PM Formalisation of
Micro Food Processing Enterprises (PM-FME) Scheme

TRAINING FOR MASTER TRAINERS

HANDBOOK OF MEAT AND POULTRY PROCESSING



Organized by

ICAR National Research Centre on Meat

ISO 9001:2015 Certified & ISO/IEC 17025:2017 NABL Accredited Institute
Chengicherla, Hyderabad – 500092, Telangana
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In Collaboration with
Indian Institute of Food Processing Technology, Thanjavur, Tamil Nadu

MOFPI
MINISTRY OF FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

IIFPT

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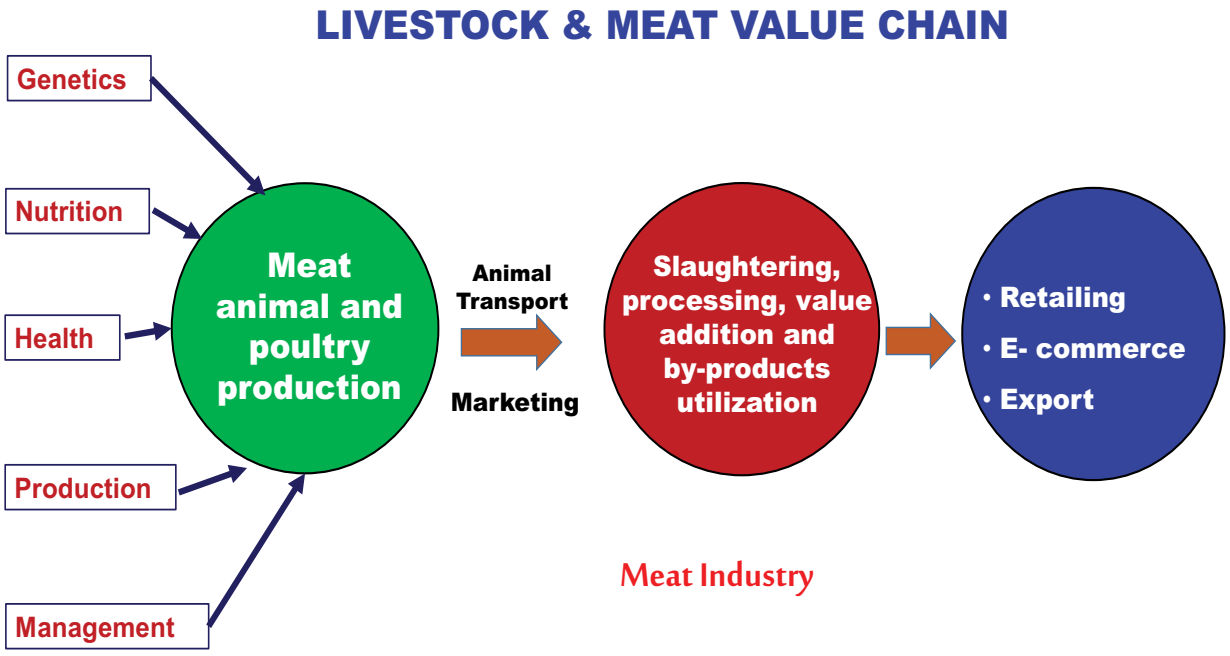
INTRODUCTION

1.1 Status, market size and scope of meat production and processing in India

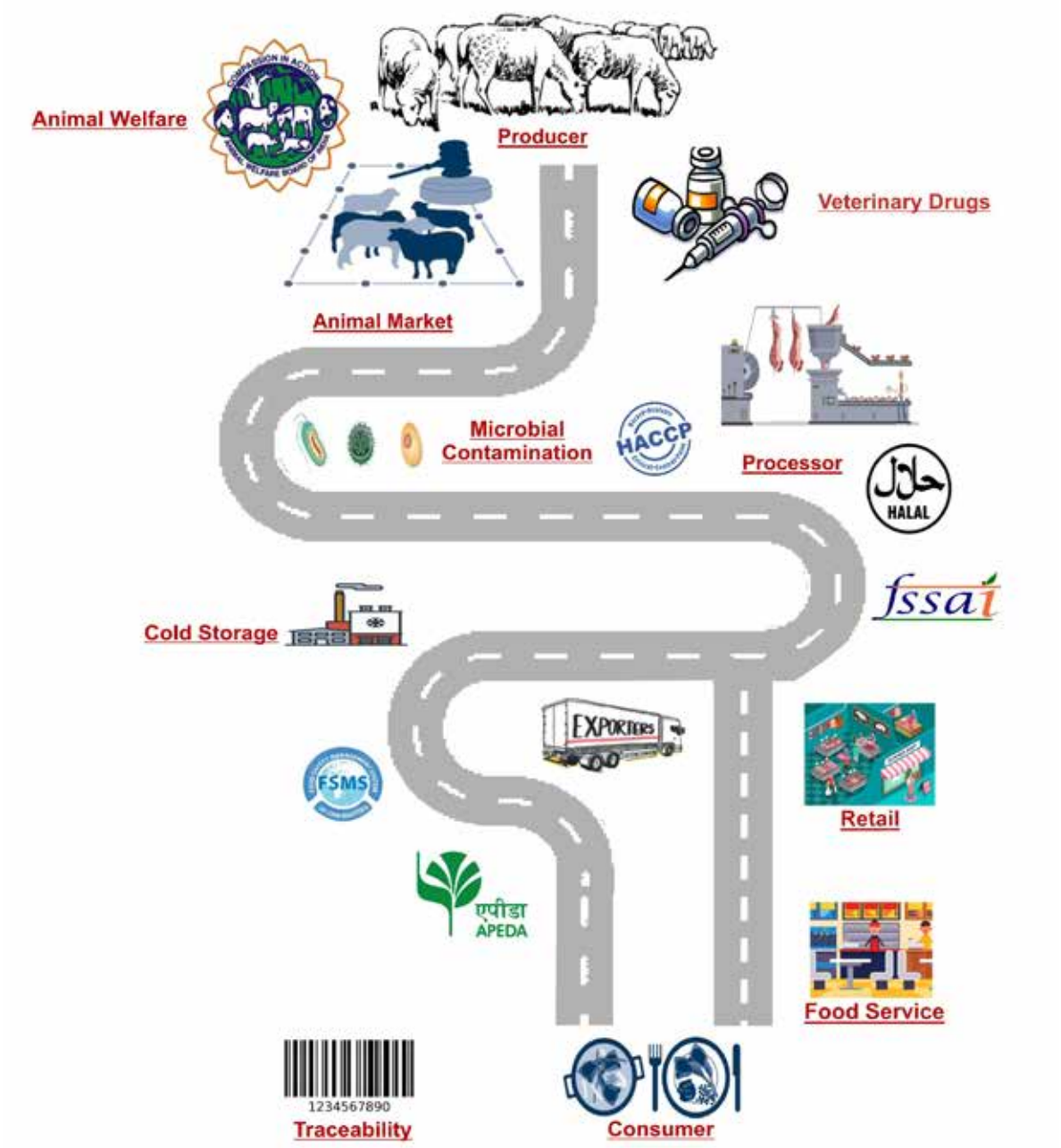
Livestock play an important role in Indian economy and provide livelihood to two-thirds of rural community. Livestock and poultry including cattle, water buffalo, sheep, goat, pig and chicken are primarily produced by the masses for milk, meat, egg, draught power and biomass. Few other species viz, yak, mithun, camel, rabbit, duck, emu, Japanese quail, etc. are also produced in some parts of India as livelihood activities. India has around 42 sheep breeds, 26 goat breeds, 13 buffalo breeds, 40 cattle breeds, 6 pig breeds and 17 chicken breeds registered with Indian Council of Agricultural Research-National Bureau of Animal Genetic Resources (ICAR-NBAGR). India has a huge livestock wealth and ranks 1st, 2nd, 2nd and 4th in the world for water buffalo, cattle, goat and sheep population, respectively during the year 2019 (FAOSTAT). In the year 2018-19, India has produced 8.1 million tonnes of meat and has the distinction of producing largest amount of buffalo meat in the world (42.15%). It is also the 2nd largest producer of goat meat in the world. Per capita consumption of meat in India still remains relatively low at less than 6.5 kg/person/annum.

Meat sector activities includes live animal transport, marketing, slaughtering of animals, processing, value addition, by-products utilization, disposal of solid and liquid waste, distribution and retailing of meat and offals. India has around 4000 registered slaughterhouses/places maintained by local bodies, where animals are slaughtered for domestic consumption. Slaughtering is performed in designated abattoirs or slaughterhouses and most of the meat is consumed on the same day or kept in a refrigerator in the households. The meat produced for the domestic market is sold as hot meat (pre-rigor meat without any chilling). Food safety and standards act, 2006 enacted from Food Safety and Standards Authority of India (FSSAI) regulates production of meat for domestic consumption. An overview of species-wise meat sector contribution in India is presented below.



Important components of livestock and meat value chain

1.1.1 Buffalo meat sector: India possesses about 109 million buffaloes which are reared mainly for milk purpose. There are no exclusive meat purpose breeds and buffalo meat is sourced as byproducts of dairy industry from the spent animals. Majority of the meat science literature in India mention that only 2 -3 % of the total meat undergoes processing and value addition. However, more than 21% of the total meat produced in India (8.1million tonnes) undergoes processing and value addition. This is mainly because of buffalo meat in which around 90% of total buffalo meat produced in India (~1.5 MT) undergoes chilling, packaging, freezing and branding and then exported. Most of the buffalo meat is processed at around 82 state of the art export slaughterhouses approved under APEDA. These processing plants have all the facilities for solid and liquid waste management and convert all the inedible waste and byproducts into meat and bone meal, meat meal, blood meal or fertilizer using rendering or composting technique. Hence wastage from buffalo meat sector in India is limited. Total leather and leather good export from India stood at US$ 5.07 billion during April 2019 to 2020 (Council for Leather Exports). Around 3500 companies are manufacturing or exporting leather and leather products are members of CLE. Around 40% of the leather produced and exported from India comes from buffaloes, whereas 30% comes from goats. Buffalo meat exports (1.15 MT) from India has contributed Rs. 22,669 crores during the year 2019-20 (APEDA).



Overview of domestic and export meat sector in India

1.1.2 Sheep and goat meat sector: As per 19th livestock census (2012) India possess about 65 million sheep and 135.17 million goats, which is about 12.71 % and 26 % of the livestock in terms of numbers, respectively. Out of estimate total meat production of 8.1 million tonnes, total goat and sheep meat production during 2017-18 was 1.64 million tons, which has a value of about rupees 66,814 Crore (DADF 2020). There is a huge gap between demand and supply of mutton. Hence, price of mutton is rising continuously. Sheep and goat meat are premium meats in India sold at around Rs. 600-800 per kg across the country. Most of the edible offal or

by-products produced from sheep and goat are also marketed and consumed in India. Hence the wastage from this sector is minimal. However, major chunk of the sheep and goat meat in India is produced in domestic slaughterhouses which are in very poor condition and realisation from inedible byproducts is very less. Organised slaughtering in sheep and goat sector will improve the returns to farmers.

1.1.3 Poultry meat sector: The poultry Industry in India is a Rs. 1,00,000 crores sector. The 75% of poultry sector (breeding, feeding, hatcheries and broiler farming) in India is organised with complete integration, however remaining 25% including slaughtering, distribution and retailing is unorganised with predominantly wet market business. This also includes microeconomic activity for sustainability in rural areas. The 11% of poultry meat is produced in India from more than 21 large (>1000 birds/hour capacity) and around 20 smaller (<1000 BPH) poultry processing plants. This means almost 90% of the poultry meat in India is produced under wet market conditions through highly scattered roadside poultry processing retail units. This is resulting in inefficient utilization of all poultry by-products and disposal problems. However, no meat or edible by-products is wasted either at retail or consumer level. Most of the loss in poultry value chain is happening during transportation of live birds (pre-harvest) due to transportation loss, injuries and death of birds. To some extent loss may happen at restaurants/hotels or in functions where buffet lunch/dinner is served.

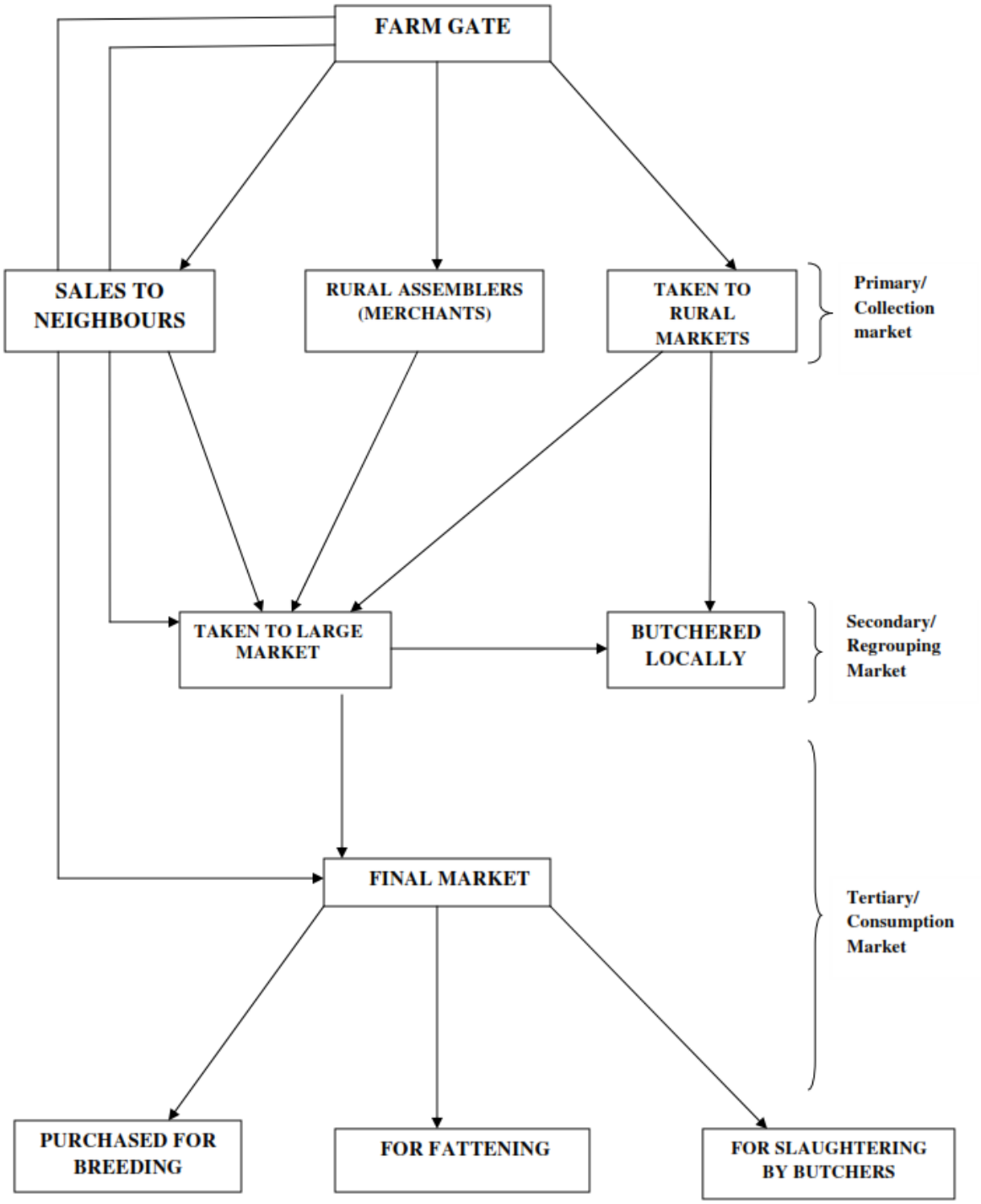
1.1.4 Pig meat sector: Among the various livestock species, piggery is the most potential source of meat production and more efficient feed converters after the broiler. Apart from providing meat, it is also a source of bristles and manure. Around 150 meat processing plants which are mainly processing pork and pork products like sausages, bacon and ham are functioning on small scale in the private sector in India. Most of the production and processing activities are under unorganized sector. As per the reports there are 25,000 pig farmers in Telangana state with 10-500 animals in each. Punjab has around 400 pig farmers with an average farm size of 50-200 each. Pig producers cooperative federations are coming up in some of the States. India has several indigenous and exotic pig breeds. The commonly used exotic pig breeds in India are Large white Yorkshire, Hampshire, Landrace, Large black and Duroc either pure or their crosses. Besides these exotic pig breeds, the indigenous pig breed, Ghungroo is also available in few states of NE. Thus the present shortfall of pork in the country is about 0.60 million tonnes. Pork production and processing can be a profitable enterprise for nutritional security and meeting employment generation requirement of ever increasing population.

1.2 Livestock and meat supply chain in India

In India, meat production is largely byproduct system of livestock production. Most of the large animals (buffalo and cattle) utilized for meat production are aged/ spent animals, which have completed their productive and reproductive life. However, goats, sheep, pig and poultry are reared largely for meat purpose. Buffaloes utilized as triple purpose animals in most parts of the country for milk, meat and draught purpose. Cow and bullock slaughter is restricted and it varies from state to state. Pig is purely a meat animal reared mainly by the weaker sections of the society and tribal people. Broiler chicken is largely contributing to meet the increasing demand of the growing populations.

1.2.1 Marketing of livestock: The livestock marketing system in India is still in a primitive stage. There are about 2000 livestock markets in India, which are mainly governed by local bodies such as Panchayats, Municipalities and Corporations, fair committees under the supervision of Controller of fairs or by the Agricultural Produce Marketing Controllers which are called regulated markets. Typically, marketing of food animals begins at the farm gate and passes through several intermediaries and various marketing channels before ending up in a slaughterhouse. Generally animal growers/farmers dispose their buffaloes, cattle, sheep, goats and pigs at farm gate to the commission/collecting agents or traders to avoid the risk and problems associated with marketing. The commission/collecting agent is the first intermediary who goes to the remote village areas to buy animals and moves them from farm to the secondary or final distribution centre.

