E-book

VALUE ADDITION IN ANIMAL PRODUCTS

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This e-book is a compilation of resource text obtained from various subject experts for the Collaborative Online Training Programme of Karnataka Veterinary Animal and Fisheries Sciences University (B), Karnataka & MANAGE, Hyderabad, Telangana on "VALUE ADDITION IN ANIMAL PRODUCTS" conducted from 22nd to 24th August, 2024. This e-book is designed to educate extension workers, students, research scholars, and academicians related to veterinary science and animal husbandry about innovations and value addition to edible and non-edible animal products. Neither the publisher nor the contributors, authors and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editor/authors. Publisher and editor do not give warranty for any error or omissions regarding the materials in this e-book.

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FOREWORD

KVAFSU Bidar is one of the leading Veterinary University of the county and is striving its best evolving farmer friendly technologies and disseminating to the end users. Veterinary College, Hassan has emerged as the fourth constituent Veterinary College of KVAFSU, Bidar and it renders Teaching, Research and Extension services with the mission to cater Rural Oriented and Farmer Friendly services for the betterment of the farming community.

In today's world, the agricultural and livestock sectors are not just pillars of food security but also hold immense potential for economic growth and sustainable livelihoods. The importance of value addition in animal products cannot be overstated, as it directly contributes to improving the quality, marketability, and profitability of these products.

This e-book addresses a wide spectrum of topics related to the processing, enhancement, and diversification of animal-based products, ranging from dairy, meat, and poultry to non-edible products such as hides and wool. It highlights both the scientific advances and traditional methods that can be leveraged to maximize the value derived from livestock resources. Moreover, the book provides valuable insights into the global trends in animal product value addition, emphasizing innovations that ensure sustainability, efficiency, and consumer health. The subject is of particular relevance in today's context of shifting consumer preferences, climate change, and the need for greener, more ethical production methods. By embracing value addition, not only do we uplift the livelihoods of smallholder farmers and producers, but we also contribute significantly to national economies by creating higher-quality, export-ready products.

I congratulate the authors and contributors for their rigorous research and thoughtful perspectives in bringing this essential topic to the forefront and MANAGE Hyderabad in publishing this e-book on "**VALUE ADDITION IN ANIMAL PRODUCTS**" and I trust that this publication will inspire greater innovation and collaboration in the pursuit of excellence in animal product value addition.

Dr. O. R. Nataraju
(Dean, Veterinary College, KVAFSU, Hassan, Karnataka, India)

PREFACE

The agricultural sector, especially animal husbandry, has long been a cornerstone of the global food system, providing nutrition, livelihoods, and economic stability to billions of people. However, as markets evolve and consumer demands shift towards higher-quality and ethically produced goods, the concept of value addition has emerged as a transformative force in the animal products industry. This e-book, Value Addition in Animal Products, is a comprehensive exploration of how the production, processing, and marketing of animal-derived goods can be enhanced to meet these modern demands while simultaneously driving economic growth. Value addition in animal products encompasses a wide array of processes, from improving raw products such as milk, meat, and eggs, to developing innovative by-products from animal waste and non-edible parts. These efforts not only enhance the quality, safety, and appeal of products but also create new market opportunities, particularly in emerging sectors like organic and sustainable animal husbandry. Moreover, as global concerns about climate change, animal welfare, and resource sustainability grow, this book highlights how adopting value-addition practices can contribute to a more ethical and environmentally friendly industry.

This e-book is an outcome of collaborative online training program on "VALUE ADDITION IN ANIMAL PRODUCTS" conducted from 22nd to 24th August, 2024. Each chapter dives into specific products, techniques, and case studies that demonstrate the potential for farmers, processors, and entrepreneurs to create high-value products that meet both local and global demands. Furthermore, the book offers insights into policy frameworks, consumer trends, and technological advancements that support the growth of value-added animal products.

The editors express sincere thanks to Prof. K.C. Veeranna, Hon'ble Vice Chancellor, Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, Karnataka, for inspiration and motivation in publishing this e-book. The financial aid provided by MANAGE, Hyderabad for this training program is duly acknowledged. We hope and trust that the valuable inputs provided through this e-book will help to improve the ability of all the stakeholders.

AUGUST, 2024

Hemanth Gowda K
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CONTENTS

Chapter 1

FROM FARM TO MARKET: BOOSTING VALUE AND EFFICIENCY IN ANIMAL PRODUCTION

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Introduction

Livestock plays an important role in Indian economy, key driver of rural Indian economy and acts as crucial insurance against the vagaries of crop failure, providing round the year income, and wholesome food.

According to the UN Food and Agriculture Organization (FAO), the world produced 965.7 million tonnes of milk in 2023, which is a 1.5% increase from the previous year. This growth was primarily driven by increased production in Asia, which now accounts for 46% of the world's milk output. Global meat consumption is anticipated to rise 12% by 2033 relative to the Outlook 2021-23 base period. with poultry, pork, and beef being the most produced types.

India's milk production has grown remarkably over the past decade, with a Compound Annual Growth Rate (CAGR) of 6 percent. This surge is evident from the increase in production from 187.30 million tonnes in 2018-19 to 230.58 million tonnes in 2022-23. Further as per the FAO Dairy Market Review (2023) milk production of India is estimated to reach 236.35 million tonnes in 2023-24 registering a growth of 2.5% over the last year beating the world average growth rate. This growth is significantly higher than the global milk production growth rate of 1.3 percent in 2023 over the previous year. In India, about 50 percent of milk is consumed on-farm. Dairy is the single largest agricultural commodity contributing 5 percent of the Indian national economy and employing more than 8 crore farmers directly. India accounts for about 7 percent of the global egg production, 2.42 percent of global meat production, and 7.56 percent of global fish production.

In recent years, the agricultural sector, particularly animal production, has witnessed significant advancements aimed at enhancing efficiency and maximizing value from farm to market. This progress is crucial not only for meeting the growing global demand for animal products but also for ensuring sustainability and profitability in the industry. As of the latest data, the global demand for animal products continues to rise steadily, driven by population growth, urbanization, and changing dietary preferences, particularly in emerging economies. Consumer preferences are evolving towards products that are not only nutritious but also ethically produced and sustainably sourced. Meeting these demands requires transparent production practices, animal welfare standards, and certifications that assure consumers of the quality and sustainability of animal products.

Edible Products from Animal Origin

Meat and Dairy Products

Innovations in meat and dairy processing technologies aim to improve product quality, extend shelf life, and diversify product offerings. Advanced chilling and freezing techniques preserve meat quality and freshness, while vacuum packaging and modified atmosphere packaging (MAP) extend shelf life and reduce food waste. Furthermore, the development of leaner meat cuts and low-fat dairy products caters to health-conscious consumers.

Eggs and Poultry Products

Egg processing technologies, such as pasteurization and drying, ensure safety and enhance storage stability. Value-added poultry products, including marinated cuts, sausages, and ready-to-cook meals, capitalize on consumer demand for convenience and variety.

Fish and Aquatic Products

Aquaculture innovations focus on sustainable fish farming practices and value-added processing techniques. These include smoked fish products, fish fillets, fish oil extraction for dietary supplements, and collagen extraction from fish skins for cosmetic and biomedical applications.

Non- Edible Products from Animal Origin

Leather and Hide Processing

The leather industry utilizes advanced tanning technologies to produce high-quality leather products with improved durability and aesthetic appeal. By-products such as collagen and gelatin extracted from hides find applications in pharmaceuticals, cosmetics, and food industries.

Animal Fibers

India's wool and animal fiber sector includes production from sheep, goats, and camels, providing raw materials for textiles, carpets, and handicrafts. Value addition involves wool processing into yarn, fabric, and finished garments through spinning, weaving, and dyeing processes. Innovations in eco-friendly dyeing techniques, organic certifications, and sustainable wool production practices cater to global demand for ethically sourced and environmentally sustainable textiles. Handloom and handicraft industries promote traditional skills and cultural heritage while adding value to animal fibers.

Biochemicals and Pharmaceuticals

Animal by-products, such as fats, proteins, and organs, serve as valuable sources of biochemicals and pharmaceutical ingredients. Bovine serum albumin (BSA), collagen peptides, and heparin extracted from animal tissues find applications in biomedical research, pharmaceutical formulations, and regenerative medicine.

Advancements in biomedical and biotechnological applications continue to expand the scope of value-added products from animals. Research into regenerative medicine utilizes animal-derived tissues and bioactive compounds for tissue engineering, wound healing, and organ transplantation. Collagen from animal skins and bones, for example, serves as a scaffold for tissue regeneration, while growth factors derived from animal tissues promote cellular repair and regeneration.

Renewable Energy and Biofuels

Animal by-products, such as manure and fats, are increasingly utilized for renewable energy production and biofuel generation. Anaerobic digestion of livestock waste produces

biogas for electricity generation and heat, reducing dependency on fossil fuels and mitigating greenhouse gas emissions. Rendering processes convert animal fats into biodiesel, contributing to sustainable energy solutions and promoting energy independence in agricultural communities.

Textiles and Fashion

Animal fibers, such as wool and cashmere, undergo innovative processing techniques to enhance their quality and versatility in textile manufacturing. Sustainable practices in wool processing, including organic certifications and eco-friendly dyeing processes, cater to environmentally conscious consumers. Furthermore, innovations in fiber blending and garment manufacturing ensure durability, comfort, and aesthetic appeal in animal-derived textiles.

Value Addition in Animal Products

Value addition in animal products refers to the process of enhancing the economic value, quality, and appeal of raw animal-derived goods through various methods and techniques. This process is essential for maximizing profitability, meeting consumer demands, and expanding market opportunities within the agriculture and food sectors.

Importance of Value Addition

1. Economic Significance: Value addition increases the economic returns from animal products by transforming them into higher-value goods. This enhances profitability for producers and stakeholders across the supply chain.
2. Market Diversification: By adding value, products can cater to diverse consumer preferences and market segments. This reduces dependency on commodity pricing and opens avenues for premium pricing strategies.
3. Quality Enhancement: Value addition improves the quality attributes of animal products, such as taste, texture, nutritional content, and shelf-life. This meets consumer expectations for safe, nutritious, and appealing food products.
4. Waste Minimization: Value addition often involves utilizing by-products and reducing waste in the production process. This enhances sustainability and efficiency in animal product processing.

Strategies for Value Addition

1. Processing and Preservation Techniques: Utilize appropriate processing techniques such as smoking, curing, drying, and canning to enhance product shelf-life and appeal.
2. Quality Standards and Certifications: Adhere to quality standards and certifications (e.g., organic, free-range) to differentiate products in the market and appeal to health-conscious consumers.
3. Product Innovation: Innovate new product forms or flavors to attract niche markets and enhance consumer interest and loyalty.
4. Packaging and Presentation: Invest in attractive and functional packaging that enhances product visibility, convenience, and perceived value.

Challenges and Considerations

- Cost and Infrastructure: Establishing processing facilities and complying with quality standards can be costly and require significant infrastructure investment.
- Consumer Education: Educating consumers about the benefits and value of processed animal products is crucial for market acceptance and premium pricing.

- Regulatory Compliance: Ensuring compliance with food safety regulations and quality standards is essential to maintain consumer trust and market access.
- Cost of Processing: Establishing and maintaining processing facilities can be capital-intensive, especially for small-scale producers. High operational costs, including energy and labor expenses, contribute to the overall production costs.
- Market Competition: The market for value-added animal products is competitive, with established brands and products vying for consumer attention. New entrants must differentiate themselves through innovation, quality, and effective marketing strategies.

Solutions

- Efficiency and Scale: Implementing efficient production processes and economies of scale can help reduce per-unit processing costs. Collaborating with other producers or utilizing shared processing facilities can also lower operational expenses.

- Innovation and Differentiation: Continuously innovate by developing unique product offerings, flavors, or packaging formats that cater to specific consumer preferences or emerging trends. Emphasize quality, sustainability, and ethical practices to differentiate from competitors.
- Compliance Management: Invest in robust quality assurance and compliance management systems to ensure adherence to regulatory requirements. Regular audits, training programs, and certification processes can enhance operational transparency and credibility.
- Consumer Education: Engage consumers through transparent labeling, educational campaigns, and demonstrations to build trust and promote understanding of the benefits of value-added animal products. Highlight nutritional advantages, convenience, and sustainability aspects to appeal to health-conscious consumers.
- Resilience and Adaptation to Climate Change: Climate change poses challenges and opportunities for enhancing resilience and adaptation in animal production systems. Sustainable land management practices, such as agroforestry and rotational grazing, mitigate environmental impacts and enhance carbon sequestration in agricultural landscapes. Adoption of climate-smart technologies, including precision agriculture tools and climate-resilient animal breeds, improves resource use efficiency and mitigates climate-related risks. Research and innovation in climate adaptation strategies promote adaptive capacity and sustainable livelihoods for livestock farmers in the face of changing environmental conditions.
- Circular Economy and Waste Utilization: The adoption of circular economy principles promotes resource efficiency and waste reduction across value chains in animal production. By-products from animal processing, including bones, feathers, and blood, are transformed into valuable bio-based materials and ingredients. For example, bone meal and feather meal serve as nutrient-rich supplements for animal feed, reducing reliance on synthetic additives and minimizing environmental impacts. Biogas production from animal waste through anaerobic digestion provides renewable energy sources for on-farm operations and local communities, contributing to energy independence and greenhouse gas mitigation efforts.

- Strengthening Market Linkages: Strengthening market linkages and value chains is crucial to ensure fair prices, market access, and profitability for smallholder farmers. Initiatives to promote cooperative farming models, market infrastructure development, and e-commerce platforms facilitate direct farmer-consumer interactions and reduce intermediaries' role in value chains.

Future Trends and Opportunities

- Automation and Robotics: Integrating automation and robotics in processing facilities can improve efficiency, reduce labor costs, and ensure consistent product quality.
- Blockchain Technology: Implementing blockchain for supply chain transparency and traceability can enhance consumer confidence in product origins, quality, and ethical practices.
- Global Market Access: Explore opportunities for export markets by complying with international trade regulations and leveraging certifications that enhance product credibility and marketability abroad.
- E-commerce and Direct Marketing: Capitalize on the growth of e-commerce platforms and direct-to-consumer marketing channels to reach geographically dispersed consumer bases and bypass traditional distribution channels.
- Brand Positioning: Develop a strong brand identity that communicates value propositions such as product quality, sustainability, ethical sourcing, and consumer health benefits. Differentiate products through unique attributes and storytelling.
- Product Innovation: Invest in research and development to continuously innovate and introduce new products, flavors, packaging formats, or formulations that align with evolving consumer trends and preferences.

Conclusion

Value addition in animal products is a pivotal strategy for enhancing profitability, meeting consumer demands, and driving sustainability in the agriculture and food industries. By implementing appropriate processing techniques, adhering to quality standards, and innovating product offerings, stakeholders can capitalize on market opportunities and establish competitive advantages. Continuous improvement, adaptation to market trends, and commitment to quality

and sustainability will be key drivers of success in delivering value-added animal products that resonate with today's discerning consumers.

References:

1. Food and Agriculture Organization (FAO) of the United Nations. (2023). State of the World's Animal Genetic Resources for Food and Agriculture.
2. United Nations Food Systems Summit. (2021). Innovation for Sustainable Agri-food Systems: Case Studies. United Nations.
3. World Economic Forum. (2022). The Future of Food Systems: Technology, Innovation and Regulation.
4. FAO. (2022). Climate Change and Food Security: Risks and Responses. Food and Agriculture Organization of the United Nations.
5. European Commission. (2023). Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food System. European Union.
6. World Bank. (2023). Livestock and Climate Change: Mitigating Greenhouse Gas Emissions from Livestock Production.

Chapter 2

VALUE ADDED MEAT: PIONEERING TRENDS AND TECHNOLOGIES

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INTRODUCTION

There is continuous growth and innovations in meat processing sector owing to change in consumer demand, increased disposable income and global competition. There is a growing demand for healthier meat products that are low in salt, fat, cholesterol, and calories, and free from nitrites. Additionally, consumers are seeking products enriched with health-promoting bioactive components such as carotenoids, unsaturated fatty acids, sterols, and fibers. These consumer demand for novel meat products with altered formulations have to be met without change in taste, look and smell from traditional processed products. Consumption of meat and meat products is increasingly recognized as a factor that may elevate the risk of developing chronic diseases such as obesity, cancer, and stroke. In recent years, the meat industry has witnessed a surge in innovative approaches aimed at enhancing the nutritional value and overall quality of meat products. This chapter explores the various methods of value addition that are transforming the landscape of meat consumption. This includes advancements in processing techniques, formulation of healthier meat products, and the integration of functional ingredients that cater to evolving consumer preferences for health-conscious. By delving into these pioneering trends and technologies, this chapter aims to provide a comprehensive understanding of how modern value addition strategies are addressing the challenges of health concerns, sustainability, and market demands, ultimately shaping the future of the meat industry.

1. Advanced ingredient systems for meat products

1.1 Fat Replacers: The World Health Organisation (WHO) recommended to reduce the fat intake in the human diet (WHO, 2003). A reduction of fat in the product can be achieved by altering product formulation. To achieve this alginate, carrageenan, xanthan gum, cellulose

derivates, starches and pectins (Garcia-Garcia & Totosaus, 2008), carboxymethyl cellulose (Ruusunen et al., 2003), isolated soy protein or sodium caseinate in emulsion type meat (Choi et al., 2010), Water-soluble oat fiber in Beef patties (Pinero et al., 2008), Citrus fiber and soy protein concentrate in frankfurters (Cengiz and Gokoglu, 2007), Vegetable fibers in emulsion products (Tornberg, 2005), Inulin and lupin-kernel fiber in sausages (Archer et al., 2004) has been studied. Among them some apart from acting as fat replacers also act as source of fibre.

1.2 Change in fatty acid profile: The optimal ratio of PUFA:SFA and ω-6/ω-3 PUFA recommended should be between 0.4-1.0 and 1-4 respectively (WHO, 2003; Wood et al., 2003). In meat industry altered fatty acid profile has been attained by use of corn, sunflower oil, sodium caseinate in frankfurter (Bloukas and Paneras, 1993), fish oil in dry fermented sausage (Muguerza et al., 2004), fish oil, canola, flaxseed in dutch fermented sausage (Pelser et al. 2006) and linseed oil or algae in dry fermented sausage (Ciriano et al. 2010).

1.3 Cholesterol level reduction in meat products: The cholesterol content varies depending on type of meat, the cut, and the product preparation conditions in meat and meat products. As per RDA cholesterol intake should be limited to less than 300 mg per day (Chizzolini et al., 1999; WHO, 2003). Congugated linoleic acid (CLA) is gaining importance in this direction. The main source of CLA is beef fat and bovine milk (Schmid et al., 2006). CLA has been experimentally proven to decrease accumulation of cholesterol in acetylated LDL in mouse (Ringseis et al., 2008). Juarez et al. (2009) added CLA to sausages to demonstrate its activity.

1.4 Salt and sodium reduction in processed meat products: In meat and meat products salt is being used as preservative, reduction of water activity, improved flavour and forms desired texture (Desmond, 2006, 2007). Use of sodium as a part of sodium chloride or sodium tripolyphosphate or any other salts are increasingly associated with high blood pressure and other cardiac diseases (McGregor, 2007; CDC, 2009). This can be achieved by replacement with potassium chloride (Varma et al., 2010; , use of flavour enhancers (Ruusunen et al., 2003) and altered physical structure (Angus, 2007) of sodium chloride.

1.5 Nitrite reduction: Nitrite helps in development characteristic pink/red color in cured and smoked meat and retards the development of rancidity and offodors. But under certain circumstances nitrite can react with amines to form nitrosamines (Jakszyn & Gonzalez, 2006).

Nitrite reduction is achieved by use of ingredient with high nitrate content ((Jakszyn & Gonzalez, 2006), use spice or vegetable source nitrates (Sebranek and Bacus, 2007), nitrate-reducing starter culture (Fischer et al., 2005)

1.6 Novel naturally occurring antimicrobials: Naturally occurring antimicrobials, unlike traditional or synthetic antimicrobials, are compounds found in spices, herbs, or their essential oils, such as terpenes, coumarins, and flavonoids (Kim et al., 1995). Additionally, naturally occurring antimicrobials can also be derived from microbial sources, such as nisin, or from animal sources, including lysozyme and antimicrobial polypeptides (AMPs) (Gaysinsky & Weiss, 2007).

1.7 Sanitizing meat surfaces: Sanitation of meat surfaces prior to grinding or prior to the production of batters may improve the control of growth of food borne pathogens. Anitizarion can be done by various methods like electrolyzed oxidizing water (Fabrizio & Cutter, 2005), high pressure in combination with antimicrobials (Hugas t al., 2002), irradiation and light pulses (Aymerich et al., 2008), and surface sanitizers such as chlorine dioxide, cetylpyridinium chloride, and lactic acid (Jiminez-Villarreal, et al., 2003) could extend shelf life of meats.

1.8 Enzyme in meat Industry: The rapid degradation of the intrinsic structure of proteins in meats, especially intermediate filament proteins, by proteolytic enzymes is a well-documented process that enhances the water-holding capacity and tenderness of meat products (Huff-Lonergan & Lonergan, 2005). Innovative enzymes used for this purpose include novel fungal extracellular protease (Benito et al., 2003), elastase from Bacillus sp. EL31410 (Qihe et al., 2006), Microbial transglutaminase (Herrero et al., 2008), polyphenol oxidases (PPO) and lipoxygenases (Lantto et al., 2006), Laccase (Littoz & McClements, 2008).

2. Advances in meat processing systems

2.1 Vacuum fillers: The meat manufacturing sector is becoming progressively industrialized, with process and machine specifications being adapted from various industries, including automotive, pharmaceutical, chemical, and personal care sectors. This shift aims not only to reduce variations in product quality but also to boost throughput. In this context, high and low vacuum filling techniques are increasingly employed in the meat industry. One notable

advantage of vacuum fillers is their compatibility with other processing equipment, allowing for seamless integration and enhanced operational efficiency (Reutter et al., 2003).

2.2 Meat Grinder, bowl choppers and meat slicer: Reduction of particle size of meats is one of the most widely used process operations in meat product manufacturing. Vacuum pump ump grinders are being used for the continuous manufacturing of raw fermented sausages (Büchele, 2009). Bowl choppers are being replaced by continuously working fine homogenizer (Inotec, 2009). Continuous slicer lines are increasingly installed by meat product manufacturers (Holac, 2009) and are often used in combination with portioning units and/or stacking/shingling devices (Rust, 2004).

