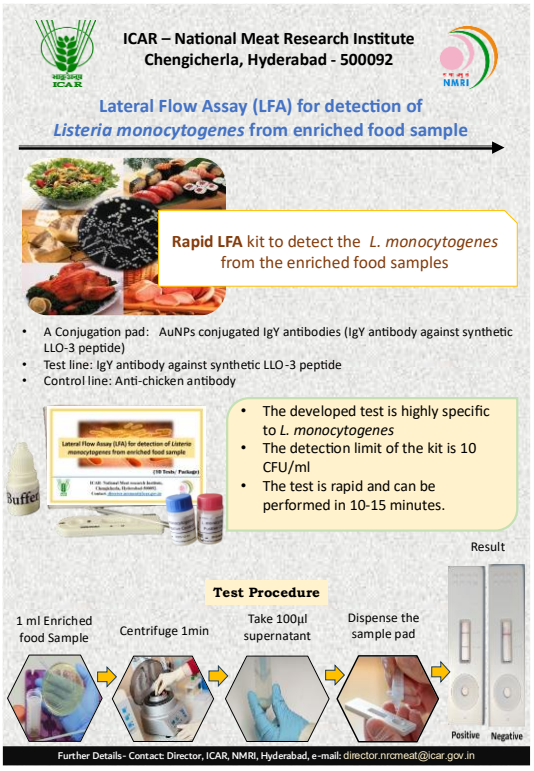
Synthetic peptide-based Lateral Flow Assay (LFA) for the detection of *Listeria monocytogenes* from enriched foods

Inventor: Dr. S. B. Barbuddhe, Dr. Deepak B. Rawool.

Brief Description: The present product/technology is novel as it involves the development of an LFA for detecting *L. monocytogenes* in food of animal origin employing synthetic LLO-3 peptide-derived polyclonal IgY antibodies. The developed technology saves time, labour, and has point of care applicability. The results of the developed technology is almost at par with IS 14988: Part 1: 2020 culture method. The IgY antibodies derived against LLO-3 synthetic peptide, are stable, economical, and can be scalable to any extent. The developed technology will be quite useful for food processing industries, and diagnostic laboratories. The unique features of the developed technology are

Cost of the technology: Yet to be decided



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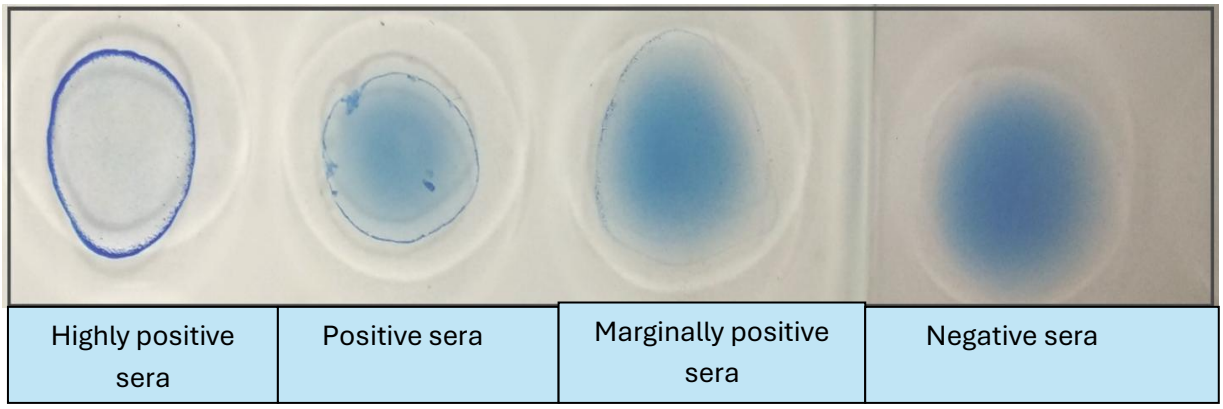
Multiple antigenic peptide (MAP) based Latex agglutination test (LAT) for serodiagnosis of Bovine coxiellosis

Inventor: Dr. Deepak B. Rawool

Brief Description: The present product/technology is intended for serological screening coxiellosis in bovines. The MAP comprises of a specific and immunogenic linear antigenic peptide (LAP) of Com1 protein arranged in multiple orientations (with two branches of LAP) which increases the surface binding of the antibodies developed against Coxiella. The developed Com1-MAP based LAT assay recorded the relative sensitivity and relative specificity of 83.09% and 97.60%, respectively, with the kappa value of 0.812 when compared with ELISA taken as a reference test. The developed assay is rapid, reliable, cost effective and can be used for on-site screening of the bovine population without the need of highly sophisticated laboratory and trained personnel to perform the test.