Basically, there are 3 tiers of marketing system – primary, secondary and tracery/ final markets prevail in India. These markets may be composite involving all the species or sometimes exclusively for a single species. The primary markets (tier-I) functions at the village and farm-gate level where collecting agents and small traders operate. The secondary larger size weekly markets (tier-II) organized on a specific day(s) of the week at various locations in each state, where wholesalers, agents and processors operate. The weekly markets act as feeder centres to the daily markets and deal with livestock meant for rearing for milk, draught as well as for slaughter. The final livestock market (tier-III) is mostly under the control of butchers, traders processors and exporters. These daily markets are operated around metropolitan urban centers in close proximity to slaughterhouses to facilitate butchers for buying the daily requirement of meat animals.



Livestock marketing channels

Large animals like buffaloes, cattle are sold individually, whereas small animals like sheep, goats are grouped in lots of 10 or 20 and sold. The buyer makes the transaction based on the visual appraisal of animals for its age, body conformation, muscular development, fat distribution, etc. Live animal prices are affected by demand and supply, drought conditions and hide and skin rates. Middlemen or commission agents play active role in the prices negotiation and transactions. Export oriented buffalo/sheep meat processing plants generally procure the animals through network of authorized traders/agents and payment to them is made on the basis of hot carcass weight.

1.2.2 Marketing of meat: Meat is produced in about 4000 local body managed slaughterhouses and mostly located at the outskirts of town and cities. Meat retailers source their requirements of carcasses from wholesalers or from abattoirs or purchase live animals and get them slaughtered in the abattoir and bring the carcasses/ primal meat cuts to the shop. Meat of sheep, goat and chicken are sold as boneless and with bone, while buffalo meat and pork is mostly sold as boneless. Edible offals like liver, heart, tripe, tongue, brain etc are also source of income and are marketed separately from the carcass. The vast majority of meat is sold fresh on the same day of animal slaughter through retail meat stalls without any chilling. Almost all of the chickens are sold through wet markets, where the live birds kept at the sides of the retail shop and as and when consumer places demand, the birds are freshly slaughtered, dressed, cut into pieces and dispensed in polyethylene or polypropylene pouches. Consumers have the option of choosing birds in such retail outlets. The sale of packed chilled and frozen meat in the supermarkets is slowly increasing in big towns and cities. In the case of broiler chicken, recently some of modern integrated poultry processing plants directly procure birds from their own and contract poultry farms and selling the hygienically processed chicken in cities and export to various countries. In villages, the retail meat marketing for sheep, goat and buffalo is practiced by slaughtering one or two animals once in a week or on special occasions by a group of people joining together and sharing the cost of the animals and the meat so obtained. There is not much of overhead cost on meat in villages.

Intermediaries involved between producer and consumer in different marketing channels.

Channel 1:

Producer

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Wholesaler

↓

Retailer

↓

Consumer

Channel 2:

Producer

↓

Wholesaler

↓

Secondary wholesaler

↓

Retailer

↓

Consumer

Channel 3:

Producer

Trader

Wholesaler

Retailer

Consumer

Channel 4:

Producer

Retailer

Consumer

1.2.3 Issues in livestock and meat supply chain: Meat supply chain, which includes the marketing of livestock, slaughtering of food animals and sale of carcasses for wholesale and retail outlets is also poorly organized in India. Middleman operates the market with entrenched business interests who in most cases make the major share of the total price charged to the

customer. Four or five categories of middlemen intervene between the farmers/producers (in rural area) and the urban abattoirs, butchers and meat shop owners. Due to lengthy marketing channel and involvement of too many middlemen in the marketing of live animals, farmers get only about 40-45% of the total value of meat and other by-products.

Scarce infrastructure facilities at livestock markets, slaughterhouses, highly perishable nature of meat, religious taboos, wider variation in the regional agro-climatic conditions, inadequate cold storage facilities and refrigerated delivery vans, seasonal fluctuation in meat prices, lack of grading systems, overall poor economic condition of the stakeholders are also major factors creating problems in livestock and meat marketing in India.

1.2.4 Strategies for better livestock and meat marketing: Meat should be considered as important commodity rather than as a byproduct and various measures to be taken to use effectively and efficiently. Efficient marketing systems and supply chain ensures remunerative prices to the farmers and less cost of marketing and margins, assured quality and safe meat and meat products at reasonable prices to consumers and promote efficient utilization of surpluses for economic development. Organized development of processed meat industry is important to realize the full benefits from meat and edible by-products of slaughtered animals and create demand for meat and thereby contribution to sustained growth in meat sector. The recent trend in popularity of processed meat confirms a bright future for meat industry.

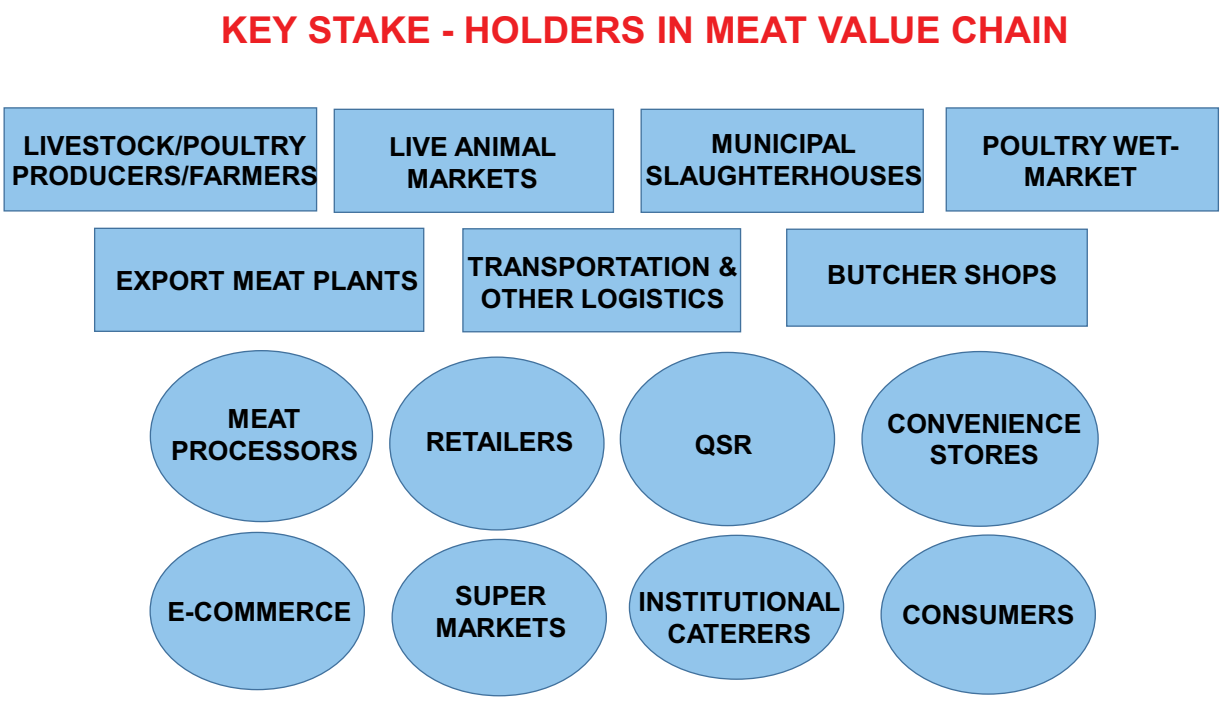
The following are some of requirements to make the livestock and meat marketing more efficient and provide due remuneration to the stakeholders.

- Most of the live animals markets do not have the adequate infrastructure for shelter, facilities for unloading, watering, feeding, weighing etc. Upgrading the existing live animal markets and abattoirs with required facilities for assuring welfare and fair transaction of meat animals and quality and safe meat at reasonable price to consumers.
- There is a need to educate and train farmers and other functionaries on important aspects of marketing such as grading, storage, processing, market information and pricing of farm animals.
- Producers/retailers should follow hygienic methods at various steps of meat production, transportation and processing. The retail shops should be hygienically maintained because improper handling and storage of perishable products may cause food poisoning.

Genuine cold chain facility for proper production channelization, distribution and retailing of meat

1.3 Pre and post-harvest losses in livestock produce

Assessment of quantum of harvest and post-harvest losses in any food sector is of paramount importance for the economy of the country. The apt terminology for meat sector would be "pre-slaughter losses", "slaughter losses" and "post-slaughter losses". Studies conducted at Indian Veterinary Research Institute under National Agricultural Technology Project revealed higher pre-slaughter losses (injuries, illness and death) in sheep and goat (10-12%) relative to buffaloes (4-5%). The slaughter losses (condemnation of meat and byproducts) remains negligible (<0.5%) for buffalo, sheep and goat and pig meat. Higher post-slaughter losses (transportation, storage, preparation and serving) mainly comprising byproducts were observed in buffaloes compared to sheep, goat and pigs. All India Coordinated Research Project (AICRP) on Post-harvest Technology (PHT) estimated total losses in meat and poultry sector to be 2.3 and 3.7% accounting for Rs. 235 crores and 104 crores, respectively. Losses comprising all materials routinely discarded during slaughter, dressing and byproducts processing operations have potential for revenue generation, if organised collection and processing into value added products are carried out. According to a report by Jha et al. (2015) extent of post-har-



vest losses in livestock produce in the year 2012-13 is estimated around Rs. 18,987 crores. Poultry meat accounts for 21% of the total loss accounting for Rs. 3,987 crores. Quantitative and qualitative loss happening through livestock value chain at different steps is mentioned below.

1.3.1 Quantifying postharvest losses

I. Pre-slaughter loss: From the point of purchase of animals-transportation shrinkage, injury, lairage conditions, diseases, death etc.

a. Farmer level:

- Death of animals
- Disease scare situation
- Seasonal losses (summer/holy months)

b. Animal trader level:

- Death of animals during transit
- Live animal weight loss
- Injuries

II. Slaughter loss: Condemned carcasses, removal of affected parts, trimmings, byproducts etc.

- Skin damage due to faulty flaying and handling
- Meat loss due to fracture and bruise
- Meat loss due to contamination
- Disease and defects

III. Post-slaughter loss: Transportation loss, loss at retail shops, packaging and further processing, loss at consumer level, spoilage etc.

a. Meat trader/Processor level

- Weight loss due to storage (chiller loss, evaporative loss)
- Processing loss (connective tissue, cooking loss)
- Spoilage

- Unsold meat

b. Consumer level: Household/Hotels and Restaurants/Mess/ Canteens

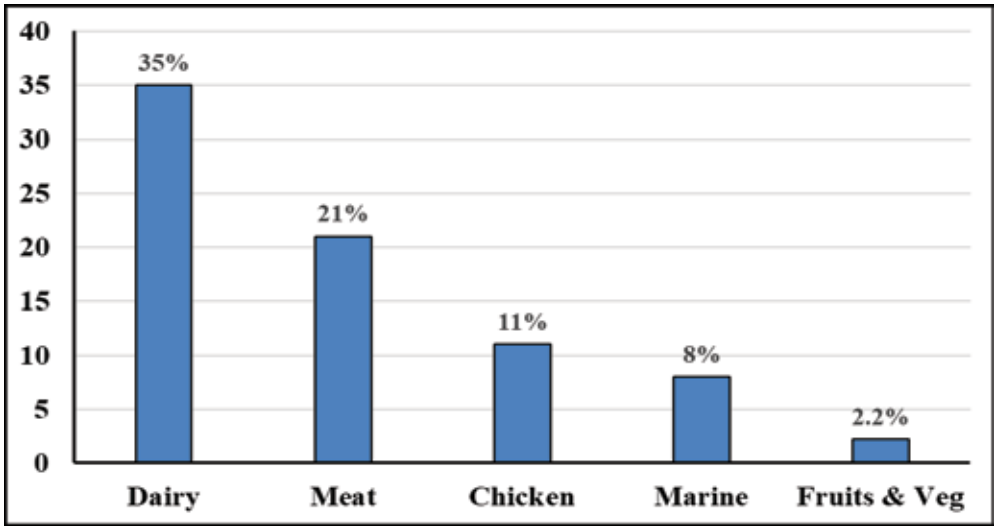
- Spoilage

1.3.2 Losses in quality

- Buffalo meat exported from India is produced from millions of spent, female buffaloes after completion of their milk production period. Hence, buffalo meat produced in India is a by-product of the dairy Industry and fetches low price of 2500 to 3000 USD/tonne relative to meat from developed countries. If male buffalo calves can be reared till 200-250 kg body weight through better integration, backward linkages and Government schemes, this meat will fetch higher price in International market.
- Only deboned, frozen buffalo meat is being exported from India. Value addition and further processing and export of processed buffalo meat products will increase the profit margins.
- Lack of specific meat breeds, absence of disease free zones, shortage of hygienic and modern slaughterhouses are resulting in qualitative loss.

1.3.3 Processing level in different commodities in India

Sale of fresh meat may yield 4-5% margin however, processing into value added meat products will result in 15-20% profit margin for meat processors. It has been estimated that about 7-15 % of the gross income come from the byproducts utilization for all meat processors. The level of further processing and value addition in different commodities is mentioned below.



Processing level for different commodities in India

1.4 Important issues in Indian meat sector

- Lack of specific breeds for meat production/absence of selection process/poor genetic potential
- Non-availability of quality feed and reducing of grazing land
- Non-availability of basic minimum facilities for live animal marketing and absence of animal grading system
- Limited number of environmentally controlled poultry farms, absence of HACCP measures and inadequate biosecurity implementation
- Movement of animals between states, absence of disease free zones and lack of traceability system
- Poor recording of antibiotic and hormonal use and enforcing withdrawal mechanism
- Limited transportation vehicles for live animal, carcasses and meat
- Inadequate cold-chain logistics and additional tax on frozen meat products
- Limited market intelligence (both domestic and export) and shortage of skilled manpower

1.5 Challenges and suggested solutions for meat sector in India

1.5.1 Challenges

- Failure of most of the local bodies to provide basic minimal facilities or infrastructure (supply of potable water, proper roads, slaughter and dressing facilities) to produce clean and safe meat for consumers. Little infrastructure for slaughterhouse byproducts utilization and waste disposal.
- Restrictions on slaughter and utilization of male buffalo calves. Steps are needed to curb mortality of male buffalo calves in different parts of the country as these calves could otherwise be salvaged for providing quality meat for export and domestic consumption. As per the available data, 14 million male buffalo calves perish annually. If 70% can be salvaged, reared and processed @ 175 kg per head–including edible offals – when reared they could yield 1.72 million tonnes of additional meat per annum. Even if we save 50% of the 14 million male buffalo calves and fatten them for the meat industry then they have a potential worth Rs. 22,000 Crore of export.

- Lack of specific meat breeds, slaughtering of animals at very young age or early age due to shortage of feed and absence of uniform slaughter policy across India are resulting in both qualitative and quantitative loss.
- Long distance mobilization and transportation of live animals/birds. Live pigs transportation from Uttar Pradesh, Telangana and Andhra Pradesh to NEH states; buffalo transportation from across the country to the meat export units located in Uttar Pradesh, Maharashtra, Telangana, Andhra Pradesh and other states. This leads to transportation loss, middleman involvement and cost escalation.
- Inadequate livestock mandis, vehicles for transportation of live animals as per standard guidelines, animal loading and unloading ramps.
- Around 90% of broiler chicken are produced in 6 states (Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Telangana and Haryana) and live bird transportation between states resulting in transportation loss besides biosecurity issues.
- Poor condition of domestic slaughterhouses: Lack of approach roads, insufficient potable water supply, floor slaughtering, absence of demarcation between clean and unclean areas, improper recovery and utilization of byproducts, inappropriate disposal of inedible waste etc.
- Lack of refrigerated transport vehicles for dressed carcass transportation; poor condition of retail shops without basic minimal facilities.
- Absence of skilled manpower for producing clean and safe meat; Lack of awareness about quality, safety, chilling, packaging and modern retailing of meat and meat products; Inadequate knowledge on the potential use, economic value and alternative use of livestock products.

1.5.2 Solutions

1. Studies indicating qualitative and quantitative losses across meat value chain from all food animals and birds must be undertaken covering different zones of the country. Potential value of utilizing animal by-products and meat industry waste need to be evaluated.

2. To prevent long distance transportation of live animals and birds and associated losses due to shrinkage, death and diseases, it is suggested to establish one hygienic slaughterhouse at each district place or in each cluster with all the facilities for efficient utilization of edible and in-edible by-products and effluent treatment plant. Instead of one big slaughterhouse in Metropolitan cities, it is suggested to establish few modern slaughterhouses surrounding the city in peri-urban areas so that the small meat traders (with 3-5 animals) need not to transport the animals for long distance.

3. Slaughterhouse construction/modernization, byproducts utilization and effluent treatment must be an important component and must be incorporated in SMART CITY plans.

4. Banning/restricting of scattered poultry processing in wet market within city limits and popularization and promotion of chilled and packaged poultry meat through central processing facilities.

5. Municipalities to create better facilities at service abattoirs: Roads, potable water supply, composting, rendering and waste disposal facilities. Each municipal abattoir/ slaughterhouse must have Rendering/Composting and Effluent treatment plant for solid and liquid waste management.

    i. Each service abattoir should have a waste management plan which stipulates the procedures for collection, treatment and disposal of solid and liquid waste.

    ii. Solid waste derived from lairages in the form of left over feed and fodder material and sweeping of dung and fecal material and paunch manure from slaughter hall must be disposed using composting and vermi-composting. This should be carried out by local bodies.

    iii. Solid waste comes from animal tissues such as dead animals, condemned carcasses and meat, offal, inedible byproducts from the service abattoir and waste from chicken stalls. Proper system for organized collection of this stream of solid waste and processing them in a dry rendering plant of appropriate size to be undertaken by local bodies.

    iv. With respect to chicken stalls, an appropriately designed four / three wheeler van must be used for collecting solid waste from chicken stalls daily. The operating cost of the van may be recovered by charging monthly fees from the chicken stalls.

6. Review the existing restrictions on buffalo slaughter especially SLAUGHTER OF MALE BUFFALO CALVES and propose regulations with a pragmatic approach for efficient utilization of buffalo resources with better productivity and many other associated benefits in terms of economic, social, livelihood, employment, food and nutritional security etc.

7. Municipalities may authorize or sublease the construction/modernization of slaughterhouses, maintenance, clean and safe meat production, waste utilization and all other meat sector related activities (animal transportation, ante-mortem and post-mortem examination, meat retailing etc.) to ANIMAL HUSBANDRY Departments or MEAT DEVELOPMENT CORPORATIONS of respective states.