3. Other innovations in meat industry:

3.1 Bioengineering of meat Animals: Biotechnology in animals is primarily achieved by cloning, transgenesis, or transgenesis followed by cloning to produce genetically identical copies of a selected animal. This has been used to produce animal with improved meat quality in bovine (Takahashi and Ito 2004), ovine (Ryder, 2002), caprine (Behboodi et al., 2004) and porcine (Pursel et al. 2004) animals with mixed results.

3.2. Automation for the Modern Slaughterhouse: The tools utilized in the meat industry vary greatly, spanning from basic knives operated by butchers to sophisticated autonomous systems designed for intricate tasks such as evisceration and optimal carcass breakdown. Automation in meat processing addresses product variation through a variety of methods. Some approaches leverage advanced sensing technologies to detect and adapt to variations in real-time, while others rely on historical data and statistical models to predict and manage these variations. Additionally, certain systems are designed to adjust processes to capitalize on the strengths of the machinery, ensuring consistent quality and efficiency across production. Automation being used include automated grading (Watkins et al., 1999), automated chill rooms (Field, 2004), pork killing (Madsen and Nielsen 2002), beef killing (Food Science Australia 2004), and mutton production (Meat New Zealand 2004).

3.3 High hydrostatic pressure for meat processing: Among all foods and food constituents, muscle and muscle proteins are probably most susceptible to high pressure (de Lambellerie-Anton et al., 2002). Research has suggested that although HDP does improve meat tenderness,

the magnitude of tenderness improvement is conditional depending on many factors (Solomon et al., 2004). Variability in instantaneous tenderization using HDP was elucidated to be related to time postmortem of application of the treatment (Paroczay et al. 2002). Even after many reports of effectiveness, commercial use in meat industry is limited due to four technical problems: safety, throughput, packaging, and performance. Effects of HDP treatment on further processed meat products are not fully understood (Sagili and Claus 2003). The role of HDP as a nonthermal treatment to reduce bacterial populations in meat remains unclear, as there are conflicting reports on its bactericidal effect (Zuckerman et al., 2002).

3.4. Biochemical Proteolysis: Skeletal muscle contains a diverse array of enzymes that are integral to various metabolic pathways, with endopeptidases like calpains and cathepsins playing a significant role in the breakdown of proteins. These enzymes are essential for the proteolytic processes that facilitate muscle protein turnover and contribute to the tenderization of meat. Interestingly, the mechanisms by which microbial enzymes degrade proteins are similar to those employed by muscle enzymes. Both microbial and muscle enzymes utilize comparable proteolytic pathways to cleave protein molecules, underscoring a fundamental similarity in their biochemical functions. This resemblance in proteolytic activity highlights the broader biochemical principles governing protein degradation across different biological systems (Visser, 1993). Several microbial enzymes have been used in meat industry like exopeptidases in *Lactobacillus sakei* (Sanz and Toldrá 1997), arginine aminopeptidase (Sanz and Toldrá 2002), protease B from *Debaryomices hansenii* (Bolumar et al., 2005). This enzymes help in degradation of muscle proteins leading to enhancement of product quality.

3.5. Vacuum Salting by Vacuum impregnation (VI): Various methods are employed for salting meat, with the primary techniques being dry salting and wet salting (FOA, 1981; Ismail and Wooton, 1992). One advanced method is vacuum impregnation (VI), which is used for products submerged in a liquid. The primary function of VI is to enhance the salting rate by introducing brine into the meat's pores through the application of alternating pressures, which promotes a hydrodynamic mechanism (Fito et al., 1994; Fito et al., 1996). This technique significantly improves the efficiency of the salting process by ensuring more effective penetration of the brine.

3.6. Use of Bacteriocins Against Meat-Borne Pathogens: Meat serves as a nutrient-rich matrix that creates an ideal environment for the growth of spoilage microorganisms and common foodborne pathogens. Among the primary microbial hazards associated with meat products are Salmonella, Listeria monocytogenes, enterohemorrhagic Escherichia coli, Campylobacter, and Staphylococcus aureus. These pathogens pose significant risks due to their potential to cause severe foodborne illnesses. Additionally, there are several minor microbial hazards that must also be considered, including Yersinia enterocolitica, various Clostridium species, bacteria that produce biogenic amines, and molds that can produce mycotoxins (Mead et al., 1999).

In response to these microbial threats, bacteriocins produced by lactic acid bacteria (LAB) have emerged as a valuable tool in meat preservation. These bacteriocins are typically cationic, hydrophobic, or amphiphilic molecules, consisting of 20 to 60 amino acid residues (Nes and Holo, 2000). Within the meat industry, bacteriocins of particular interest generally belong to Class IIA, with the notable exception of nisin, which is classified under Class IA (Hurst, 1981). These bacteriocins are utilized to enhance meat safety by being applied to the surface of various meat products. For instance, they are sprayed onto red meat carcasses (Cutter and Siragusa, 1994), fresh pork sausages (Scannell et al., 1997), chicken cold cuts (Katla et al., 2002), and Frankfurter sausages (Hugas et al., 2002), among other products. This application helps to sanitize the surfaces of these products, thereby reducing microbial contamination and extending their shelf life.

3.7. Shock wave technology: Meat tenderness is an important quality parameter determining consumer acceptance and price. The application of hydrodynamic pressure or shockwaves has showed outstanding improvements by reducing the Warner Bratzler Shear Force by 25% or more. However, the technology has not penetrated into the market as first systems were based on the use of explosives and further developments seemed to lack the robustness to fulfill industrial requirements (Bolumar et al., 2014).

4. Conclusion

In summary, the exploration of advanced processing technologies in the meat industry underscores a transformative shift towards more sophisticated and efficient methods. These innovations, from automation and precision tools to novel techniques like vacuum impregnation and bacteriocin application, are driving improvements in product quality, safety, and

sustainability. By integrating cutting-edge technologies, the industry is able to address key challenges such as product variability, safety concerns, and evolving consumer preferences for healthier and more convenient options. The advancements discussed not only enhance the overall efficiency of meat production but also align with the growing demand for higher-quality, value-added products. As these technologies continue to evolve, they will play a crucial role in shaping the future of meat processing, ensuring that the industry remains responsive to both market demands and sustainability goals.

References:

1. Angus, F. (2007). Dietary salt intake: Sources and targets for reduction. In D. Kilcast, & F. Angus (Eds.), *Reducing salt foods* (pp. 3−17). Cambridge, UK: Woodhead Publishing Ltd.
2. Archer, B. J., Johnson, S. K., Devereux, H. M., & Baxter, A. L. (2004). Effect of fat replacement by inulin or lupin-kernel fibre on sausage patty acceptability, post meal perceptions of satiety and food intake in men. *British Journal of Nutrition*, 91 (4), 591−599.
3. Aymerich, T., Picouet, P. A., & Monfort, J. M. (2008). Decontamination technologies for meat products. *Meat Science*, 78, 114−129.
4. Behboodi, E., E. Memili, D. T. Melican, M. M. Destrempes, S. A. Overton, J. L. Williams, P. A. Flanagan, R. E. Butler, H. Liem, L. H. Chen, H. M. Meade, W. G. Gavin, and Y. Echelard. 2004. Viable transgenic goats derived from skin cells. *Transgenesis Research*. BW2118:1–10.
5. Benito, M. J., Rodriguez, M., Acosta, R., & Cordoba, J. J. (2003). Effect of the fungal extracellular protease EPg222 on texture of whole pieces of pork loin. *Meat Science*, 65, 877−884.
6. Bloukas, J. G., & Paneras, E. D. (1993). Substituting olive oil for pork back fat affects quality of low-fat frankfurters. *Journal of Food Science*, 58(4), 705−709.
7. Bolumar, T., Bindrich, U., Toepfl, S., Toldrá, F., and Heinz V. (2014). Effect of electrohydraulic shockwave treatment on tenderness, muscle cathepsin and peptidase activities and microstructure of beef loin steaks from Holstein young bulls. *Meat Science*, 98(4):759- 65.
8. Bolumar, T., Y. Sanz., M. C. Aristoy., and F. Toldrá. (2005). Protease B from *Debaryomyces hansenii*: Purification and biochemical properties. *International Journal of Food Microbiology,* 98:167–177.
9. Büchele, A. (2009). Realising full technological potential. *Fleischwirtschaft*, 89(8), 44−45.
10. CDC National Center for Chronic Disease Prevention. (2005). Number of Americans with Diabetes Continues to Increase. In O Communication (Ed.), (Vol. CDC).
11. Cengiz, E., & Gokoglu, N. (2007). Effects of fat reduction and fat replacer addition on some quality characteristics of frankfurter-type sausages. *International Journal of Food Science and Technology,* 42(3), 366−372.

12. Chizzolini, R., Zanardi, E., Dorigoni, V., & Ghidini, S. (1999). Calorific value and cholesterol content of normal and low-fat meat and meat products. *Trends in Food Science and Technology,* 10(4–5), 119−128.
13. Choi, Y. S., Choi, J. H., Han, D. J., Kim, H. Y., Lee, M. A., Jeong, J. Y., et al. (2010). Effects of replacing pork back fat with vegetable oils and rice bran fiber on the quality of reduced-fat frankfurters. *Meat Science*, 84(3), 557−563.
14. Ciriano, M. G. d., Larequi, E., Rehecho, S., Calvo, M. I., Cavero, R. Y., Navarro-Blasco, I., et al. (2010). Selenium, iodine, w-3 PUFA and natural antioxidant from *Melissa officinalis L.*: A combination of components from healthier dry fermented sausages formulation. *Meat Science,* 85(2), 274−279.
15. Cutter, C. N., and G. R. Siragusa. (1994). Decontamination of beef carcass tissue with nisin using a pilot scale model carcass washer. *Food Microbiology,* 11:481–489.
16. de Lambellerie-Anton, E. M., R. G. Taylor., and J. Culioli. (2002). High pressure processing of meat. In *Meat processing: Improving quality*, eds. J. Kerry, J. Kerry, and D. A. Ledward, 313–331. Boca Raton, FL:CRC/Wood Head.
17. Desmond, E. (2006). Reducing salt: A challenge for the meat industry. *Meat Science*, 74 (1), 188−196.
18. Desmond, E. (2007). Reducing salt in meat and poultry products. In D. Kilcast, & F. Angus (Eds.), *Reducing salt foods* (pp. 233−255). Cambridge, UK: Woodhead Publishing Ltd.
19. Fabrizio, K. A., & Cutter, C. N. (2005). Application of electrolyzed oxidizing water to reduce *Listeria monocytogenes* on ready-to-eat meats. *Meat Science*, 71, 327−333.
20. FAO. (1981). The preservation of losses in cured fish (Rep. No. 279). FAO Fish.
21. Field, M. (2004). Evolution in practice. *New Food.* 2004:41–43.
22. Fito, P., A. Andrés, A. Chiralt, and P. Pardo. 1996. Coupling of hydrodynamic mechanism and deformation-relaxation phenomena during vacuum treatments in solids porous food- liquid systems. *Journal of Food Engineering*, 27:229–240.
23. Fito, P., A. Chiralt., J. Serra., M. Mata., R. Pastor., A. Andrés., and X. Q. Shi. (1994). An alternating flow procedure to improve liquid exchanges in food products and equipment for carrying out said procedure. *European patent 0,625,314,A2.*
24. Food Science Australia. (2004). www.foodscience.afisc.csiro.au/tis/equipdev.
25. Garcia-Garcia, E., & Totosaus, A. (2008). Low-fat sodium-reduced sausages: Effect of the interaction between locust bean gum, potato starch and k-carrageenan by a mixture design approach. *Meat Science*, 78(4), 406−413.
26. Gaysinsky, S., & Weiss, J. (2007). Aromatic and spice plants: Uses in food safety. *Stewart Post harvest Solutions,* 4, 9−16.
27. Herrero, A. M., Cambero, M. I., Ordonez, J. A., De la Hoz, L., & Carmona, P. (2008). Raman spectroscopy study of the structural effect of microbial transglutaminase on meat systems and its relationship with textural characteristics. *Food Chemistry*, 109, 25−32.
28. Holac (2009). Holac/continuous high-volume slicing. *Fleischwirtschaft International*, 4.
29. Huff-Lonergan, E., & Lonergan, S. M. (2005). Mechanisms of water-holding capacity of meat: The role of postmortem biochemicl and structural changes. *Meat Science*, 71, 194−204.
30. Hugas, M., Garriga, M., & Monfort, J. M. (2002). New mild technologies in meat processing: High pressure as a model technology. *Meat Science*, 62, 359−371.
31. Hurst, A. (1981). Nisin. *Advances in Applied Microbiology*, 27:85–123.

32. Inotec (2009). Inotec/Homogenes Schnittbild durch kontinuierliche Produktion. *Fleischwirtschaft,* 89(12), 60.
33. Ismail, N., and M. Wooton. (1992). Fish salting and drying: A review. *Asean Journal*, 7:175– 183.
34. Jakszyn, P., & Gonzalez, C. A. (2006). Nitrosamine and related food intake and gastric and oesophageal cancer risk: A systematic review of the epidemiological evidence. *World Journal of Gastroenterology,* 12(27), 4296−4303.
35. Jiminez-Villarreal, J. R., Pohlman, F. W., Johnson, J. H., & Brown, A. H., Jr. (2003). Lipid, instrumental color, and sensory characteristics of ground beef produced using trisodium phosphate, cetylpyridinium chloride, chlorine dioxide or lactic acid as multiple antimicrobial interventions. *Meat Science*, 65, 885−891.
36. Juarez, M., Marco, A., Brunton, N., Lynch, B., Troy, D. J., & Mullen, A. M. (2009). Cooking effect on fatty acid profile of pork breakfast sausages enriched in conjugated linoleic acid by dietary supplementation or direct addition. *Food Chemistry*, 117(3), 393−397.
37. Katla, T., T. Moretro., I. Sveen, I. M., Aesen, L., Axelsson, L., M. Rorvik., and K. Naterstad. (2002). Inhibition of *Listeria monocytogenes* in chicken cold cuts by addiction of sakacin P and sakacin P-producing *Lactobacillus sakei*. *Journal of Applied Microbiology*, 93:191–196.
38. Kim, J., Marshal, M. R., & Wei, C. (1995). Antibacterial activity of some essential oil components against five food borne pathogens. *Journal of Agricultural Food Chemistry*, 43, 2839−2845.
39. Lantto, R., Plathin, P., Niemisto, M., Buchert, J., & Autio, K. (2006). Effects of transglutaminase, tyrosinase, and freeze dried apple pommace powder on gel forming and structure of pork meat. *LWT — Food Science and Technology*, 39, 1117−1124.
40. Littoz, F., & McClements, D. J. (2008). Bio-mimetic approach to improving emulsion stability: Cross-linking adsorbed beet pectin layers using laccase. *Food Hydrocolloids*, 22(7), 1203−1211.
41. Madsen, K. B., and J. U. Nielsen. (2002). Automated meat processing. In *Meat processing: Improving quality*, ed. J. Kerry, J. Kerry, and D. Ledward, 283–296. Cambridge, UK: Woodhead Publishing.
42. McGregor, R. (2007). The use of bitter blockers to replace salt in food products. *Reducing Salt Foods* (7647-14-5 (Sodium chloride) Role: FFD (Food or feed use), BIOL (Biological study), USES (Uses) (use of bitter blockers to replace salt in food products)), 221–230.
43. Mead, P. S., L. Slutsker., V. Dietz., L. F. McCaig., J. S. Bresee., C. Shapiro., P. M. Griffin., and R. V. Tauxe. (1999). Food-related illness and death in the United States. *Emerging Infectious Disease.* 5:607–625.
44. Meat NewZealand. 2004. http://www.meatnz.co.nz/wdbctx/corporate/docs/SECURED_R_AND_D_BRIEFS/R_D_BRIEF_32.PDF2
45. Muguerza, E., Ansorena, D., & Astiasaran, I. (2004). Functional dry fermented sausages manufactured with high levels of n-3 fatty acids: Nutritional benefits and evaluation of oxidation. *Journal of the Science of Food and Agriculture*, 84(9), 1061−1068.
46. Nes, I. F., and H. Holo. (2000). Class II antimicrobial peptides from lactic acid bacteria. *Biopolymers,* 55:50–61.

47. Paroczay, E. W., M. B. Solomon., B. W. Berry., J. S. Eastridge., and J. A. Callahan. (2002). Evaluating tenderness improvement using hydrodynamic pressure processing (HDP). In 2002 IFT *Annual Meeting Book of Abstracts*, 185. Chicago: Institute of Food Technologists.
48. Pelser, W. M., Linssen, J. P. H., Legger, A., & Houben, J. H. (2006). Lipid oxidation in n-3 fatty acid enriched Dutch style fermented sausages. *Meat Science*, 75(1), 1−11.
49. Pinero, M. P., Parra, K., Huerta-Leidenz, N., Arenas de Moreno, L., Ferrer, M., Araujo, S. (2008). Effect of oat's soluble fiber (beta-glucan) as a fat replacer on physical, chemical, microbiological and sensory properties of low-fat beef patties. *Meat Science*, 80(3), 675−680.
50. Pursel, V. G., A. D. Mitchell., G. Bee., T. H. Elsasser., J. P. McMurtry., R. J. Wall., M. E. Coleman., and R. J. Schwartz. (2004). Growth and tissue accretion rates of swine expressing an Insulin-like Growth Factor I transgene. *Animal Biotechnology*, 15:33–45.
51. Qihe, C., Guoqing, H., Yingchun, J., & Hui, N. (2006). Effects of elastase from a Bacillus strain on the tenderization of beef meat. *Food Chemistry*, 98, 624−629.
52. Reutter, S.D., Schliesser, Gerhard (2003). Device and method for producing a strand of plastic material and an extrusion head for the device/method. In: Handtmann, Albert Maschf (DE).
53. Ringseis, R., Wen, G., Saal, D., & Eder, K. (2008). Conjugated linoleic acid isomers reduce cholesterol accumulation in acetylated LDL-induced mouse RAW264.7 macrophage- derived foam cells. *Lipids*, 43(10), 913−923.
54. Rust, R. E. (2004). Processing equipment|mixing and cutting equipment. In C. Devine, M. Dikeman, &W. K. Jensen (Eds.), *Encyclopedia of meat sciences* (pp. 1057−1061). Oxford: Elsevier.
55. Ruusunen, M., Vainionpaa, J., Puolanne, E., Lyly, M., Lahteenmaki, L., Niemisto, M. (2003). Effect of sodium citrate, carboxymethyl cellulose and carrageenan levels on quality characteristics of low-salt and low-fat bologna type sausages. *Meat Science*, 64(4), 371−381.
56. Ryder, O. A. (2002). Cloning advances and challenges for conservation. *Trends in Biotechnology*. 20:231–232.
57. Sagili, J. V. V., and J. R. Claus. (2003). Tenderization effects of electrically produced hydrodynamic shock waves on top round and strip loin muscles of beef. In *Proceedings of the 56th Annual Reciprocal Meat Conference*, Columbia, MO, June 15–18, 2003, 122. Savoy, IL: American Meat Science Association.
58. Sanz, Y., and F. Toldrá. (1997). Purification and characterization of an aminopeptidase from *Lactobacillus sake*. *Journal of Agriculture and Food Chemistry*, 45:1552–1558.
59. Scannell, A. G. M., C. Hill., R. P. Ross., S. Marx., W. Hartmeier., and E. K. Arendt. (2000). Development of bioactive food packaging materials using immobilized bacteriocins Lacticin 3147 and Nisaplin. *International Journal of Food Microbiology*, 60:241–249.
60. Sebranek, J. G., & Bacus, J. N. (2007). Cured meat products without direct addition of nitrate and nitrite: What are the issues? *Meat Science*, 77, 136−147.

Chapter 3

ENTREPRENEURSHIP OPPORTUNITIES IN LIVESTOCK AND MEAT SECTOR

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The role of livestock sector is very crucial for developing countries as they offer nutritious food, draught power, manure, draught energy, besides revenue generation. Among livestock products, meat foods provide all essential nutrients required for growth and wellbeing of human. India produces about 9.8 million tonnes of meat annually from all species comprising buffalo meat (1.72 million tonnes), beef (0.24million tonnes), chicken (4.99 million tonnes), chevon (1.41 million tonnes), mutton (1.02 million tonnes), and pork (0.38 million tonnes). (DAHD, 2023). About 72 % of Indians currently follow a non-vegetarian diet and Regular meat intake has been steadily rising over time. Holding of 11.6% of world livestock population and 17.71% of the world human population, India has enormous potential for producing, processing, and marketing of meat. The revenue in Indian meat market is valued close to USD 33.70 billion in 2024 and is one of the fastest growing industries at an annual growth rate of 5.99 per cent (Statista, 2024). Even in unfavourable weather circumstances, livestock production generates a net output from the unit of investment that is quite high when compared to other agricultural operations. However, existing livestock production system in India "produce a lot to get a little" is putting pressure on environment. Hence, effective blending of scientific knowledge with understanding of market dynamics and business principles are imperative to create business ventures in meat value chain. The article describes about various entrepreneurship opportunities in meat value chain comprising meat animal and poultry production, meat production and processing, value addition and marketing.

Meat animal production

The primary objective of first segment is production of meat animals and poultry with higher body weight at optimum slaughter age to yield quality meat.

Integrated meat animal production: Except chicken, this segment has not made significant strides in our country although sheep, goats and pigs are reared by the countrymen for meat production using extensive and semi-intensive methods. Inadequate feeding and complete dependence on free grazing, lack of awareness about superior quality breeds/animals for breeding, poor access to preventive and curative health care led to poor live weight goats and sheep (< 10.0 Kg). Technological interventions have resulted in transformation of unorganized and unscientific chicken farming practice in India to a highly successful commercial production system. Poultry Industry in India is a 28.8 billion USD sector with an annual growth rate of 8-10%. The total value of output at current basic price (2020-21) from livestock sector is Rs. 15,63,399 crores, out of which poultry egg and meat sector alone contributes Rs. 2,30,528 crores. Thus, poultry sector contributes 14.75% of total annual value of outputs from livestock (CSO, MoSPI, 2023). Similar to organised poultry production system, sheep, goat and pig farming need to be taken-up on intensive/semi-intensive concept in larger scale with complete integration. Crop residue based complete feed to be promoted on large scale in rural areas along with silage and other fodder development programmes to curtail the major production cost. It will be a practical alternative to prevent adverse effects of crop burning on climate and at the same time solves the livestock feed and fodder shortage. The integrated production will also suffice mandatory requirement of traceability of food products as per the Food Safety & Standards (Food Recall Procedure) Regulations, 2017.