Cost of the technology: Yet to be decided



Highly positive sera	Positive sera	Marginally positive sera	Negative sera

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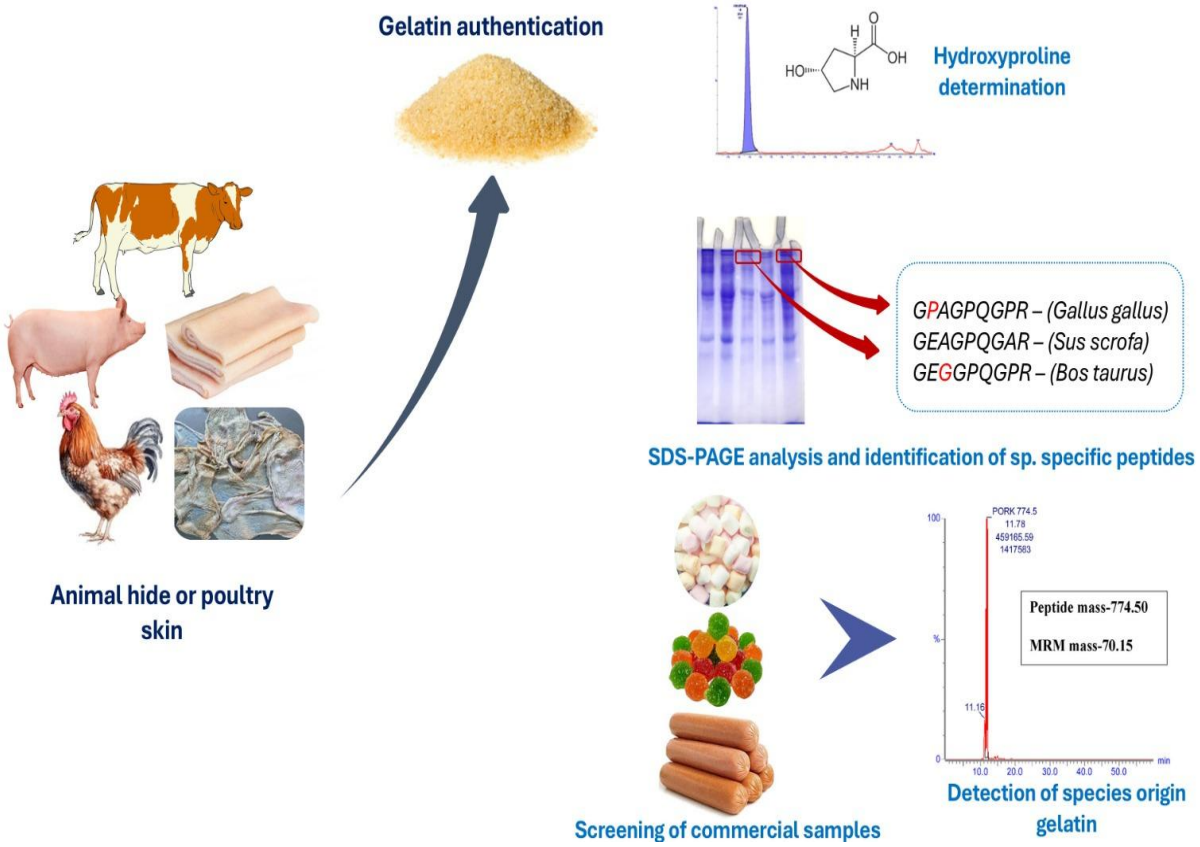
Multiple reaction monitoring mass spectrometry method for authentication of animal-origin gelatin

Inventors /Developers: Dr. Naveena B. Maheswarappa and Dr. Rituparna Banerjee

Brief description about the technology

Gelatin, derived through selective hydrolysis of collagen of food animal skin/hide, has been widely utilized in food, pharmaceutical, and cosmetic industries. Currently there are no methods to authenticate water buffalo skin derived gelatin. The rapid monitoring of hydroxyproline (a signature amino acid) can be used as a preliminary screening tool for detection of animal derived gelatin. Ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS) is used and 5 unique peptide biomarkers derived from water buffalo hide (BHG) and pork skin gelatin (PSG) are identified. The developed LC-MS/MS Multiple Reaction Monitoring (MRM) method can successfully detect BHG/PSG in commercial products up to a 0.5% (w/w). The developed LC-MS/MS MRM based-method provides an efficient and sensitive authentication and traceability of gelatin-containing highly processed food and bakery products. The limit of detection (LOD) for peptide markers and hydroxyproline is as low as 0.5% (w/w) and 0.975 pmol/µl, respectively. Further, the Multiple peptide transitions allow for selective identification of bovine and porcine gelatin even in thermally processed foods.

The developed methodology is first-of-its kind for authentication of water buffalo hide derived gelatin. The developed MRM-MS method is highly efficient and uniquely capable of detecting and quantifying animal-origin gelatin in complex, processed foods. Unlike PCR and immunoassay-based methods (ELISA), it offers excellent specificity, thermal stability tolerance, and precise quantitation through species-specific peptide markers. This makes the current method a superior choice for routine regulatory screening and food authentication.



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Superchilling, a promising technology for improving shelf-life of meat and poultry

Inventors /Developers: Dr. Naveena B. Maheswarappa, Dr. Rituparna Banerjee, Dr. M. Muthukumar

Brief Description:

Superchilling process implies storage of muscle food at temperature between its initial freezing point (−0.5 °C to −2.8 °C) and 1–2°C below this, specifically in the borderline between chilling and freezing temperatures. During preservation of muscle foods, superchilling freezes part of the water and insulates the food products from temperature fluctuations, thereby enhancing the shelf-life during storage, transportation, and retailing. Superchilling process synergistically improves the product shelf-life when used in combination with vacuum or modified atmospheric packaging.

A superchilling cabinet is developed by the ICAR-NMRI and the technology is patented (Indian patent No. 2334/CHE/2012). Superchilling (−2°C) was able maintain the shelf life of buffalo meat upto 3 months, poultry meat upto 35 days, and boneless goat meat cut-up parts upto 45 days under vacuum conditions. Superchilled samples exhibit lower rate of oxidation, discoloration, and minimal protein denaturation compared to chilled samples. Superchilling do not adversely affect the quality of meat as compared to freezing due to the damage caused by ice crystals.

Efficiency:

As an alternative to traditional chilling and freezing methods, superchilling enables safe, and high-quality product with higher yield, and reduced energy, labour, or transport costs.

Significantly higher shelf-life ensures better management of supply chain logistics among retailers and e-commerce business platforms.

This technology is transferred to:

1. Technologies for packaging of fresh buffalo meat for improved shelf life (transferred to Mr. Mohammed Abdul Azeem, Hyderabad).
2. Studies on extended shelf life of chicken and enhancing post cooking quality and safety (transferred to Jubilant FoodWorks Limited, Noida, UP)

3. Packaging interventions for chilled and superchilled meat/poultry- a pragmatic solution for improving the quality and shelf-life (**transferred to Sealed Air Packaging Materials India LLP, Ghatkopar, Mumbai**)

Vacuum packed buffalo meat

Shrink wrapped and tray packed chicken

Shrink wrapped lamb cuts

Vacuum skin and heat shrink packed goat meat

Super-chilling cabinet designed at ICAR-NMRI, Hyderabad

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Immunochromatography-based pork detection kit (IPDK)

Inventors /Developers: Dr. Naveena B. Maheswarappa, Dr. Rituparna Banerjee, and Dr. S.B. Barbuddhe

Brief description about the technology

The technology is developed to extract target analytes using field-deployable extraction buffer without any stationary laboratory set-up by simple trituration followed by filtration within 10 min. This kit is a qualitative sandwich immunochromatographic test in a strip format to determine pork content in raw meat, processed meat, and meat mixes.

Sample extract is directly added to the sample pad and flows through the strip by capillary action. If the sample contains pork or target analyte, two colored lines develop at the test line and control line area, whereas in absence of pork, only the control line will appear. The total duration of the assay is only 15 min.