8. In the currently approved food parks/mega food parks there are hardly any meat/poultry processors due to restrictions from other food commodity entrepreneurs about inclusion of meat and poultry. Exclusive ANIMAL PROTEIN food parks/food hubs for meat/fish/poultry/egg may be created.

9. Agencies/private entrepreneurs to link small scale entrepreneurs to food parks for better marketing of their produce.

10. Skill development programmes and hands-on trainings to various stake-holders in meat value chain viz, butchers, meat processors, retailers, veterinarians, quality control inspectors and other meat processors in the area of clean and safe meat production, waste utilization, value added meat products etc.

11. Creation of agencies/NGO's to link all the small and medium-scale entrepreneurs and stake-holders to MARKET in a value chain: Farmers, Producers, Primary Processors, Secondary Processors, Transportation, Storage, Wholesalers, Retailers, Quick Service Restaurants, Super-Markets and Service Providers etc.

12. Market infrastructure

    a. Establishment of livestock trading mandis in each district/clusters.

    b. Regulate movement of live animals between states and encourage establishment of disease-free zones, quarantine stations and mobile sanitizing vehicles.

    c. Policies to restrict the movement of live animals and birds and encouragement for transportation and sale of chilled, packed and frozen meat.

d. Promotion of e-commerce and online meat marketing entrepreneurs to create better processing, storage, transportation and other logistics in meat value chain.

13. Cold chain and storage infrastructure along the meat value chain

- Better infrastructure creation for live animal transportation, animal market modern slaughterhouses for clean and safe meat production and waste utilization.
- Creation of meat food hubs in states where there is great demand for meat and meat products (Kerala, West Bengal and North-Eastern States).
- Establishment of Food Banks, Any Time Meat (ATM), Meat Vending Machines, Smart Kiosks at airports and railway stations for ready to eat and frozen meats.
- Roping private entrepreneurs and NGO's for establishing Community Fridge.
- Refrigerated vehicles for transportation of carcasses and meat from slaughterhouses to retail meat shops.
- Chiller and freezer facilities at retail meat shops.

1.6 Way forward for Livestock/poultry producers, meat processors and exporters

- Building sustainable production chain
- Industry driven collaboration to advance food safety and traceability
- Agencies/Government Departments to link key-stakeholders in a value chain
- Judicious and responsible use of antibiotics to maintain health, hygiene and welfare of animals
- Ensuring animal health, welfare, environment protection and efficient usage of natural resources
- Obtaining globally recognized certification
- Evolving a comprehensive national policy for slaughter of animals and meat production system in India

CHAPTER-2

PLANT LAYOUT AND MAINTENANCE

Ensuring safety of animal products has received greater attention in the recent years. In addition to meat of infected/diseased animal, slaughtering and handling practices as well as poor transportation conditions adds to meat borne illnesses. There is need to visualize an organized meat sector in India and clean meat production is the most important requirement of organized meat industry. The abattoir need to be well designed, managed on modern scientific lines and run by trained and skilled manpower with hygienic and sanitary procedures, along with ante mortem and post mortem - meat inspection to produce good quality meat. As preparedness for implementation of Food Safety and Standards Act 2006, it is necessary to modernize the slaughterhouses for clean meat production.

2.1 Criteria for selection of site to establish an abattoir

Abattoir is a place where animals are slaughtered or sacrificed for food. Before finalizing site for establishment of an abattoir following factors are to be kept in mind:

- The location of the abattoir should be away from the residential area. Acceptability of slaughterhouse to the locality has also to be considered before finalizing the location.
- There must be enough open space nearby for future expansion. An area of 3-4 acres is required for slaughtering 500 sheep.
- Abattoir has to be located far away from airport.
- It should have good approach road facilities for bringing meat animals and for dispatch of meat in shortest period. Approach road for the abattoir must be at least 6.10 m wide.
- There should be an arrangement of uninterrupted electric supply.
- It should be free from pollution of industrial odors smoke, dust, ash etc.
- Skilled manpower should be available in the nearby area.
- There should be availability of sufficient number of good meat animals in the region.
- The soil should be able to support good foundation and pillars of the spacious building.

2.1.1 Abattoir design and construction

The guiding principle for designing abattoir is to provide all related services under hygienic conditions at lowest cost. In general the following basic technical guidelines should receive serious considerations.

- **Plant lay out:** Abattoir building should face either to east or west. A clear-cut separation between clean and unclean sections. There should be only forward flow of operation without any possibility of reversal. Completely separate routes for live animals and meat vehicles must be provided.
- **Walls:** It is recommended to put hard, smooth and impervious material up to a height of not less than 3 m from the floor. This will enable proper cleaning of the walls with jet spray of water. Junctures between walls and ceilings, and between walls and floors should be rounded (or coved) with a radius of one inch or greater. Coving minimizes a right angle crevice, which is difficult to clean and maintain. Abattoir ceiling should be at a height of at least 5 m.
- **Floor:** Floors should be non-slippery and non-absorbent and made up of concrete, granolithic concrete, tiles etc. A gradient of 2cm/m is recommended.
- **Doors:** Width of the doors provided in slaughterhouses must be about 4.5 ft. Wood must not be used for preparing doors or any other equipment and tools in an abattoir.
- **Water:** Potable water must be distributed in all parts of the plants under adequate pressure (i.e. 20 psi in the mains). As per FAO bulletin (1978), the water requirements for clean and unclean abattoir sections are 1000 ltr per buffalo or cattle, 100 ltrs per sheep or goat and 450 ltrs per pig.
- **Electricity:** Industrial three-phase electricity should be supplied, and a stand by generator to be installed.
- **Drainage:** The building should have efficient drainage with one drainage inlet for every 36 sq.m of floor space. The Drain should have effluent flow in opposite direction from edible product flow. Drains should be designed with catch baskets for debris, and hose stations should be provided to facilitate cleaning and maintenance. The gradient being ¼ inch/foot (6.35 cm/ 3.05 m). Drains must be covered with grid made of cast iron. Close attention to drainage is essential for hygienic operations.
- **Lighting:** Adequate natural or artificial light must be provided and that should not

distort colours. The lighting intensity should be 540 lux (50 ft candles) at all inspection point, 220 lux (20 ft candles) at work rooms and 110 lux (10 ft candles) in other areas. These intensities of light are usually taken at level of 0.9 m from the floor, except in inspection area where the height is 1.5 m. Lighting fixtures should be shielded with a non-breakable, transparent material.

- **Ventilation:** Adequate ventilation must be provided to prevent excessive heat, steam and condensation.
- **Pest control system**: Entire abattoir should be protected from pests, birds, rats and mice and insects etc. to avoid zoonotic as well as food poisoning disease. Installing flanging to foundations below ground level will discourage rodents from burrowing under the floor slab. Further, avoiding any horizontal ledges or overhangs in construction will discourage roosting or nesting of animals. If ledges cannot be avoided, they should be sloped rather than flat or horizontal. Preventing the entry of rodents and insects into buildings can be accomplished by sealing all openings to the outside which are 1/4 inch or greater.

2.1.2 Sections of slaughterhouse

The following sections are essential components of a modern abattoir

a. **Animal reception area:** Should preferably be roofed to protect animals and staff, particularly during identification, handling and sorting. An off-loading dock of about 1.2 m height to permit careful off-loading should be provided. Healthy animals are sent to lairage while sick and injured animals are to be sent to isolation pen.

b. **Lairage:** Place where animals are provided rest before slaughter to overcome the physiological stress involved in transportation of animals. Lairage must have watering, feeding and animal inspection facilities. Resting period may vary from minimum 6 hr to maximum 24 hr. Animals have to be kept off feed up to 12 hours before slaughter in lairage to reduce the gut contents, thereby reducing the chances of contamination during dressing of carcasses. Ample drinking water during rest should be provided as it lowers the bacterial load in intestines, and facilitates dehiding procedure. Lairage space sufficient for 5 days supply of animals is regarded as ample. Space requirement for lairaging of sheep is 0.6 m^2 per animal. A weighbridge suitably located is an essential feature of a modern lairage. In lairage all stocks must be handled gently and quietly. Knowledge of animals' behavior is fundamental to lairage design. Sharp corners and projections should

be avoided. The lairage gradient should be at least 2.5 cm is every 1.2 m. The size of hold pen for 5-6 animals is 2.5 X 2.5 m. Animals passed ante mortem inspection by Veterinarian only should only be utilized for slaughter.

c. **V – race:** It is the pathway that connects lairage with the slaughter hall. The Pathway is of tapering with 50 cm wide at the floor, 80 cm wide at the top. Catwalks must be provided alongside the V- race to enable handlers to control stock movement, check identification etc.

d. **Stunning area:** No person shall slaughter any animals in a slaughterhouse in the sight of any other animals awaiting slaughter. It is general impression that strange surroundings, smells and noises cause most stresses. Restrainer is necessary for easy and safe stunning.

e. **Bleeding area:** Majority of blood flow takes 5-6 minutes. The bleeding trough has two points for the reception of blood. One at the actual point of sticking where the greater volume of blood will be handled and there after a longer gradual slope collects “drip” blood. Subsequently, flaying, evisceration, inspection, stations must have platforms at suitable positions and heights for operatives and inspectors to work efficiently without unnecessary stooping and labour.

f. **Overhead rail dressing:** In modern abattoirs, overhead rail system ensures the basic requirements of hygienic conditions during slaughter and dressing. Carcass is conveyed by gravity along an overhead rail, after stunning and bleeding. The process of flaying, evisceration and carcass washing are performed on the rail. This reduces the contamination associated with floor slaughtering.

g. **Inedible offals room:** Should be located adjacent to flaying point and should have chute like provision to drop the offals into the room. Workers entry should be from outside. The room may be utilized to handle stomach and intestines.

h. **Skin store:** Utilized to store salted skin till dispatch. Should have chute like provision to drop the skins into the room.

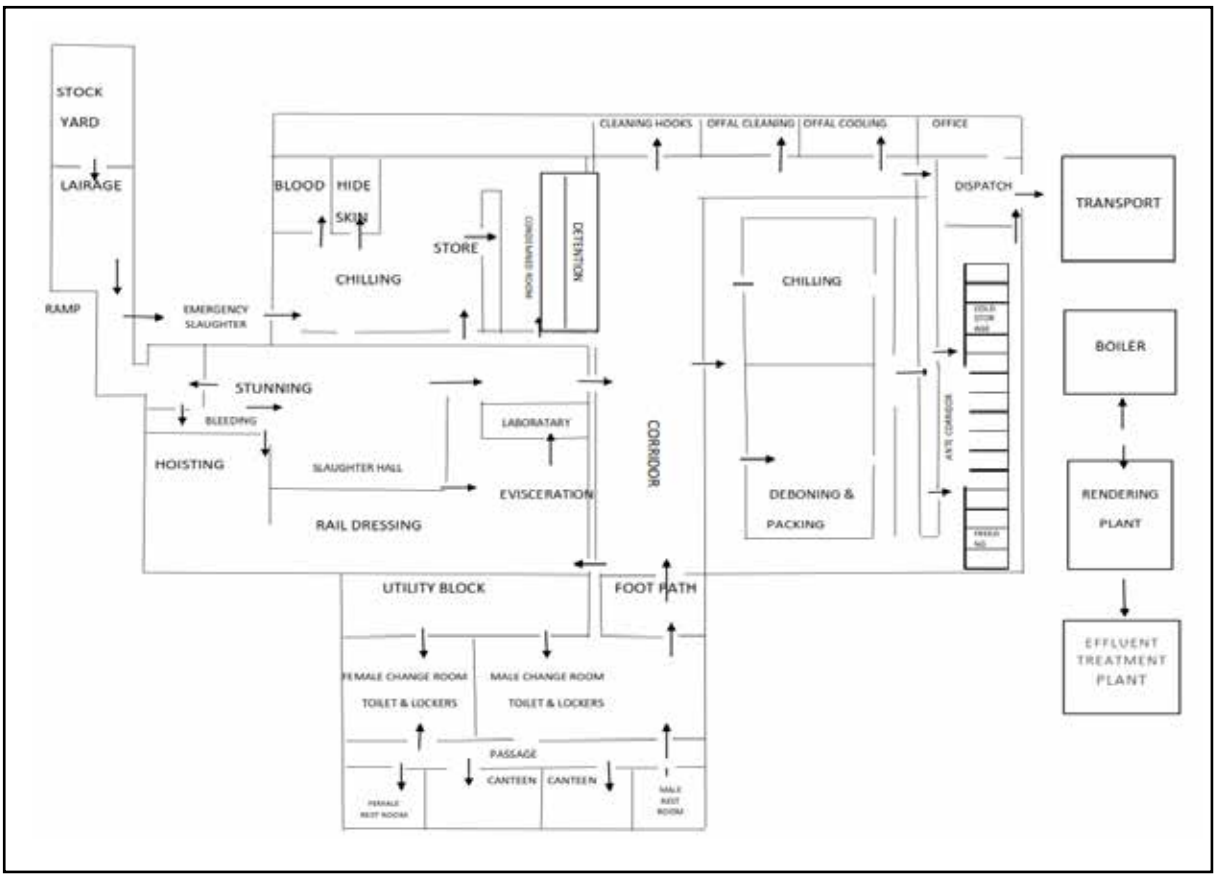
i. **Edible offal room:** Should be located adjacent to slaughter hall and offals may be delivered through chute like provision to avoid contamination.

j. **Veterinary office cum Laboratory:** For disease diagnosis and maintain over all hygienic standards.

k. **Facilities for personnel:** Wash basin (foot or leg operated type), showers, separate lockers, toilet rooms, first aid room etc. should be provided to keep up personal hygiene. Workers of clean and unclean units (abattoir, edible, inedible, dispatch) should have specific work wear (head gear, overcoat, apron, gum boot, face mask, etc.). At any point of time, the workers of different section should not mingle each other. All workers should have closely trimmed nails, hair and should not wear any ornaments including rings, watch, etc. All the entry points into the plant should have air and plastic curtains (to prevent entry of dust), fly killers and foot dip filled with disinfectant solutions. Signs boards for various personal hygiene measures like 'No spiting', 'No smoking', 'Wash hands before enter' etc., should be displayed prominently at relevant places. Each component of slaughterhouse should have sufficient number of wash basin (foot or leg operated type) and knives sterilizers. Personnel works in abattoir are more prone various types of injuries, hence facilities for wound dressing and other first aid procedures in food premises is very essential.

l. **Manure bay:** To store stomach and intestinal content. It may be located nearby effluent treatment plant and should be protected from pest and vermin.

m. **Effluent treatment plant:** During the process of slaughter and dressing, lot of waste is generated in slaughterhouses. Efficient management of waste management will protect public health and will also improve the acceptability of the meat production activities among the adjacent residential population. Every service abattoir should have an effluent treatment plant of appropriate capacity for treatment of liquid waste. For small and medium sized abattoirs, land based effluent treatment may serve the purpose. Effluent treatment plants are obligatory for larger capacity slaughterhouses.



Layout of a modern abattoir

Minimum facilities for hygienic meat production

2.2 Equipments and specifications of machineries in meat and poultry processing

Meat production involves several processing steps from slaughtering to packing, which needs several machineries. Slaughter and dressing operations require tools to immobilize, slaughter and separate the meat and organs offal from carcass. Conversion of muscle to meat is a highly complex process involving various biochemical and physico-chemical mechanisms. Owing to its highly perishable nature, meat and meat products needs to be handled, processed and packaged properly and preserved at low temperature at every stage. Processing of meat into different convenience, value added meat products needs diverse group of machineries viz., slicer, mincer, bowl chopper, tumbler, massager/mixer etc. Different cooking methods like moist and dry cooking are essential for making the meat products digestible and more palatable.

Availability of cheaper, durable and simple meat processing machineries is a prerequisite to increase the meat production, processing, value addition and consumption. However, very few entrepreneurs in India are presently involved in the manufacture of some of the slaughter and meat processing equipments. By and large meat processing equipments are being imported. Imported processing equipments are costlier, and no qualified service personnel are available for after supply services. In the absence of enough local manufacturers and higher costs involved with imported equipments it will be difficult to any entrepreneurs willing to venture into meat processing business. This has hampered the growth of meat production, processing and value addition. Further, it has resulted in poor, unhygienic and unscientific ways of processing leading to negative image of meat sector. There is a need to promote meat processing machinery production, which will in turn bring down the input costs and makes it possible for more entrepreneurs to take up production and processing of meat.

2.2.1 Required features of meat processing machineries:

- Made of rust-free food grade stainless-steel material
- Easy to clean features to avoid contamination
- User friendly, compact and economical
- High efficiency with minimal processing time
- Ability to withstand tough meat fibres

While selecting the meat processing machineries, dimensions (width, height and length), power requirements and minimum room requirement must be kept in mind so as to fit into the assigned place of work.