Growing male buffalo calves to higher weights: Every year, several millions of male calves are removed from the buffalo production system by the farmers to save dam's milk due to non remunerative cost of raising male animals. These calves could be salvaged for meat production, which would increase meat production. The buffalo male calves could be raised upto 1 year of age with high protein / high energy diet to yield 250 kg body weight and 150-kg meat. Meat from such animals is tender, lean and juicy and fetches good price in the export market. Moreover, hides of well grown calves also have good demand (Ranjhan, 1999). According to an estimate, the available male buffalo calf potential is about 15 million. In addition, there are surplus female calves that are culled for various reasons. An additional 1-1.5 million tonnes of buffalo meat per annum could be produced when calves are reared to a higher body weight of 200 - 300 kg. However, at present a smaller number of male buffalo calves survive to maturity and the meat yield from these calves is very low. Though there is scheme by Govt. of India for

male buffalo calf rearing, due to the restrictions in the Animal Preservation Acts on their utilization for meat production, the practice has not taken up so far.

Growing demand for meat from free range and naturally grown native chicken and organic meat: A growing worldwide trend towards consumption of meat from animals/birds reared under free-range condition is evident. The demand for such produce is steadily on increase in response to the concerns of animal welfare and move away from the widespread use of antibiotics and feed additives. Organic animal and poultry production system, which follows natural process of animal production with utmost regards for food safety and food security is emerging as an effective alternative to address all these issues. All the organic food products are likely to fetch premium price in the market as they are targeted for niche consumers who are quality conscious and would be willing to pay premium price for quality products.

Live animal trading: Live animal marketing in India is highly unorganized and is mostly performed through traditional channels like traders, fairs, word of mouth, etc. This makes the buying and selling of quality and verified livestock at right price. Few of startups like Pashushala, Anitra, Animall have established ecosystem that offers innovative business models to monetization of livestock along with animal traceability, health assistance, logistics support for easy & effective monetization of livestock.

Meat production, processing and value addition

The second major segment deals with slaughter of meat animals and poultry for harvesting of meat and edible offal and aspects pertaining to post-harvest handling, processing, by-products utilization and value added meat products. The primary objective of this segment is supply of clean and safe meat and meat products to the consumers.

Meat production: For domestic consumption, slaughtering is performed in designated abattoirs or slaughterhouses maintained by local bodies. The conditions in the vast majority of public slaughterhouses catering to the domestic market are highly appalling; premises are old and dilapidated; hygiene is neglected; meat inspection is scanty; carcasses and edible offal are usually contaminated; carcasses and edible offal are handled and transported to meat stalls in all sorts of unhygienic methods. Meat is sold as hot meat (pre-rigor meat without any chilling) and most of the meat is consumed on the same day. Supply of clean and safe meat to the public is the responsibility of the government. Improvisation of the traditional abattoirs at nominal investment is the immediate solution to achieve the objective of enforcing hygiene. It will also include

newly built low cost non-mechanized abattoirs with overhead railing system or abattoirs with off-the-floor slaughter facilities. Medium and small capacity abattoirs should be established with all the components to produce clean and safe meat, efficient by-products utilization, effluent treatment, chilling, packaging to ensure the norms stipulated by Food safety and standards act, 2006 enacted from Food Safety and Standards Authority of India (FSSAI) for production of hygienic meat. NMRI has developed several portable model slaughter units suits for rural as well as small scale meat production. At the other extreme, there are state-of-the-art modern export oriented abattoirs and meat processing plants with excellent cold chain facilities and practicing meat hygiene to the core as per international standards.

Meat retailing: Despite spectacular increase in broiler production, marketing of meat and meat products in India still remains in juvenile stage. In the present scenario poultry trade is either in the form of sale of live birds or as skin-out carcasses in wet market. Except some of retail meat outlets of supermarkets in metropolitan cities, which are catering to high end markets with all kinds of meat and meat products are at par with standards in developed countries, vast majority of meat retail shops lack minimum facilities for hygienic handling of meat. Lack of hygiene in the traditional meat markets have given rise to online meat selling market, which has better supply chain management and technological intervention than the offline options. Subsequently several vertically integrated poultry companies, which have modern, mechanized poultry processing plants have established their own modern retail outlets with better packaging, labeling, chilling and cold chain facilities. Few large players like METRO, SPAR Hypermarket, Walmart etc. have already entered into retail sector.

Further processing and value addition: At present further processing and value addition of meat in India remains less than 2.0% with the exception of poultry where ~10% of meat undergoes processing. Urbanization, strong GDP growth, growing younger population, larger exposure among consumers and fast changing socio-economic and cultural aspects have fueled the increased the demand for value added and convenience products. National Food Processing Policy aims to increase the level of food processing from 10% in 2010 to 25% in 2025. According to the India Food Services Report-2024 by the National Restaurants Association of India (NRAI), India's food services sector the sector is poised to grow at a compounded annual growth rate (CAGR) of 8.1 per cent between 2024 and 2028. Further, the 1Lattice reported that the QSR market is expected to witness a CAGR of 19% reaching a market size of USD 15 billion

in 2028. Accordingly, the Indian market is witnessing a revolutionary change and several multinational companies are introducing globally known products in the Indian markets. There has been an increase in both, the number of players in the frozen products segment and the availability of convenience and ready to eat meat products. Compared to broiler industry, which is growing at 12-15% per annum, the ready to eat meat products segment is growing at more than 20% in India. Even though, cultural patterns rather than income dominate meat consumption in India, the ready to-eat meat sector is growing with consumer affluence. Large meat processing companies like METRO, SPAR Hypermarket, Walmart, etc. have already entered into retail sector and catering to the demands of urban population. KFC, McDonald, Subway, Suguna Daily Fresh, Venky's Xprs, Godrej-Tyson, Godrej-Tyson, Sumeru, Falcon Foods have created the infrastructure to market poultry products in most of the western and southern cities in India. But such initiatives in sheep, goat and large animal meat are almost absent. However, the Government plans to triple the capacity of food processing sector in India from the current 10 per cent of agriculture produce through investments in mega food parks, will generate momentum towards development of viable meat processing sector.

Traditional meat products: Traditional meat products have tremendous mass appeal with unique sensory attributes. Large varieties of traditional food products of indigenous taste profile are being prepared and consumed in various regions of India. Biryani, haleem, kebabs, koftas, tandoori items and meat curries are few to name. Even the multinational companies like Subway, KFC, and McDonald etc. have realized the importance of traditional meat products for Indian customers and started blending western products with traditional meat products or introducing new ethnic products with their brand. Considering this, traditional meat products will have huge demand among quick service restaurant chains if organized on more scientific lines. Process optimization, large scale production, safety management and better packaging will further boost their acceptability. Most of traditional meat products are generally confined to the native geographical region mainly due to their shorter storage stability. There is huge demand for indigenous meat products from ethnic population residing various parts of the globe, especially to South-east and Middle-east countries. Further, the existing market is limited to a few identified snacks and meal accompaniments and specialty foods like haleem, kababs, biryani, tandoori items etc. However, many are still awaiting the larger recognition. Extending the shelf life through technological interventions will boost the commercial value of traditional meat

products. Retort processing is a promising technology for increasing the shelf life, which will ensure their availability throughout the year. Hence shelf-stable traditional meat products could be produced in large scale and find export potential in different geographical areas.

Utilisation of byproducts: Over the years, the quantum of production of deboned carcass frames, skin, fat and various byproducts from integrated poultry and meat processing plants are increasing in many folds. These materials could be efficiently converted into value added products for human consumption, pet and animal freed and also various industrial products.

1. Technologies are available for preparing highly acceptable, nutritionally superior low cost meat products by incorporating edible byproducts like fat, heart, gizzard and skin of chicken. Formulations were developed to incorporate chicken byproducts up to 30 % in the meat products. These carcass frames and edible byproducts from poultry processing can be profitably utilized for making several nutritious value added products viz., chicken samosa, pickle and soup.
2. Nutritious pet foods with good organoleptic (texture, flavour, and palatability) quality could be prepared from a combination of animal coproducts, cereals, cereal co-products. The carcass frame and other byproducts could be utilized to produce wet pet food by retorting processing technology.
3. Unutilized byproducts including intestine, skin, head, feet, carcass frame of chicken and other animal are made into meat cum bone meal rich in protein and phosphorous and used as feeding materials for livestock, fish and pets.

Branding in meat/poultry Industry

The evolution of modern retail outlets with better packaging, labeling, and cold chain facilities will hopefully address the drawbacks of the existing situation. Branding is a tool for improving marketability of meat/poultry produce. Many commodities like edible oil and milk are now transformed into the brands. The milk is a classic example of commodity which came over the challenge of perishability, sourcing, storage, supply chain and has produced various brands of dairy products. Chilled/frozen chicken has slowly started entering into consumer's refrigerator even though the availability is limited to some cities. Consumers in some cities are now witnessing few branded chicken shops and even the supermarkets have started to allocate a corner for the meat and fish.

Harnessing E-commerce: With the growth of digital media marketplace in the last few years, food retailing has also grown dramatically, becoming an even stronger presence in the lives of people. Lack of products choices and unhygienic conditions in the traditional 'seller-centric market' largely drive the consumers towards online meat selling market, which has better supply chain management and technological interventions. In addition to the fresh meat category, the online retailers are also offering processed and semi processed meat products to satisfying their customers demand and convenience. This will help to cover larger population of wider geographical area. Invasion of online ordering is considered as a new adaptive technique of urban families. Companies are innovating the subscription models which were limited for milk and newspaper to be extended to other products. There are a number of start-ups, Licious, Fresh to Home, Zapto, Big Basket, Grofers, Zappfresh, and others, offering meat and meat products.

Conclusion

Large livestock wealth coupled with strong consumer base fuels greater prospects for pink revolution in the country. Emerging consumption of convenience and value added meat products will not only diversify the food production system, but also will provide huge employment opportunities to large number of micro, small and medium scale entrepreneurs. Effective interventions like using genetically superior animals for breeding, improved feeding and husbandry management, reducing the mortality rate, linking small producers to market, creating better infrastructure for meat production, minimizing the post-harvest losses, increased value addition and further processing, e-marketing will play key roles in the shaping the meat sector development in the country. Strong public-private-producer partnership (4P's) by connecting producers, input-suppliers, service providers, financial institutions, retailers and exporters will reduce the risk and ensure prosperity of the meat sector.

References

1. Department of Animal Husbandry and Dairying, Ministry of Agriculture, Govt. of India.
2. Kondaiah, N. 2014. Impact of meat export on livestock population and ecology. In: Compendium of 6th Conference of Indian Meat Science Association and National Symposium on Sustainable Meat Production for Nutritional Security and Consumer Well-being: Challenges and Strategies. 28-30 November, 2014; DUVASU, Mathura (UP). 23-36.

3. Muthukumar, M and Prince Devadason, I. 2013. Technology o f comminuted meat products. In: Animal Products Technology. Studium Press (India) Pvt. Ltd., New Delhi. Pp 79-109.ISBN: 978-93-80012-62-9.
4. Naveena, B.M.,M. Muthukumar,A.S.R. Anjaneyulu, A.R. Sen,and N. Kondaiah.2011. Value added chicken products: an entrepreneur guide. Hind Publisher, Hyderabad. Pages: 109. ISBN: 978-81-921893-2-1.

Chapter 4

FROM STARTUP TO SUCCESS: SURABHIA2MILK

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The main people

Founder and co-founders : Gangadhara B S and Shwetha Gowda K S

The story of how it all started - The first struggles.

Am Shwetha Gowda Here am Explaining how we started Surabhi a2 milk brand (desi cows milk) and Goushala, its very big lesson for us and others too.

My Husband Have Big Dream about desi cows Goushala, from 2015 he started to collect information about Natural Farming, that time he realise how our ancestors doing agriculture without Chemical fertilizers, and importance of our Indian cows. That time he started research about desi cows and he starts travelling to Gujarat, Nagpur, Mangaluru, Haryana and another parts of Karnataka also. That is, he learnt about different breeds of desi cows and fodders including cows maintenance. Basically he is from farmers' background only, in his childhood his home they maintain few cows so he had basic knowledge about cows. That is very helpfull begin for us.

Daily he explained about his dream project and what are the challenges in this field, its my Responsibility to full fill his Dream as a wife and we both have equel Mindset. Then I started learning about desi cows and desi cows milk benefits, then we decided he buy only two Gir cows for our little once health.

In 2018 April, we bought two Gir Cows and kept in our Native (**Sree Krishna Ganga Goushala**) Making Ghee and milk for our Personal use. Later our friends and relatives are asking about milk and ghee, later we decided make it as a brand and strats selling desi cows milk and ghee , after lot of research we finalize the brand name as Surabhi A2 milk.

Behind the Brand Name

The Anushasana Parva book of the epic narrates that Surabhi was born from the belch of "the creator" (Prajapati) Daksha after he drank the Amrita that rose from the Samudra Manthana. Further, Surabhi gave birth to many golden cows called Kapila cows, who were called the mothers of the world.

Rules and Regulation for milk brand and selling

- Brand Registration
- FSSAI (Food safety and Standards Authority of India)
- ISI (Indian Standards Institution)

2019, we started officially milk branding and home delivery service with one of middle man. He is not co operative for our vision so we are not satisfied with work him together and Gangadhar left his IT job then we give full time in this milk industrie from 15th June 2020 I only started individually Marketing and customers service till date. Always we supporting each other for our work.

Challenge's at Goushala

- Labours
- Fodder
- Climate
- Diseases in Cows
- Financial Management
- Self-Involvement is very important
- Pregnancy Issues in Cows
- Calf Reproduction Starts at the age of after 3years in Desi Cows
- Natural disasters.
- Desi cow Breed Management.

Challenge's in milk industries

- Milk is very perishable product

- Chilling
- Transportation
- Without Preservation
- Serving with Raw milk
- Delivery Challenges
- 365days Working
- Marketing
- On time Service
- Attractive Packaging
- Competitors

Marketing Ideas

- Branding
- Go Social
- A smart Website
- Content
- Influencer Marketing
- Social Media Marketing
- Off Line Marketing.

We Started Our website www.surabhia2milk.com in that we shared a lot of information's about desi cows, desi cows milk and ghee benefits, after that start doing SEO (Search Engine Optimization), Social Media Marketing (Face Book and Instagram), attending Organic Fairs and courses related desi cows and by products like, Cow Urine, Cow Dung, Milk, Ghee, and curd. We both are attending many training like Value added in milk and milk products, cow dung & desi cows urine by products.

Our Suggestion

- Always Open for Learning
- Don't Think Cows are our source of profits
- Do heartfully

- Always share your love and affection with cows
- Ready to Answers our customers Queries
- Enough Knowledge
- Maintain The good Quality milk & milk products
- Give importance for packaging
- Adopt new things

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Chapter 5

TRANSFORMING LIVESTOCK FARMING: ECONOMIC OPPORTUNITIES IN ORGANIC ANIMAL HUSBANDRY & ITS PRODUCTS

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Introduction

Organic animal husbandry is an integral part of organic farming, focusing on sustainable and environmentally friendly practices that ensure the well-being of animals. In India, organic farming and animal husbandry are governed by specific guidelines that adhere to international standards while reflecting the country's unique agricultural landscape.

Key Principles of Organic Animal Husbandry

1. **Animal Welfare**: Animals must be treated with respect and care, with a focus on their health, comfort, and natural behavior. Access to the outdoors, adequate space, and a stress-free environment are essential.

2. **No Use of Synthetic Inputs**: Organic animal husbandry prohibits the use of synthetic hormones, antibiotics, and genetically modified organisms (GMOs). Feed must be organic and free from artificial additives or by-products.

3. **Sustainable Practices**: Farmers must employ practices that protect and enhance the environment. This includes rotational grazing, use of manure as fertilizer, and conservation of biodiversity.

4. **Natural Breeding**: Artificial breeding methods like artificial insemination are allowed, but practices like cloning and embryo transfer are prohibited. The focus is on maintaining the genetic integrity of the animals.

5. **Health Management**: Preventive health care is emphasized, including the use of natural remedies and homeopathy. Vaccinations are permitted under specific circumstances but must follow organic certification rules.

Key Guidelines for Organic Animal Husbandry:

1. **Source of Animals**:

- Animals used for organic production must be raised under organic management from birth or a weaning period.
- In cases where organically raised animals are unavailable, conventional animals may be introduced but must be transitioned to organic management.

2. **Housing and Living Conditions**:
   - Animals must have access to outdoor grazing and pasture.
   - Adequate space, ventilation, and bedding must be provided to ensure comfort.
   - Indoor housing is permitted, but it must be designed to facilitate natural behaviors, such as free movement and social interaction.
3. **Feed**:
   - Feed must be 100% organic, derived from organic crops, free from synthetic chemicals, GMOs, or animal by-products.
   - Pasture grazing is encouraged, and silage or hay must be organically sourced.
4. **Health Care**:
   - Organic farms emphasize preventive measures, including appropriate nutrition, selection of breeds with natural disease resistance, and maintaining hygienic conditions.
   - The use of antibiotics is strictly limited. If necessary to save an animal's life, antibiotics may be used, but the animal will lose its organic certification.
   - Hormonal treatments, such as growth hormones, are prohibited.
5. **Breeding**:
   - Natural breeding methods are preferred, and artificial insemination is allowed.
   - Cloning, embryo transfer, and genetic engineering are prohibited.
6. **Manure Management**:
   - Farms must have proper waste and manure management systems to prevent environmental contamination.
   - Manure is considered an important resource and is typically recycled into the farming system to enhance soil fertility.
7. **Certification**:
   - Organic animal husbandry farms in India must be certified by accredited bodies under NPOP.

- Regular inspections and audits are conducted to ensure compliance with organic standards.

Global Standards and Certification for Organic Animal Products

Organic certification is crucial for farmers seeking to access premium markets, both domestically and internationally. India's organic certification is recognized globally, which enables organic animal products to be marketed as certified organic abroad.

Key Certification Standards

1. **National Programme for Organic Production (NPOP)**: As mentioned earlier, NPOP sets the framework for organic certification in India. The certification process includes a thorough assessment of farming practices, including feed management, animal welfare, housing, and health care. It ensures that all stages of production comply with organic standards, from breeding to processing.

2. **International Standards**: Indian organic animal products, once certified under NPOP, can meet global certification standards such as the EU Organic Regulation and the USDA Organic label. This alignment opens opportunities for Indian farmers to export certified organic dairy, meat, and other animal products to lucrative markets in Europe, North America, and the Middle East.

3. **Participatory Guarantee Systems (PGS)**: For small-scale farmers, PGS offers a community-driven approach to certification. This system is more affordable and accessible than formal certification and is gaining popularity in India. PGS certification involves peer-based monitoring, where farmers in a local network verify each other's organic practices.

4. **Traceability**: Organic certification emphasizes traceability, ensuring that the origin of the product and the entire production process can be tracked. For organic animal products, this means that consumers can be assured of the ethical treatment of animals, adherence to organic feed standards, and the absence of harmful chemicals.

Government Support for Organic Animal Husbandry

The Indian government is increasingly recognizing the importance of organic farming, including organic animal husbandry. Several initiatives and schemes have been launched to support farmers in transitioning to organic methods:

1. **Paramparagat Krishi Vikas Yojana (PKVY)**: This scheme promotes organic farming and provides financial support for farmers to adopt organic practices, including organic livestock management. It emphasizes cluster-based farming and certification.

2. **National Mission on Sustainable Agriculture (NMSA)**: Under the NMSA, various initiatives focus on promoting sustainable agricultural practices, including organic farming and animal husbandry. It provides technical and financial assistance to encourage farmers to adopt eco-friendly farming methods.

3. **Rashtriya Gokul Mission (RGM)**: The RGM focuses on the development of indigenous breeds of cattle. Promoting natural breeding, better nutrition, and health management, this initiative complements the principles of organic animal husbandry by preserving native breeds and ensuring their welfare.

4. **Organic Certification Schemes**: The government supports certification through various schemes, including subsidies for small and marginal farmers. NPOP's certification is internationally recognized, facilitating the export of organic animal products.

5. **National Mission on Sustainable Agriculture (NMSA)** – This mission focuses on sustainable farming practices and organic farming, including animal husbandry.

6. **State Initiatives**: Several states, such as Sikkim (which became the first organic state in India), Kerala, and Uttarakhand, have implemented state-level policies to promote organic farming, including organic livestock farming. These policies provide further incentives and support to farmers.

Role of Indigenous Knowledge in Organic Animal Husbandry

One of the key strengths of organic animal husbandry in India lies in the use of indigenous knowledge and traditional practices. Indian farmers, particularly in rural areas, have long relied on time-tested methods of animal care that align closely with the principles of organic farming. These traditional practices offer valuable insights and can be integrated into modern organic farming systems.

1. **Ethnoveterinary Medicine**: Indigenous communities in India have a rich tradition of using natural remedies for treating livestock ailments. These herbal treatments, derived from local plants, are often highly effective and align with organic standards. Ethnoveterinary practices are increasingly being recognized and incorporated into organic animal husbandry to reduce dependence on synthetic drugs and antibiotics.

2. **Traditional Grazing Practices**: Rotational grazing, allowing animals to move across different pastures to avoid overgrazing and promote soil fertility, has been a common practice in many parts of rural India. This method, rooted in traditional knowledge, supports organic principles by maintaining ecosystem balance and enhancing biodiversity.

3. **Indigenous Breeds**: India has a wealth of indigenous livestock breeds, including Gir, Sahiwal, and Red Sindhi cattle, and local goat, sheep, and poultry varieties. These breeds

are well-suited to India's diverse climatic conditions and require fewer inputs compared to high-yielding exotic breeds. Their natural resistance to diseases and adaptability make them ideal for organic farming, where minimal intervention is a priority.

4. **Manure Management**: Indian farmers have traditionally used animal manure as a valuable resource for soil fertility. Organic farming promotes this age-old practice, emphasizing the use of farmyard manure and composting techniques to recycle nutrients back into the soil. These methods help reduce chemical inputs and maintain long-term soil health.

5. **Community-Based Systems**: Traditional community-based systems for animal rearing, such as **Gaushalas** (cow shelters) and **Pashupalak Sanghs** (livestock keeper groups), support collective care and sustainable management of animals. These systems encourage shared resources, such as grazing lands and water sources, ensuring that animals are raised in humane and environmentally friendly conditions.