Traditional analytical methods for identifying meat fraud require specially equipped stationary laboratories, high-tech equipment, and qualified personnel. Current methodology is simple, rapid, low-cost, highly specific, and sensitive, which can be complemented with stationary arbitration methods in resource-limited settings.

- The total duration of the assay (from sample extraction to visual detection) can be completed within 15 min.
- No skilled manpower or specialized laboratory setup is required.
- The kit can detect as low as 0.5% level of pork adulteration (0.5% w/w) in raw and cooked (100 °C) meat and meat mixes.
- Sensitivity: 10 ng/ml
- Detection limit: 0.063%
- Each test costs less than 100 Rs.

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Ultrasound-assisted green extraction technology for gelatin/collagen hydrolysates from poultry processing waste

Inventors /Developers: Dr. Rituparna Banerjee, Dr. Naveena B. Maheswarappa, and Dr. M. Muthukumar

Brief introduction about technology

With the rising demand for collagen and gelatin across various industries, tapping poultry by-products as a valuable resource offers a sustainable solution that simultaneously minimizes waste and enhances resource efficiency. The proposed technology utilizes ultrasound-assisted green extraction for obtaining gelatin and collagen hydrolysates from poultry processing waste, particularly skin, head, and feet. This eco-innovative method replaces conventional acid or alkali hydrolysis with ultrasound pretreatment, significantly enhancing yield, efficiency, and bioactivity while reducing environmental impact. The methodology involves ultrasound pre-treatment of poultry processing waste using an ultrasonic probe or bath at optimized frequency, power, temperature and time. For hydrolysate preparation, enzymatic hydrolysis is carried out post-sonication and resultant mixture is filtered, concentrated, and dried.

Ultrasound pretreatment improves the yield of collagen and collagen hydrolysate by 9% and 10-16% respectively, compared to traditional methods. Functional properties of gelatin and hydrolysates are significantly enhanced. Bioactive assays revealed improved antioxidant activity and higher ACE-inhibitory potential. This green extraction approach is energy-efficient, scalable, and labor-saving, supporting the circular economy and sustainable valorization of poultry by-products for food and nutraceutical applications. The processing time reduced by 40–60% due to elimination of prolonged acid/alkali treatment. Further, the process is more energy-efficient as ultrasonication requires lower thermal input.

Efficiency:

- Gel strength of skin-head-feet gelatin is comparable or superior to commercial pork gelatin
- Ultrasound pre-treatment improved functional properties and bioactivities (antioxidant and anti-ACE inhibition) of collagen hydrolysates

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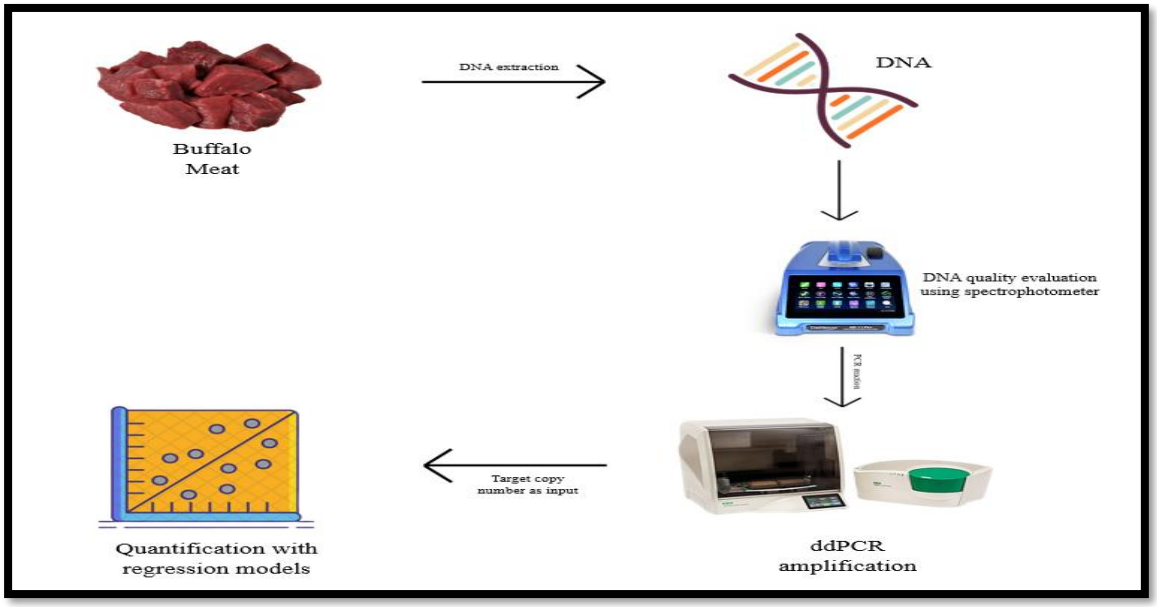
Technology for quantification of buffalo meat substitution levels in meat and meat products of other species using digital PCR

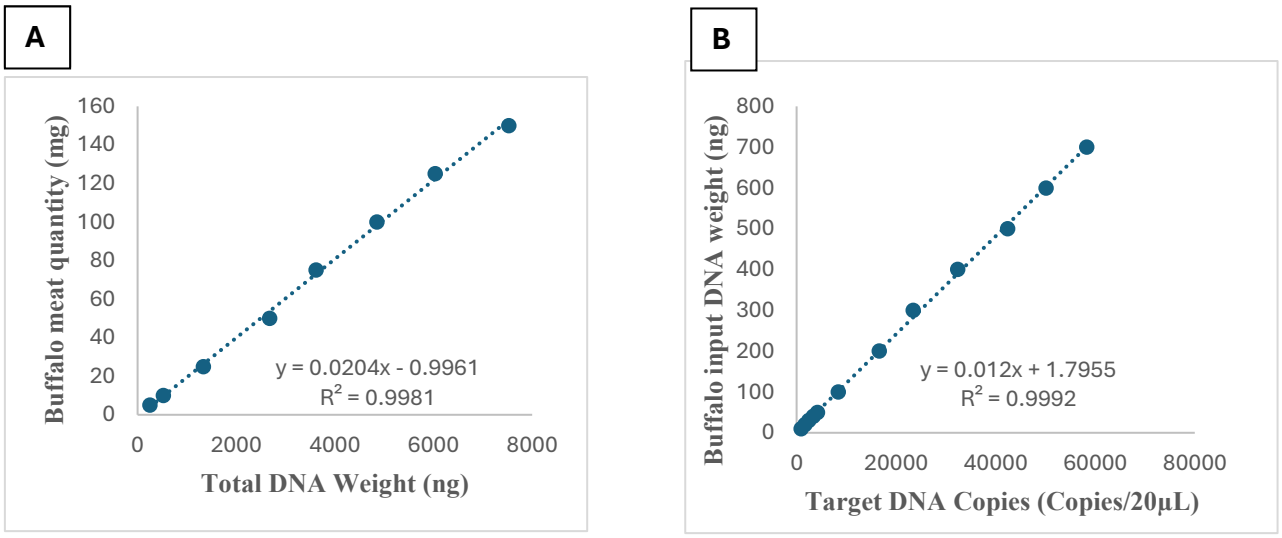
Inventor: Dr. Vishnuraj M.R.