2.2.2. Equipment required for establishing a slaughterhouse

a. **Restrainer:** Restrainer is used to restrict the movement of the animal for stunning. The restrainer will have narrow leg space at bottom and broader body space at the top. The trap door should permit only one animal and it should not see the other animal being stunned or slaughtered.

b. **Stunners for meat animals:** Stunning is a welfare requirement to achieve painless killing. It is desirable to render an animal unconscious before it is slaughtered in order to eliminate pain, discomfort and stress from the procedure. Most developed and many developing countries have legislation that requires pre-slaughter stunning, with the exception of authorised ritual slaughter like Kosher and Halal. Whatever the stunning method, the animal should be rendered unconscious for long enough so that bleeding results in enough loss of blood to cause death from lack of oxygen to the brain (cerebral anoxia). Captive bolt pistol is used for stunning of large and small ruminants. It works by driving the bolt into animal's brain or to give a non-penetrating blow to the head by either the detonation of an explosive cartridge or by compressed air. Electrical stunner (Elther apparatus) is commonly used for stunning pigs and chicken, and also for sheep and calves. It causes stunning by passing electrical current in to the brain/ heart of the animal leading to in coordination of the cerebral nerve cells. Not less than 75 V is required for stunning meat animals and for at least 10 seconds. Strength of electrical energy used in stunning is calculated using the formula Watt-seconds = voltage x amperage x time. Mainly two types of electrical stunning is performed: low voltage electrical stunning involving 75 V for 7 sec and high voltage stunning involving 300 V for 2 to 3 sec. In terms of maintaining meat quality high voltage electrical stunning is most preferred compared to captive bolt and gaseous (CO_2) stunning methods.

c. **Sticking platform / Bleeding trough:** Used to receive the animal from the restrainer in stunned condition. The platform will be used to slit the throat of the animals for bleeding and collection of blood of the animal. Bleeding trough must be at least 1.1-1.2 m wide for sheep/ goat.

d. **Overhead rail system:** Used for carrying the animal in inverted position with the head facing downwards, till all the dressing operations are complete

e. **Electrical stimulators:** They are used to pass the electrical current through the carcass

immediately after slaughter. This accelerates the onset of rigor mortis and ageing and the pH of 6 is reached within 2 to 3 hours. It prevents toughening of meat due to rigor shortening and enables rapid cooling of carcasses. It helps in improving tenderness and color of meat..

f. **Chutes:** Suitable for gravity conveying of disposable parts of the animals at different stages of dressing.

g. **Carcass wash chamber:** The unit will be used for washing of the carcass by means of high pressure water jets. The washing cabinet will be formed using two screens on both sides of the rail to completely protect splashing/spilling of wash water.

h. **Hand wash basin:** For cleaning the hands of the personnel involved in slaughter and dressing of animals. It should be of feet/leg operated type to avoid cross contamination.

i. **Knife Sterilizer:** For sterilizing knives used in slaughter and dressing of the animals. The hot water temperature should be above 82^0C.

j. **Gambrels with Hooks:** Required for hanging the animal on both rear legs, during the dressing operation on over-head rail system. Gambrel should be provided with galvanized hook with roller for free movement on rail network. Periodical sterilization of hooks is must to prevent contamination.

k. **Air Curtain:** The air curtain should be installed at the entrance of the slaughter hall for preventing aerosol contamination.

l. Fly Catchers / Insecticutors: They are units with ultra violet lamps to destroy flies. The unit should be hanging type from the roof and placed at relent places to control flies menace.

m. Hose reel with gun: The hose reel with gun will be used for cleaning of the floor, walls and also the equipments after slaughtering is completed.

n. Knife Sharpener: The knife sharpener is electrically operated one and its grinding stone is periodically used for sharpening of the knives in the slaughterhouse.

o. Weighing balances: Required for weighing live animals, carcasses, meat and byproducts.

Electrical stunning tongs

Head only stunning

Knife sterilizer

Model small ruminant slaughterhouse of ICAR-NRC on Meat

List of slaughtering equipments for different species of food animals

Buffalo	Pig	Sheep/Goat	Poultry
1. Stunning hammer (mechanical) or 0.22 caliber rifle/ Pneumatic stunner 2. Stunning box 3. Bleeding grillage 4. Hoist with lander 5. Boning knife 6. Horn cutter 7. Pneumatic dehiding knife 8. Hide puller 9. Brisket saw 10. Different rails, conveyors and chutes 11. Splitting saw 12. Spinal cord remover 13. Jet cleaning machine 14. Knives, knife sharpener and steriliser 15. Air curtains 16. Utilities	1. Low voltage immobilizer 2. Electrical stunner 3. Scalder and scrubber 4. Bell shaped scraper 5. Flame gun for singeing 6. Hock cutter 7. Toe web cutter 8. Hog bung dropper 9. Brisket saw 10. Aitch bone cutter 11. Leaf lard puller 12. Circular splitting saw 13. Spinal cord remover 14. Jet cleaning machine 15. Knives, knife sharpner and steriliser 16. Air curtains	1. Low voltage immobilizer 2. Electric stunner 3. Deskinner/hider 4. Brisket scissors/saw 5. Carcass splitting saw 6. Jet cleaning machine 7. Knives, knife sharpener and steriliser 8. Air curtains 9. Utilities	1. Bleeding cones 2. Electric water bath stunner 3. Scalder 4. Defeathering machine 5. Dressing table 6. Chicken hock and neck cutter 7. Poultry vent cutter 8. Oil gland cutter 9. Screw chiller 10. Jet cleaning machine 11. Knives, knife sharpener and steriliser 12. Air curtains 13. Utilities

2.2.3 Equipments for maintaining cold chain:

Meat is a highly perishable product. Its composition makes it more prone to microbial spoilage and oxidative rancidity. Process of spoilage can be delayed by keeping the meat in low temperature *i.e.* at refrigeration (4 ± 1^0 C) for short term storage of 24-48 hours for conditioning/ageing to happen. After refrigeration carcasses should be made into cut-up-parts and frozen (-18 ± 1^0 C) for long term storage. Large scale meat processing plants maintain cold and freezer rooms to preserve large quantities of meat. Freezers are of different types: mainly plate freezers and blast freezers. Blast freezers bring down the temperature by blowing of cold air into the room. In plate freezers, temperature is brought down, by bringing the meat in contact with the plates at low temperature.

To ensure better quality be sure to prepare and freeze cuts promptly, protect meat from drying out (freezer burn) and oxidation by packaging in airtight and moisture-vapour resistant materials, label and date each package, freeze at -30 to -40^0 C, use ground meat within 4 months and do not store frozen meat more than 12 months for beef, buffalo meat, sheep and goat and 6-8 months for pork. Frozen meat should be thawed in refrigerator. Thawed meat should be cooked immediately or kept for only short time in refrigerator and should avoid refreezing of thawed meat.

2.2.4 Machineries for packaging of meat products

Packaging is the scientific method of containing food products against physical damage, chemical changes, and further microbial contamination and to display the product in the most attractive manner for consumer preference. Packaging helps in transportation and protects against losses due to exposure to environment. It also aids in proper labeling and provide necessary information to persuade the consumer. There are three types of packaging *viz.,* aerobic, anaerobic and modified atmospheric packaging methods.

a. **Aerobic packaging machines (Impulse sealers):** It is commonly used equipment for aerobic packaging of meat. It packages the meat in the presence of atmospheric air. Aerobic packaging ensures that the fresh meat maintains its bloom for longer period. It is the simplest method of packaging, hence commonly used for packing different food products. It can be done by using low-density polyethylene (LDPE) pouches with sealing machine.

b. **Vacuum packaging machines:** It involves packaging by removing the air around the product. Presence of oxygen helps in microbial growth and also leads to oxidation reactions. Hence, vacuum packaging helps in restricting microbial growth and also prevents drying out. After removing air, the pack is sealed (single or double seam) for proper maintenance of vacuum. Vacuum packaging machines will have seal bars of varying width and a lid.

c. **Modified atmospheric packaging:** In this method, the atmosphere surrounding the product is modified as per the requirement of the product. For meat products, carbon dioxide, nitrogen and oxygen are put alone or in combination. All three individual gas cylinders are connected with gas mixers so as to put the gases in required proportions into the pack. MAP is preferred for maintaining bright red colour of meat during display and storage.

Vacuum packaging machine

Vacuum packaged meat

2.3 Machineries for processing of meat products:

The following machineries are essential for development of various value added meat products viz., emulsion products, restructured meat products, cured and smoked products etc.

a. **Slicer:** Meat and meat products are cut in the form of thin slices for different requirements. It is achieved by a revolving blade which can be adjusted to get slices of different thickness. In built blade sharpeners are also available for efficient slicing of samples. Slicers of different capacities and types are available for different products.

b. **Mincer:** It is used for reducing the size of meat into different particle sizes. With the help of grinder plates of different hole sizes (3, 5, 8 & 13 mm), meat can be minced into required particle size as per the product requirement. Minced meat is used for the preparation of different value added meat products especially emulsion/restructured type products. Proper fixing of blade and knife and maintaining lower meat temperature are important for achieving better mincing and thorough output.

c. **Bowl chopper:** Chopping of meat is done with bowl chopper consisting of sharp multiple blades with revolving bowl. During chopping, the minced meat is converted into fine paste and all the ingredients (binder, spice mix, condiments, etc) are mixed well to form meat emulsion/ batter, which is used for the preparation of patties, burgers, nuggets and sausages. Because most of these steps induce lipid oxidation and affects the emulsion quality, it is advisable to use vacuum bowl chopper, wherein all the operations will be done under vacuum.

d. **Tumbler:** It helps in penetration of curing ingredients and extraction of meat proteins to the surface of meat chunks through fragmentation of meat fibers due to the pressure impact caused by dropping of the meat chunks. It consists of a drum with paddles inside. When the cylinder rotates with the meat in it, the impact caused by falling will help in mixing and penetration of cure ingredients. Use of vacuum tumblers will minimize the lipid oxidation. Tumbler is an important requirement for preparation of restructured meat products.

e. **Mixer/Massager:** Used in the manufacture of ground meat products**.** Here the minced meat is mixed with all other non-meat ingredients and seasonings inside a steel drum consisting of rotating paddles.

f. **Brine injector:** Brine is a solution containing different curing ingredients like salt,

phosphate, nitrite, ascorbate, sugar etc. As penetration of brine/curing solution into the bigger meat pieces takes longer period, it can be accelerated by injecting brine into chunks. This is essential in the preparation of cured and smoked meat products like bacon and ham.

g. **Sausage filler:** It is used for stuffing meat emulsion into natural or synthetic casings in the preparation of sausages. Both hydraulic operated and manual sausage fillers are available. Unit consists of cylinder, filler tube (nozzle) and a lid. Upward/parallel movement of piston in the cylinder helps in filling of emulsion into casings.

h. **Automatic patty making and meat ball forming machines:** Meat emulsion of fixed weight/shape will be moulded in the form of patty or meat ball in continuous operations.

i. **Blade tenderizer:** It is a physical method for tenderizing tough meat cuts. Here, meat chunks/steaks is pressed between set of multiple blades causing tissue disruption.

Sausage filler

Tumbler

Meat slicer

Meat mincer

Bowl chopper

Planetory mixer

2.3.1 Machineries for cooking of meat:

Indian cuisine is popular due to its exotic flavors and healthful preparations. India has excellent wholesome snacks or small meals that will just delight any gourmet. Diverse group of meat products are made using different cooking methods. Cooking of meat helps in tenderization of meat, improving digestibility, enhancing flavor and makes the meat safe to the consumer.

a. **Flame cookers:** It helps in indirect cooking of meat.

b. **Steam cookers:** It is moist cooking equipment wherein meat is directly or indirectly cooked by the action of steam.

c. **Hot air ovens:** Used for dry cooking or broiling. It is commonly used for preparation of patties.

d. **Microwave ovens:** Microwave is a form of electromagnetic radiation. For food applications microwave is used at a frequency of 2450 MHz. Upon application microwave radiation excites polarized molecules leading to uniform heating of product. Major disadvantage of the microwave oven is that it will not produce browning of the product which is a preferred attribute of the consumers. It is mainly used for reheating of meat products.

e. **Smoke ovens:** These ovens help in application of smoke generated by burning of hard wood to meat and meat products. Smoke ingredients extend the shelf life of meat apart from imparting smoked flavor. Advanced smoking units have the functions of cooking, drying and steaming. Microprocessor based systems can do these functions efficiently by regulating smoke, heat and steam as per the product requirement. One of the common problems in smoke houses is the accumulation of smoke tar on the inner surfaces of the unit. Hence unit with inbuilt cleaning system must be preferred.

f. **Deep fat fryers:** It is a method of dry cooking used for frying of meat products like enrobed meat products.

g. **Griller:** It is a method of cooking tender/marinated meat over direct heat (fire) on electric, gas or charcoal grill.

h. **Barbequing:** Method of cooking meat cuts, especially whole carcasses marinated with barbeque sause in an open firepit using coals, hardwoods, gas or electricity as heating source. Barbequing is usually done at outdoors.

i. **Tandoor oven:** Specially designed from clay for cooking meat cuts over coal or hard wood imparting unique flavour to cooked meats.

Smoke oven

Deep fat fryer

Griller

Meat processing unit of ICAR-NRC on Meat

Cooking unit of ICAR-NRC on Meat

2.4 Personnel hygiene

Meat handlers shall maintain high standards of personal cleanliness at all times. They should avoid habits that are potentially hazardous when associated with handling carcass or meat products, and might lead to contamination through the transfer of bacteria from the employee to product during its preparation. The following are some of the important personal hygiene measures to be implemented mandatorily in meat and meat products processing units:

- Persons suffering from infectious diseases shall not be permitted to work. Any cuts or wounds shall remain covered at all time and the person should not be allowed to come in direct contact with food. Arrangements shall be made to get the meat handlers / employees of the establishment medically examined (for TB, Salmonellosis, and any communicable diseases) once in a year.
- In case any of the personnel having the signs or symptoms of fever, jaundice, skin infection on hands, arms and face, boils, styes or sepsis on fingers, discharge from eye, ear or gums/mouth, diarrhoea and/vomiting and any other typhoid symptoms, a thorough examination is required.
- Meat handlers must be vaccinated against Typhoid and Hepatitis-B from a registered medical practitioner.

- Meat handlers shall maintain a high degree of personal cleanliness. They shall be provided with adequate and suitable clean protective clothing, head covering, face musk, gloves and foot wear.
- All meat handlers shall keep their finger nails trimmed, clean and wash their hands with soap, or detergent and water before commencing work, immediately after handling raw food or any contaminated material and every time after using toilet.
- Meat handlers shall refrain from eating, smoking, spitting, chewing, sneezing or coughing over any food and eating in food preparation and food service areas.
- All meat handlers should avoid wearing false nails or loose jewelry that might fall into food and also avoid touching their face or hair.
- They should avoid habits like scratching nose, running finger through hair, rubbing eyes, ears and mouth, scratching beard, scratching parts of bodies, etc.

Tools for ensuring slaughter personnel safety and meat hygiene

Generally visitors should be discouraged from entering the food handling areas. Proper care has to be taken to ensure that food safety and hygiene is not getting compromised due to visitors in the floor area.

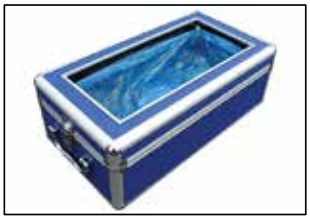
- Personal items must be stored away from production area.
- Personnel facilities shall include wash basins, lavatories, changing rooms, rest and refreshments rooms and such facilities shall be suitably located so that they do not open directly into meat processing, handling or storage areas.

Gum boots

Shoe cleaner

Foot operated hand wash

Hand drier



Shoe covers

Hand sanitizer

- No nail varnish
- No perfume/aftershave
- No watch/jewellery
- No long nails
- No use of gutka/tobacco

Hygienic practices for slaughter personnel

2.5 Cleaning, Sanitation and Pest Control: Equipment and Facility Design for Meat Industry

Sanitation and hygiene are most important requirement in meat plant operations. Meat product quality, shelf life and consumer acceptability are directly influenced by the sanitary conditions under which the meat is processed and hygienic practices followed in a meat plant. Sanitation can be defined as safeguarding human health through cleanliness. Hygiene is the practice of keeping self and living and working areas clean in order to prevent illness and diseases. Sanitation and hygienic programs have become integral part of meat processing operations. The effective sanitation program in a meat plant would help in achieving the above goals.

a. **Cleaning:** Physical removal of all visible soil and debris by chemical and or/physical means.

b. **Sanitizing:** Process used to reduce the number of microorganisms on a surface to safe levels. Sanitizer is a chemical which kills 5 log bacteria on equipment surface or 3 log bacteria on food surface within 30 seconds.

2.5.1 General cleaning and sanitizing procedure

Step 1. Remove all exposed products

Step 2. Dry clean/sweep area

Step 3. Wet area to be cleaned

Step 4. Clean and scrub area

Step 5. Rinse

Step 6. Sanitize

Step 7. Air dry/store properly

2.5.2 Sanitizers

a. **Chlorine based sanitizers:** Acts by inhibiting protein synthesis; breakdown nucleic acid; alter the permeability of cell membranes and oxidize the cell surface compounds. Most commonly used upto 200 ppm, cheap, broad spectrum antimicrobial, works with any water hardness. However, they are rapidly inactivated in presence of organic matter, pH sensitive (<7 most effective), Temperature sensitive (ideal 21-48º C), short storage stability. May results in formation of carcinogenic chloramines and trihalomethanes. Examples includes Sodium Hypochlorite (liquid); Calcium hypochlorite (powder); Chlorine dioxide (gas); Chloramine-T (powder)

b. **Quaternary Ammonium Compounds:** They are most suitable for meat Industries. They are synthetic surface active agents eg. Cationic detergents and act by binding with phospholipid and proteins-permeability change, breaks cell membranes. Their benefits includes no taste or odour, more stable in presence of organic compounds, forms bacteriostatic film on the surface after treatment, comparatively cheap and have good storage stability. However, these are very selective (does not kill viruses), require longer contact time and not suitable with hard water.

3. **Peroxides:** Includes Peracetic Acid/Peroxyacetic acid and Hydrogen Peroxide (Acetic acid+H_2O_2=PAA). They denatures proteins and lipids of microorganisms, oxidizes outer cell membrane of microorganisms. Their benefits includes broad-spectrum, rapid inactivation and excellent for low temperature application. However, they are corrosive to skin, special training required for handling, inactivated in presence of high organic matter and not effective against yeast/mold.

4. **Ozone:** It is formed when O_2 molecules collide with oxygen atom (O) to produce O_3. Powerful, naturally unstable gas, excellent germicidal activity and more effective than Chlorine/Chlorine dioxide. It is very strong oxidizing, fast reactive and decomposes rapidly without harmful residues. However, it is extremely unstable-must be generated onsite, irritating and toxic, no residual effect, costly with initial capital cost and operational cost.

Other sanitizers includes iodine based sanitizers, acid-anionic sanitizers, fatty acid sanitizers

2.5.3 Sanitation and maintenance practices

A cleaning and sanitation programme shall be drawn up and observed and the record thereof shall be properly maintained, which shall indicate specific areas to be cleaned, cleaning frequency and cleaning procedure to be followed, including equipment and materials to be used for cleaning. Equipment used in manufacturing will be cleaned and sterilized at set frequencies. Cleaning chemicals shall be handled and used carefully in accordance with the instructions of the manufacturer.

- Should have adequate potable water supply and free from cross-connections and back-flow
- Proper plumbing with adequate floor drainage and sewage disposal
- Adequate, accessible, sanitary toilet facilities and proper trash and waste disposal facilities
- Convenient hand-washing and sanitizing facilities
- Building shall be kept in good repair to prevent pest access and to eliminate potential breeding sites. Holes, drains and other places where pests are likely to gain access shall be kept in sealed condition or fitted with mesh / grills / claddings or any other suitable means as required and animals, birds and pets shall not be allowed to enter into the food establishment areas/ premises. Treatment with permissible chemical, physical or biological agents, within the appropriate limits, shall be carried out without posing a threat to the safety or suitability of food.