Economic Opportunities in Organic Animal Husbandry

Organic animal husbandry in India offers significant economic opportunities, particularly as demand for organic products increases both domestically and globally. Some key areas of opportunity include:

- **Organic Dairy Farming**: Organic milk and dairy products are in high demand due to their health benefits and the absence of synthetic chemicals.
- **Organic Meat Production**: Consumers are increasingly seeking organic, free-range meat that is produced sustainably and ethically.
- **Value-Added Organic Products**: Organic wool, leather, and other animal products are gaining market traction, opening avenues for artisanal and eco-friendly products.
- **Export Potential**: India has a growing market for organic exports, and organic animal products have significant potential in international markets.

Benefits to Farmers and the Economy

Organic animal husbandry not only supports environmental sustainability but also offers numerous economic benefits to farmers. Some of the key advantages include:

1. **Premium Prices**: Organic products often command higher prices in the market. Farmers who invest in organic certification and value addition can access premium pricing for their organic milk, meat, and other animal products, increasing their profitability.

2. **Reduced Input Costs**: By relying on organic feed, natural remedies, and indigenous breeds, organic livestock farmers can reduce costs associated with synthetic inputs like

fertilizers, pesticides, and veterinary drugs. This makes organic farming a more cost-effective and sustainable option in the long run.

3. **Diversification of Income**: Organic animal husbandry allows for the diversification of farm income. Farmers can produce not only organic milk and meat but also wool, leather, and manure-based biofertilizers. Value-added products, such as organic dairy products (cheese, ghee, yogurt), woolen textiles, and organic skincare products derived from animal by-products, offer additional revenue streams.

4. **Climate Resilience**: Organic practices, particularly the use of indigenous breeds and natural feed, are more resilient to climate fluctuations. This can protect farmers from economic losses due to droughts, floods, and other extreme weather events, which are becoming more common in India due to climate change.

5. **Job Creation**: As organic farming and animal husbandry require more labor-intensive management practices, they offer opportunities for job creation, particularly in rural areas. Organic farms tend to rely on more manual labor for activities such as rotational grazing, composting, and health monitoring, thus supporting local employment.

6. **Access to Export Markets**: The global demand for organic animal products is growing, and India is well-positioned to tap into this market. Indian farmers can capitalize on export opportunities for organic milk, meat, leather, and wool, particularly in countries where organic standards are highly valued.

Environmental and Social Impact

1. **Reduction in Environmental Pollution**: Organic animal husbandry reduces the reliance on chemical inputs, such as synthetic fertilizers and pesticides, that can pollute water sources and degrade soil. By integrating manure management and organic feed production, farmers can minimize their environmental footprint.

2. **Conservation of Biodiversity**: Organic farms that prioritize the use of indigenous breeds help conserve genetic diversity, which is crucial for the resilience of livestock populations. Indigenous animals are often more resistant to diseases and better adapted to local climates, thus contributing to the sustainability of the farming system.

3. **Improved Soil Health**: The use of organic manure and compost enriches soil fertility, increases microbial activity, and enhances water retention, all of which are critical for maintaining productive agricultural systems.

4. **Social Empowerment**: Organic animal husbandry empowers smallholder farmers, particularly women, by providing them with an economically viable and sustainable livelihood. Women often play a central role in managing livestock in rural India, and organic farming offers them greater financial independence and social status.

Challenges in Organic Animal Husbandry in India

While organic animal husbandry offers numerous benefits, it also faces several challenges, especially in a country like India, where conventional farming and livestock practices are deeply entrenched. Some of the key challenges include:

1. **Limited Awareness and Knowledge**: Many farmers lack awareness about organic practices and their benefits. This includes understanding certification processes, organic feed production, and sustainable livestock management.

2. **Higher Production Costs**: Organic livestock farming often requires more investment in terms of infrastructure, organic feed, and health care. Organic feeds, for instance, are more expensive and less available than conventional alternatives. This can raise the overall cost of production.

3. **Certification and Compliance**: Organic certification can be a lengthy and expensive process, especially for small-scale farmers. Ensuring compliance with organic standards and undergoing regular inspections can be burdensome for many farmers in rural areas.

4. **Scarcity of Organic Inputs**: In many regions of India, there is a shortage of organic inputs such as organic feed, natural remedies, and veterinary services that cater specifically to organic livestock. This scarcity can hinder the transition to organic farming.

5. **Market Access**: Though the demand for organic products is growing, access to organic markets can be limited. Farmers often struggle with proper marketing channels and face difficulties in getting fair prices for their organic products due to limited consumer awareness and availability of organic marketplaces.

6. **Infrastructure and Support**: Many regions in India still lack the necessary infrastructure for organic animal husbandry, such as processing units for organic meat, dairy, and wool. Additionally, the extension services and support systems for organic livestock farming are not yet robust.

7. **Climate Change Impact**: Climate change is impacting agriculture and livestock farming in India. Extreme weather patterns can disrupt grazing, feed production, and the general well-being of livestock, making it more challenging to maintain organic practices, which are reliant on natural cycles.

Future Prospects and Trends

The future of organic animal husbandry in India looks promising, with growing consumer demand for organic and sustainable products both locally and internationally. The following trends are shaping the future of this sector:

1. **Rising Consumer Awareness**: As consumers become more health-conscious and environmentally aware, the demand for organic products, including organic animal products such as milk, meat, and wool, is set to rise. Organic animal husbandry is well-positioned to meet this growing demand.

2. **Integration of Technology**: New technologies, such as precision farming tools, smart feeding systems, and health-monitoring technologies, are being adapted to organic animal husbandry. These technologies can help farmers optimize their production while adhering to organic principles.

3. **Value Addition and Organic Certification**: Value addition in organic livestock products, such as producing organic ghee, cheese, woolen garments, and biofertilizers, is expected to grow. Farmers who invest in processing and certification can tap into premium markets both domestically and abroad.

4. **Organic and Sustainable Tourism**: There is a growing interest in agri-tourism and organic tourism, where visitors experience farm life and learn about sustainable farming and animal husbandry practices. Organic farms can serve as both production units and educational hubs, diversifying income streams for farmers.

5. **Focus on Indigenous Breeds**: The emphasis on indigenous breeds, which are well-adapted to local climates and require fewer inputs, is gaining momentum. These breeds often have better disease resistance and lower feed requirements, making them suitable for organic farming.

6. **Organic Exports**: India's organic livestock products, including organic dairy and meat, have a growing export potential, particularly in European, North American, and Gulf markets, where consumers are willing to pay a premium for organic, ethically produced goods.

Conclusion

Organic animal husbandry in India is a growing sector with vast potential for promoting sustainability, animal welfare, and economic development. The guidelines set by the NPOP ensure that organic farming practices adhere to strict standards, safeguarding both the environment and consumer health. Organic animal husbandry presents a wealth of economic opportunities, from premium pricing and reduced input costs to market expansion and export potential. As the demand for organic products grows globally, India has the potential to become a major player in the organic livestock sector. However, overcoming challenges related to certification costs, labor intensity, and lower productivity, market access, and infrastructure will require continued government support, investments in education and awareness, and greater collaboration between farmers, researchers, and industry stakeholders. Organic animal husbandry can play a pivotal role in transforming the agricultural landscape in India.

References

1. Azeem, A., Hussain, M., Tahir, M., & Saeed, Z. (2020). *Global organic food market trends and economic opportunities for sustainable agriculture*. Journal of Agricultural Economics, 58(2), 145-160. Retrieved from https://www.jaee.org/articles/organic-food-market
2. Smith, J., Williams, K., & Johnson, L. (2021). *Precision Livestock Farming: Opportunities and Challenges for Organic Systems*. International Journal of Agricultural Technology, 67(3), 220-234. Retrieved from https://www.agritechjournals.org/articles/plf-organic-systems

Chapter 6

VALORISATION OF INEDIBLE ANIMAL PRODUCTS FOR BIOENERGY GENERATION

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Livestock is an important sub-sector of Indian agricultural economy which plays a multifaceted role in providing lively hood support to the rural population and food security. The contribution of livestock sector to the agriculture output has significantly increased from 1.8% to 30.1 % in the year 2020-21 [**24**]. In India, 18 million people are employed in livestock sector. In the last decade, the socio-economic mobility of people has opened a dietary diversification from cereal based to protein rich food. From the year 2009 to 2019, there was 16.6% reduction in the consumption of cereals while there was an increase of 25.4% in the consumption of milk, meat, fish and eggs, reiterating the economic principle as income rise, demand tend to shift towards protein rich foods of animal origin [**10**]. The livestock sector is gradually getting transformed from traditional to commercial and beyond, in the post COVID era. From the perspective of increasing production in 80 and 90's, the current perspective is climate resilient animals, increasing productivity, quality of products, choice for the consumer and value addition [**4**].

Last 70 years has seen unprecedented change in the dairy sector of India. From a milk deficient country in the year 1950, producing a meagre 17 million tonnes of milk, India has transformed into the world's largest producer of milk, producing a bulk volume of 209.96 million tonnes in the year 2020-21, accounting for 17.6% of the total global output [**23**].

As of 2020, India is also the top country by the number of cattle and buffaloes in the world accounting for 33.33% of the world number of cattle and buffaloes possessing 305.4 million animals [**33**]. Though this is a matter of pride, this is also a matter of concern as ruminants are one of the major source of anthropogenic methane emission and also suffer from the after effects of climatic change. Methane is stated to be one of the major greenhouse gases responsible for stratospheric ozone depletion and also 25 times more potent in terms of heat

trapping [**6**]. Livestock and climate change are interdependent and linked through a complex mechanism where adversity of one affects the other one in many ways [**2**].

Animal Farming for fuel

All Animal farming activity can produce fuel in terms of biogas from animal excreta and biodiesel from animal fats. The world is on a quest for energy, the premier source of which is now petroleum. Developing alternate source will carry the flame of progress to the future [**32**]. Energy is the most fundamental requirement of every nation as it progress through the ladder of development. India with 16% of the world population could boast of only 0.5% of the world oil reserves. The estimated crude oil import cost comes to about 10% of the country's Gross Domestic Product [**10**]. With the Indian economy poised for a robust growth of 7.5 to 9.5% per annum, energy security would remain vulnerable until alternative fuels to supplement conventional fuels are developed based on indigenously available feed stocks. The Indian bio-fuel policy 2018 proposed 10 per cent reduction in the import of crude oil in four years' time. Renewable energy is a major source for fighting climate change [**6**]. In bio-fuels, the country has a ray of hope. Development and utilization of new indigenous bio-mass feedstock and development of next generation of more efficient bio-fuel conversion technologies is the need of the hour. In this context, animal farming for fuel offers new scope as it contributes to national energy security by producing 'wealth from waste', following the four basic principles of waste management i.e. REDUCE, REUSE, RECYCLE and RECOVER. [**7**].

The crude oil price has been increasing and fluctuating causing geopolitical instabilities around the world, which prompted the government of India to deregulate the petrol prices. Ever since, the petroleum prices had been increasing steadily. With the onset of the Russian war, the crude has hit the all-time high of 118.42 $. Therefore, the time is ripe to explore the possibilities of 'animal farming for alternate fuel'

Bio-diesel Production from Animal Slaughter Waste

Bio-diesel is an alternate fuel, which is produced from vegetable oil and animal fats that can be used in all diesel engines which reduces vehicular pollution considerably. Bio-diesel can be used in all diesel engines at 20 per cent blending level (B20) without modification. In the engine it reduces the total fuel consumption and brake specific fuel consumption, while it

increases the mechanical efficiency and brake thermal efficiency [**13**]. The biodiesel lead to less engine wear, a quieter engine and better fuel economy. The better lubricating qualities of bio-diesel prevented the overheating of engine. The blending of biodiesel at 20%, substantially reduce the engine emissions as proved by significantly lower smoke levels of 47.14 %. This is due to the high Cetane value of animal fat bio-diesel which has shorter ignition delays, providing more time for fuel combustion, leading to more efficiency and less exhaust emission [**15**].

Poultry industry wastes

World over, the demand for broiler chicken had drastically increased in the last decade. Broiler chicken has become the cheapest source of animal protein in many parts of the globe. India is at present the fourth largest poultry producer in terms of volume. It is estimated that during 2019, about 3.8 million tonnes of poultry meat was consumed in the country, which was valued at about Rs.85, 000 crores [**4**]. In Kerala, it is estimated that about 5.4 lakh birds are slaughtered daily (Ali, 2020). The disposal of this much waste is a daunting task. These waste are collected by agents from the chicken stall at the rate of Rs. 5/kg and are now dispose of in uninhabited areas and in water bodies. This poses a catastrophic threat to the environment and may result in major health hazard. Broiler slaughter waste has become a major source of pollution in the country. The unscientific disposal of these wastes poses catastrophic threats to the human population in the wake of emerging diseases like avian flu, swine flu and rabies. As on now, the broiler slaughter waste and dead birds from commercial poultry farms are un-hygienically disposed off in un-inhabited areas and in water bodies leading to ground and surface water pollution, obnoxious odors and health hazards posed by indiscriminate breeding of pathogenic microorganism, parasites, house flies and also indiscriminate breeding of stray dogs which spreads rabies.

Processing of poultry industry waste

The chicken slaughter wastes inclusive of feather, head, feet and viscera are collected and cooked at high temperature and pressure by a process called ‘dry batch rendering’ during which the oil is extracted. The dry batch rendering process consists of pre-breaking, charging the cooker, cooking, sterilization, drying, centrifuging and milling. The dry rendering machinery comprised of pre-breaker, a travelling electric hoist, horizontal steam jacketed cooker (Dry

Melter), equipped with a set of agitators, percolating tank, fat balance tank, screw press and milling unit. The overall oil yield was 10.84% of the raw material. This is the only method which could immediately hydrolyse the feathers, which contributed 4.55% of the Rendered Chicken Oil (RCO).

The average yield of protein powder was 36.10% of the weight of the slaughter waste loaded into the cooker and the yield of oil was10% of the weight of the slaughter waste [**14**]

Biodiesel Production

Biodiesel production from animal fat/Oil is gaining prominence as this renewable fuel is produced from in-edible oil without any competition for food. It is a two-step reaction, acid catalyzed esterification of the FFA portion of oil followed by the base catalyzed transesterfication of the triglyceride with standardized methanol molar ratio, catalyst concentration, reaction temperature and reaction time to obtain maximum biodiesel yield of 92%. Heterogeneous catalyst was standardized for transesterification of rendered chicken oil, which could reduce the processing cost and it absorbs water leading to better quality bio-diesel [**15**]. 68.5% of the methanol initially used could be recovered back for re-use After methanol recovery the chicken oil biodiesel was first acid washed with 50 vol % of 0.2 wt % H_2SO_4 and then successively with 50 vol % of warm deionised water until the pH of the washing water was the same as of the deionised water. After washing, the biodiesel was vacuum dried (70 °C) for 3 h and stored in a air excluded container [**14**]

The quality of bio-diesel was validated by the quality control lab of B.P.C.L, Kochi refinery. They reported that all the quality parameters were as per BIS specification for bio-diesel (IS-15607). A co-product of this process is glycerol which can be purified into pharmaceutical grade which has wide range of uses in pharmaceuticals, bakery, foods and beverages, expoxy resins etc and fetch about Rs.105/L. The process for the production of glycerine soaps from curde glycerol has been standardized.

Engine testing

Engine testing was carried out by several researchers (Dileep, B.[**3**], Sivadasan, Justin, J. [**18**] as part of their M. Tech research work. Their results revealed that with the use of 20% blend

of bio-diesel (B20), reduced the total fuel consumption and brake specific fuel consumption, while mechanical efficiency and brake thermal efficiency improved compared to commercial diesel. Bio-diesel produced from RCO had a cetane number of 72 compared to petro diesel which had a cetane number of only 54, considerably improving the engine efficiency. The exhaust gas temperature was lower in the entire range of loads. The RCO biodiesel lead to less engine wear, a quieter engine and better fuel economy. The better lubricating qualities of bio-diesel, prevented the overheating of engine. The RCO biodiesel had 11% oxygen by weight which improved the combustion inside the engine. Thus this bio-diesel could substantially reduce the engine emissions as proved by significantly lower smoke levels (47.14%) compared to that of diesel in a CRDI engine, thus have a considerable impact on environmental pollution, mitigating climatic change. The bio-diesel produced from the pilot plant (B20) was continuously tested in a Bolero Jeep without any modification, for three years, which improved its efficiency and became very smooth, emitting significantly low smoke

The swill feeding of pigs provides an opportunity to efficiently convert food waste (swill) into meat and fat. An average body weight of 150.28 ± 7.34 kg could be obtained by feeding 1008.88 kg hotel waste during a period of 51 weeks in Large White Yorkshire pigs. Up on slaughter each pig produced 79.64 kg of lean pork and 39.08 kg of trimmed lard. The fat yield was 5.8 per cent of the live body weight. This could produce 35.17 kg of good quality biodiesel. The premium price of lean pork and biodiesel makes this enterprise an economically viable one. Rearing of pigs by feeding swill gave a net profit of Rs. 34,300 per year per pig [**31**]. Along with this biogas could be produced in an anaerobic digester using pig excreta.

Bio-CNG from Animal Waste

The production of biogas from animal waste to replace LPG has gained priority form consumer point. It solves a major problem of non-availability of cooking gas at affordable price to the common man. At the same time this also utilise animal dung a potential pollutant for renewable energy generation *vis-à-vis* the production of organic manure for organic farming [**11**]. Biogas contains 60% methane, 30% carbon dioxide, 5% hydrogen, 1% nitrogen, 0.3% water vapour and hydrogen sulphide in traces [**25**]

The biogas production potential of different animal waste was worked out by Jyjothi *et al.* [**19**].1 kg of cattle dung could produce 0.077 ± 0.01 m^3 of biogas, while 1kg goat pellets could produce 0.088 ± 0.01 m^3. 1kg pig manure produced 0.092 ± 0.02 m^3 and 1kg poultry droppings could produce 0.082 ± 0.02 m^3. The methane emenating from poultry manure can be effectively sequestered to produce an important cooking fuel in a biogas plant

Rumen model biogas plant

This is a new two stage digestion system, the digester is divided into acidogenic and methanogenic chamber and each chamber is provided with vertical baffles which restrict the movement of digesta through it at the same time increasing the surface area. 2 m^3 of bio-gas could be produced in 24 hours period which was collected in a bio-gas balloon. The Hydraulic Retention Time (HRT) was considerably reduced in this plant to 24 days as compared to 30 days in conventional plant. The organic loading rate increased to 20 kg VS $d^{-1}m^{-3}$ [**12**]. One of the major drawbacks of conventional biogas plants is the inhibition of gas production as the acidogenic bacteria reduces the pH of the digester while the methanogenic bacteria efficiently operates in a strictly defined pH range of 8.00 to 8.50 [**25**]. The balloon could be easily transported from place to place. The composition of biogas was analysed using a bio-gas analyser (Model No. L-314 Precision scientific). The results revealed 63.5% methane, 20.4 % Carbon dioxide and 16.1 % other gases. This gas could be used in stove using a bio-gas compressor which burned continuously for 2 hours 43 minutes under high flame [**26**]

Rumen model biogas plant

Compressed Natural Gas (CNG) Production

Natural gas is 100% methane and 60% of biogas is methane. This process comprises of scrubbing out the contaminants in the biogas to produce pure methane and then compressing at high pressure of 200 bar to form CNG which can be used as a fuel for automobiles and for

cooking. The CNG bottling plants consists of a high-pressure compressor, cascade of storage cylinders and a dispensing nozzle for filling the compressed purified gas in the vehicles. Dried and purified gas goes into the suction of high-pressure compressor, where it compresses the gas to desired working pressure (~200 Bar) and fill into the storage cylinder [**26**]. This cylinder can be used to run vehicles and also as a replacement for LPG. This project will also address the shortage of organic fertilizer for organic farming [**10**].

Compressed CNG plant

Bio-Hydrogen Production

Hydrogen is a clean and efficient fuel of the future, holding the potential to significantly reduce our reliance on fossil fuels and mitigate environmental pollution. One promising method for producing hydrogen is through the utilization of methane, which can be obtained from animal dung. This approach not only provides a renewable source of energy but also addresses waste management issues in agriculture. Methane (CH_4) is a simple hydrocarbon and the main component of natural gas. It is an excellent source of hydrogen due to its high hydrogen content. Methane can be reformed through several processes to produce hydrogen, including steam methane reforming (SMR), partial oxidation, and autothermal reforming. Among these, steam methane reforming is the most widely used method. [**22**]

Steam Methane Reforming (SMR)

Steam methane reforming is the most common method for producing hydrogen from methane. The process involves two main reactions:

1. **Reforming Reaction**:

$$CH4 + H2O \rightarrow CO + 3H2$$

In this endothermic reaction, methane reacts with steam at high temperatures (700-1,000°C) in the presence of a nickel-based catalyst to produce carbon monoxide (CO) and hydrogen (H_2).

2. **Water-Gas Shift Reaction**:

$$CO + H2O \rightarrow CO2 + H2$$

In this exothermic reaction, the carbon monoxide produced in the reforming reaction reacts with steam to produce additional hydrogen and carbon dioxide.

Partial Oxidation

Partial oxidation involves the reaction of methane with a limited amount of oxygen to produce syngas (a mixture of hydrogen and carbon monoxide):

$$CH4 + 21O2 \rightarrow CO + 2H2$$

This process is exothermic and occurs at high temperatures (1200-1500°C).

Autothermal Reforming

Autothermal reforming combines elements of both steam methane reforming and partial oxidation. It uses a mixture of oxygen and steam to convert methane into hydrogen and carbon monoxide:

$$CH4 + 21O2 + H2O \rightarrow CO + 3H2$$

This process is thermally neutral, balancing the endothermic and exothermic reactions.

Environmental Benefits

Producing hydrogen from methane obtained from animal dung has several environmental advantages:

1. **Reduction in Greenhouse Gas Emissions**: By utilizing biogas instead of fossil fuels, this method reduces the overall emissions of greenhouse gases. Methane itself is a potent greenhouse gas, and its capture and conversion to hydrogen prevent its release into the atmosphere.

2. **Waste Management**: This process provides an effective way to manage animal waste, reducing environmental pollution and improving sanitation in agricultural areas.
3. **Renewable Energy**: Biogas is a renewable resource, making hydrogen production from this source more sustainable compared to traditional methods that rely on natural gas.