Brief description about technology

Buffalo meat is often used to adulterate costlier meats such as mutton or chevon for economic gain, especially in processed products where common molecular methods lack sensitivity due to the complex nature of food matrices and the presence of PCR inhibitors. To overcome these challenges, a droplet digital PCR (ddPCR) assay targeting the buffalo-specific melanocortin 1 receptor gene was developed to specifically quantify the level of adulteration. Statistically validated linear regression models were employed to correlate gene copy number with DNA input and, subsequently, with the proportion of buffalo meat in the sample. The assay was validated according to international guidelines and was effectively applied to real-world samples, offering a robust tool for both detection and quantification in food fraud investigations. The developed ddPCR assay can be commercialized as a "Buffalo Detection and Quantification Method" and marketed to both government and private laboratories in India, supporting food safety in testing of animal-origin products. Furthermore, the applicability of this technology to other items, such as ghee and tallow—with predicted accuracy—may lead to broader acceptance and generate significant commercial potential.



Basic process of the developed technology (ddPCR assay with regression models)



Developed regression models connecting buffalo meat weight to target DNA copies obtained from ddPCR analysis

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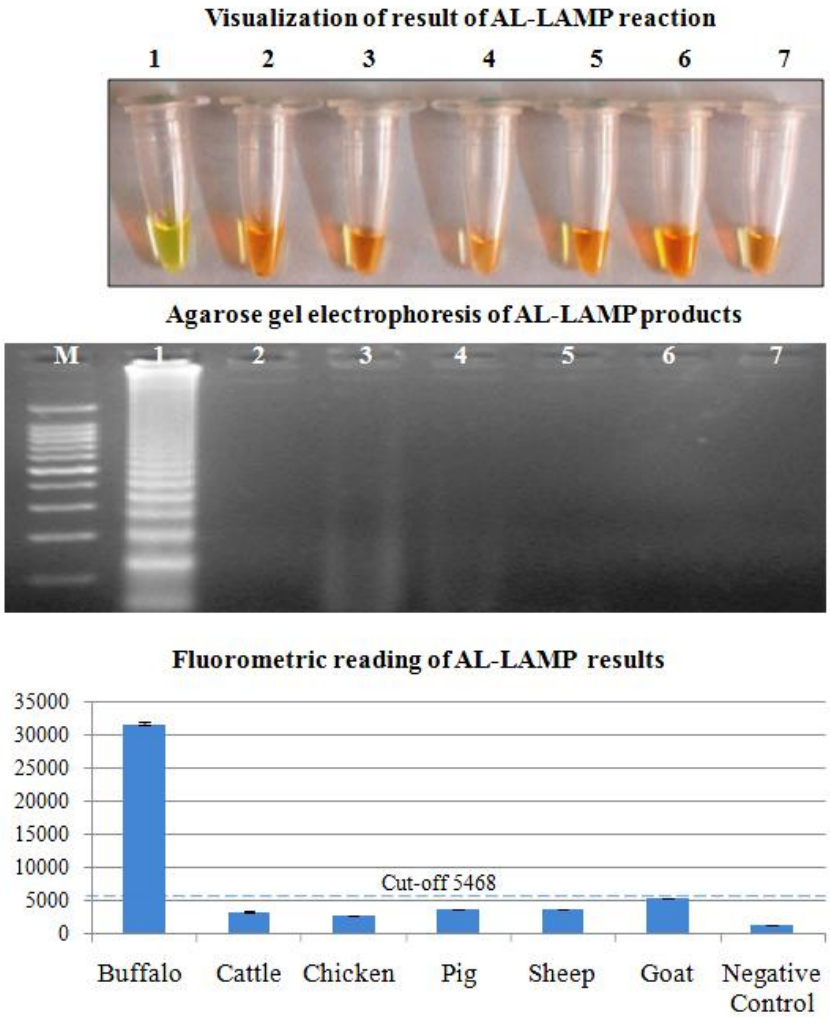
Alkaline lysis – Loop mediated Isothermal Amplification (AL-LAMP) assay for the species authentication of buffalo meat, pork and mutton

Inventors/Developers: Dr Girish Patil, S., Dr S. B. Barbuddhe, Dr C. Ramakrishna and Dr Mounika, T.

Brief description about the technology

AL-LAMP is a simple method for species identification of meat which combines Alkaline Lysis (AL) method of DNA extraction and Loop Mediated Isothermal Amplification (LAMP). Visual detection of presence of target DNA signal in the tube is accomplished by the color change using the SyBr Green I dye. Technique is suitable for the specific detection of origin of meat samples in raw, cooked and adulterated meat samples. Dependable amplification was possible in thermally processing meat samples heated even up to 121 ºC for 30 minutes. Species specific primers for LAMP amplification were designed for Buffalo meat, Pork and Mutton. Cross-amplification of the related species was excluded by incorporating DNA from closely related species in the reaction assay. The AL method of DNA preparation was found economic, less cumbersome and easy method compared to other traditional methods. Further, DNA amplification using LAMP principle precludes need for costly sophisticated equipment such as a thermal cycler, agarose gel electrophoresis unit and gel documentation unit. Combination of alkaline lysis method of DNA extraction with LAMP based detection of amplified signal and visual colour comparison of result interpretation obviates hitherto used employed PCR based or amplification methods or post-PCR requirements such as gel electrophoresis. The novel approach (AL-LAMP technique) was found robust and handy, even for resource compromised laboratories engaged in the food analysis that require authentication of origin of meat and meat products.



Species authentication of buffalo meat by AL-LAMP assay. Green colour indicates presence of buffalo DNA while orange colour indicates it's absence.