- Fly catcher lights shall not be placed above the meat processing equipments to avoid physical contamination.
- Staff handling exposed or wrapped fresh meat or working in rooms and areas in which such meat is handled, packaged or transported must in particular wear clean and easily cleanable headgear, footwear and light-colored working clothes and, where necessary, clean neck shields or other protective clothing.
- Water facilities should be readily available to wash hands during working days. The temperature of the water must be optimum (Too hot and too cold water is to be avoided). Water must be supplied with a non-hand-operated outlet. This may be controlled by foot, knee or sensor. Bactericidal soap must be available, with disposable paper towels provided.

Pest Control	
Signs of Infestation	*Good Hygiene*
• Droppings • Damaged packaging • Smell • Smears/discoloration of walls • Holes in fabrication • Larvae/Pupae • Eggs • Webbing • Piles of debris	• Factory kept clean • Effective waste control • Food in preparation kept covered • Clean spillages quickly and effectively • No food left outside the facility • Food stored off the floor and away from walls • Raw materials checked upon intake and during storage • Food stored in pest proof containers • Drains kept clean and screened

Pest control tools for meat processing plant

2.6 Primary meat processing

Meat production from food animals is the process whereby healthy, live animals are humanely stunned, bled, dehided/dehaired and eviscerated. In India cattle, buffalo, sheep, goat, pigs and poultry are the common meat animals. The following are brief description about various steps involved in slaughter and dressing of food animals.

a. **Rest and fasting:** The animals intended for slaughter are rested for minimum period of 12 to 24 hours. Ample drinking water during rest should be provided as it lowers the bacterial load in intestines, and facilitates dehiding procedure. Animals awaiting slaughter should be fasted for 12- 24 hours. Fasting improves appearance of the carcass and helps in dressing.

b. **Ante mortem inspection:** Ante mortem inspection of food animals is carried out by a qualified veterinarian with the object of providing wholesome meat to the consumers by deciding their fitness for slaughter. The live animal examination should be done within 24 hours prior to slaughter to detect communicable disease like Anthrax, Foot and Mouth disease, sheep pox, swine fever etc. Diseases like Tetanus, Rabies are detected only in ante mortem examination. It should be carried out in adequate lighting in the lairage.

c. **Stunning:** Stunning is the first step in the slaughter procedure. This must be done in a way that complies with the humane slaughter act. In conventional slaughter methods in most developed countries, it is normal practice to render the animal insensible by stunning, except in Jewish and Muslim methods and then to kill it by bleeding. Stunning induce an immediate state of insensibility and produce sufficient immobility to facilitate the sticking process to initiate bleeding. Electrical, mechanical and gaseous stunning are three important methods.

d. **Sticking and bleeding:** It is desirable to keep the animal live, but stunned, in order to eliminate the blood. Therefore bleeding can be achieved when the heart and respiratory functions are still working. Jewish and Halal (Muslim) are the two major forms of religious method of slaughter. Besides this, Jhatka (Sikh) method is also followed in some parts of Northern India. In the slaughter of animals, bleeding is usually carried out by an incision in the jugular furrow close to the head, severing both carotid arteries and jugular veins and blood drains, causing death through exsanguinations. Bleeding should be complete, and continued to a minimum period of 6 minutes. The efficiency of bleeding has greater impact on the subsequent keeping quality of the carcass.

e. **Dressing of meat animals:** Following bleeding, carcasses are dressed and excess fat, viscera and offals are separated from the bones and the edible tissue.

f. **Deheading:** The head as well as front and rear feet are removed after completion of bleeding. Prior to hide removal, care is taken to tie the esophagus and bung to prevent fecal contamination later in the process. In case of pigs, the head, skin, feet and tail are left attached to the carcass.

g. **Dehiding:** The hide/skin is removed by down and side pullers and fisting off the pelt (sheep and goats). In case of pigs and poultry, skin is edible and is retained with carcass. In these animals, after bleeding, carcasses are scalded with hot water at (55-65°C) to remove the hairs/ feathers.

h. **Evisceration:** Carcasses are sprayed with pressurized water to eliminate external contamination. Evisceration involves opening of pelvic, abdominal and thoracic cavities and removing the internal organs. Adequate precaution should be taken to segregate edible and inedible parts of the carcass in such a way that the contamination of the edible parts is strictly restricted.

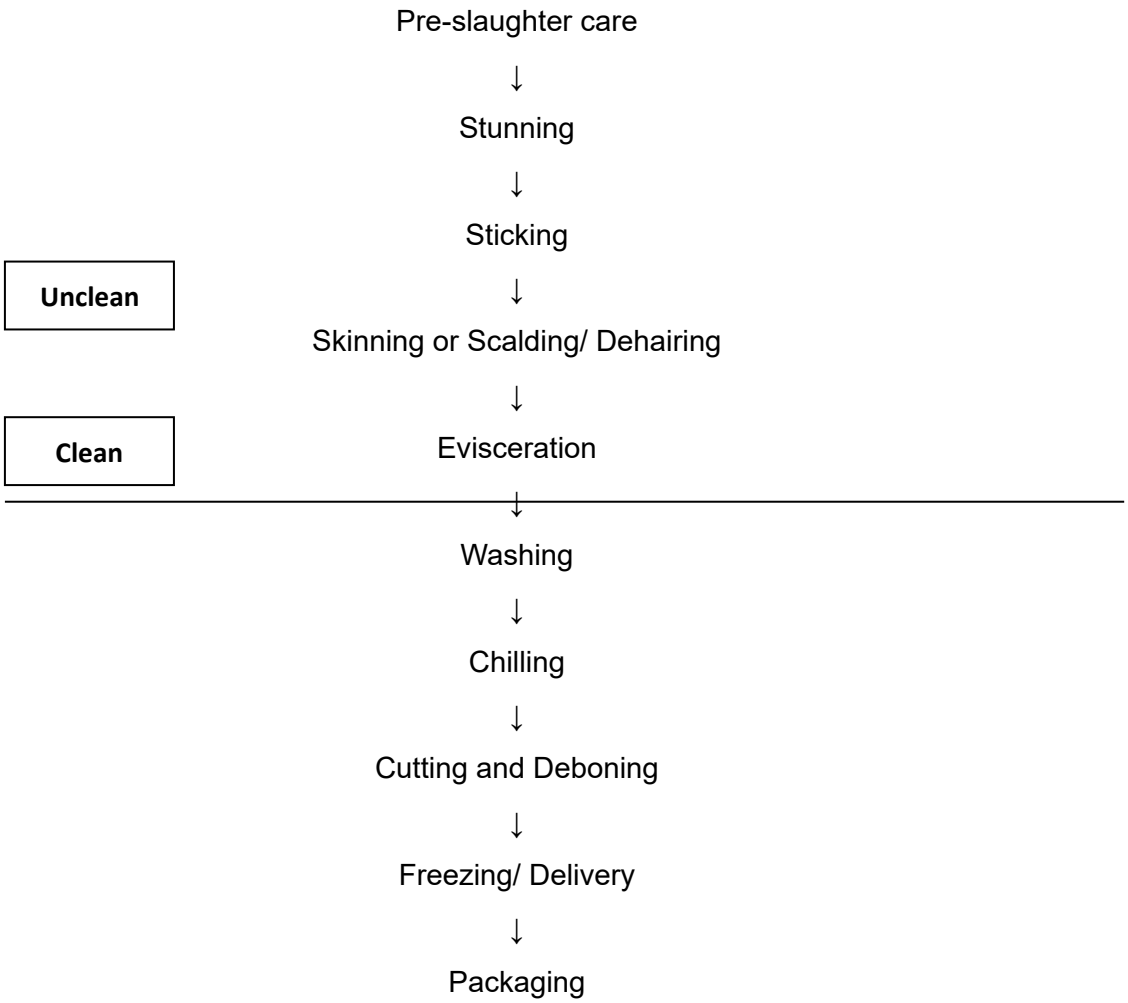
i. **Post mortem inspection:** The carcass and internal organs should be inspected for safety. The internal organs are removed and inspected for internal parasites and signs of disease. Lymph nodes are examined for signs of systemic disease. If any pathological condition is detected, part of or carcass as a whole should be condemned and sent for destruction.

j. **Carcass washing and decontamination:** Then the carcass is washed with pressurized potable water to remove the external contamination and also reduce the body temperature. Decontaminants like chlorinated water, lactic acid, etc employed to minimize the microbial load.

k. **Chilling:** Carcasses of freshly slaughtered animals have surfaces that are warm and wet and thus provide a perfect substrate for the growth of pathogenic and spoilage organisms. Chilling immediately post-slaughter reduces the surface temperature to a value below the minimum growth temperature for many pathogens. The combination of low temperature and surface drying inhibits the growth of spoilage bacteria. Hence, carcass sides should be cooled as soon as possible after weighing. Meat fabrication is generally carried out after the carcass has been cooled for 18 hours or more in chilling rooms at the temperature of 0 to 5^0C and 85-95% relative humidity to attain 5.8–6 pH to

prevent the growth of microorganisms and reduce meat deterioration. Chilled meat has shelf life of 2-3 days. Hot boning is the removal of muscles from carcasses immediately after slaughter. In our country, except export units, no carcass chilling is followed and sold as hot meat immediately after slaughter.

Flow diagram for fresh meat production processing



l. **Fabrication:** Fabrication refers to creating the various cuts from the chilled carcass to produce particular types of products. Primal or wholesale cuts are made first. Their names usually identify where the meat comes from on the animal such as loin, the shoulder etc. Retail cuts tell what part of the primal cut the meat comes from, for example rib roast. Often primal cuts are boned before cutting into retail cuts, in order to produce boneless items. The cuttings of carcasses into reasonably large wholesale or primal cuts make it convenient for the butchers to handle. Different standard cuts are made in sheep and goat viz. leg, loin, rack, breast and fore shank, neck and shoulder. The shape and size of primal cuts depend to some extent on the anatomy of the animal, but they also have regard to the suitability of the final smaller cuts for cooking. In India, the retailers do not follow any standard procedures, make bone in wholesale cuts and consumers use to prefer the choice cuts as per their needs and experience.

m. **Ageing of meat:** In the absence of microbial spoilage, holding of unprocessed meat above the freezing point is known as conditioning or ageing and it has long been associated with an increase in tenderness and flavour. During the first 24-36 hrs post mortem, the dominant circumstance is glycolysis. Of the protein in muscle, it has been generally accepted that the collagen and elastin of connective tissue do not denature during conditioning. During postmortem conditioning, the proteins of the myofibril and of the sarcoplasm denature in varying degree. Immediately after death and before the onset of rigor mortis, muscles are pliable and tender when cooked. With the onset of rigor mortis, the muscle becomes inextensible and is tough when cooked. As conditioning proceeds, the muscle becomes pliable once more and increasingly tender on cooking. Muscle does not cease to function at the time an animal dies. However, metabolic function is markedly altered due to cessation of blood supply and oxygen. The conversion of muscle to meat is a complex phenomena involving many biochemical and physical changes. The pyruvate that is generated as an end product of glycolysis is converted to lactic acid which accumulates in the muscle. The speed and extent of postmortem metabolism has a profound effect on the properties of the muscle and its subsequent use for food. The major physical change that occurs in postmortem muscle is the development of rigor mortis. However, the time for completion of rigor mortis depends on animal, species and even muscle. In case of beef it is 18 to 24 hours, 6 to 12 hours in lambs and less than 3 hours for poultry. The postmortem metabolism has important effects on the colour of meat, its texture and its usefulness for inclusion in processed meat products.

n. **Packaging:** Meat needs to be packaged to prevent contamination, color deterioration, loss of moisture, odor pickup, oxidative rancidity etc. It also helps in easier transport, display of necessary information and to convince consumers. Packaging is one factor affecting the shelf life of meat.

o. **Storage:** Combining a high standard of hygiene and packing with a low temperature during storage, transport and display can extend the shelf life. If the meat is desired to be stored for longer time quick freezing is always a desirable process to retain the natural quality of meat and to avoid deterioration due to delay in process. Commercially several methods are used to freeze meat viz. plate freezing, blast freezing and cryogenic freezing. Plate freezing is generally limited to thin pieces of meat and meat products such as steaks, chops, fillets etc. Blast freezers are widely used for meat of all type and suits for freezing whole sides, primal cuts and irregular shaped products.

2.7 Utilization of animal byproducts

When an animal is slaughtered, only one-third it is harvested as meat and the rest comprise byproducts and waste. The byproducts (including organs, fat, skin, feet, abdominal and intestinal contents, bone and blood) of cattle, pigs and sheep represent 66.0, 52.0 and 68.0% of the live weight, respectively. More than half the animal byproducts are not suitable for normal consumption, because of their unusual physical and chemical characteristics. Hence, processing and utilization of these byproducts not only meet the environmental regulations, but also recover useful nutrients rich products. Further, during slaughter operation, starting from lairage to meat production stages, huge quantities of wastes is generated. Though small scale slaughter does not result in excessive waste loads when distributed geographically, centralized slaughter requires greater attention to manage the waste. Despite the fact that pollutants of meat industry are of bio-degradable nature, their management is essential to prevent public health risks, meet the regulations and provide positive image to the sector. Organized development of livestock and poultry sectors with positive effect on environment and aesthetics is important for sustainability of these sectors in providing livelihood, food security and nutrition to the growing populations. This article discusses on the economics of utilizing byproducts and wastes.

Almost every byproduct of slaughter house can be utilized. It has been estimated that 11.4% of the gross income from beef, and 7.5% of the income from pork, come from the byproducts. This non carcass material is usually separated into categories of decreasing value such as edible byproducts, pet food, animal feed or fertilizer depending upon the potential

market. In the past, by-products were a favorite food in Asia, but gradually decreasing because of improvement in income level and health concerns. In response to these problems, meat processors have directed their marketing and research efforts towards non-food uses, such as pet food, pharmaceuticals, cosmetics and animal feed. However, various circumstances do not always permit byproduct recovery. The reasons may be inadequate quantity of materials, lack of markets, cost of processing etc.

2.7.1 Edible byproducts: The edible byproducts are also called as variety meats or specialty meats. They are generally internal organs such as hearts, tongues, livers etc. or external parts such as feet, tail. Yield varies based on the size and condition of the animal. Edible byproducts except blood are largely recovered and utilized. Though most of these materials are biologically edible, the utilization of the visceral organs of food animals depends upon religious, economical status and local customs of population. Further, the high cholesterol content of many organ meats, and the possible accumulation of pesticides, drug residues and toxic heavy metals, is also a reason for limited consumption.

In many of the Indian export slaughterhouses, a sizable quantity of brain, tongue, lungs, liver, heart, kidney, tail, tripe and feet of buffaloes are segregated, processed, chilled and exported as frozen. This list originally included the spinal cord and brain, but these are now banned for food use since the outbreak of bovine spongiform encephalopathy (BSE), popularly known as Mad Cow Disease. Many byproducts of small ruminants like brain, head, heart, liver and kidney are delicious items in domestic market. Many times liver, kidney and heart are sold along with skeletal muscles. Ethnic delicacies like curries, fries, soups are prepared out of variety meats. Animal blood has long been used to make blood pudding. However, consumption of blood is prohibited in Islam and Jewish religions. In Asian countries, crushed bones are cooked with water and the extracts are often used as a soup base or in noodle products, sauces, stews and curries. The gastro-intestinal tracts of small ruminants are often utilized for making fries alone or along with blood.

Potential uses and preparation of edible meat by-products

By-product	Main Use
Liver	Braised, broiled, fried; in loaf, patty and sausage
Kidney	Broiled, cooked in liquid, braised
Heart	Cooked in liquid
Brains	Broiled, braised and cooked in liquid
Tongue	Cooked in liquid
Tripe	Fried, broiled or cooked in liquid smoked and pickled
Sweetbread	Fried, broiled, braised and cooked pickled, soaked before use in liquid
Oxtail	Cooked in liquid
Intestines (small & large)	Sausage casings
Cheek and head trimmings	Cooked sausages, stews, soup, bouillon
Udder	Boiled, fried, smoked and salted
Skin	Gelatin
Feet	Jelly
Fat	Shortening, drippings, chewing gum
Blood	Black pudding, sausage, blood and barley loaf
Bone	Gelatin, soup, jellied products, refined sugar

2.7.2 Inedible byproducts: Many edible byproducts are downgraded due to lack of profitable market and utilized as pet food, animal feed, pharmaceuticals and cosmetics.

a. Utilization of byproducts for animal feed/pet food manufacturing: As many of the byproducts are good source of protein and other nutrients, it is economical to use them as pet food and animal feed. Unutilized byproducts are made into meal and used as feeding materials for livestock, poultry and pets. Thus Meat and Bone Meal provides an ideal combination of

protein and phosphorous to animals. Feeding animal tissue based feed for the synthesis of animal proteins is of obvious benefit when considering amino acid balance. For many years meat and bone meal were fed to cattle. This practice is now prohibited because it is believed to be the main route for the spread of bovine spongiform encephalopathy (mad-cow disease, BSE). In many of the integrated slaughterhouses, buffalo byproducts like lungs, heart, paunch are dried and exported for pet food manufacturing. In India, as most of the pet owners are sensitive to beef products, pet foods are made with chicken byproducts like head, feet, intestine etc. Further chicken industry wastes are utilized for feeding fish. Blood is one of the non-edible byproducts which are under utilized in our country. Though some amount of coagulated blood is added into the meat cum bone meal production, its use is restricted due to its dark colour and poor digestibility. The tallow resulting from rendering of byproducts is used as energy source in poultry and animal feed.