Economic Considerations

While the environmental benefits are significant, there are also economic factors to consider:

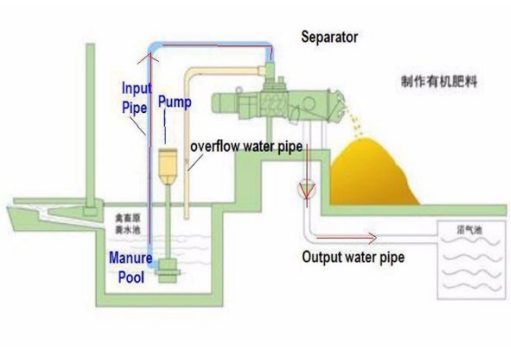
1. **Infrastructure Costs**: Setting up biogas plants and hydrogen production facilities requires significant initial investment. However, these costs can be offset by the long-term benefits of reduced waste management expenses and the generation of renewable energy.
2. **Operational Costs**: The operational costs of anaerobic digesters and reforming units need to be managed effectively. Technological advancements and economies of scale can help reduce these costs over time.
3. **Market Viability**: The market for hydrogen as a fuel is still developing. Government policies, incentives, and the adoption of hydrogen technologies in various sectors will play a crucial role in determining the economic viability of this production method. [**34]**

Dung De-watering machine and briquetting

Dung de-watering machine

Dung de-watering machine is a new addition in scientific manure management. It is a de-watering screw press machine, which reduces the moisture content of the droppings to 20%. The manure mixed with equal quantity of water is pumped up by a submersible 2 HP chopper pump to the screw press, where the manure is pushed forward by the screw and it is pushed back by the back pressure disc, to squeeze out the filtrate. The solid phase is separated from the liquid phase, which flows through the screen. The solid fraction is pushed towards the outlet on which is installed a counter-pressure diaphragm leading to the formation of a material plug. The dried manure is discharged at the end of the screw in a powdered form. The separated water goes into the collection box from where it is pumped for irrigation. This is a good machine to convert animal excreta to odourless organic manure which retains enough moisture for the beneficial

micro-biome to survive. The throughput is 3 to 4 tonnes per hour. The power source is a 3 HP motor for the screw press. A part of the de-watered liquid is again pushed back to the manure collection pit which aids in automatic agitation and prevents settling of large solid particles in the manure collection pit. The manure is rich in organic carbon, phosphorus, potassium, calcium and magnesium. The de-watered liquid has phosphorus and potassium more than the solid fraction which can be used for fodder cultivation [**9**].



Dung de-watering machine

Composition of de-watered dung

	Organic Carbon	**Nitrogen**	**Phosphorus (P2O5)**	**Potassium (K2O)**	**Calcium**	**Magnesium**
De-watered Dung	7.45 ± 0.11%	0.81± 0.15 %	6.66 ± .29%.	0.44 ± 0.14%	19%	18%
Separated Water	1.06 ± 0.21	0.34 ± 0.23	0.86 ± 0.23	0.92 ± 0.15	8%	4%
Dung	7.22 ± 0.13%	0.78 ± 0.21%	0.72 ± 0.24%	0.65 ± 0.17%	16%	14%

A germination and shoot elongation study was conducted in de-watered manure, separated water and control as water using *pisum sativum* seeds. Germination percentage was higher in dewatered manure (92% compared to 90% in control while shoot elongation was highest in separated water compared to control (2 cm in 3 days). [**8**]

Bio-Briquetting

Bio-briquette is a solid fuel made from organic waste, industrial waste, and urban waste. This solid fuel is potentially becomes a cheap alternative fuel because of its needs simple

technology and simple equipment relatively to fossil fuel [**10**]. Cow Dung Bio-briquettes (CDBs) preparation is one of the methods for biomass gasification process to obtain syngas. The dried cow dung obtained from dung-dewatering machine is sun drying, grounding, and briquetting using a four tonne hydraulic press. The calorific heating value of produced cow dung briquetts ranged from 2.92 – 3.325 Kcal/g depend on the particle size of cow dung [**30**]

Future Perspectives

Bio-diesel production technology provides opportunity to produce highly valued bio-fuel from dead animal, birds and slaughter waste, which can improve the engine efficiency and reduce vehicular pollution considerably. Simultaneously, this technology can also solve the major problem of unscientific disposal of dead birds and slaughter waste which is prevalent in developing countries, leading to severe environmental pollution.

As such, animal production in the future may orient towards "Animals for food and fuel" which would revolutionize this sector leading to greater financial viability, production of renewable energy and environmental production. Pigs and poultry would lead this sector because of their excellent attributes such as prolificacy, short generation interval and quick body weight gain for slaughter. Fat less pork at a premium price is gaining consumer acceptance phenomenally. This provides the separated fat to be converted to biodiesel economically. The production of hydrogen from methane obtained from bio-gas/animal dung represents a promising intersection of waste management, renewable energy production, and greenhouse gas mitigation. While there are challenges to overcome, particularly in terms of infrastructure and market development, the potential environmental and economic benefits make this an attractive area for further research and investment. Thus development and utilization of new bio-mass feed stocks for the production of bio-fuel and development of next generation of more efficient bio-fuel conversion technologies awaits the future.

References

1. Ali. N. 2020. Kerala State Poultry Development Corporation, personal communication.
2. Anon. 2022. Annual Report. 2021-22. Department of Animal Husbandry and Dairying. Ministry of Fisheries, Animal Husbandry and Dairying, Government of India. 174 p.
3. Dileep Balakrishnan. 2015. Engine performance of various bio-diesel blends derived from chicken fat. *M. Tech thesis,* Calicut University, Malpuram.

4. Henderson, M.R., Reinert, A. S., Dekhtyar, P and Migdal, A. 2018. Climate Change in 2018: Impact for Business. Harvard Business School. https://www.hbs.edu/environment/Documents/climate-change-2018.pdf
5. Jaganmohan, N. 2020. Consumption volume of poultry meat in India from 2013 to 2019. Statistics available from: http://www.statista.com/statistics/826711/india-poultry-meat consumption. Accessed on [15/05/2024].
6. John Abraham and Anil K.S. 2007. *Global warming and Climatic changes. The impact of Livestock.* -An overview. Souvenir of the Veterinarians annual convention 2007. Pp 57-60
7. John Abraham. 2013. Chapter 16, Microclimatic modification in Animal Husbandry. *Fundamentals of Livestock Meteorology, Vol.II*, Centre for Animal Adaptation to Environment and Climate Change Studies, Kerala Veterinary and Animal Sciences University. Pp 207-217.
8. John Abraham. 2019. Dung de-watering machine, a new addition in manure management. *Compendium of National conference on Innovations in animal production for sustainability in doubling farmer's income. 23-25 January 2019*, College of Veterinary and Animal Sciences, Mannuthy page No.316.
9. John Abraham. 2020. Manure handling in Chapter 4 in the book *Swine Production and Management*. (International Edition) Francis and Taylor. CRC Press.131-132.
10. John Abraham. 2022. Animal Farming for food and fuel. Acta Scientific Veterinary Sciences Vol4. (6) 01-04.
11. John Abraham and Jyothi, S.B. 2019. Advances in Bio-methanisation Technologies. Journal of Indian veterinary association *Vol; 17, Issue 2, August 2019. 07-14.*
12. John Abraham, Jyothi. S.B and Chintu Ravishankar (2017) Comparison of two new digester designs for bio-gas production using cattle dung as substrate. (2017) *Indian Journal of Animal Production and Management.* Vol.33 (3-4) 31-33.
13. John Abraham and Ramesh Saravanakumar. 2014a. Effect of two methods of fat extraction on the proximate composition of poultry carcass meal. *Indian Veterinary Journal,* March, 2014; 91(3) 16-18
14. John Abraham, Ramesh Saravana Kumar, Kulkarni V.V, Singh A. P and Visha. P. 2014. Yield and quality Characteristics of rendered chicken oil. *Journal of American Oil Chemist Society* Vol. 91 (1) pp 133-141.
15. John Abraham and Ramesh Saravanakumar. 2014b. Tamil Nadu Veterinary and Animal Sciences University. *Biodiesel Production from Rendered Chicken Oil*. Indian Patent No. 371344 (219/CHE/2014. Date of Grant: 07/07/2021
16. John Abraham, Ramesh Saravanakumar and M. R. Purushothaman.2015. Factors Affecting Fatty Acid Composition of Farm Animals and its Impact on Human Health. *Journal of Indian Veterinary Association*. Vol. 12, Issue 2, December 2015. 1-5
17. John Abraham, Ramesh Saravanakumar, Francis Xavier and Deepak Mathew. 2015b. Biodiesel production from broiler chicken waste. International *Journal of Biological, Bio-molecular, Agricultural, Food and Biotechnological Engineering*. Vol: 9, No: 12, 2015.
18. Justin Jacob. T. 2016. Reactivity controlled compression ignition combustion using alternate fuel blend. *M. Tech thesis,* Anna University, Chennai.
19. Jyothi, S.B, John Abraham, Deepak Biradar and Sachin. S.P .2017. Bio-gas production potential of ruminant and non-ruminant animal excreta. *Indian Journal of Animal Production and Management.* Vol.33 (3-4) 82-85.,18.

20. Jonathan, H., Frumkin., Tracey, H., Daniel, V. and Andy, H. 2014. Climate Change Challenges and Opportunities for Global Health. *The Journal of the American Medical Association* · September 2021.
21. Olufemi, A., Okocha, R. and Olufemi O. 2014. Global Climate Change. *Journal of Geoscience and Environment Protection*, 2014, 2, 114-122.
22. Rawat, S., Rautela, A., Yadav, I. *et al.* A Comprehensive Review on Enhanced Biohydrogen Production: Pretreatment, Applied Strategies, Techno-Economic Assessment, and Future Perspective. *Bioenerg. Res.* **16**, 2131–2154 (2023). https://doi.org/10.1007/s12155-023-10598-3.
23. Report. 2020. 20th Livestock Census 2019. *All India Report. Ministry of Agriculture, Department of Animal Husbandry and Dairying, New Delhi*. Pp1-54.
24. Report. 2021-22. Economic Survey of India 2021-22, Govt. of India, Ministry of Finance, department of Economic Affairs, January 2022, Chapter 7, Agriculture and Food Management. Pp. 250-263
25. Shradha Shetty, John Abraham, Balusami C and Shehnaaz. 2020. Mechanism of Methane Production in Biogas Plants and its Upgrading Methods. *International Journal of Livestock Research.* Vol.10 (8). 25-32.
26. Shradha Shetty, John Abraham, Balusami C. 2021. Effect and efficiency of two different purification systems for the production of enriched bio-gas. *The pharma Innovation Journal.* 2021; 10 (4): 286-292
27. Shradha Shetty, John Abraham, Balusami C, Sabin George and Renuka Nayar. 2022. Performance analysis of a new two stage restricted flow anaerobic baffled biogas digester. *The pharma Innovation Journal*. SP-11(10): 1746-1750.
28. Sivakumaran Sivaramanan.2015. Global Warming and Climate change causes, impacts and mitigation. https://www.researchgate.net/publication/280548391_Global_Warming_and_Climate_change_causes_impacts_and_mitigation
29. Srivastava, A.K. 2010. Climate Change Impacts on Livestock and Dairy Sector. Issues and Strategies: Pp 127-135. *Lead Papers. National Symposium on Climate Change and Rain fed Agriculture, February 18-20, 2010.* Indian Society of Dry Land Agriculture, Central Research Institute for Dry Land Agriculture, Hyderabad. India.
30. Susanti, A.D., Paryanto and Wibowo, W.A. 2019. Preparation of cow dung bio-briquettes for gasification stoves as renewable energy source. Paper presented in the 1st workshop on engineering, education, applied science and technology. 1364.012012. 1-7.
31. Vijin, V. L., John, A., Balusami, C., Sabin, G., Biju, C. and Sathu, T. 2022. Rearing of Large White Yorkshire pigs for meat and biodiesel production (In Press)
32. Warrier. B.S. 2011. Wells, platforms and the flow of energy. The Hindu, Education plus. 19th September, 2011.
33. World data Atlas.2021. Available: https://www.knoema.com/ATLAS [18 April. 2022]
34. Xing, Y., Li, Z., Fan, Y., Hou, H.2010. Biohydrogen production from dairy manures with acidification pretreatment by anaerobic fermentation. Environ Sci Pollut Res 17:392–399. https://doi.org/10.1007/s11356-009-0187-4

Chapter 7

VALUE ADDITION OF COW DUNG AND URINE IN AGRICULTURE

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1. Introduction

In the realm of sustainable agriculture, the utilization of organic waste materials has gained significant importance. Among these, cow dung and urine stand out due to their rich nutrient content and multifaceted benefits to soil health and crop productivity. Traditionally, cow dung and urine have been integral components of farming systems, particularly in regions with strong agricultural heritages. However, contemporary practices have often overshadowed these natural resources, favouring chemical fertilizers and synthetic additives.

Cow dung, a by-product of bovine digestion, is a powerhouse of organic matter, essential nutrients, and beneficial microorganisms. When decomposed properly, it transforms into high-quality compost, enhancing soil structure, water retention capacity, and microbial activity. This not only boosts the nutrient availability for plants but also promotes a balanced ecosystem within the soil. Furthermore, cow dung has been used in various forms, such as manure, biogas production, and even as a pest repellent, demonstrating its versatility in agricultural practices.

Similarly, cow urine, rich in nitrogen, phosphorus, potassium, and other trace elements, serves as an excellent bio-fertilizer. Its application in fields has shown promising results in terms of increased crop yields and improved plant health. Beyond its fertilizing properties, cow urine possesses pesticidal attributes, offering a natural alternative to chemical pesticides, thus reducing the chemical load on the environment and supporting organic farming endeavours.

This chapter delves into the historical and contemporary perspectives on the use of cow dung and urine in agriculture. It explores the processes involved in converting these waste products into valuable agricultural inputs, examines their benefits over conventional methods, and discusses the role they play in promoting sustainable farming practices. By understanding the value addition of cow dung and urine, we can harness these resources to foster a more eco-friendly and productive agricultural landscape.

Cow dung and urine have been integral components of agricultural practices for centuries. Traditionally used as natural fertilizers, these by-products of cattle are rich in nutrients essential for plant growth. In recent years, the focus on sustainable agriculture has rekindled

interest in these natural resources, highlighting their potential to enhance soil fertility, reduce chemical inputs, and support eco-friendly farming practices.

2. Composition of cow dung and cow urine

The composition of cow urine and cow dung reveals distinct differences in their chemical properties (Table.1). Cow urine has a pH ranging from 7.4 to 8.4, higher electrical conductivity (48-52 dS m^{-1}), and lower organic carbon (1.10-1.30%) compared to cow dung, which has a pH of 7 to 8, lower electrical conductivity (2.5-3.5 dS m^{-1}), and significantly higher organic carbon (10-20%). Nitrogen content is higher in cow urine (0.90-1.01%) than in cow dung (0.3-0.4%), while phosphorus is lower in cow urine (0.017-0.019%) compared to cow dung (0.1-0.2%). Potash content is greater in cow urine (1.65-1.72%) compared to cow dung (0.4-0.5%). Cow dung has higher concentrations of calcium (2000-3000 mg kg^{-1}), iron (1000-2000 mg kg^{-1}), copper (5-10 mg kg^{-1}), manganese (300-500 mg kg^{-1}), zinc (50-100 mg kg^{-1}), and boron (10-20 mg kg^{-1}) than cow urine, which contains lower levels of these elements. However, cow urine has significantly higher levels of sulfur (12789-12800 mg kg^{-1}) and magnesium (980-992 mg kg^{-1}) compared to cow dung, which contains 1000-2000 mg kg^{-1} of sulfur and 300-500 mg kg^{-1} of magnesium.

Table.1. Characteristics of cow dung and cow urine

Parameters	Cow urine	Cow dung
pH	7.4 to 8.4	7 to 8
Electrical conductivity (dS m^{-1})	48-52	2.5 to 3.5
Organic carbon (%)	1.10 - 1.30	10-20
Nitrogen (N) (%)	0.90 – 1.01	0.3-0.4
Phosphorous (P) (%)	0.017 - 0.019	0.1-0.2
Potash (K) (%)	1.65- 1.72	0.4-0.5
Calcium (Ca)(mg kg−1)	104 - 110	2000-3000
Magnesium (Mg)(mg kg−1)	980- 992	300-500
Sulfur (S)(mg kg−1)	12789 - 12800	1000-2000
Iron (Fe)(mg kg−1)	114- 125	1000-2000
Copper (Cu) (mg kg−1)	0.28 - 0.32	5-10
Manganese (Mn) (mg kg−1)	1 - 2	300-500
Zinc (Zn) (mg kg−1)	5 - 7	50-100
Boron (B) (mg kg−1)	2- 4	10-20

3. Uses of Cow Dung and Urine in agriculture

Historically, cow dung has been used in various forms—such as compost, slurry, and dried cakes—for fertilizing crops, building materials, and even as a fuel source. Urine, often overlooked, has been used for its nitrogen-rich content, providing a boost to crop growth. These practices are deeply rooted in many cultures, emphasizing the recycling of organic waste and minimizing environmental impact

Cow dung and urine have been used traditionally in various cultures, especially in rural and agrarian societies, for a wide range of purposes. These uses are rooted in the belief that cows are sacred and their by-products are valuable. Below is a detailed explanation of the traditional uses of cow dung and urine:

3.1. Composting

Composting is a widely used technique that involves the decomposition of organic materials to produce compost which is nutrient-rich soil amendment. It utilizes the natural process of microbial breakdown and transformation of organic matter into stable humus. Composting requires a suitable mix of carbon-rich (e.g., crop residues, straw) and nitrogen-rich (e.g., animal manure, food scraps) materials, along with appropriate moisture and aeration. The organic waste is piled or placed in compost bins, where it undergoes microbial decomposition. Regular turning and monitoring of the compost pile ensure proper aeration and temperature control. Composting can be implemented on a small scale, such as backyard composting, or in larger-scale systems on farms.

Composting of livestock wastes is an effective and sustainable practice that can help reduce waste, improve soil health, and promote organic farming. It involves the decomposition of various organic materials, such as crop residues, animal manure, straw, hay, and other farm by-products, through the action of microorganisms. The end result is a nutrient-rich compost that can be used as a natural fertilizer and soil amendment (Table.1).

Here is a detailed breakdown of the composting process for farm wastes:

3.1.1. Selecting the materials

The first step in composting farm wastes is to gather the appropriate materials. These can include crop residues like paddy straw, corn stalks, wheat straw, or sugarcane bagasse, as well as animal manure from livestock such as cows, pigs, or chickens. It's important to have a balanced mix of carbon-rich (brown) and nitrogen-rich (green) materials to facilitate the decomposition process. Carbon-rich materials include straw, dried leaves, and wood chips, while nitrogen-rich

materials include fresh grass clippings, animal manure, and vegetable scraps. The optimum C:N ratio of the material for effective degradation is 30-35 :1

3.1.2. Preparing the compost pile

Once the materials are collected, they are piled together to create a compost heap or bin. The size of the pile can vary depending on the available space and the amount of waste generated. However, a pile with a minimum size of 3 feet (1 meter) in height, width, and length is recommended to ensure proper heat generation and decomposition.

3.1.3. Layering the materials

Layering the materials is crucial to promote proper airflow and decomposition. Start by creating a base layer of coarse materials like twigs or straw to allow for drainage and aeration. Then, alternate between layers of carbon-rich and nitrogen-rich materials. The carbon-rich layer helps prevent the pile from becoming too compact, while the nitrogen-rich layer provides the necessary nutrients for the microorganisms. Repeat this layering process until the pile is built.

3.1.4. Managing moisture

Moisture is essential for the composting process, as it helps the microorganisms break down the organic matter. The pile should be kept moist but not waterlogged. If the pile is too dry, decomposition will slow down, while excessive moisture can lead to unpleasant odours and anaerobic conditions. Hence, an optimum moisture of 60% should be maintained throughout the composting period.

3.1.5. Turning the pile

Regularly turning or mixing the compost pile helps aerate it and accelerates the decomposition process. This allows oxygen to reach the microorganisms, preventing the formation of foul-smelling anaerobic conditions. Turning the pile every 15 days with a fork or shovel helps ensure that all parts of the compost are exposed to oxygen.

3.1.6. Monitoring temperature

As the organic materials decompose, the compost pile generates heat. Monitoring the temperature is important because it indicates the activity of the microorganisms. Ideally, the compost pile should reach temperatures between 130°F and 160°F (55°C and 70°C). These high temperatures help kill weed seeds, pathogens, and undesirable insects. If the temperature drops significantly, turning the pile can reignite the decomposition process.

3.1.7. Allowing for maturation

The composting process can take several days to months, depending on various factors such as the size of the pile, the materials used, and the environmental conditions. During this time, the compost pile gradually breaks down, and the organic materials transform into a dark, crumbly, and earthy-smelling substance. This mature compost is rich in nutrients and can be used to enrich soil.

3.1.8. Using the compost

Once the compost has matured, it is ready for use. It is recommended as basal fertilizer @5 t /ha for all the crops. It can be spread on fields or used in garden beds as a natural fertilizer and soil conditioner. The nutrients released from the compost improve soil structure, water-holding capacity, and nutrient content, promoting healthy plant growth. Compost can also help suppress plant diseases and enhance overall soil biodiversity.

It's important to note that composting farm wastes should be done responsibly to avoid potential issues. Here are a few considerations:

(i) **Avoiding contaminants:** Care should be taken about introduction of contaminants into the compost pile. Avoid adding materials that may contain pesticides, herbicides, or chemicals that could potentially harm plants or animals.

(ii) **Managing odor and pests**: Properly managing the compost pile can help minimize odors and deter pests. Avoid adding meat, dairy products, or oily substances, as they can attract unwanted animals. Covering the compost pile with a tarp or using a compost bin with a lid can help contain odors and prevent animals from accessing the pile.

(iii) **Composting large-scale farm waste:** Large-scale farm waste composting requires additional considerations, such as mechanical turning equipment, proper space allocation, and monitoring systems.