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Alkaline lysis - Polymerase Spiral Reaction (AL-PSR) assay for the specific authentication of goat (*Capra hircus*) meat

Inventors/Developers: Dr Girish Patil, S., Dr S. B. Barbuddhe, Dr C. Ramakrishna and Dr Laitha Shree

Brief description about the technology

Goat meat (chevon) is the costliest meat in India and it closely resembles other red meat species mostly the sheep meat (mutton). In order to establish authenticity of chevon and confirm mislabelling there is a need for a reliable laboratory test. Polymerase spiral reaction (PSR) assay is one of the recent DNA based isothermal tests available for molecular analysis mostly microorganisms. Present study describes development and validation of a novel PSR for the detection of chevon for the first time. The goat specific PSR makes use of a pair of chevon-specific primers targeted against the mitochondrial DNA and test could be read based on the visual colour change after the addition of SYBR Green I dye to the amplified product. The possibility of cross-amplification was ruled out by testing related meat species (meat species buffalo, cattle, chicken, pig and sheep) and results of PSR were further confirmed by fluorometry and agarose gel electrophoresis. PSR could be undertaken at isothermal temperature of 62 °C temperature for 60 min with the limit of detection of 0.5 ng DNA and detection of meat admixing of 0.1%. The PSR was found efficient in the detection of not only raw meat but also meat heated to 121 °C for 30 min. When combined with the alkaline lysis method of DNA extraction, the goat-specific PSR takes only 90 min for sample analysis and hence can be used as field assay.

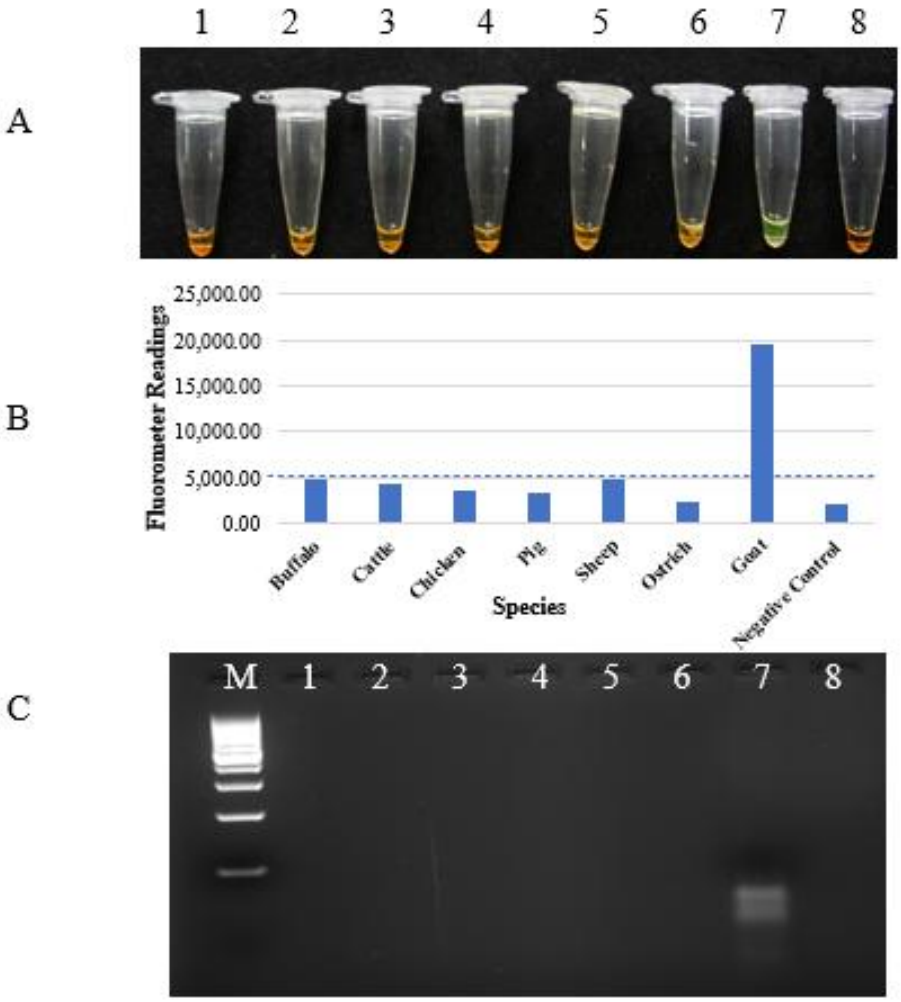

Fig. Polymerase spiral reaction showing goat specific amplification. 1) Buffalo, 2) Cattle, 3) Chicken, 4) Pork, 5) Ostrich, 6) Sheep and 7) Goat (Lane 8. No template control). A) Visual, B) Fluorometric and C) Agarose gel electrophoresis. Green colour indicates presence of goat DNA while orange colour indicates it's absence.

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Technology for detection of chicken giblets (offal/organ meat) in chicken meat and meat products using microRNA- RT-qPCR.

Inventor: Dr. Vishnuraj M.R.

Brief description about technology

The rising demand for processed poultry products like sausages, burgers, patties, nuggets and keema has led to economically motivated adulteration, where cheaper offal meats are added to replace skeletal meat. This practice violates Quantitative Ingredient Declaration norms and poses a major regulatory concern, as conventional DNA-based methods cannot differentiate tissues from same species due to identical DNA sequences. To address this, we developed a novel RT-qPCR-based molecular method to detect chicken giblets (liver, heart, gizzard) in meat products by evaluating tissue-specific microRNA expression. This is the first such approach in food safety, validated as per international guidelines and successfully tested on real-world samples.