Inedible by-products and its uses

By-product	Main Use
Blood	Leather finishing agent, Animal feed, Blood Meal
Bone	Glue, Gelatin
Hide	Leather, Gelatin
Intestine	Casing, Suturing Material
Foot & Hoof	Neats Foot oil, protein hydrolysate
Bile	Detergent
Fat	Soap, Grease
Feathers	Feather meal, Protein hydrolysate
Ruminal contents	Biogas

b. Pharmaceutical industry: There are large numbers of glands present in an animal involved in synthesis and secretion of enzymes, hormones, pigments and vitamins. These enzymes are involved in the metabolic process in living cell and hence their availability in its natural form is very useful in the medicinal and industrial products. Animal glands and organs are traditionally used as medicine in many countries, including China, India and Japan. The best method of preserving most glands is by rapid freezing. Before freezing, the glands need be cleaned, and

the surrounding fat and connective tissue trimmed off. The glands are then placed onto waxed paper and kept at -18°C or less. The collection of animal glands from slaughtered animals is very important in terms of cost and availability. Haem derived from animal blood is a valuable source of organic iron and it was used as a food supplement. However, this process has been banned in India. In the beginning, insulin medications were made from insulin obtained from cows, pigs or salmon. This animal insulin worked quite satisfactorily for many years, but tiny impurities in the insulin caused immune reactions in the blood and skin. Presently recombinant DNA gene technology is used to synthesize human insulin from the E. coli bacteria. Similarly many hormones and enzymes of synthetic nature were developed. This resulted in the loss of a substantial market of meat by-product solids for pharmaceutical use.

c. Industrial use: Hides and skins are generally one of the most valuable by-products from animals. Skin and hides of cattle, sheep and goat are utilized for manufacturing leather shoes and bags, athletic equipment, reformed sausage casing and cosmetic products, edible gelatine and glue. Gelatin is added to a wide range of foods, as well as forming a major ingredient in jellies and aspic. Its main use is the production of jellied desserts, because of its "melt in the mouth" properties. Gelatin is also widely used as a stabilizer for ice cream and other frozen desserts. The gelatin is thought to inhibit the formation of ice crystals and the recrystallization of lactose during storage. The inedible gelatin is used in cosmetic products, and in printing for silk screen printing, photogravure printing etc. Blood also has industrial uses, as an adhesive and in the manufacture of paper, plywood, fiber, plastics and glue. It is used in sprays, as in insecticides and fungicides, and as a stabilizer in consmetics. It is also used as a foaming agent in fire extinguishers. The edible tallow is used for deep frying and baking. However, this use is declining in the fast-food industry, due to consumer health concerns.

CHAPTER-3

VALUE ADDITION OF MEAT AND POULTRY

Meat processing refers to any treatment including salting which brings about a substantial chemical and physical change in the natural state of meat. However, simple handling of fresh meat (making into different cut-up parts, minimal packaging) or preservation using refrigeration or freezing is generally excluded from the definition of meat processing. Therefore, in broad sense meat processing may include particle size reduction (mincing, grinding), marination or mixing with various additives, massaging or tumbling, curing, smoking, stuffing, canning or any other process that alter the freshness of meat. Meat which undergoes any of the aforesaid physical, chemical or enzymatic process is also called further processed meat. Further processing of meat is primarily done to add value to the meat, provide variety and convenience to the consumers, better utilization of low value cuts and byproducts from slaughterhouses, extend shelf-life of meat, facilitates incorporation of non-meat ingredients, for better marketing and distribution and provides employment, better profits and increased scope for export.

Added to shrinking free time, increasing nuclear families and decreasing meat related taboo in the younger generation especially in the urban areas is expected to drastically increase the demand for ready to eat, ready to cook, convenience and semi convenience meat products. This will push the demand further, there by opening up huge market for processed and packaged meat and meat products.

Despite the availability of great variety of meat products around the world, they can be divided into seven groups based on their characteristics. Based on their processing type, meat products may be roughly classified into 8-10 groups. Meat products also be classified based on their functions and requirements as functional/designer meat products, geriatric products and Institutional products etc.

Meat products by variety

Meats	Processing/characteristic	Example
Canned meats	Retort to sterilize; fully cooked; cured or non-cured	Corned beef, Vienna sausages, Beef stew
Frozen meats	Cooked or raw	Breaded cutlets or burger patties, meat loaf, meat balls
Dry-preserved meats	Low water activity; cured; refrigeration not required	Beef jerky, Pastrami
Cured meats	Cured with salt, nitrite and other adjuncts by injection or dry rub	Hams, Bacon, Deli meats
Sausages	Fresh, cured, or fermented; comminuted or emulsified	Frankfurter, Salami, Pepperoni, Hot dogs
Dinner meats	Prepared meals; pumped products; battered/ breaded meats; precooked or raw; frozen or refrigerated	Steak with vegetables; Seasoned pork roast
Luncheon meats	Deli meats; fully cooked and ready to consume; restructured meats	Sliced ham, Bologna and Salami

Meat products by processing type

Product Type	Examples
Sectioned and formed meat products	Beef rolls, Turkey rolls, Boneless hams etc.
Emulsion meat products	Nuggets, Meat balls/kofta, Emulsion sausages
Restructured meat products	Restructured meat loaves/slices
Ground meat products	Ground meat patties
Enrobed meat products	Enrobed wings, drummettes, Enrobed patties
Cured and smoked meat products	Ham, Bacon
Dried meat products	Beef jerky, Pastrami
Canned/retort pouched meat products	Corned beef
Fermented meat products	Salami sausages, Luncheon meats

Production of further processed product involves different machineries, ingredients, several processing steps and cooking methods. Details of different machineries are discussed in another chapter.

3.1 Different meat processing steps

a. Particle Size Reduction

Reducing particle size will be the first step to be followed in many of the meat processing activities. Generally tender meats are suitable for whole muscle or chunked products. Meats containing moderate to high levels of connective tissue should be reduced to fine particle size to ensure uniform palatability. Removal of connective tissue membranes surrounding muscles, called denuding results in extremely high quality raw materials. Particle size reduction may be accomplished by sectioning, chunking, slicing, flaking, grinding, or chopping. Reducing the particle size of meat results in increased surface area, exposure to atmospheric oxygen and other contaminating materials. All these lead to higher lipid and myoglobin oxidation and reduction in microbial quality of meat. Therefore care must be taken to maintain the temperature of the meat and the processing room not to exceed 7 °C and 12 °C respectively.

i. ***Sectioning:*** Sectioning involves separation of entire muscles by seaming between them with a knife.

ii. ***Chunking:*** Chunking is the process of making coarse particles or chunks. Meat can be made into chunks with very coarse grinder plate or by using meat dicer or with help of ordinary knife.

iii. ***Slicing:*** Frozen and partially thawed (tempered) boneless meat/block were usually sliced using a meat slicer with revolving blade to different thickness.

iv. ***Flaking:*** Flaking is a process of reducing particle size with meat flaking machine fitted with rotating impeller which forces frozen meat through the openings of the flaking heads of different sizes.

v. ***Mincing:*** Meat mincing/grinding is accomplished by feeding boneless meat chunks onto a rotating spiral shaft (screw auger) or a pump type system that presses the meat against a rotating knife and through a static end plate with holes of 1.5-13 mm diameter. The knife rotates at the speed of the spiral shaft. In addition to the static plate, the meat also passes through kidney plates with larger holes. The degree of cutting through fibrillar and filamental structures is rather limited. A mincer is able to grind semi-frozen or partially thawed meat. The temperature should not exceed 2°C at the end of the mincing process. Hand operated mincers are also used in many retail meat shops in India especially for preparing minced beef, mutton/goat meat.

vi. ***Chopping:*** Chopping also called comminution of meat, is usually done in bowl chopper or silent cutter. A bowl chopper consists of a rotating bowl that forces the meat to pass through a series of rotating knives that are closely adjusted to the surface of the bowl. Bowl choppers are usually used in the preparation of emulsion meat products. In contrast to mincing where degree of reduction of particle size is limited, bowl chopping involves cutting through meat many times with very sharp knives.

3.2 Ingredients and their role in meat products processing

a. Raw meat, fat and byproducts

Meat used for making emulsion products should have sufficiently high protein content and the proteins should be readily extracted and form gels during cooking. Pre-rigor meat has superior water binding properties and is used in fresh sausages. These desirable properties of pre-rigor meat can be preserved by addition of NaCl to the meat after comminution. This presumably solubilises protein before a strong bond is formed between actin and myosin. Filler meats having little or no binding ability such as edible offal meats (e.g. tripe, snouts), skin (from pork or poultry) could be included up to 10-20 percent in economic sausage formulations to “fill” the void space.

Inclusion of fat in comminuted meat products greatly improve palatability and enhance the tenderness and juiciness. It also serves as the dispersed phase in meat emulsion. The fat content of meat ingredients varies more widely than the moisture/ protein ratio and depends primarily upon the type of cut as well as on the carcass grade. Several aspects of the characteristics of fat are important for emulsion stability. According to United States Department of Agriculture (USDA) guidelines fat can be incorporated up to a maximum of 30 % level, so that fat and added water in the final product does not exceed 40% of the product weight.

b. Non meat ingredients

In addition to meat proteins, a variety of non-meat ingredients have been used as fillers, binders and extenders to reduce cook shrink and formulation costs. These non-meat ingredients can contribute nutrients, flavour and valuable functional properties to the meat emulsion. However, they can also alter or improve the appearance, palatability and texture of the final meat product. The binders have been used in meat emulsions because they are capable of replacing some of the functions of the meat, the most critical being the stabilization

of fat during cooking. Though, the addition of non-meat functional ingredients to processed meat products can increase product yield, product firmness may be reduced due to retention of water without an increase in gel rigidity. In practical applications, the most important factors to be considered are stability, yield, texture, palatability and cost.

i. **Binders and extenders:** Meat binders are non-meat substances with substantial protein content, whereas extenders/fillers are high in carbohydrates. The main meat emulsion binders commonly used are milk products, soy proteins, whole egg liquid and dried egg powders. Cereal products such as floor and starch are used as good source of extenders. Binders or extenders are commonly used upto 3.5% in comminuted meat products.

ii. **Milk proteins:** The milk protein products widely used in processed meat preparation includes non fat dry milk (NFDM), calcium reduced non fat dry milk, dried whey, whey protein concentrate, casein, lactalbumin, lactoglobulin and other serum proteins. Sodium caseinate is most widely used as an emulsifying agent in processed meats, while calcium and potassium caseinates are used when lower sodium formulations are required. It is a fine white powder with neutral taste and a protein content of approximately 94 %. Unlike the coagulable soy proteins, milk protein does not coagulate, shrink or form a gel while heating. Milk co-precipitates contain both casein and whey protein and used as good emulsifiers, water binder, gelling agent and thickeners in various emulsion meat products like bolognas, nuggets and frankfurters.

iii. **Soy proteins:** These are table proteins from soybeans in the form of flours (full fat and defatted), grits, concentrates and isolates, texturized, untexturized, extruded and spun soy protein fibres. Soy proteins are well known for their emulsifying and emulsion stabilizing properties. Soy protein is incorporated in meat products in a pre-hydrated form, at levels up to 4% to improve product quality through its moisture and fat binding ability as well as through its emulsifying and structure forming potential. However, both flour and grits give a slightly bitter taste to meat products, which limits their use (up to 2 %). Soy protein concentrates are high protein products (not less than 70 %). They possess good water absorption abilities and are used in emulsion type sausages, luncheon loaves and meat patties (at 2.5–3.0% level). Soy protein isolates are the most refined form of soy proteins, without water soluble sugars and other insoluble components. Owing to their high protein content (minimum 97%) they have excellent dispersing, emulsifying, gelling and water and fat binding properties.

Textured soy proteins are available in a variety of shapes, sizes, flavours (beef, pork, ham, chicken etc.), textures and colours. They are used as extenders in comminuted sausages, meat patties and canned meat products.

iv. **Flours and starch:** Flours of cereal grains (corn, wheat, rice) and tubers (potato, cassava) are used as extenders due to their high carbohydrate and low protein contents. Starch is a complex sugar of plant origin. The basic technological function of starch is to absorb released water and juice during heat treatment. Starch is used up to 4%. During heat treatment of sausages, added starch binds part of the free water and swells, thus decreasing weight losses.

v. **Vegetables:** Boiled potato mince, blanched vegetables such as cabbage, cauliflower, carrot, bottle gourd, etc. could be used from 5 to 10 per cent for reducing the production cost. Instead of single vegetable, a mixture of vegetables would be better and seasonal vegetables should be preferred for quality and economy. The peeled bottle guard and cabbage must be blanched (i.e. dipping in boiled water for few minutes) to inhibit any enzyme activity if present before mincing and chopping.

vi. **Water:** Ice flakes and/ or chilled water added (5-12 % level) during chopping permits longer and efficient churning of meat mass without mechanical overheating. Added water aids in dissolving and uniform distribution of non meat ingredients, providing fluid condition during fat chopping and increasing the product yield. It is usual to add up to 50% of water as ice to minimize temperature rise and microbial growth during chopping. Texture and tenderness of the products are markedly affected by the added water content.

vii. **Salt:** The main form of salt utilized in meat products production is sodium chloride. Interactions between muscle proteins and the sodium and chloride ions cause swelling of myofibrils, depolymerization of myofilaments and dissociation of the actomyosin complex. Thus, salt is responsible for the increased water retention, yield, increased meat binding, cohesion, increased fat binding and texture changes of finished products. Of course, it also imparts flavour and antimicrobial effects. Most of the emulsion meat products contain 1.5 - 2.0 % added salt. Salt must be sprinkled on the pre-ground meat in the bowl as soon as possible. By mixing meat and salt at the slowest speed, salt starts to extract proteins from broken muscle cells. Addition of ice water speeds up this process and controls the temperature rise.

viii. **Phosphates:** The phosphates commonly used in meat processing includes pyrophosphates or tripolyphosphates and available as tetra-sodium pyrophosphate and sodium tri-polyphosphate, respectively. In addition to their direct effect on water binding, phosphates increase effects of salt on cooking loss, yields, meat binding, fat binding and texture. As higher level of inclusion of phosphate leads to bitter taste and soapy texture in the finished products, they are used at 0.3-0.5% level.

ix. **Nitrite:** Sodium nitrite serves as a vital bacteriostatic control over the outgrowth of spores produced from *Clostridium botulinum*. Nitrite also involved in cured colour development and flavour protection. Nitrite reacts with myoglobin and upon heating, forms a heat stable cured pink colour pigment – Nitrosomyochromogen. Nitrite contributes flavour stability by retarding lipid oxidation through complexing with heme iron, which is a potent catalyst. Sodium nitrite is commonly used, although in certain cases it may be substituted for by potassium nitrite. The maximum level of nitrite allowed in comminuted products is 0.0156% (156 ppm per kg formulation). Nitrite is used in conjunction with the reducing agents - ascorbate or erythorbate, and phosphates.

x. **Antioxidants:** Ascorbic acid (vitamin C) is among the most used antioxidants in meat products production. The purpose is to prolong the product shelf-life by preventing lipid oxidation and color change that is caused by exposure of oxygen in the air. Other synthetic (butylated hydroxyanisole, BHA; butylated hydroxytoluene, BHT; tertiary-butyl hydroquinone, TBHQ; Propyl gallate, ethylenediaminetetraacetic acid, EDTA etc.) and natural (Rosemary, tea catechins, various fruits and vegetables especially pomegranate and their by-products powders) antioxidants are also used in meat products processing.

xi. **Preservatives:** Preservatives are used in very small quantity to keep food safe for longer by preventing the growth of microbes that cause spoilage and food poisoning. Some preservatives are used to impart and preserve the color of the product. Most commonly used preservatives in meat products include lactic acid, potassium sorbate, sodium sulphite, sodium nitrite, sodium and potassium lactate, citric acid, alginates, etc.

xii. **Flavour enhancers:** Flavour enhancer reinforces the flavor inherent in the product

by its effect on the taste buds. Monosodium glutamate is among the most used flavour enhancer in meat products manufacturing.

xiii. **Flavorings, spice and herb extracts:** Various herbs and spice extracts are used in meat products to enhance flavor. Coriander, sage, paprika, nutmeg, pepper, cardamom, cinnamon, thyme, anise etc. are most commonly used for meat product preparation. Mix of dried and powdered common spices is used at 0.75 to 1.5 % level in value added products preparation. Condiments prepared with onion and garlic mixture in the proportion of 3:1 or 4:1 could be used up to 3.5 % level.

3.3 Different value added meat products

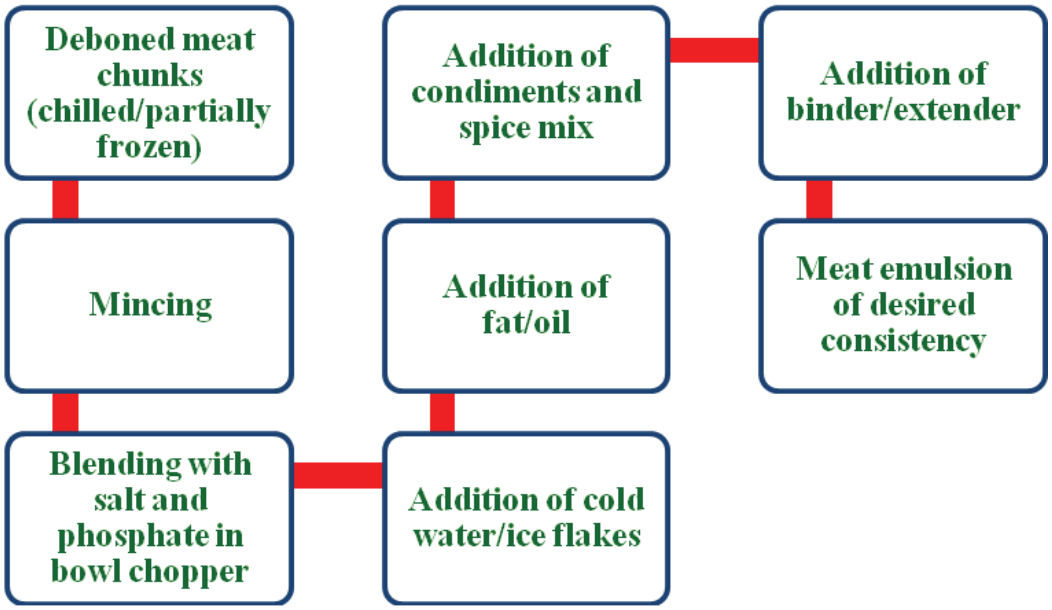
A brief description about different value added meat products based on the processing are furnished below.

I. Sectioned and formed meat products

Sectioned and formed meat products are prepared from pieces or chunks of meat that are bonded together to form a single fused piece. Technically speaking they are restructured products, since they are partially disassembled and then reassembled to form products resembling intact meat cuts. Sectioned and formed meat products differ from restructured products, which are manufactured by flaking or dicing and then reforming. Sectioned and formed products do not utilize grinding, chopping, emulsification, slicing or flaking.