Nutrient content of compost

Biocompost	Nutrient content (%)		
	Nitrogen	Phosphorus	Potash
Animal Refuse			
Cattle dung	0.3 - 0.1	0.1 - 0.2	0.1 - 0.3
Horse dung	0.4 - 0.5	0.3 - 0.4	0.3 - 0.4

Sheep dung	0.5 - 0.7	0.4 - 0.6	0.3 - 0.1
Night soil	1.0 - 1.6	0.8 - 1.2	0.2 - 0.6
Poultry manure	1.8 - 2.2	1.4 - 1.8	0.8 - 0.9
Cattle urine	0.9 - 1.2	Trace	0.5 - 1.0
Horse urine	1.2 - 1.5	Trace	1.3 - 1.5
Sheep urine	1.5 - 1.7	0.1 - 0.2	0.1 - 0.3
Wood Ash			
Ash Coal	0.73	0.45	0.53
Ash Wood	0.1 - 0.2	0.8 - 5.9	1.56 - 36.00
Habitation waste & factory waste			
Rural compost	0.5 - 0.1	0.4 - 0.8	0.8 - 1.2
Urban compost	0.7 - 2.0	0.9 - 3.0	1.0 - 2.0
Farmyard manure	0.4 - 1.5	0.3 - 0.9	0.3 - 1.9
Filter press cake	1.0 - 1.5	4.0 - 5.0	2.0 - 7.0
Straw and stalk			
Pearl millet	0.65	0.75	250
Cotton	0.44	0.10	0.66
Banana pseudo stem	0.61	0.12	1.00
Sorghum	0.40	0.23	2.17
Maize	0.42	1.57	1.65
Paddy straw	0.36	0.08	0.71
Tobacco	1.12	0.84	0.80
Pigeon pea	1.10	0.58	1.28
Sugarcane trash	0.53	0.10	1.10
Wheat	0.53	0.10	1.10
Tobacco dust	1.10	0.31	0.93

3.2. Compost tea

Compost tea is a liquid organic fertilizer and soil conditioner made by steeping compost in water, along with other additives, to extract the beneficial microorganisms and nutrients from the compost. This nutrient-rich liquid can be applied to plants and soil to improve plant health,

stimulate growth, and enhance soil quality. Compost tea is a valuable addition to organic gardening and farming practices.

Dilute the compost tea with clean water (usually a 1:10 ratio of compost tea to water) and apply it to plants or soil. Watering can, sprayer, or irrigation system can be used. It's best to apply compost tea within a few hours of straining to ensure the microbial activity is still high. Compost tea is a valuable natural fertilizer and soil conditioner that enhances the soil's biological activity and improves plant health. Regular applications can lead to healthier, more productive gardens and crops.

3.3. Vermicomposting

Vermicomposting is a specialized form of composting that utilizes earthworms to decompose organic waste materials. Earthworms consume and break down the organic matter, producing nutrient-rich castings or vermicompost. Vermicomposting is ideal for managing food scraps, kitchen waste, crop residues, animal dung, and other organic materials. It can be done in small-scale systems, such as vermiculture bins or beds, which provide a suitable environment for the worms to thrive. Vermicompost is highly valued for its nutrient content, microbial activity, and ability to improve soil structure.

Vermicomposting is a process that utilizes earthworms to decompose organic wastes and convert them into nutrient-rich compost. It is an effective and sustainable method of recycling organic materials while producing high-quality fertilizer for plants. The worms used in vermicomposting are *Eudrilus eugeniae*, *Eisenia fetida* or *Lumbricus rubellus*, it consumes the organic matter and excrete nutrient-rich castings, which are also known as worm castings or vermicompost.

The details of vermicomposting process are listed below.

3.3.1. Selecting a vermicomposting system

There are various vermicomposting systems available, ranging from simple home setups to larger-scale commercial systems. The selection of a system depends on the amount of organic waste generated and the available space. Common systems include stacked bins, flow-through systems, or even outdoor windrows for larger operations.

3.3.2. Choosing the bedding material

The bedding material provides a favourable environment for the worms and helps retains moisture. Suitable bedding materials include shredded newspaper, cardboard, coconut coir, straw, or a combination of these. The bedding should be moistened before adding the worms and organic waste.

3.3.3. Introducing the worms

Once the bedding material is prepared, the worms can be introduced. Red worms are most commonly used in vermicomposting due to their high consumption rate and ability to thrive in organic waste environments. The number of worms required depends on the size of the vermicomposting system and the amount of organic waste produced. A general guideline is to start with 0.5 kg of worms for every square foot (0.09 square meters) of surface area.

3.3.4. Adding organic waste

The pre-digested organic waste should be added in the vermicompost bed. Suitable materials for vermicomposting include animal dung, fruit and vegetable scraps, coffee grounds, tea leaves, crushed eggshells, shredded plant trimmings, and other non-animal food waste. It's important to avoid adding meat, dairy, oily substances, and large quantities of citrus or acidic materials, as they can be detrimental to the worms' health.

3.3.5. Maintaining the vermicomposting system

Regular maintenance is necessary to ensure optimal conditions for the worms and the decomposition process. Here are some key considerations:

- **Moisture:** The vermicomposting system should be kept moist. Around 60% of the moisture should be maintained. Dry conditions can harm the worms, while overly wet conditions can lead to anaerobic conditions and unpleasant odors.
- **Temperature:** Worms thrive in temperatures between 55°F and 77°F (13°C and 25°C). It's important to provide a suitable environment by keeping the vermicomposting system within this temperature range. Insulating the system in colder climates or shading it in hotter climates can help regulate the temperature.
- **Airflow:** Adequate airflow is crucial for the worms' health and the decomposition process. Avoid compacting the bedding material and periodically fluff it to maintain proper aeration.

Some vermicomposting systems have built-in ventilation or can be manually aerated using a pitchfork or similar tool.

3.3.6. Harvesting the vermicompost

Over time, the worms will convert the organic waste into nutrient-rich castings. Harvesting the vermicompost involves separating the worms from the finished compost. There are several methods to do this:

- **Migration method:** Create a new section in the vermicomposting system with fresh bedding/cowdung and food. Place it next to the section with mature compost. The worms will migrate to the new section in search of food, allowing you to collect the worm-free vermicompost.
- **Hand sorting method:** Spread a tarp or plastic sheet on a flat surface and dump the contents of the vermicomposting system onto it. Create small piles and expose them to light. Since worms dislike light, they will burrow deeper into the pile, allowing you to remove the top layer of worm-free vermicompost.
- **Screen method:** Use a screen or sieve with holes large enough for the worm castings to pass through but small enough to retain the worms. Sift the vermicompost, collecting the fine castings and returning any worms caught in the screen back to the vermicomposting system.

3.3.7. Using the vermicompost

The harvested vermicompost is a nutrient-rich organic fertilizer and soil amendment. It is recommended @ 5t/ha for all the crops as basal dose. It can be used in various ways:

- **Garden soil amendment:** Mix the vermicompost into garden soil to improve its structure, water-holding capacity, and nutrient content. Apply it as a top dressing or incorporate it during soil preparation.
- **Potting mix component:** Use vermicompost as a component in homemade or commercial potting mixes to enhance plant growth and health.

3.3.8. Nutritive value of vermicompost

The nutrients content in vermicompost vary depending on the waste materials that are being used for compost preparation. If the waste materials are heterogeneous one, there will be wide range of nutrients available ion the compost. If the waste materials are homogenous one,

there will be only certain nutrients are available. The common available nutrients in vermicompost are as follows.

Organic carbon (%)	=	9.50 - 17.9
Nitrogen (%)	=	0.50 - 1.50
Phosphorus (%)	=	0.10 - 0.30
Potassium (%)	=	0.15 - 0.56
Sodium (%)	=	0.06 - 0.30
Calcium & Magnesium (meq/100g)	=	22.7 - 47.6
Copper (mg kg^{-1})	=	2.00 - 9.50
Iron (mg kg^{-1})	=	2.00 - 9.30
Zinc (mg kg^{-1})	=	5.70 - 11.5
Sulphur (mg kg^{-1})	=	128 - 548

3.3.9. Benefits of vermicompost

- Vermicomposts have higher nutritive value when compared to Bio-compost
- Vermicompost have higher number of beneficial organisms like *Azotobacter, Azosprillum* and phosphobacteria
- These beneficial organisms contribute their benefits to the vermicompost
- Vermicomposts have growth promoting substances like indole acetic acid and gibberellic acid influence crop growth.

3.4. Vermiwash

Vermiwash is the liquid that is collected after water passes through vermicompost made by earthworms. It is rich in plant growth hormones, micro-nutrients, and major nutrients like nitrogen, phosphorous and potassium.

Vermiwash unit

The vermiwash unit is prepared in a drum, tank or bucket of about 200 liters capacity of clay, iron or plastic. The upper part of the drum should be open for making vermiwash. By making a hole in the bottom of the tank, put a vertical "T" shaped tube, whose half inch should be submerged inside the tank. One side of the hose is attached with a tape and the other side is tightened with a dummy nut. The entire set is kept in a shady place above a proper post. Useful items for preparing vermiwash is Dung, soil, coarse sand, earthworm, straw or dry leaves, earthen pot, water, bucket, drum, small pieces of brick or ballast etc.

Application: Vermiwash can be applied in various ways, including foliar spraying @ 3%, root drenching, or as a soil amendment. It's important to dilute vermiwash with water before application to prevent over-fertilization and to ensure even distribution.

3.5. Anaerobic Digestion:

Anaerobic digestion (AD) is a natural biological process that breaks down organic materials in the absence of oxygen, resulting in the production of biogas and nutrient-rich digestate. This process has gained significant attention as a sustainable waste management solution that simultaneously addresses energy generation and nutrient recycling needs.

3.5.1. Anaerobic Digestion Process: Anaerobic digestion occurs in several stages, each facilitated by specific groups of microorganisms. The process can be divided into four main stages:

a) **Hydrolysis:** Complex organic materials such as proteins, carbohydrates, and fats are broken down into simpler compounds by hydrolytic bacteria. This stage prepares the waste for further degradation.

b) **Acidogenesis:** Acid-forming bacteria convert the simpler compounds from hydrolysis into volatile fatty acids, alcohols, and other organic acids.

c) **Acetogenesis:** Acetic acid-forming bacteria convert the organic acids produced in the previous stage into acetic acid, hydrogen, and carbon dioxide.

d) **Methanogenesis:** Methane-forming archaea convert acetic acid, hydrogen, and carbon dioxide into methane (CH_4) gas, which constitutes the primary component of biogas.

3.5.2. Products of Anaerobic Digestion:

a) **Biogas:** The methane-rich biogas produced during anaerobic digestion can be used as a renewable energy source. It has various applications, including electricity generation, heating, and fueling vehicles.

b) **Digestate:** The residual material remaining after anaerobic digestion is known as digestate. It is nutrient-rich and can be used as a valuable organic fertilizer, helping to close nutrient loops in agriculture.

3.5.3. Benefits of Anaerobic Digestion:

a) **Renewable Energy Generation:** Biogas produced during anaerobic digestion contains methane, a potent greenhouse gas. By capturing and utilizing biogas, AD reduces methane emissions while generating clean and renewable energy.

b) **Waste Management:** AD reduces the volume of organic waste and minimizes its environmental impact. It provides a sustainable alternative to landfilling or incineration.

c) **Nutrient Recycling:** The nutrient-rich digestate can replace synthetic fertilizers, reducing the reliance on non-renewable resources. This enhances soil fertility, improves crop yields, and supports sustainable agriculture.

d) **Greenhouse Gas Reduction:** AD reduces greenhouse gas emissions by preventing the release of methane, which is more harmful to the environment than carbon dioxide.

e) **Waste Valorisation:** AD transforms organic waste into valuable resources—energy and nutrients—contributing to a circular economy.

3.6. Panchagavya

Panchagavya is an excellent natural liquid fertilizer made from materials derived from cows. It promotes crop growth and enhances resistance to pests and diseases. In Tamil Nadu, Panchagavya has revolutionized organic farming and has made a global impact.

Materials required : Cow dung: 5 kg, Cow's urine : 3 L, Cow's milk : 2 L, Curd : 2 L, Ghee : 1 L., Tender Coconut: 3 lit, jaggery : 3 kg, Ripened banana 1 kg

Procedure

- Collect fresh cow dung, mix it with ghee, and keep it in a wooden or plastic barrel for 3 days.
- On the third day, mix in the other ingredients (cow's urine, cow's milk, cow's curd, etc.) in the same wooden or plastic barrel. Allow the contents to ferment for 15 days, stirring with a wooden stick twice a day.
- Cover the mouth of the barrel with netted cloth or khada cloth.
- After 15 days, filter the product using khada cloth or Terracotta (TC) cloth and store it in closed containers. Pierce small holes in the caps of the containers to prevent bursting.
- It can be stored for 6 months; dilution should be done only at the time of spraying.

Note:

1. Avoid airtight bottles for storage.
2. Shake the bottle once in 3 days to avoid fungal mycelia growth on the surface.
3. Use wooden sticks for stirring
4. The water used can be tap water.

Dosage: 3 % for foliar spray for all the crops, 50 litres/ha for soil application for all the crops

Role of Panchagavya in Crop Improvement

- It provides nutrients to the plants.
- Improves the growth of crops
- Increases root multiplication of crops
- Protects crops from pest and disease attack
- Helps in producing quality produce
- Increases crop yield by 20 to 23 percent.

3.7. Formulations/Concoctions to active soil biology

Although many local and on-farm-based natural formulations or concoctions (mixtures) are used in chemical free farming approaches such as organic farming, Panchagavya farming,

biodynamic farming, nateco farming, etc., the natural farming relies on on-farm prepared formulations or concoctions among which the important ones used are seed invigoration through Beejamrit, re-invigorating the soil through Jeevamrit, Ghanjeevamrit. The preparation technique and detailed guidelines for the use of these formulations are described by Hari Om et al. (2024). Some key bio-concoction employed under natural framing practices are:

3.7.1. Beejamirth

It is basically made up of water (20l), cow dung (5 kg), urine (5 litre), lime (50gm) and just a handful of soil.

3.7.1.1. Preparation

- Take 5 kg of cow dung, wrap it in a cloth, tie it with a small rope to form a bundle, and hang it for 12 hours in 20 liters of water.
- In another container, dissolve 50 g of lime in 1 liter of water and leave it overnight.
- The next morning, squeeze the cow dung into the water, add a handful of soil, and stir well.
- Add 5 liters of Desi cow urine and the lime water to the solution, and stir well.

3.7.1.2. Usage

- Add *beejamirth* to the seeds of any crop, coat them by mixing by hand, dry them well in the shade, and use for sowing. For leguminous seeds, simply dip the seeds quickly (for 5 minutes), dry them well in the shade, and use for sowing.
- While transplanting, dip the roots of the seedlings, setts, or cuttings in the *beejamirth* solution for five minutes before planting or transplanting.
- Treating the seeds in *beejamirth*, drying them in the shade, and then using them for sowing protects the crops from harmful fungi, bacteria, and other pathogens of soil-borne diseases. It contains hormones and alkaloids that enhance germination and protect seeds and seedlings (Palekar, 2006).
- It is used for seed dressing or dipping seedling roots. Seed dressing involves coating seeds with Beejamrit before sowing and drying them in the shade. Beejamrit has been shown to protect seeds and young seedling roots from soil-borne and seed-borne pathogens, reduce germination time, and enhance seedling vigor, leading to better

growth. The application of beneficial microbes to seeds effectively places microbial inocula in the soil, positioning them to colonize seedling roots and protect them against soil-borne diseases and pests (O'Callaghan, 2016). Microbes improve seed germination, shoot and root length, seedling vigor, and crop performance (Wu et.al., 2016). Beejamrit promotes root dry weight and root proliferation (Colla et.al., 2015), enhancing nitrogen, nutrient, and water uptake by crop plants. Study undertaken by Indian Council of Agricultural Research establish that Beejamrit provides a dynamic, microbe-based metabolic network and may, therefore, act as a plant biostimulant to crop plants. A plant-based bioassay finally demonstrates the role of Beejamrit in the seed treatment to improve seed germination, seedling survival rate, and shoot length trait in French beans ($p < 0.01$). In conclusion, this study highlighted, for the first time, the scientific insights of Beejamrit as a potential seed priming agent in agriculture (Shibasis Mukherjee et al., 2022). Therefore, treating seeds with Beejamrit can contribute to the nitrogen budget of crops by reducing leaching losses and increasing plant uptake.

3.7.2. Jeevamirth

It is a fermented microbial culture made from on-farm ingredients. *Jeevamrit* acts as a catalyst, promoting soil microorganism activity, including earthworms, and making nutrients available to crops. Indigenous cow dung and urine produce the best *Jeevamrit* due to higher beneficial microbial populations, but it can also be prepared using dung and urine from other breeds.

3.7.2.1. Preparation method

Jeevamrit is a miracle microbial culture and is not a fertilizer. The useful soil microorganisms, earthworms are activated when *Jeevamrit* given with irrigation water. Desi cow dung is the main base of *Jeevamrit.*

3.7.2.2. Ingredients for Jeevamrit:

- Water 200 liters
- Jaggery 2 kg
- Cow dung 10 kg
- Pulse flour 2 kg
- Cow urine 10 l
- Handful of soil from farm/forest/bund

3.7.2.3. **Procedure**

- Take a 50-liter container or plastic drum and add 10 kg of cow dung, 10 liters of cow urine, and 10 liters of water. Mix it thoroughly.
- Then add 2 kg of pulse flour, 2 kg of organic jaggery, and a handful of garden soil, along with 10 liters of water.
- Stir the mixture clockwise to form a homogeneous solution.
- Transfer this solution to a 200-liter plastic barrel and top up the volume to 200 liters.
- Keep the drum in the shade or in a room and cover it with a wet jute bag.
- Stir the solution daily in a clockwise direction in the morning, afternoon, and evening.
- Incubate the solution for 4 to 7 days before using it (Palekar, 2006 and Devakumar et al., 2008)

3.7.3. Gnanajeevamirth : *It is solid form of Jeewamirth used for soil application*

3.7.3. 1.. Ingredients

- Cow dung - 50 kg
- Cow urine - 10 l
- Jaggery – 2 kg
- Green Gram powder – 2 kg
- Soil

3.7.3.2. Preparation methods

It is composed of the cow-dung, cow urine, jaggery and pulse flour and a hand full of soil. These ingredients are mixed together and make a ball like structure. While preparing the lumps should not be formed. Shade dry it and store for 6 months.

3.7.3.3. Usage: 100 kg / acre for soil application during last plough

The average nutrients content of above concoctions (Choudhary *et al*., 2022) are given below.

Concoctions/special manures	N (%)	P (%)	K (%)
Beejamirt	0.72-2.38	0.12-0.14	0.23-0.49
Jeevamirt	0.25-1.40	0.13-0.42	0.26-0.31

Ghanjeevamirt	1.05-1.80	0.16-0.30	0.68-0.85

3.8. Amudham solution

Required Ingredients: 5 liters of cattle urine, 1 kg of dung, 1 liter of juice from any waste fruit. **Preparation:** Mix the cow dung thoroughly with the urine and juice, and let the mixture ferment for five days. This solution can only be used with irrigation, not for spraying. Use 20–30 liters per acre to support crop growth.

Usage: Add one liter of this solution to ten liters of water (for a 10% solution) for spraying

3.9 Pest Repellent

Both cow dung and urine are used as natural pest repellents in farming. Cow dung, when dried and burned, produces smoke that repels insects and pests. Cow urine, when mixed with water and sprayed on crops, helps in keeping away harmful insects.

3.9. Future Directions and Opportunities

The future of cow dung and urine in agriculture looks promising, with ongoing research exploring new applications and improved processing techniques. The potential for integrating these resources into urban agriculture and horticulture presents exciting opportunities, particularly in the context of growing interest in sustainable and organic food production. The use of modern technologies, such as IoT and precision farming, can further enhance the efficiency and effectiveness of these natural fertilizers, enabling more targeted and sustainable agricultural practices.

Conclusion

Cow dung and urine have significant potential to contribute to sustainable agriculture, offering both environmental and economic benefits. By leveraging these natural resources, farmers can improve soil health, reduce chemical inputs, and promote eco-friendly farming practices. As the world moves towards more sustainable and resilient agricultural systems, the value addition of cow dung and urine will play a crucial role in this transformation.

References

1. Colla, G., Rouphael, Y., Di Mattia, E., El-Nakhel, C., Cardarelli, M. (2015) Coinoculation of *Glomus intraradices* and Trichoderma atroviride acts as a biostimulant 18 to promote growth, yield, and nutrient uptake of vegetable crops. Journal of the Science of Food and Agriculture 95, 1706-1715. https://doi.org/10.1002/jsfa.675.
2. Devakumar, N., Rao, G.G.E., Shubha, S., Nagaraj, I.M., Gowda, S.B. (2008). Activities of Organic Farming Research Centre. Navile, Shimoga, University of Agriculture Sciences Bangalore, 12 p
3. O'Callaghan, M. (2016) Microbial inoculation of seed for improved crop performance: issues and opportunities. Applied Microbiology and Biotechnology 100, 5729–5746. https://doi.org/10.1007/s00253-016-7590-9.
4. Palekar, S. (2006) The principles of spiritual farming II. 2nd ed. Zero Budget Natural Farming Research, Development & Extension Movement, Amravati, Maharashtra, India. Available at: http://www.vedicbooks.net/principles-spiritual-farming-volume-p14779.html (Accessed on 23 July 2024).
5. Shibasis Mukherjee, Suchana Sen, Md. Nasim Ali, Rupak Goswami, Argha Chakraborty, Krishnendu Ray, Rantim Bhattacharjee, Bhubaneswar Pradhan, N. Ravisankar, Gautam Chatterjee.2022. Microbiological properties of *Beejamrit,* an ancient Indian traditional knowledge, uncover a dynamic plant beneicial microbial network, World Journal of Microbiology and Biotechnology, 38 (111): 1-12
6. Wu, Y.N., Feng, Y.L., Paré, P.W., Chen, Y.L., Xu, R., Wu, S., Wang, S.M., Zhao, Q., Li, H.R., Wang, Y.Q., Zhang, J.L. (2016) Beneficial soil microbe promotes seed germination, plant growth and photosynthesis in herbal crop *Codonopsis pilosula*. Crop and Pasture Science 67(1), 91–98

Chapter 8

VALUE ADDITION AND BUSINESS OPPORTUNITIES IN FISHERIES SECTOR

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Introduction

Fish and other fishery products are recognized as a very rich source of nutritious food items. Fish provides a high amount of unsaturated fatty acids, lipids, proteins, calcium, phosphorus, iron, etc. The nutritional value of fish outweighs its food cost and logistic difficulties due to its high perishable nature. Fish proteins are scored high among animal proteins due to high acceptability, low cholesterol, high digestibility and fat content when consumed. Fish is a preferred protein source in many geographic locations globally and is regularly consumed in many economies. However, raw fish is highly susceptibility to spoilage by enzymatic and bacterial activities while it is harvested from aquaculture farms or from marine catch. Hence, these properties pose a problem for the preservation and adding value to the products. As a result of these spoilage activities leading to an increase in the rate of fish post-harvest loss, developing better fishery product that enhances the shelf life along with increasing the value of the fishery product has become a necessity. Value can be added to the product simply by increasing the practicality of the fishery, like enhancing the quality, shelf life and acceptability of the product through consumer preferences.