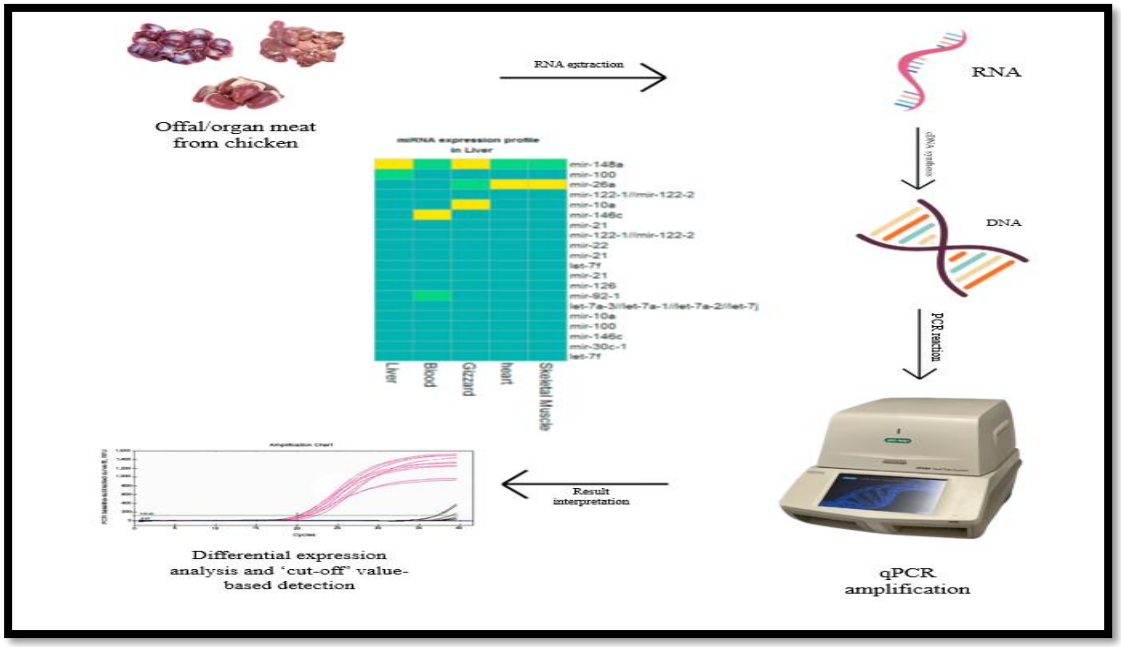

Fig 1. Basic process of developed technology (miRNA-qRT-PCR assay)

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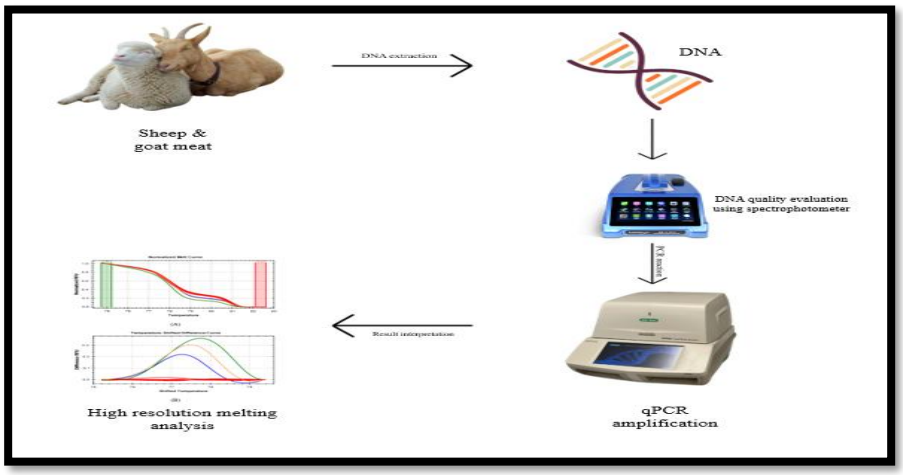
Technology for simultaneous differentiation of sheep and goat meat using high resolution melt analysis PCR.

Inventor: Dr. Vishnuraj M.R.

Brief description about technology

Authenticity evaluation of meat and meat products is crucial for preventing adulteration, especially when such fraud is not visually detectable. Differentiating between sheep and goat meat is particularly challenging due to their morphological similarity. In such cases, analysts require a method capable of simultaneously detecting both species in a single test. Additionally, there is a need to avoid labor-intensive and time-consuming post-PCR steps such as gel electrophoresis and DNA sequencing, while still ensuring accurate species-level identification. To address these challenges, we developed and validated a duplex real-time polymerase chain reaction (qPCR) assay combined with high-resolution melt analysis (HRMA) for precise and sensitive differentiation of mutton and chevon. The method was validated in accordance with international guidelines and successfully applied to real-world samples. Results demonstrated that this closed-tube qPCR-HRMA technique is a rapid, reliable, and sensitive tool for distinguishing between sheep and goat meat.



Workflow of the proposed duplex, qPCR-HRMA assay for sheep and goat detection.

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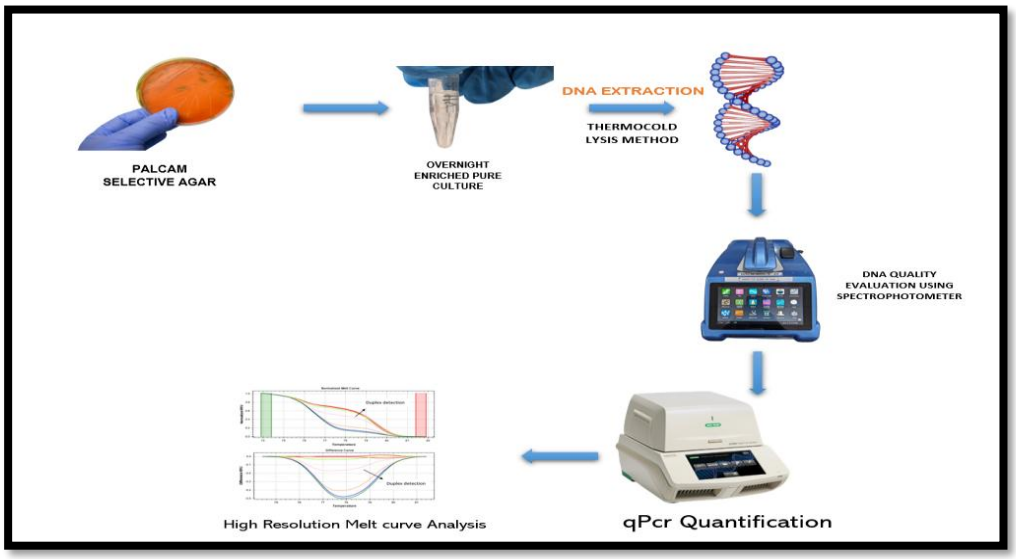
Technology for detection of *Listeria species* and *Listeria monocytogenes* in meat products using duplex real time PCR assay with high resolution melt analysis.