II. Emulsion/comminuted meat products

Meat emulsions/batters are made by mixing or chopping meat and water with the addition of common salt (NaCl) until a fine, protein-rich slurry is formed. This matrix is then capable of binding fat, water and other non-meat ingredients. After cooking, the salt soluble proteins are coagulated and this results in an immobilization of the fat, water and other constituents. The basic structure of a meat emulsion is a mixture of finely divided meat constituents dispersed as a fat-in-water emulsion, where the discontinuous phase is fat and the continuous phase is water containing solubilized protein components. The emulsifier in a meat system is solubilized muscle protein. The sarcoplasmic proteins have very week binding properties, whereas the solubilized myofibrillar proteins, including actin and myosin have powerful binding properties in a meat system. Addition of salt and phosphates during emulsion making enhances the myofibrillar protein solubility and activate the proteins with better water immobilization and fat emulsification capacity.



Process flow chart for emulsion preparation

Gelation: It is a process of protein-protein interaction, which leads to formation of contin-ues, cross-linked protein gel matrix. The formation of continuous protein gel network has a large influence on the yield, textural and sensory properties of meat products.

Emulsification: It is nothing but protein-fat interaction and the ability of proteins to hold fat particles. In the presence of salt and polyphosphate, the muscle fibers swell, myofibrils are fragmented into shorter pieces, myofibrillar proteins are extracted and solubilized resulting in formation of a thick paste- like batter which holds water and fat

Chicken nuggets

Chicken croquette

Chicken idly

Sausages

Sausages are nothing but comminuted meat products that are usually spiced or seasoned to obtain various flavour intensities and profiles. The word *sausage* is derived from the Latin word *salsus* meaning *preserved*, or literally, *salted*. The development of sausages was initially driven primarily by economic factors mainly to utilize low quality meats such as trimmings, head and shoulder meat, and edible by-products. Convenience and variety sausages were developed in many parts of the world dependent on the climate of the region and the availability of various spices.

Chicken sausage

Process flow chart for preparation of sausages

Meat emulsion is stuffed inside synthetic or natural casing either by hand operated or hydraulic sausage stuffer. Filling of emulsion should be uniform without any air gaps

↓

Filled casings must be twisted or tied with thread to obtain sausage links of desired length

↓

Filled and linked sausages may be cooked in boiled water with 2.0% salt for 20 minutes or till the internal core temperature reaches 80˚C.

↓

Sausages filled in natural casings may be consumed along with casing, however for those filled with synthetic casings, casing material must be peeled before consumption.

Based on the product characteristics and the specific processing method used, sausages can be classified into four major groups:

1. Fresh sausages
2. Uncooked smoked sausages
3. Cooked sausages
4. Dry and semi-dry sausages

Sausage types

a. **Fresh sausages:** Fresh sausages are made from selected cuts of fresh meat (not cooked) and are salted but not cured with nitrite. They may be kept in refrigerator for maximum of 3-4 days and should be thoroughly cooked before serving. Examples of fresh sausages include breakfast sausage, fresh pork sausage, bratwurst, bock-wurst, fresh kielbasa (Polish) and Italian sausage etc.

b. **Uncooked smoked sausages:** These cured or fresh sausages that are smoked but not cooked prior to being sold. They must be refrigerated and stable for one week. Uncooked smoked sausages should be cooked thoroughly before they are served. Examples are smoked pork sausage, mettwurst and smoked country-style sausages etc.

c. **Cooked sausages:** Cooked sausages constitutes major chunk of sausages produced around the world. They are usually made from fresh meats that are cured during processing, fully cooked and smoked. Cooked sausages should be refrigerated until they are consumed. Since they are fully cooked, these sausages are ready to eat. Examples of cooked sausages are frankfurters, bologna, beerwurst, mettwurst, German style mortadella, knackwurst, thuringer and Vienna sausages etc.

d. **Fermented Sausages:** Fermented sausages can be divided into dry and semi-dry groups based on the processing procedure and product characteristics. The dry and semi-dry sausages are made from fresh meats that are cured during processing and may or may not be smoked. Carefully controlled bacterial fermentation produces a lower pH (4.7-5.3), which aids in preservation and produces the tangy flavours associated with fermented meat products. Fermentation process occurs through inoculation of lactic acid bacteria (LAB) which produce lactic acid through glycolysis.

The LAB may be introduced into meat by natural fermentation (through processing equipment or portion of fermented meat from previous batch called “Back sloping) or by inoculating a starter culture. Starter cultures are available as frozen concentrates and lyophilized dry powder and includes microorganisms like *Lactobacillus, Pediococcus, Lactococcus* and *Micrococcus*.

Dry sausages require long drying periods (ranging from 21-90 days), whereas semi-dry sausages are often fermented and cooked in a smoke oven. Both sausages are ready to eat. Semi-dry sausages requires refrigeration during storage whereas, dry sausages can be stored under room temperature. Of the different fermented meat products produced domestically, salami and pepperoni are two of the most popular items. Examples of dry and semi-dry sausages include summer sausage, thuringer, salami, pepperoni, genoa, milano, chorizo, lebanon bologna, mortadella etc.

III. Restructured Meat Products

In broadest sense, any meat product that is partially or completely disassembled and then reformed into the same or a different form is restructured. In real sense, all varieties of sectioned and formed meats, ground and comminuted meat products may be included under restructured products. However, certain steps or processing methodologies may differ between the aforesaid products. As mentioned earlier, either chunked, ground, or flaked meat pieces are used in restructured products wherein the meat pieces bind each other with proteins extracted through mechanical action using tumbling/massaging. Alternatively a small amount of meat emulsion or non meat binders (Alginates) may be used along with salt, phosphates and other ingredients.

In massaging frictional energy is generated from meat pieces being rubbed and massaged against each other by rotating paddles. The basic goal of massaging process is to develop protein-rich exudates without gross physical damage to muscle chunks. Tumbling provides more rigorous physical treatment and involve the impact energy from forcing meat pieces to fall from the top of a rotating drum. In the recent days vacuum tumbling is more commonly used by the meat industries.

Process flow chart for preparation of restructured meat products

Raw materials (Chilled/hot meat)

↓

Particle size reduction (Chunking/flaking)

↓

Mixing with non-meat ingredients (Massaging/tumbling)

↓

Stuffing

↓

Equilibration (4ºC/12 hrs)

↓

Freezing (-10ºC/24 hrs)

↓

Thawing, Cooking and Slicing

Restructured chicken slices and cubes

iv. Ground Meat Products

Ground meat products are nothing but restructured meat products, wherein minced or ground meat and fat is added with non-meat ingredients and then mixed in a meat mixer or massager to facilitate extraction of meat proteins and binding. Later the meat mix is extruded in casings for preparation of sausages or made into burger patties or some other ground meat products. Unlike emulsion meat products, here no chopping will be done and there is no formation of meat emulsion.

EMULSION MEAT PRODUCTS	GROUND MEAT PRODUCTS
Minced meat + Salt + Water + Phosphate	Minced meat + Salt + Water + Phosphate
↓	↓
Fat	Fat
↓	↓
Comminution in Bowl chopper	Mixing in Massager/mixer
↓	↓
Dispersion of fat cells, learn meat particles, binder and water	Protein extract or exudate which binds meat to meat, fatty tissue and water
↓	↓
Bound by protein suspension	Product with less fibrous texture
↓	
Product with reduced water loss and better yield	

Steps indicating preparation of emulsion and ground meat products

V. Enrobed Meat Products

Enrobing also called as coating is nothing but applying an edible coating material around the product. Commonly employed for poultry and fish products for better colour, taste, texture and smell. Enrobing brings several advantages to meat products such as value addition, versatility to consumers and improvement of nutritive value as well as eating qualities of the products. Enrobing improves the texture of the product, remarkably reduce the product cost, making it an avenue for value addition and better consumer acceptability. Enrobing also contributes other advantages like preserving the nutritive value, reducing

moisture and weight loss, and improving juiciness and tenderness. Enrobing/coating of meat products with edible materials enhances the acceptability and creation of variety to meat products. Enrobing provides convenience and variety for the consumer while increasing profits to the processors. Enrobing includes three distinguish steps, i.e. pre-dusting, battering and breading.

Predusting: The first step in coating sequence and involves dry coating which improves adhesion and pickup and also protect flavour from degradation during frying.

Battering: Dipping meat piece in a solution or a paste made by suspending dry solids (wheat flour, corn flour, starch and gums, etc.) in liquid that forms either the complete outer coating for a substrate or the binding layer between the food base and the subsequent layers of breading.

Breading: The process of applying coating material (e.g. rusk powder) to a moistened substrate. A cereal based breading is typically applied to moistened or battered food substrates to influence their flavor, colour, texture/crispiness and appearance.

Enrobed chicken drumettes and wings

Process flow chart for preparation of enrobed meat products

Marinate chicken cut-up parts viz. winglet, drumettes, drumsticks etc. with salt and seasonings

Pre-cook the chicken cut-up parts by steaming for 10-12 minutes

Pre-dust the cooked chicken cuts with corn flour or dipped in egg liquid

Pre-dusted cuts are coated with liquid battering mix

Breading is done by gentle rotation of battered pieces in breading mix manually or in automatic batter applicator

Breaded cuts are fried at 180-190˚C till attractive golden brown colour develops

Fried products may be consumed fresh or may be cooled, properly packaged and stored at 1-4˚C in refrigerator or in deep freezer at -18˚C

Frozen or refrigerated enrobed products may be reheated in microwave oven and served warm for better palatability

VI. Cured and Smoked Meat Products

Curing: Curing, also known as salting is the oldest form of preservation of meat. In curing, smaller meat pieces or bigger cuts either deboned or with bone is dipped in/injected with curing brine/pickle solution. The curing solution consists of salt, phosphate, nitrate/nitrite, ascorbate, sugar dissolved in potable water. Each ingredient has its own role and imparts unique cured meat flavor and appearance (pink colour). There are two types of curing methods: wet and dry. In wet/pickle curing, the meat cuts are either dipped in curing solution or injected with curing

solution using multi-needle injector followed by dipping. Injection facilitates uniform distribution of curing solution and development of attractive cured meat colour without any grey spots. In dry curing, all the curing ingredients are rubbed over the meat surface and stored for a prolonged time under controlled temperature and humidity.

Salt provides taste, flavor and acts as preservative by reducing the water activity, whereas phosphate helps to absorb and hold more curing solution and gives juiciness. The sugar counteracts the harshness or drying effect of salt and enhances the product flavor. Ascorbate helps to reduce nitrite into nitric oxide which reacts with myoglobin protein in meat and gives characteristic pink colour to cured and cooked meat as a result of formation of "nitrosohemochrome". Nitrites also help to prevent the growth of *Clostridium botulinum* which causes food poisoning in wide range of meat and meat products. Nitrate/nitrites are toxic to human beings when consumed in excess and hence their level is restricted to 150 - 200 parts per million (ppm, i.e. 150-200 mg/kg finished product). The in-going nitrite level is restricted to 120 ppm in some products like bacon. Nitrites reacts with secondary amines and results in formation of nitrosamines which are considered to be carcinogenic (cancer causing agent).

Smoking: It is the addition of either traditional vaporous or liquid smoke to meat. Smoking gives a drying effect to the meat, imparts a desirable taste, gives a pleasant odour, brings out the colour of the meat, and helps to prevent rancidity. The purpose of smoking most meat products today is to impart a unique smoke flavor and aroma and to give the surface a uniform smoked colour. There are two types of smoking: natural wood smoke and liquid smoke.

Natural wood smoke is generally produced from hardwood sawdust, woodchips, or logs. The hardwoods such as hickory, oak, maple, ash apple, cherry etc. are most commonly used for smoke generation. The smoke may be produced from an electronically controlled smoke generator or from a variety of much simpler versions, ranging from log burning to power controlled smoke generators. Pyrolysis or burning of major wood components viz, cellulose, hemicelluloses and lignin at 200-500 °C produces condensable compounds like organic acids, carbonyls, phenols and polycyclic hydrocarbons. The phenolic fraction is the primary source of smoky aroma and flavor and responsible for the preservative properties of wood smoke. The carbonyl fraction is demonstrated to be the source of desirable amber-brown colour generated during the smoking process. Modern smoke chambers operate in 3 steps: cooking, smoking and showering. Therefore, cured meat cuts may be completely cooked and smoked in a smoke chamber or they may be cooked separately and smoked later.

Smoked chicken

Liquid smoke is manufactured from the condensable fraction of natural wood smoke through water permeation-distillation process. Through further processing, the essential volatiles are refined and marketed in various forms (eg. oil-based, water soluble or dry powder). Liquid smoke may be applied to meat through dipping or drenching, atomizing (spraying) or directly mixing with meat formulation. Examples of cured and smoked products include Bacon, Canadian bacon, Corned beef, Hams, Country hams, Prociutto (parma) hams, Westphalian (German) hams, Boston butt and picnic shoulder etc.

VII. Dried Meat Products

Dried meat products are classified into low moisture foods and intermediate moisture foods. Low moisture foods are defined as those having a water activity (a_w) of less than 0.60 and containing less than 25% moisture. Intermediate moisture foods have a water activity between 0.60 and 0.85 and contain less than 50% moisture. Moisture requirements for microbial growth should be defined in terms of a_w in the environment (meat) of the microorganisms. Water activity is the ratio of the water vapour pressure of the food substrate over the vapour pressure of pure water at the same temperature. The a_w of fresh meat is above 0.99.

Dried meat products may be intact muscle based product or emulsion type sausage. They can be subcategorized by different forms because many are similar products produced in different cultures. Drying may be accomplished by low temperature drying (< 48 °C), high temperature drying (> 93 °C), freeze drying, sun drying and salting etc. Examples of dried and intermediate moisture meat products include: dried beef, beef Jerky (American), Bil-

tong (African), Pastrami (Turkey), Charque (Brazilian), Bologna (Lebanon), Salami, Pepperoni, Genoa (Italian) Cervelet (European) etc.

VIII. Canned and or/ Retort Pouched Meat Products

Canned meat products are prepared by hermatically sealing (preventing the escape or entry of air) the product in a container (usually tin coated steel cans) and thermally processed to destroy spoilage microorganisms. Canned meat products also called thermally processed products may be grouped into two categories: sterilized products and pasteurized products. Sterilized products must be heated to reach an internal temperature of at least 101 °C (heating temperature of 121 °C) and are shelf-stable (need no refrigeration). In commercially sterile canned meat products all viable microorganisms including spores be either destroyed or rendered dormant. The time in minutes at 121 °C required to destroy all the microorganisms and their spores is called as F_0 *value*. A safe cook is considered to have an F_0 *value* of 2.78 or more. The *Clostridium botulinum* is used as an indicator organism in canned/retort pouched products. Pasteurized products must be heated to an internal temperature of 65.5°C and require refrigeration to inhibit spoilage. Can filling, exhaustion and heat treatment are three main canning operations. Canned products are processed in retort cooker that operates under 12-15 psi pressure.

Recently metal cans have been replaced by retort pouches i.e. laminated multi-layer, flexible pouches which can withstand high temperature and pressure processing. These laminated pouches act as barrier to gases and moisture. Foil laminated retortable pouches costs less, lighter in weight enabling easy distribution and marketing with faster processing time.

IX. Fermented Meat Products

Fermented meat products are produced by mixing chopped or minced meat, fat, curing salt and/ or sugar together with spices, herbs and other plant materials (carbohydrates) with salt tolerant lactic acid producing bacteria (starter culture e.g. *Lactobacillus lactis, Leuconostoc Sp.* and *Bifidobacterium Sp.*), vacuum stuffed and subjected to various temperature and humidity conditions. These starter culture organisms produces antibacterial compounds “bacteriocins” along with lower pH of the product which inhibit the growth of pathogenic bacteria. The shelf-life, safety, specific flavour, texture and colour of these products are determined by combinations of acidulation brought about by lactic acid production and the lowering water activity by the addition of salt and drying. The simultaneous

or successive combination of these processes is generally referred to as fermentation. The fermented meat products may be classified into semi-dry and dry sausages. These are made from fresh meats that are cured during processing and may or may not be smoked. A carefully controlled bacterial fermentation produces a lower pH (4.6-5.3), which aids in preservation and produces the tangy flavor associated with fermented meat products.

The period required for production of fermented meat products is referred to as “ripening” and is separated into fermentation and drying. The dry sausages are generally not cooked and require long drying period (21-90 days), whereas semi-dry sausages are often fermented and cooked in a smokehouse. During ripening of fermented products, many healthier compounds are produced and may exert healthful effects on the consumers. The commonly used lactic acid producing bacteria available as frozen cultures for producing fermented meat products include *Lactobacillus plantarum*, *Pediococcus acidilactici*, *Micrococcus sp.* etc.

Classification of Fermented Meat Products

	Semi-dry Sausages	**Dry Sausages**
pH	< 5.3	4.6 - 4.7
a_w	0.90 - 0.94	0.85 - 0.91
Processing	Fermented, cooked and / smoked	Fermented, prolonged drying (No cooking)
Moisture: Protein ratio	< 3.1:1	< 2:1
Storage	Keep refrigerated	Shelf-stable
Flavour	More tangy	Less tangy
Type	Ready-to-eat	Ready-to-eat
Examples	Summer Sausage, Cervelat, Thuringer, Lebanon Bologna, Mortadella,	Italian Salami, Pepperoni, Genoa Salami, Sopressata

X. Traditional meat products

India being a wide country with large number of ethnic groups with diversity in tradition, culture and varied food habits, large varieties of traditional meat products of indigenous taste profile are being prepared and consumed. The knowledge on the traditional preparation methods is generally passed across generations through practice and word of mouth. These products vary from region to region and place to place. Based on the availability of raw materials, people have developed taste to particular food products and in this process, they have developed various speciality products traditional to their regions. The traditional style of preparation and the specific ingredients added to each product has resulted into development of products with unique sensory attributes. However, they have one common factor, they rely on local resources and social and environmental conditions. Moreover, the historical invasion of Arabs, Mughals, Portuguese and Persians have brought many interesting products to our country, particularly different variety of kebabs, koftas, tandoori items and meat curries etc.