Overview of the Fishery Industry

Worldwide, fish and fishery products have emerged as valuable commodities in balance-of-payments considerations. The increasing importance of this sector lies in the fact that fish is the cheapest source of animal protein and the major source of animal food for around 75% of the earth's population. This underlines the critical role that the industry continues to play in national economies. It is important to understand and recognize the existing unexplored potential in improving the operations of the fish processing industry.

The term "fishery industry" refers to the collective activities involved in the harvesting, processing, and marketing of fish and fishery products up to the retail stage, while "fish trade" deals only with the commerce of such products. With intensive development in technology, marketing, and scientific investigation, the nature and scope of fishery operations and commercial activities have seen a rapid transformation in mode, size, technique, methods, and devices. The complexity and scope of modern fishing relative to fish collection for domestic use are intricate enough to have led to the formation of a separate and new branch of the fishery industry, viz. fishing. There has been remarkable growth in the fishing industry worldwide during the present century and the rise in the size and investment of the industry has been almost continuous except in those places where the resources have become depleted

Fish and fishery products are a very rich source of protein, omega-3 fatty acids and are widely consumed throughout the world. India is the second largest fish producing and exporting nation globally. Despite the growing demand for the fishery products, there was a problem of handling the increased production of low-value fish along with the rising demand for fish. As a solution, the fish processing was developed to take advantage of value additions to fish or fishery products. At present, along with exporting raw fishery products, there is an immense potential to export ready-to-eat products developed from low value fishes to capture the ever-increasing demand for processed fishery products in India.

Importance of Value Addition in the Fishery Sector

Fish is a good source of rich source of protein, omega-3 fatty acids. The nutritional value of fish outweighs its food cost and logistic difficulties due to its perishable nature. Raw fish when transformed and processed under different conditions produces a product that has enhanced shelf life and value. The low value fishes, that earlier were being discarded can be developed into value added products such as canned, smoked, frozen, breaded or battered fish, enables the fishermen and the seafood industries to significantly increase their overall profitability. Value addition also helps in waste reduction, by utilizing the parts of the fish like bones, skins, head, fins, scales which would otherwise be discarded into value added fishery by-products. Through this waste reduction and utilization of the entire fish it contributes to the long term preservation and the sustainable use of fishery resources. The developed by-products can include fish meal, fish oil, fish skin leather, or any other analog products. Canned and frozen seafood have longer shelf life making them more accessible to consumers. It also enables these products to reach

distant markets while reducing the risk of spoilage during transportation and storage. Value added products also contribute to food security by making nutritious seafood available and easily accessible to consumers. Value addition also creates additional employment opportunities contributing to the overall economic development of communities that rely on the fishery sector. Adhering to specific regulatory standards and requirements, such as labeling, safety and quality standards we can access a broader market segment. Facilitating the implementation of the traceability systems, allows better tracking and handling of the seafood, thereby enhancing transparency and consumer confidence. These benefits can contribute to the overall development of the value added fishery sector.

Techniques and Methods of Value Addition in the Fishery Sector

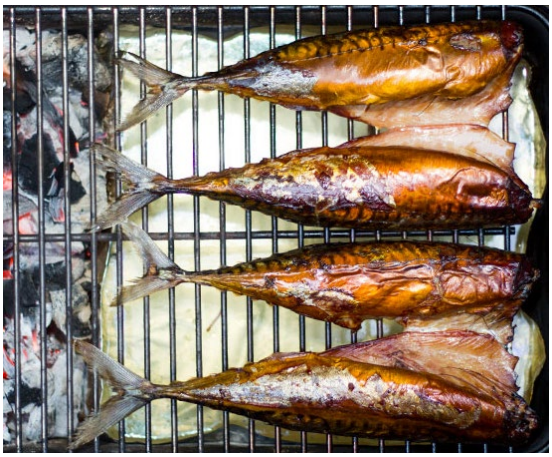
The fishery sector offers numerous opportunities for enhancing the value, which can be achieved through a variety of techniques and methods. An overview of several essential techniques and methods employed for value addition within the fishery are identified. These techniques are based on the processing and preservation methods, product diversification, by-product utilization, packaging and labeling techniques, eco-labeling and certification, product development and innovation.

Processing techniques such as canning, freezing, drying, smoking and pickling enhance the sensory properties and the nutritional value of the fishery products. Employing these techniques, we can diversify and enhance the value of the product by items such as fish sausages, fish balls, fish cutlets, breaded and battered seafood, canned fishery products. This enables them to accommodate a broader spectrum of consumer preferences and market demand. Improving the overall utilization of the seafood resources also while reducing waste can allow us to generate much greater value through processing seafood by-products from fish heads, skins and bones by transforming these materials into certain products like fish meal, fish oil, collagen, fish protein hydrolysate, fish skin leather. Investment in research and development can lead to the creation of novel value-added products. More advanced techniques like extraction and utilization of bioactive compounds from seafood into these value-added products can be utilized to produce products benefiting human health. The implementation of these techniques and methods allows fisheries to augment the value and competitiveness, resulting in heightened profitability, waste reduction and enhanced sustainability within the industry.

Smoking and Drying

Smoking and drying represent two traditional methods that significantly enhance the value of the fishery product. These processes not only prolong the preservation of the seafood but also contribute distinctive texture and flavor that attracts a diverse consumer base.

Smoking



Smoking is a process that involves exposing fish to the smoke generated from the combustion of specific types of wood or other materials. The smoke imparts distinct flavors, colors, and preservative properties to the fish. There are mainly two types of smoking techniques i.e., cold smoking and hot smoking.

Cold smoking is a method of preservation that preserves the raw texture and moisture content of the fish, resulting in a delicately smoked flavor. This is carried out by exposing the fish such as salmon and trout, to smoke at a comparatively low temperature, usually between 20°C and 30°C. Hot smoking involves exposing fish to smoke at a higher temperature, typically between 65°C and 80°C. At this temperature, the fish is partially cooked, resulting in a firmer texture and a more pronounced smoky flavor.

Smoking is typically characterized by several distinct stages such as brining, drying and smoking. Brining is a crucial step that enhances the taste and shelf life of the fish, whereas the drying process is essential for removing excess moisture which in turn reduces the likelihood of microbial growth. The smoking phase that contributes to its intended smoke flavor and color may extend from several hours to several days.

Drying

Drying is another traditional method that involves removing moisture from the fish, resulting in a product that is shelf stable with more concentrated flavor and improved texture. There are several drying techniques that enhance the value of the fish product. In regions marked by warm, dry climates and low humidity levels, sun drying, a traditional method is used by exposing fish to direct sunlight, allowing moisture to evaporate manually. This produces products such as bacalao (dried salted cod), katsuobushi (dried bonoto flakes), balyk (dried sturgeon meat) and trepang (dried sea cucumber). In the absence of such environmental conditions, the use of specialized equipment, such as dehydrators or drying ovens are used to remove the moisture from the fish and this process is known as mechanical drying. This method allows for more controlled drying conditions, such as temperature and air circulation, thereby producing a final product that exhibits greater consistency and predictability. Mechanically dried fish products, like dried squid or fish jerky, have a longer shelf life, facilitating their distribution to remote markets. The essential aspect of any drying method is to achieve an equilibrium that effectively eliminates sufficient moisture to prevent spoilage, while simultaneously preserving the intended texture and flavor characteristics. Proper attention to handling, storage, and packaging is vital to uphold the quality and safety of dried fish products.

Canning and Packaging

These are two essential value addition techniques in the fishery sector that not only extends the shelf life of the seafood product but also their distribution to more extensive markets, which in turn enhances the profitability and competitiveness of the sector.

Canning

Canning is a method of food preservation in which food is packed in metal or glass or plastic containers, sealed air tight and heated sufficiently to destroy the spoilage, pathogenic and poisoning microorganisms making the food safe for consumption. This process effectively extends the shelf life of the seafood and can be made instantly available for consumption with little or no further preparations for the table. The canning process involves a unit operation consisting of processes such as pre-processing operations which include preparation of raw material, washing, dressing, brining, precooking; can filling through manual or mechanical means; exhausting by thermal exhausting, mechanical exhausting by vacuum seaming or steam injection method; seaming or can closing; retorting/heat processing in a retorting chamber and cooling of the cans. These processes collectively extend the shelf life, convenience and help to preserve the nutritional values and sensory properties of the seafood.

Retort Pouches

Fish and fishery products have been used to produce retort pouch products either as main products or value-added by-products. Processing the seafood in pouches significantly reduces the

possibility of nutrient loss and maintains a quality similar to that of fresh products. Processing of seafood under high temperature and high pressure thermal retorts, it is possible to achieve commercial sterility and extend the shelf life of the product. The retorting process also inactivates and destroys the pathogenic & spoilage microorganisms. The retort pouches thus produced are lightweight, compact and easy to store & transport, making them an alternative for a variety of value-added seafood products, including tuna, salmon, shrimp and other value-added seafood items.

Retort pouches are used for seafood products such as tuna, salmon, sardines, shrimp and other value-added seafood items. In the case of smaller fish species, these products are typically packaged in their entirety, while those of larger species are packed in forms of chunks. The pouches are then processed in pressurized retorts, air-cooled and conditioned.

Packaging

Fishery products are perishable commodities that have a short shelf-life and are generally not consumed immediately after being harvested. The implementation of effective packaging strategies can significantly improve the market appeal, longevity, and safety of seafood products. Modified Atmosphere Packaging (MAP) is that systems allow gases surrounding a packaged product to be headspace controlled. MAP can be also used for value-added fish products packaging in products such as crispy fish skin, spicy fried fish, and other types of fish crisped fried products. MAP is applied as a preservation technique, which is a method for modifying the composition of the original package atmosphere to extend the product shelf life also while maintain its freshness, color and overall quality of the seafood. Vacuum package is a type of

film package where the process of filling and sealing it includes a reduction in pressure, spoiling the ambient air surrounding the fishery products.

The ambient air's partial oxygen pressure thus prevents the growth of the spoilage-causing. Vacuum packaging also has the effect of retaining product freshness, inhibiting oxidative spoilage, and hindering some undesirable chemical reactions, such as oxidation of drip, fat, and amino acids. A more advanced form of packaging is intelligent packaging systems that are characterized by their bioactive and bio-interactive properties, which result from functional modifications. These systems utilize advanced materials, innovative structures, and cutting-edge technologies to improve both the quality and safety of packaged products.

Freezing and Chilling

Proper storage of fishery products is a complex problem, directly related to both the commercial value and the safety of the product. Fishery products quickly lose their freshness after harvest, and post-harvest quality deterioration is principally due to changes in conditions related to the action of water. Freezing and chilling are two prominent preservation techniques that significantly enhance value addition. Chilling is widely used for both fresh fish storage and the production of most fresh fishery products. Freezing retards the spoilage of fish and fishery products because the low temperatures employed in the freezing process destroy microorganisms responsible for this spoilage. These methods enhance the shelf life of the seafood products and enable distribution to remote markets, increasing the industry's profitability and competitiveness.

Freezing

The frozen fishery industries are engaged in the preparation, packing, and preservation of fresh fishery products and other marine products that involves lowering the temperature of the seafood to a point where majority of the water content is converted into ice crystals i.e., below

the freezing point. This technique significantly retards or stunts microbial growth and enzymatic reactions leading to spoilage, thereby extending the shelf life of the seafood.

Freezing of seafood is done by subjecting it to rapid freezing at temperatures typically below -35°C in mechanical freezers such as airblast freezer, contact freezers, immersion freezers, cryogenic freezers for a specified time interval. The frozen is then packaged in airtight, moisture-resistant materials to prevent dehydration as well as to protect the product from external contaminants. It is then stored at a stable low temperature, typically below -18°C, to ensure their quality and safety throughout the transportation and distribution process.

Frozen seafood products, including fish fillets, shrimp, and crab meat, have a significantly longer shelf life, facilitating their distribution to remote markets and fulfills consumer demand all year round. The freezing process effectively preserves the seafood's nutritional value, texture, and flavor, making it an important method for adding value.

Chilling

Chilling is a preservation method of reducing the temperature of seafood to just above freezing, generally maintained between 0°C and 4°C. Chilling refers to the process of extracting a significant and limited amount of heat that can negatively impact the fish in the short term. Seafood is subjected to chilling temperatures which reduces the microbial spoilage and enzymatic reactions. This extends the shelf life of the seafood product without fully freezing it. Chilling is brought about using ice or refrigeration systems, to lower the temperature to a desired range. It is then stored at optimal chilling temperatures, while constantly monitoring the temperature, to maintain desired level of freshness and quality. Consumers place a high value on chilled seafood products, including fresh fish fillets, whole fish, and shellfish, because they offer superior quality and freshness. Chilling can also be integrated with other value-adding methods, such as modified atmosphere packaging, to improve both the shelf life and quality.

Fermentation and Pickling

The practice of fermentation and pickling are significant both as traditional and innovative methods of value addition in the fishery sector. This technique not only enhances the shelf life of seafood products but also develops unique flavors and textures that engage a broad spectrum of consumer preferences.

Fermentation

Fermentation is a chemical process in which complex organic compounds, such as proteins and carbohydrates, are broken down into simpler, more readily utilizable compounds by the enzymes of fermenting bacteria, such as molds, or yeasts. This is done with the help of enzymes which are either inherent or added to the food material. The prepared seafood is mixed with the starter culture, typically involving a specific strain of bacteria or yeast, to initiate the process. It is then allowed to ferment under controlled conditions, such as temperature and pH, for a specific duration, until the entire complex compounds are fermented to desired compounds.

Pickling

Pickling is a preservation method that involves submerging seafood in an acidic solution, such as vinegar or brine, to inhibit the microbial growth and extend the shelf life of the seafood product. Pickling along with preserving the seafood also imparts unique flavors and textures that enhance consumer preference. The prepared fish is submerged in a brine solution which aids in the removal of moisture and inhibits the growth of microorganisms. The fish is then immersed in an acidic solution, typically vinegar. The vinegar's low pH level establishes an environment that is unfavorable for the growth and proliferation of harmful bacteria. Various spices, herbs, and aromatics can be added to the pickling solution to enhance the flavor profile. The fish, once seasoned, along with the pickling liquid, is sealed in airtight containers. The pickled seafood products provide various benefits such as extended shelf life, enhanced flavors and improves food security while maintaining the nutritional value of the product.

Salted Seafood Products

Salted fish products are a category of seafood products that have undergone a preservation process involving the addition of salt. This is an ancient preservation technique that enhances the shelf life of seafood by reducing the moisture content and inhibiting the growth of microorganisms. Salted fish products are prevalent in various culinary traditions around the world and play a significant role in the global seafood industry.

Salted fish products are created by immersing or rubbing raw fish, shellfish or other seafood in salt or a brine solution. This salt penetrates the seafood, drawing out moisture and creating an unfavorable environment, preventing microbial growth, thus preserving the quality of the product. Salting can be combined with various other preservation techniques, such as drying or smoking, to further enhance the product's shelf life and flavor profile. These products are

often shelf-stable and can be stored for an extended period without any need for refrigeration, making them a convenient and an accessible seafood option.

Fish analog products

Fish analog products, also known as imitation or surimi-based seafood, are a category of food products that are developed to mimic the taste, texture, and appearance of traditional seafood products, such as crab, lobster, or shrimp. These products are typically produced from surimi, often combined with various functional ingredients and flavorings, to create a seafood-like experience for consumers.

Fish analog products are primarily composed of surimi, which is then combined with other ingredients such as binders, starches, flavors, and coloring agents, to create the desired seafood properties. The production of fish analog products involves a series of steps, including forming the prepared surimi into the desired shape and texture. These products may also undergo additional processing such as cooking, smoking, or freezing, to enhance their shelf life and sensory characteristics. These products can be used for a wide range of applications, from imitation crab or lobster meat in salads to value-added products like fish burgers, fish sausages, fish nuggets and fingers.

Surimi

Surimi is a frozen, essentially flavorless, kneadable, gelling slime-free fish paste intended for human consumption. It is produced when low value white fleshed fish is mechanically deboned, minced, water washed, refined and mixed with cryoprotectants for prolonged shelf life during frozen storage. It is typically derived from white-fleshed fish species like Alaska pollock, Pacific whiting, or cod. Due to its high concentration of myofibrillar protein content, surimi can readily mimic the chewy, elastic texture that is associated with the shellfish. This Surimi, when processed into imitation seafood enhances the value of lower grade fishes and the market for traditional seafood products.

Imitation Crab

Imitation Crab, also known as Crab Sticks are one of the most prominent and widely available fish analog products. They are made from surimi and designed to mimic the taste and texture of real crab meat without using actual crab meat. Various flavorings such as crab extract or artificial flavors and food coloring are added to mimic the taste and appearance of real crab

meat. Imitation crab is commonly used in numerous seafood preparations, such as sushi, salads, dips, and seafood cocktails. This product serves as a popular and cost-effective alternative to authentic crab meat, thus enhancing its accessibility to a larger demographic of consumers. Similarly, many other imitation products are produced, such as imitation lobsters and shrimps without using actual lobster or shrimp meat.

Fish Sausages

Fish sausages have emerged as a popular value-added seafood product, offering a convenient and versatile alternative to traditional seafood preparations. Fish sausage is an emulsion or surimi-based fish product that is made by combining seafood ingredients such as fish meat, with various spices, binders, and other additives to create a unique and flavorful product.

Surimi or emulsified meat of desired texture and consistency is combined with binders, seasonings, and other ingredients. The mixture thus formed is thoroughly blended to create a homogeneous emulsion. The emulsified mixture is then stuffed in a variety of casings, which may include natural options like collagen or cellulose, as well as synthetic alternatives. Through additional thermal processing techniques such as cooking, smoking, or drying, which may depend on the specific recipe and production method employed, the flavor, texture, and shelf life of fish sausages can be improved.

Fish Burgers

Fish burgers, also known as seafood burgers or fish patties, are a type of processed seafood product that is developed to resemble and function similarly to a traditional beef burger.

They are typically made from surimi or fish paste which is then mixed with various binders, fillers, and seasonings to create a cohesive and flavorful patty mixture. The patty mixture is then shaped and formed into desired burger shapes, often using molds or presses. The shaped patties are either cooked or frozen for later use. These fish burgers can be served in a variety of ways, such as between buns with traditional burger toppings, or as a part of a seafood-based meal.

Battered and Breaded Products

Battered and breaded fishery products are one of the earliest value added products, consisting of a raw fish fillet that is seasoned, coated in a mixture of flour, crumbs, and seasoning, and then fried, broiled, baked, or frozen for future cooking in home, institutional, restaurant, or catering food service. They are a very popular product, with abundant choice at retail displayed as fresh, refrigerated or frozen forms, as well as numerous packaged products for

home and institutional preparation. These products leverage the unique characteristics of various fish & seafood to create a delightful combination of crispy, crunchy exteriors and tender, flavorful interiors.

Fish Cutlets


Fish cutlets, also known as fish cakes or fish patties, are a type of seafood product made from a mixture of white-fleshed fish, potatoes, various seasonings and binders. They are typically flattened into a patty or cutlet-like shape and then breaded, fried or baked. Fish cutlets are a popular seafood dish in many parts of the world, particularly in South Asian and Southeast Asian cuisines. Fish cutlets are used as a component in burgers, sandwiches or as a snack or appetizer. The combination of fish and potatoes in the fish cutlets provides a satisfying and nutritious seafood option for consumers.

Fish Fingers


Fish fingers, also known as fish sticks, are a type of breaded and fried or baked seafood product made from white-fleshed fish, typically cod or haddock. They are designed to resemble the shape and size of a human finger, hence the name "fish fingers".

The raw fish is deboned, skinned, and cut into long, thin strips or fingers. These fish strips are then coated with a breading or batter mixture, which can include ingredients such as breadcrumbs, flour, eggs, and seasonings. The breaded or battered fish strips are then fried or baked until they are crispy and golden brown on the outside, while the inside remains moist and flaky.

Similarly, many other breaded and battered seafood products are developed such as breaded calamari or squid rings, fried shrimp or prawn, breaded scallops.

Fish Byproducts

The term fish byproducts encompass all the materials derived from the processing and handling of aquatic species, which are not classified as primary seafood or fish products. Fish waste is prone to rapid spoil, necessitating effective hygiene & health concerns. Initially, the less soiled parts are processed into fishmeal & fish oil and subsequently into hydrolysates or renderings. Fishmeal & fish oil are classified as commodity products and cope with a market volatility that often threatens the competitive edge of the aquaculture industry. Nevertheless, fish discards have in recent years been viewed with renewed interest as potential raw materials, expanding their applications in various sectors including food uses. Fish discards comprise a wide variety of byproducts with different physical and nutritional properties. These fish waste variety opens up new possibilities for product diversification customized to individual markets.

Fish Protein Hydrolysate

Fish protein hydrolysate (FPH) is a product produced from fish wastes or byproducts, derived from freshwater & marine species obtained from fishing, aquaculture, and processing industries. FPH can be defined as a powder in which the seafood protein has been broken down or hydrolyzed using controlled enzymatic or chemical processes. FPH is highly digestible, contains a balanced amino acid profile, and is a rich source of bioactive peptides. FPH possesses a significant potential for application across various sectors, especially within the functional food and nutraceutical industries. The nutritional profiles and functional attributes of FPH products depend on several factors including fish species processed, solvent used during extraction, and

the hydrolysis conditions such as duration, temperature, and enzyme type. FPH is utilized across various industries including food, pharmaceuticals, cosmetics, and agriculture, serving roles such as a source of protein, flavor enhancer, and bioactive component.

Gelatin

Gelatin is a protein-based hydrocolloid derived from the partial hydrolysis of collagen, which is the main structural protein found in the skin, bones, and connective tissues of animals, including fish. Gelatin can be obtained from various sources such as fish skin, bones, and scales of various fish species. The production of fish-derived gelatin involves the pre-treatment of fish raw materials, extraction of collagen, and controlled hydrolysis to produce the final gelatin product. Salted fish gelatin specifically refers to gelatin that has been obtained through a salt-assisted extraction process. Fish gelatin exhibits unique physical and functional properties, such as gelling & emulsifying abilities, making it applicable in food, pharmaceutical, cosmetic, and biomedical applications.

Chitin

Chitin is a naturally occurring polysaccharide found in the exoskeletons of crustaceans, such as shrimp, crab, and lobsters. It is primarily extracted from the shell waste derived from the crustacean processing industries. With its antimicrobial, biodegradable, and biocompatible attributes, chitin serves as a valuable resource across multiple sectors, particularly in the fields of medicine, agriculture, water treatment, and cosmetics.

Chitosan

Chitosan is a derivative of chitin, obtained by the deacetylation of chitin using chemical or enzymatic methods. Chitosan possesses distinctive characteristics, including antimicrobial properties, wound healing properties and the potential to create films & hydrogels. Its versatility allows for applications across various sectors, including biomedical, agricultural, food, and water treatment industries.