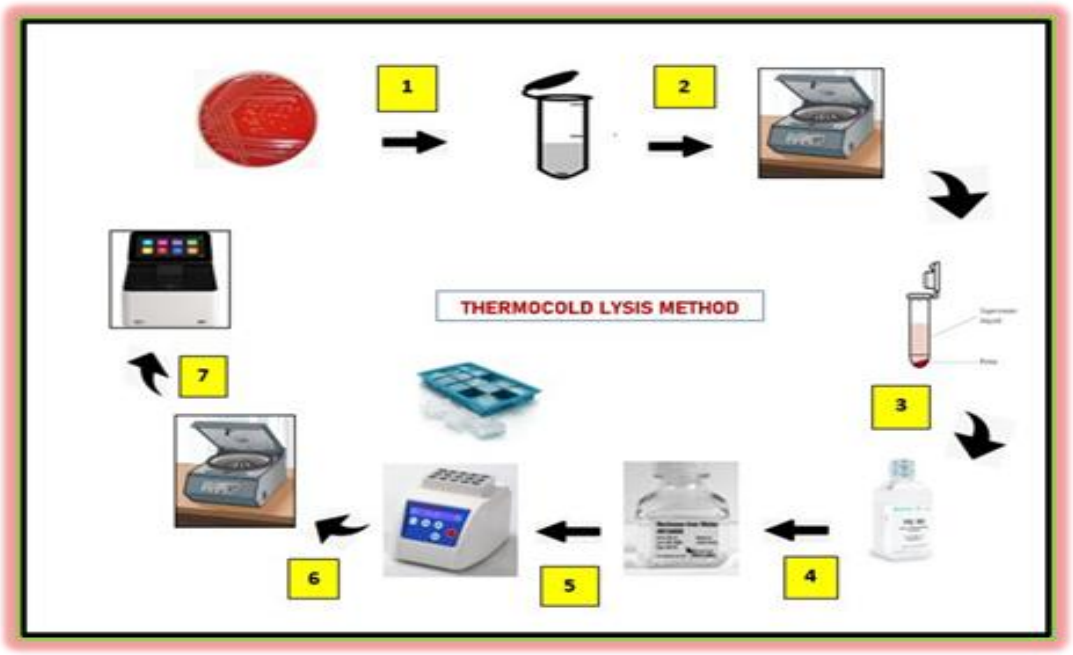
Inventor: Dr. Vishnuraj M.R.

Brief description about technology

This study tackles the critical challenge of Listeria monocytogenes contamination in animal-derived foods, highlighting the importance of early and accurate detection. The core focus is the development of a duplex real-time PCR assay utilizing SYBR Green chemistry coupled with high-resolution melting analysis (HRMA). To ensure specificity and avoid cross-reactivity with closely related Listeria species, two primer sets were designed—one targeting the Listeria genus and the other specific to L. monocytogenes. Detailed interpretation of HRM curve profiles was carried out to enhance the clarity and reliability of detection. The assay was meticulously optimized through a non-orthogonal approach and rigorously validated in accordance with international standards. It demonstrated high sensitivity, with an absolute limit of detection ($LOD_{a\beta s}$) of 0.78 ng and a limit of quantification (LOQ) of 1.56 ng of target DNA. Additionally, a relative limit of detection (LOD_{rel}) of 1% Listeria DNA in a mixed background confirms its effectiveness in complex samples. When applied to artificially spiked samples, the assay achieved a notable detection threshold of 120 CFU/mL, underscoring its potential for practical food safety applications.



Basic process of the developed technology (Duplex real-time PCR assay with high-resolution melt analysis for the detection of *Listeria* species *and Listeria monocytogene*



DNA Extraction from a Pure culture using Thermocold lysis method

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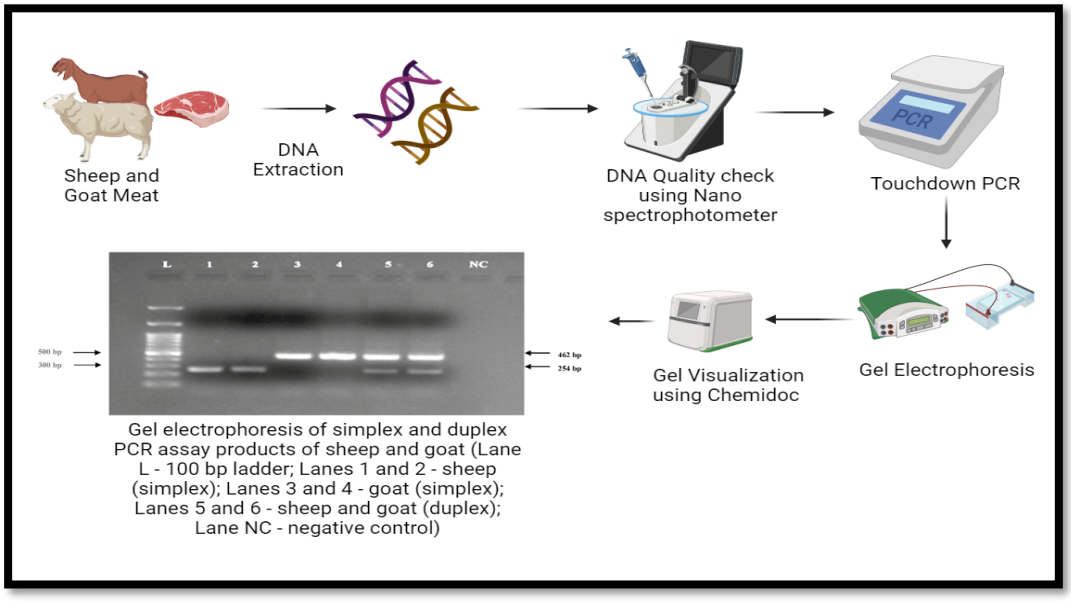
Touchdown PCR technology for differentiation of sheep and goat meat in meat products

Inventor: Dr. Vishnuraj M.R.

Brief description about the technology

Verifying the origin of meat in animal-based foods presents a significant challenge, especially in cases of adulteration where morphological identification is unreliable. Differentiating closely related species such as sheep and goat typically requires laborious and time-consuming optimization of primer annealing temperatures and specificity. To address this, a duplex PCR assay incorporating a touchdown approach was developed to enable simultaneous and reliable detection of both species. The touchdown PCR protocol streamlines the process by eliminating the need for extensive temperature optimization, while enhancing the specificity and sensitivity of mutton and chevon differentiation. This assay demonstrated high species specificity, accuracy, and the ability to detect low levels of target DNA without false positives. The developed technology holds strong potential for widespread use in food testing laboratories for the authentication and detection of adulteration in sheep and goat meat.



Gel electrophoresis of simplex and duplex PCR assay products of sheep and goat (Lane L - 100 bp ladder; Lanes 1 and 2 - sheep (simplex); Lanes 3 and 4 - goat (simplex); Lanes 5 and 6 - sheep and goat (duplex); Lane NC - negative control)

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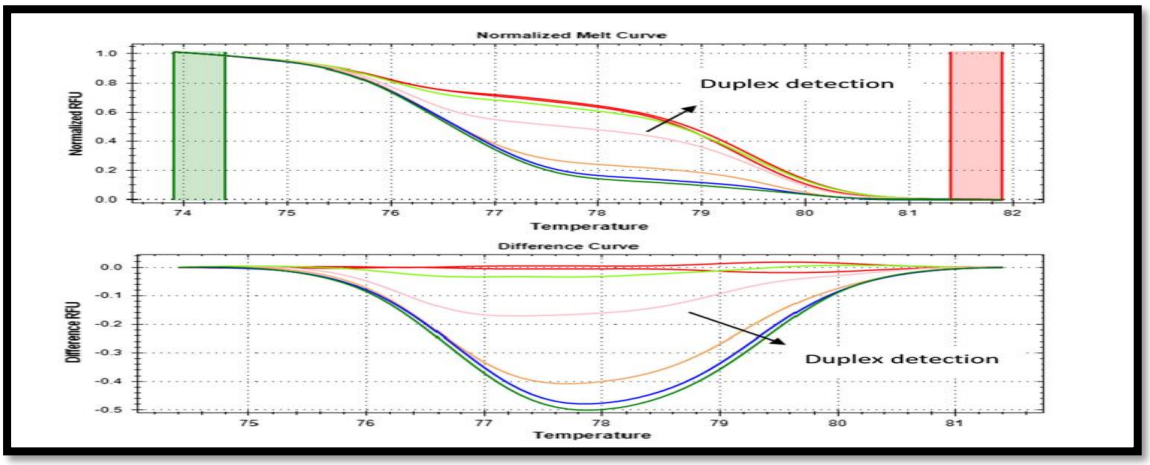
Technology for simultaneous detection of *Listeria monocytogenes* and *Salmonella typhimurium* in meat products using duplex real-time PCR assay with high-resolution melt analysis (qPCR-HRMA).

Inventor: Dr. Vishnuraj M.R.

Brief description about technology: This study addresses the pressing issue of Listeria monocytogenes and Salmonella typhimurium contamination in animal-derived foods, highlighting the urgent need for early and accurate detection. The core focus is the development of an innovative duplex real-time PCR assay utilizing SYBR Green chemistry combined with high-resolution melting analysis (HRMA). This duplex qPCR-HRMA approach allows for the simultaneous, rapid, and reliable detection of two major foodborne pathogens in meat products. The assay differentiates amplicons based on distinct melt curve profiles, with a ~4°C difference in melting temperatures—76°C for Listeria monocytogenes and 80°C for Salmonella typhimurium. It demonstrated high sensitivity, with a detection limit of 2 pg of DNA, corresponding to approximately 124 genome copies for L. monocytogenes and 100 copies for S. typhimurium. In spiked meat samples, the method achieved a detection sensitivity of 150 CFU/mL. The assay was rigorously standardized and validated in accordance with ISO 22118:2011, ensuring its reliability for practical food safety applications.



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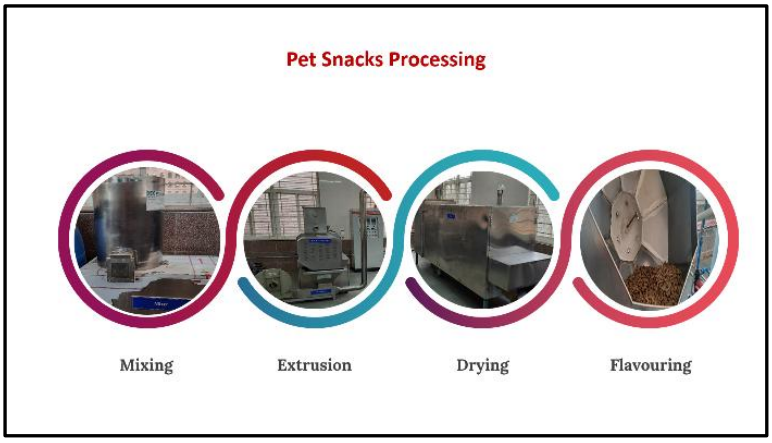
Extruded Pet snacks using rendered poultry meal

Inventors/Developers: Dr. Yogesh P. Gadekar, Dr. Girish Patil S., Dr. A. R. Sen, Dr. M. Muthukumar, Dr. Deepak B. Rawool, Dr. P. Baswa Reddy, Dr. V.V. Kadam and Dr. S.B. Barbuddhe

Brief description about the technology

The main objective was to effectively utilise and add value to the poultry slaughter by-products. The poultry slaughter by-products are subjected to dry rendering to obtain protein rich rendered poultry meal. The rendered poultry meal is used to prepare extruded pet snacks. The product is having good nutritional profile. The pet snacks is self-stable, nutritious and well acceptable product by pets. Further, a profitable utilization of animal by-products leading the enhanced income, employment generation in meat value chain. Besides all it has potential to minimise environmental pollution emanating from slaughter by-products that are unsuitable for human consumption.



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Mobile meat stall for retailing of meat and meat products

Inventors/Developers: Dr. M. Muthukumar, Dr. Girish Patil, S., Dr. B. M. Naveena, Dr A.R.Sen and Dr.S.B.Barbuddhe

Brief description about the technology

Traditionally meat and meat products are sold in the stationery meat shops. Providing mobility will help in taking products to the convenient places wherein the products can be retailed effectively. The present invention customizes to meet the requirements of the meat processors to help them to profitably market both meat and meat products on the go. Mobile meat stall is designed over a four wheeler vehicle. The vehicle was customized with space for keeping the essential equipment viz., refrigerator, freezer, frying unit, gas stove with cylinder, space for storing the ingredients, television for display of details, generator, water storage tank, water tap with wash basin etc. Mobile meat stall will help in taking the product to the place of consumers so that they can be retailed effectively and profitably.

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