Fish Skin Leather

The search for an alternative source of leather has led to the exploration of fish skin as a feasible and eco-friendly option, giving rise to the concept of fish skin leather. It is often an overlooked resource, perfect for sustainable leather and made from the by-product of the food industry. Being cured in the traditional artisanal way, using only natural ingredients, fish skin leather becomes a luxurious material with unique characteristics. In light of an increasing emphasis on sustainability, fish skin leather is being explored for its full potential. This innovative material along with the concept of utilizing it as a substitute for conventional leather, are being widely examined.

The adaptability of fish skin leather enables its utilization across numerous applications, thereby broadening the potential market and enhancing business prospects. The utilization of fish skin leather is on the rise within the fashion industry, particularly in the creation of luxury clothing, footwear, handbags, and various accessories. Additionally, this material is being employed in the automotive, furniture, and interior design industries, where its distinctive aesthetic qualities & performance attributes are highly regarded.

Market Analysis of Value-Added Fishery Products

In the recent years, the global market for the value-added fishery products has been experiencing significant growth. This growth is driven by several crucial factors, including changing consumer preferences, advancements in processing technologies the ever-increasing demand for the convenient and nutritious seafood products. According to MPEDA 2023-3024, the total export of seafood from India was estimated at 17,81,602 Metric tonnes and is valued at Rs.60,523.89 crore or US$7.38 billion. The frozen shrimp contributed 66.12% in value terms amounting to Rs.40,013.54crore and 40.19% in terms of quantity. Frozen fish was in second place amounting to 21.42% of the total seafood export and 9.09% in dollar earnings. It was followed by fish & shrimp meal, frozen squid, surimi & surimi analogs, frozen cuttlefish with total seafood exported at 15.89%, 5.25%, 4.12%, and 3.05% respectively in terms of quantity. According to the grand view research, 2022, the global market for value-added fishery products was estimated to be worth around $150 billion in 2022 and is expected to grow at a compound annual growth rate (CAGR) of 5-7% from 2023 to 2028. The Ministry of Fisheries, Animal husbandry & Dairying, Government of India, has allocated Rs.2616.44 crore to the Department

of Fisheries for the year 2024-2025. Under the Pradhan Mantri Formalization of Micro Food Processing Enterprises scheme (PMFME) several training programs are conducted to promote and train people in value added fishery products. Also, Rs.2,352crore has been allocated under Pradhan Mantri Matsya Sampada Yojana Scheme (PMMSY) for setting up of shrimp aquaculture facilities. This is a crucial step to promote the shrimp industry resulting in the increase in export of frozen as well as prepared shrimp in the value added fishery sector.

Consumer Trends and Preferences

Adding value to food products by food processing is becoming a trend, given the convenient preparation and food quality assurance improvement. Both low- and high-valued fish species are being developed for Value-added fishery products.The discern of value added fishery products being nutritious among health-conscious consumers are enhancing the demand of seafood products. Ready-to-eat, ready-to-prepare, breaded & battered fish, canned fish or shrimp also enhances the value added seafood industry. As seafood products are sourced from responsible and sustainable fisheries along with traceability & certifications, it ensures people that the value added fishery product is safe for consumption.

Technological Advancements

The value-added fishery sector has witnessed a surge of technological innovations that have significantly enhanced the overall capabilities of the value-added fishery products. These advances have been influenced over various stages of the fishery value chain, from the processing and packaging to the distribution and marketing. As a result, this has enabled the value-added products to improve in quality, efficiency, shelf life and to meet the ever-evolving consumer preferences.

Novel preservation techniques like High-pressure processing (HPP) and modified atmospheric packaging (MAP) have significantly enhanced the shelf life and the overall quality of the value-added product. With the increasing use of automated robotic systems in this sector, it has aided to improve the operational efficiency, consistency and increase the production yield. This technology has given way to reducing labor costs and enhancing productivity. Advancements in the biomass conversion and bio refinery technologies has enabled to extract valuable byproducts from the processing wastes leading to the complete utilization of the fishery resources and reducing wastes.

The development of the edible coating and films derived from natural sources such as chitosan, alginate has enhanced the physical and sensory characteristics of the value-added product. Implementation of advanced traceability systems like blockchain, radio-frequency identification (RFID), and internet of things (IoT) has ensured transparency and compliance with the food safety regulation throughout the supply chain.

Business Models and Strategies for Value Addition

In the rapidly evolving and competitive landscape of the fishery industry, the incorporation of value addition in the fishery products has become an essential approach for increasing profitability, broadening market access, and meeting the ever changing demands of consumers. Products that have undergone value addition, such as smoked fish, canned seafood, and ready-to-eat meals, not only enhance the shelf life and convenience of seafood but also offer distinctive flavor profiles and nutritional benefits that can attract higher market prices. Nevertheless, the effective execution of value addition strategies within the fishery sector requires the implementation of innovative business models and strategic methodologies.

Considering the relentless growth of competition within the market, the value added seafood sector can employ strategies such as vertical integration by expanding operations across the value chain, cooperative & cluster-based approach by leveraging shared resources & knowledge, niche market strategies by targeting specialized consumer segments, diversification & product innovation, digital transformation & E-commerce and sustainability & eco-branding.

Conclusion

The fisheries sector offers a diverse array of value addition and business opportunities, which includes, advanced processing & preservation techniques, extraction & utilization of high-value compounds, implementation of sustainable practices and the integration of cutting-edge technologies. It also holds an immense potential for value addition and the creation of diverse business opportunities, highlighting the potential for economic growth and diversification. As the global demand for seafood continues to rise, influenced by factors such as population growth, changing dietary preferences and increased health awareness, the fisheries industry is poised for significant growth and transformation. The emphasis on enhancing value within the value-added fishery sector not only supports sustainable practices but also encourages innovation, thereby playing a significant role in the overall development of the industry. Elevating the quality and

appeal of the value-added seafood products, businesses can cater to the evolving consumer preferences and enhance their competitiveness in the market. By leveraging these opportunities, the stakeholders in the fisheries sector can capitalize on the growing global demand for seafood, contribute to a more sustainable and circular economy, and create a thriving and prosperous business ecosystem.

REFERENCE:

1. Ghaly, A.E., Ramakrishnan, V.V., Brooks, M.S., Budge, S.M. and Dave, D., 2013. Fish processing wastes as a potential source of proteins, Amino acids and oils: A critical review. *J. Microb. Biochem. Technol*, ***5***(4):107-129. http://dx.doi.org/10.4172/1948-5948.1000110
2. Binsi, P.K., Sreelakshmi, K.R. and Kumar, K.A., 2018. Value added fish products. Recent trends in harvest and post-harvest technologies in fisheries the training programme. Kochi, India, pp. 134-148.
3. Mihindukulasuriya, S.D.F. and Lim, L.T., 2014. Nanotechnology development in food packaging: A review. *Trends Food Sci. Technol*., **40**(2):149-167. https://doi.org/10.1016/j.tifs.2014.09.009
4. Dana, E.B., 2020. Process optimization of fish protein hydrolysate prepared from selected fishes and studies on its bioactive and functional properties. Cochin University of Science and Technology, Kochi, India. http://hdl.handle.net/10603/342438
5. Di Pinto, A., Mottola, A., Marchetti, P., Bottaro, M., Terio, V., Bozzo, G., Bonerba, E., Ceci, E. and Tantillo, G., 2016. Packaged frozen fishery products: Species identification, mislabeling occurrence and legislative implications. *Food Chem.*, **194**:279-283. https://doi.org/10.1016/j.foodchem.2015.07.135
6. Pradhan Mantri Matsya Sampada Yojana, Ministry of Fisheries,Animal Husbandry and Dairying. https://www.myscheme.gov.in/schemes/pmmsy
7. Chand, A., 2024. Seafood preservation strategies. *Nat Food,* **5**, 273:1-1. https://doi.org/10.1038/s43016-024-00973-4
8. Siddiqui, S.A., Singh, S., Bahmid, N.A., Ibrahim, S.A. and Sasidharan, A., 2024. Applying innovative technological interventions in the preservation and packaging of fresh seafood products to minimize spoilage-A systematic review and meta-analysis. *Heliyon,* **10**(8):1-21. https://doi.org/10.1016/j.heliyon.2024.e29066
9. Speranza, B., Racioppo, A., Bevilacqua, A., Buzzo, V., Marigliano, P., Mocerino, E., Scognamiglio, R., Corbo, M.R., Scognamiglio, G. and Sinigaglia, M., 2021. Innovative preservation methods improving the quality and safety of fish products: Beneficial effects and limits. *Foods,* **10**(11):2854. **https://doi.org/10.3390/foods10112854**
10. Gokoglu, N., 2023. Value addition to seafood processing waste by using enzymes. Value addition to seafood processing waste by using enzymes. In Value-Addition in Agri-food Industry Waste Through Enzyme Technology, Academic Press. pp. 95-106.

https://doi.org/10.1016/B978-0-323-89928-4.00010-9
11. Islam, S., Bhuiyan, M.R. and Islam, M.N., 2017. Chitin and chitosan: structure, properties and applications in biomedical engineering*, J. Polym. Environ*., ***25***:854-866. https://doi.org/10.1007/s10924-016-0865-5
12. https://pmmsy.dof.gov.in/
13. https://mpeda.gov.in/

Chapter 9

SCHEMES BY MINISTRY OF FOOD PROCESSING INDUSTRIES, GOVT OF INDIA TO SUPPORT & PROMOTE FOOD PROCESSING SECTOR

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Introduction

India's food processing industry is one of the largest in the world, offering immense potential for growth, employment, and export. To harness this potential, the Government of India established the Ministry of Food Processing Industries (MoFPI). This ministry plays a pivotal role in encouraging growth, innovation, and sustainability in the sector. Through various schemes and initiatives, MoFPI aims to make India a global hub for food processing.

Ministry of Food Processing Industries

The Ministry of Food Processing Industries, abbreviated as MoFPI, is a central government body responsible for formulating and implementing the policies that support the food processing sector in India. Its primary focus is on reducing food wastage, increasing value addition, and creating employment in rural areas.

Focus of the Ministry

- Reduce **post-harvest losses** of perishables
- Promote **Value addition**, Generation of **off-farm jobs**
- Enhance **processing and preservation capacities,** Encourage **Agro-processing clusters**
- **Identify gaps in infrastructure and assist in its creation**
- Formalization of **Micro Food Processing Enterprises**
- **Creation of global food manufacturing champions**

The vision of MoFPI is to boost India's food processing capacity, ensure food security, and enhance the income of farmers. Its mission includes creating world-class infrastructure for food processing, reducing post-harvest losses, and increasing the export competitiveness of processed food products.

Why Food Processing Matters in India

Food processing is essential for transforming raw agricultural products into food fit for consumption. In India, where agriculture is the primary source of livelihood for millions, food processing holds the potential to enhance farm incomes, create jobs, and minimize post-harvest losses. It not only improves market access for farmers but also creates opportunities for entrepreneurship and employment in both rural and urban areas. The food processing sector adds value to raw agricultural products, thereby increasing their market price. It is also a significant contributor to India's export revenue, helping the country gain a competitive edge in the global market.

Contribution to the Economy by Food Processing Sector

- Total employment: 71 lakh (20 lakh in registered segment and 51 lakh in unregistered segment) approximately
- Present levels of processing – Fruits (4.5 %), Vegetables (2.7 %), Milk (21.1 %) and Fish (15.4 %)
- Gross Value Added (GVA) - Rs. 2.37 lakh crore (2020-21)
- FPI sector constitutes 10.54% of GVA in manufacturing (2020-21) sector
- Share of Processed food exports – 22.6% of total agri-exports (2021-22).

Key Schemes by Ministry of Food Processing Industries

Micro	Prime Minister Formalization of Micro Food Enterprises (PMFME) 2020-2025	Rs. 10,000 Cr.
Small and Medium	Pradhan Mantri Kisan Sampada Yojana (PMKSY) 2017-2026	Rs. 6000 Cr. (14^{th} FC) Rs. 4600 Cr. (15^{th} FC) Rs. 920 Cr. (Adnl 15^{th} FC)
Large	Production Linked Incentive (PLI) 2021-26	Rs. 10,900 Cr.

These schemes focus on creating infrastructure, promoting research and development, and ensuring food quality and safety.

PMFME Scheme (Under *Aatmanirbhar Bharat Abhiyan*)
https://pmfme.mofpi.gov.in/pmfme/#/Home-Page

Approved in May, 2020 with a Scheme outlay Rs. 10,000 cr. over 2020-21 to 2024-25. Envisages credit linked grant to 2 lakh micro food processing units

The aim of the scheme is to enhance the competitiveness of existing individual micro-enterprises and promote formalization of the sector. Support individual enterprises / FPOs/ SHGs/ Cooperatives along the entire value chain

One District One Product (ODOP) approach is followed in it. ODOP may be Agri produce, Food products, Non-Agri products, Minor forest produce etc. ODOP strategy is for value chain development of local produce. Supports New and Existing units- **Individuals** & Groups (SHGs/FPOs/Cooperatives), support for common infrastructure and marketing & branding is provided. Provisions Under PMFME Scheme are as below –

- **Individual Units-** Credit linked Grant @ 35% with max. ceiling of Rs. 10 lakh;
- **Groups (FPOs/ SHGs/ Cooperatives) –** Credit linked Grant @ 35% for capital investment, Training, Handholding support & marketing support;
- **Seed capital** @Rs. 40,000 per member of SHG for working capital and purchase of small tools;
- **Common Infrastructure-** Credit linked Grant @ 35% of the project cost for common infrastructure;
- **Marketing & Branding-** Grant up to 50% of the expenditure to Groups or an SPV for ODOP;
- **Capacity Building-** Handholding and capacity building support through NIFTEMs, SLTIs, CSIR, ICAR, KVKs institutions.

Pradhan Mantri Kisan Sampada Yojana (PMKSY): The Pradhan Mantri Kisan Sampada Yojana (PMKSY) is a flagship scheme aimed to create modern infrastructure for food processing from farm gate to retail outlet; create robust supply chain infrastructure. It includes several components such as:

1 Scheme for Integrated Cold Chain Infrastructure and Value Addition
2 Scheme for Creation/Expansion of Food Processing & preservation Capacities
3 Scheme for Creation of Infrastructure for Agro Processing Clusters (APC)
4 Food Safety & Quality Assurance Infrastructure (Food Testing Lab Scheme)
5 Operation Greens Scheme - Long Term / Short Term Interventions
6 Scheme for HRD- (R&D and Promotional Activities)

Integrated Cold Chain Infrastructure and Value Addition

- To provide integrated cold chain and preservation infrastructure from farm gate to consumers;
- Financial assistance: Grant @ 35% / 50% in general/difficult areas, SCs, STs of the project cost;
- Max. Grant: Rs. 10 crore per project;
- Eligible organizations: FPOs / FPCs / SHGs / Govt./private sector etc.

Creation/Expansion of Food Processing & preservation Capacities

- To promote food processing/ preservation units for increasing level of processing, value addition & reduction in wastage;
- Grant @ 35% / 50% in general / difficult areas, SCs, STs of project cost;
- Max. Grant: Rs. 5 crore per project;
- Eligible organizations: FPOs / FPCs / SHGs / Govt./ private sector etc.

Creation of Infrastructure for Agro Processing Clusters (APC) – Mini Food Park

- Assistance for creating common facilities and enabling infrastructure closer to production areas;
- Envisages a cluster of minimum 5 processing units with an investment of Rs 25 Cr;
- Grant @ 35% / 50% in general/difficult areas, SCs, STs of the project cost;
- Max. Grant : Rs. 10 Crore per project;
- Minimum 5 acres land for Urban area and 10 acre land for other areas purchase or on lease of 50 years;
- Eligible organizations: FPOs / FPCs / SHGs / Govt./private sector etc.

Food Safety & Quality Assurance Infrastructure

- Facilitate industry to comply with domestic/ international standards;

- Make available modern commercial testing facilities for industry;
- Grant @50% / 70% of equipment in general / difficult areas for private projects and 100% for public sector;
- Grant for TCW and F&F@2% of eligible cost of approved equipment with max cap of Rs. 15 lakh

Operation Greens

- Launched in November 2018 for integrated development of Tomato, Onion and Potato (TOP) value chain;
- 2 pronged strategy:

Short term- Price Stabilisation Measures –

- Subsidy @ 50% of cost of transportation and hiring of storage during glut period (before actual processing);
- As a part of ANB in June, 2020, extended to 41 notified F&V;
- At present, total 42 F&V notified;
- Transportation subsidy extended to Kisan Rail Scheme w.e.f. Oct, 2020 for any fruits and vegetables till 31.03.2022;
- Indian Railways (IR) has disbursed total subsidy of Rs.138.98 crore since beginning till 28.02.2022;
- Total Quantity of 7.24 Lakh MT of F&V till 28.02.2022 transported across India;
- Total subsidy of Rs.77.79 crore reimbursed by Ministry to IR with annual ceiling of Rs 50 Cr of FY 2021-22;
- Helped in evacuation of F&V from surplus to deficit regions during harvest;
- Transportation subsidy extended for notified Fruits and Vegetables transported by air from the NER and Himalayan Region States.

Long term- Value Chain Development project –

- Consist of components namely Capacity Building of FPOs, Quality production, Post-harvest processing facilities, Agri-Logistics, Marketing/Consumption points with grant support max. of Rs 15 Cr. for Integrated Value Cold Chain Development project & Rs. 10 Cr for standalone projects ;
- Scope of long term intervention is expanded from TOP to twenty-two (22) perishables through budget announcement of 2021-22.

List of 41 Notified Crops under OG-TOP to TOTAL Scheme

- *Fruits (21)* – Mango, Banana, Guava, Kiwi, Litchi, Papaya, Mousambi, Orange, Kinnow, Lime, Lemon, Pineapple, Pomegranate, Jackfruit, Apple, Almond, Aonla, Passion fruit, Pear, Sweet Potato, Chikoo
- *Vegetables (20)* – French beans, Bitter Gourd, Brinjal, Capsicum, Carrot, Cauliflower, Chillies (Green), Okra, Tomato, Onion, Potato, Cucumber, Peas, Garlic, Large Cardamon, Pumpkin, Ginger, Cabbage, Squash and Turmeric (dry)

List of 22 Perishables for Expanded Operation Greens Scheme

- Fruits (10): Mango, Banana, Apple, Pineapple, Kinnow/Mandarin/Orange, Grapes, Aonla/Amla, Pomegranate, Guava, Litchi.
- Vegetables (11): Tomato, Onion, Potato, Green Peas, Carrot, Cauliflower, Beans, Gourd Family [Bottle Gourd (Loki), Bitter Gourd (Karela), Ridge/Sponge Gourd (Torai), Pointed Gourd (Parwal) and Ash Gourd (Petha)], Okra, Garlic, Ginger
- Marine (1): Shrimp.

Scheme for HRD

i. Research and Development Scheme

   - For Govt organisations, grant-in-aid : 100%of cost of equipment, consumables and expenditure related to salaries for project staff specific to the project for maximum period of three years. Grant is released in three instalments.
   - For Private organisations grant-in-aid : 50% of equipment cost only in general areas and 70% in North East States and difficult areas. Grant is released in three instalments.

ii. Promotional Activities (discontinued as scheme under PMKSY in 15th FC Cycle)

   a. Creating awareness among stakeholders on plan, policy & programmes of Ministry & its schemes;

   b. Encourage investment in FP sector by extending financial support for organizing events;

Other Schemes Supporting Food Processing

- Credit Linked Capital Subsidy Scheme (CLCSS): Provides financial assistance for technology upgradation in food processing units.

- Agro-Processing Cluster Scheme: Aims to create clusters of food processing units to benefit from shared infrastructure.
- Operation Greens Scheme: Focuses on price stabilization of tomatoes, onions, and potatoes, ensuring their availability throughout the year.

Benefits of Government Schemes for the Food Processing Sector

- Economic Empowerment of Farmers: By promoting food processing, the government ensures that farmers get better prices for their produce, thereby improving their livelihoods. Value addition and reduction in post-harvest losses significantly enhance farmers' income.
- Export Promotion and Growth: Government schemes help improve the quality and quantity of food products, making Indian food competitive in the global market. The push for infrastructure development and adherence to food safety standards promotes exports.
- Reduction in Food Wastage: With the development of cold chains, food parks, and food preservation units, these schemes help reduce food wastage significantly. This contributes to food security and better utilization of agricultural produce.

Challenges in the Implementation of Schemes

Despite the positive impact of these schemes, challenges such as financial constraints, lack of awareness, and infrastructural bottlenecks hinder full implementation. Improving outreach and providing easier access to credit can address these challenges.

Technical Institutions under MoFPI

- Two Food Technology Institutes under the Ministry
  - National Institute of Food Technology, Entrepreneurship and Management (NIFTEM), Kundli, Haryana
  - Indian Institute of Food Processing Technology (IIFPT), Thanjavur, Tamil Nadu (now it is NIFTEM, Thanjavur)
- Offer academic courses in B.Tech, M.Tech., MBA (NIFTEM only) and Ph.D programme
- Impart training on skill development & entrepreneurship
- Conduct R&D in food processing

- In order to accord, INI Status to both the Institutions, NIFTEM Act, 2021 has been passed on 26.07.2021, notified on 30.07.2021 and came into effect on 01.10.2021.

Conclusion

The Ministry of Food Processing Industries, through its various schemes, has made a remarkable contribution to India's food processing sector. These initiatives not only improve the income of farmers but also enhance the nation's food security and export potential. Continued government support and industry participation are essential for the sector's sustained growth.

References:

1. Ministry of Food Processing Industries, GoI

VALUE ADDITION IN ANIMAL PRODUCTS

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This e-book is a compilation of resource text obtained from various subject experts for the Collaborative Online Training Programme of Karnataka Veterinary Animal and Fisheries Sciences University (B), Karnataka & MANAGE, Hyderabad, Telangana on "VALUE ADDITION IN ANIMAL PRODUCTS" conducted from 22nd to 24th August, 2024. This e-book is designed to educate extension workers, students, research scholars, and academicians related to veterinary science and animal husbandry about innovations and value addition to edible and non-edible animal products. Neither the publisher nor the contributors, authors and editors assume any liability for any damage or injury to persons or property from any use of methods, instructions, or ideas contained in the e-book. No part of this publication may be reproduced or transmitted without prior permission of the publisher/editor/authors. Publisher and editor do not give warranty for any error or omissions regarding the materials in this e-book.

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