Popular traditional meat products of different regions of India

Region Specific Traditional Meat Products of India	
Northern Region	Seekh kebab, Tandoori chicken, Goshtaba, Nate-Yakini, Tabak manss, momo
Eastern Region	Meat dopiaza, Momo, Kargyong, Suka ko maso, Satchu, Kheuri, Ngam phoat, Doh pheret
Western Region	Meat rolls, Vindaloo, Shakudi, Mutton Kolhapuri
Southern Region	Chettinad chicken, Haleem, Biryani, Chicken curry, Dry salted meat
Himalayan Region	Kargyong, Kheuri, Satchu, Suka ko masu, Chilu, Gemma, Arjia, Chartayshya
Deccani/ Hyderabadi Specialities	Haleem, Hyderabadi dum-biryani, Paya, Nahari, Bheja, Chicken kaccha kofta, Mutton kofta, Gongura mamsamu, Munagakaya mamsam
Jammu & Kashmir Specialities	Goshtaba, Nate Yakini, Tabak Manss, Rista, Aba gosh, Rogan josh, Balti meat curry
Punjab	Tandoori meat products
Uttar Pradesh	Kebabs, Meat samosa, Meat pakora, Biryani
Tamil Nadu	Chicken Chettinad, Meat curries, meat pickle
Kerala	Meat fry

Even though, India is also known for its several traditional meat products, the popularity of these products remains confined to the specific community/location. The following are some of strategies for enhancing commercial potential of traditional meat sector in India.

Strategies for promotion of traditional meat sector in India

Lack of awareness about the prospectus of value addition of meat, inadequate technological support for improvement of quality attributes and shorter shelf life of value added traditional meat products and unavailability of trained manpower are the major obstacles in the growth of the traditional meat processing market in India. Further, formation of producers/manufactures societies and ascertaining geographical identification, registration of brand names should be planned and they must be implemented with full confidence of local people in a step by stem manner.

i. **Awareness creation on the opportunities in traditional meat sector:** Considering the future demand and the changing food habits, the value added meat sector especially traditional meat products promises a huge potential to take up meat processing as an enterprise. A large number of entrepreneurs in processed meat sector are micro and small in terms of their production and operations, and are largely concentrated in the unorganized segment. Owing to increasing demand for traditional meat products several self-help groups, unemployed youths, restaurant owners, fresh meat retailer are coming forward to start new ventures. Therefore, the scope, potential and oppoertunities of traditional meat products processing enterprise should be demonstrated through exhibitions, kisan mela, workshops, print and electronic media.

ii. **Technological interventions for improvement of quality attributes and shelf life and bulk production:** Simple and relevant technologies have immense potential in Indian situation for production of value added products by a number of small scale producers. All efforts have to be made to keep production cost at minimum with selection of appropriate formulation, processing conditions and infrastructure facilities. Therefore, promoting large number of small scale units across the country will be more appropriate to meet the demand from a large number of consumers of varying socio-economic status and ethnic preferences.

Economic meat products formulations with higher cost reduction have been developed with incorporation of spent animals meat, their byproducts (fat, skin, gizzard and heart) and locally available non-meat ingredients such as eggs, milk solids, vegetables, pulses

and etc. to produce acceptable quality products. Newer products are desired to provide variety to the consumer, improve marketability and reduce cost of product. The products should be developed and marketed to the needs, expectations and acceptance of as large a population as possible.

Most of traditional meat products are generally confined to the native geographical region mainly due to their shorter storage stability. In view of the increased urbanization and increase in meat consuming class, commercialization of traditional meat products especially those are shelf stable have good potential. Retort processing is a promising technology for increasing the shelf life of the traditional meat products and their popularization in different geographical areas. Application of retort pouch processing for large scale production of shelf-stable traditional meat products will ensure their availability throughout the year and also increase their export potential.

The processing potential of the traditional meat products is limited to a particular geographical region and is in the hands of local people, who process the products in traditional way either regularly or activity during festival time or some special occasion. Most of them are only small, local and regional players. Large scale production and availability of these products throughout the year in all places will further boost their marketing potential. Availability of suitable indigenous equipment/machineries made of food grade stainless steel with automation wherever necessary may help in large scale and uniform production.

iii. **Skill and entrepreneurship development:** The preparation of the traditional meat products is usually carried by local people, who process the products in traditional way. In order to globalize traditional food, quality control procedures are essential for the production of safe products as well as the raw materials used in it. Process optimization and application of quality control tools must be followed in order to ensure safety. A step forward for commercializing the products needs uniform optimized protocols for each product. These standardized protocols can be followed on a global scale helping the indigenous products to go global. The products manufacturing should be done hygienically keeping in consideration the HACCP (Hazard Analysis Critical Control Point) and GMP (Good Manufacturing Practices) guidelines. The nutritive value of the each traditional products is needs to analyzed and maintained consistently.

Quality of the raw materials especially spices and condiments used in the products which are reported to be sources of excessive coliforms and other pathogenic bacteria must be controlled. Maintaining the hygiene and cleanliness of the premises with adequate supply

of potable water, use of fly catchers, air curtains, hand washing and sanitizing facilities is a prerequisite to manufacture safe products. Proper cooking, packaging and storage facilities and use of natural or food grade preservatives to improve the shelf-life of finished products must be considered. The sanitation of workers involved in the production processes should be managed and controlled.

Training and skill development of the entrepreneurs in meat processing and scientific meat preparation methods, demonstration and production of different meat products is required. Hand holding for the establishment of small-scale-mini-meat processing unit in respective locations and providing technical back up and input supply to promote entrepreneurship is required.

iv. **Geographical Indication status:** The authenticity of the traditional meat products could be protected through seeking the Geographical Indication (GI) status. This will eliminate the cheap imitations from unscrupulous makers of the product selling as 'traditional product'. This could be achieved by formation of producers/manufactures societies/ association involving key makers of the product and seek the 'Geographical Indication' status for the product under the Indian Geographical Indications Act, 1999. The 'Hyderabad Haleem' (a meat based traditional product with wheat and ghee as other main ingredients along with spices, slow cooked to obtain a pasty like product prepared during the month of Ramzana) from Hyderabad (Deccan) region of India has been awarded with the Geographical Indication Certification in September, 2010, and thus safeguarded the product being imitated elsewhere and sold in the same name. Adequate legal protections are provided in the Indian Act. The Geographical Indication is not only give a sense of satisfaction among the local people to enjoy the uniqueness of these products with assured quality, which are hailing from the region but also, a great sense of pride and ownership is attached to these products.

v. **Branding and establishing marketing network:** To make an identity in the competitive market, branding of the products is very essential. The brands when given a particular trademark, it helps in image development of the brand in the minds of the consumer helping in deeper penetration into the market. Establishing chain of kitchens at different parts in the city and prepare the products freshly so that it can be accessed by people in a wider living area. Aggressive marketing will spread the popularity of traditional meat products to wider areas. Further, roping the services of logistic agencies including postal departments, couriers services, logistical service providers, which have a wider network could

be engaged to supply immediately upon order (offline as well as online) even forth away place in major cities through air transport. This will help to cover larger population of wider geographical area.

Withstanding the different levels of marketing stages necessitates proper packaging and transport. The package needs to be customized depending on the feature of a particular product. Advancement in the packaging technologies like vacuum, modified atmosphere, shrink wrapping should be suitably employed to maintain the freshness and also extend the shelf life. Products may be marketed as fresh, chilled, super chilled and frozen as per the requirement of the customer and marketing channel. Adequate cold chain from the point of production to the market should be well maintained to retain the quality attributes and extend the shelf life of the products.

Xi. Functional meat products

Meat and poultry products are a food category with both positive and negative nutritional attributes. In recent years, much attention has been paid to develop meat and meat products with physiological function to promote health condition and prevent the risk of diseases among consumers'. The science of functional foods is at the confluence of two major factors in our society- food and health. The link between diet and disease has now been quite widely accepted. Functional foods used to refer to foods or isolated food ingredients that deliver specific nonnutritive physiological benefits that may enhance health. A significant driving force in the functional foods market place is consumer demand- the quest by consumers to optimize their health through food. Functional foods are similar in appearance to conventional foods and are consumed as part of a usual diet and are known to improve health status beyond basic nutritional function expected of conventional foods. The optimum wellbeing expected of functional foods in the short term is to render a disease free life with the same span as is currently the case. As such meat is a source of food protein with high biological value and is an excellent source of minerals and vitamins. Due to increasing concerns for health a considerable efforts have been made by meat industries in many countries to develop new products with tertiary functions such as anticarcinogenecity, antioxidative and antiageing activity.

Design and development: There are diverse possible strategies for developing healthier meat and meat products. The functional compounds or health promoting ingredients like conjugated linoleic acid, vitamin E, n-3 fatty acids and different antioxidants can be added in animal diets to improve animal production, carcass composition and fresh meat quality. In

addition, functional ingredients like dietary fibres, herbs and spices and lactic acid bacteria, phytochemicals, bioactive peptides etc. can be directly incorporated into meat products during processing to improve consumers' health.

Strategies for improving functional value of meat and meat products

Animal production strategies	Meat processing strategies
• Production of lean meat • Alteration in fat and fatty acids content of meat • Increasing healthy fatty acids in meat • Enriching animal diet with essential vitamins and minerals	• Enriching meat with fibre and healthy fatty acids • Fortification of meat products with essential vitamins and minerals • Ingredients with antioxidants and phytochemicals • Processing with bioactive peptides and probiotics • Low fat and nitrite free meat products

CHAPTER-4

PACKAGING OF MEAT AND POULTRY PRODUCTS

The packaging market in India seems set for the next level of growth. Strong favourable demographics aside, factors such as increasing income levels, rising consumer awareness and demand for processed food, and the multinational giants taking rapid strides in the food industry, are expected to be the key drivers of this growth story. These factors are forcing both packaging suppliers and end-user industry to shift from bulk packaging to retail, and unit-level and small-sized packaging. Although fresh meat is highly perishable, its packaging has, until recently, been a matter of only minor concern to meat traders, health officials, and consumers. Packaging is not just the materials immediately surrounding a product, it is equally essential to address specific functional and marketing requirements. These functions relate to all aspects of distribution, storage, and merchandizing along with containment, protection, preservation, portioning, convenience, and communication. For meat and meat products, packaging should provide the customer with an appropriately portioned product in a safe and wholesome condition. The functional requirements of meat packaging systems are dictated by the required marketing performance. For example, the packaging requirements for international trade in chilled meat differ from those for domestic supply. The overriding performance requirement is, however, the same in both cases – adequate storage life ensuring product resilience to meet customer expectations.

4.1 Functions of the Package

a. Protective Functions and Labels: A major function of the package is to serve as protection from external environment, which include temperature, moisture or humidity, oxygen, airborne particles, and light. It must also protect against biological contamination from microorganisms, rodents, insects, and other pests. A package further serves as a marketing tool because it must provide space for a label that carries information, such as product identification, ingredients, nutritional information, net weight, verification of inspection, cooking instructions, company name and location, and instructions on how to contact the processor. Labels today frequently

display the Universal Product QR Code, which is critical to laser scanning at the check-out counter in virtually all stores and also plays an important role in inventory management.

The package must protect against loss or gain of moisture and regulate permeation of gases such as oxygen, carbon dioxide and nitrogen. This allows the package to function in managing meat color and appearance by minimizing oxidation, influencing color, odor, flavor, and safety, and also provide the environment to discourage microbial growth, which in turn delays the occurrence of spoilage and lessens the impact of food borne pathogens. The package cannot improve or completely stabilize the product quality, but it can only slow down quality deterioration. A major consideration is product's shelf life, especially in the light of long distances for distribution of product to the ultimate consumers.

b. Barrier Properties and other package requirements: The barrier property of a packaging material is a measure of the resistance offered to a permeant, irrespective of it being gas like oxygen, carbon dioxide, nitrogen, or carbon monoxide; or moisture vapor; or a sensory trait such as aroma. This information is a very important part of a film or package specification.

Considerations in selecting and designing a package include strength factors, which include tensile, elongation and tear strength, and resistance to puncture, all of which should be considered at all temperature and humidity conditions expected. The shelf life of the film itself is important. Machinability factors include stiffness and slip (which affects the ability of people to open bags); and merchandising factors like clarity or transparency, gloss, absence of an undesired film color, and antifogging characteristics are important. The most widely considered factor, or the bottom-line trait, is the cost. It not only includes the film cost, equipment costs and labor involvement, losses due to the consequences for the product of package failure must also be strongly considered in determining cost.

Other important properties of films include flowability, machinability, printability, stability over a wide temperature range, shrinkability, thermoformability, and seal strength. Visual traits such as clarity, sparkle, absence of color and antifog (minimizing of condensation on the inside of the package) are very desirable. Some marketing options include packages with zip openers and resealable packages, such as luncheon meat packaging with resticking properties that allow it to be reopened and sealed multiple times.

4.2 Packaging materials and techniques

a. Wrapping: The simplest form of flexible packaging – wrapping – does not require machinery at all. A meat product is simply placed on a sheet of material, often greaseproof paper or

plastic cling film, which is wrapped around the product to protect it from the environment and vice versa.

b. Tray with Over-wrap: Retail cuts of fresh meat are generally placed in rigid trays of expanded polystyrene or clear plastic trays, over-wrapped with transparent plastic films. The advantages of using these trays are that they are non-absorbent and aesthetically appealing. Usually blotters are kept at the base of the tray to absorb meat juice. The over wrapping film should have excellent optical properties. Cellophane coated with nitrocellulose on one side has been in use for wrapping fresh meat for a long time. The un-coated side is kept in contact with the meat. Meat thus wrapped, can be kept for approximately 10 days at a temperature of 0°C before it becomes microbiologically unacceptable. However, it would be un-saleable in less than half this time because although still edible, it changes colour from red to an unattractive brown. If during storage, there are fluctuations in temperature up to 5°C (which is quite likely commercially) the actual shelf-life would be only 2 days. The storage life of meat is dependent on the initial level of bacterial contamination and the temperature during storage. Generally, therefore pre-packed fresh meat are refrigerated as near as possible to –1°C, which is the lowest temperature at which meat can be stored without freezing it.

c. Shrink packaging: Plastic Shrink films are used for wrapping large and uneven cuts of fresh meat. It is a technique in which heat shrinkable polymer film is shrunk around the meat product by application of heat to achieve a skin-tight and compact pack. The packaging film should have structural strength. It should be a good water vapour barrier and be capable of withstanding storage temperature of about – 45°C. The advantages include neat appearance, ease in handling and a contour fit. Hot tunnels are used to effect a tight wrap. Heat shrinkable polyvinyl chloride, polypropylene, irradiated polyethylene PVDC and rubber hydrochloride are used to shrink wrap fresh meat.

d. Vacuum Packaging: The basic principle of vacuum packaging is quite simple and has been successfully used commercially. The preservative effect in vacuum packs is achieved by removing air from within the pack and maintaining an oxygen deficient environment around the product by sealing the product in a flexible film of low oxygen permeability. This oxygen deficient in-pack environment extends the product's storage life by selecting a slower growing anaerobic spoilage microflora and preventing the proliferation of the fast growing aerobic spoilage organisms. The plastic film used for vacuum packaging must have a high resistance to gases and water vapour with perfect seals and good mechanical strength. Since vacuum packaging provides a barrier to

Properties of major packaging materials used for meat and poultry

Packaging material (0.025 mm thickness)	Water vapour transmission rate, $g/m^2/24$ h	O_2 transmission rate, $cm^3/m^2/24$ h	Tensile strength, MPa	Tear strength, g/mL	Impact strength, J/m	Haze, %	Light Transmission, %	Heat seal Temperature (^{0}C)
Poly (vinyl chloride) PVC	1.5–5	8–25	9–45	400–700	180–290	1–2	90	135–170
Poly (vinylidene chloride) PVdC	0.5–1	2–4	55–110	10–19	–	1–5	90	120–150
Polypropylene, PP	5–12	2000–4500	35.8	340	43	3		
High density Polyethylene, PE-HD	7–10	1600–2000	38.2	200–350	373	3		
Low density Polyethylene, PE-LD	10–20	6500–8500	11.6	100–200	375	5–10	80	93–150
PE-LLD Ionomer	25–35	6000	24–35	20–40	150	–	–	107–150
Ethylene/vinyl acetate, EVAC	40–60	12500	14–21	40–200	45	2–10	55–75	66–177
Ethylene/vinyl alcohol, EVAL	1000	0.5	8–12	400–600	–	1–2	90	177–205
Polyamide, PA	300–400	50–75	81	15–30	50–60	1.5	88	120–177
Poly (ethylene terephthalate)	15–20	100–150	159	20–100	100	2		
PET Polystyrene, PS	70–150	4500–6000	45.1	2–15	59	1	92	121–177

Source: Jenkins and Harrington, 1991; Brody and Marsh, 1997; Hanlon et al., 1998; Baker and Mead, 2000; Elias, 2003; Kirwan and Strawbridge, 2003; Mullan and McDowell, 2003; Robertson, 2006; Osswald et al., 2006

the product from oxygen and moisture, it is suitable for a period of 3 weeks. The most commonly used film for fresh meat vacuum packaging is PVDC (poly vinylidene chloride). It offers low oxygen permeability and shrink characteristics so that large cuts can be kept for up to 21 days with minimum loss of moisture. Typical packaging materials used are Polyethylene / co-polymer coated cellulose film laminates, Polyester / polyethylene film laminates, Polyamide / polyethylene laminates, laminates of plastic film with aluminium foil, PVDC co-polymer films, EVA / Saran / EVA laminates, Nylon / EVA / laminates, PVDC / Polyester / PVDC / PE laminates, LDPE / BA / nylon / BA / LDPE and etc.

i. **Vacuum chamber:** The most common technology used in the fresh meat industry is the vacuum chamber. Fresh or processed meat is placed into a flexible pouch made of an oxygen-barrier film, which is then placed into a chamber with the open end of the pouch positioned over a seal bar. The chamber is closed and a vacuum applied. The chamber is then evacuated to a level where water vaporizes from the meat surface, ensuring that an oxygen-free atmosphere is maintained around the product. At this stage, the open end of the pouch is hermetically sealed and the vacuum released, which results in the film collapsing tightly around the product.

   Close contact between the meat and the packaging film can be enhanced by heat shrinking the packaging on the product after heat sealing. Packaged product is passed through a shrink tunnel or bath that subjects the packaging material to temperatures between 80 and 85 ^{0}C for 1–2 s. This treatment causes the packaging material to shrink in two dimensions.

ii. **Vacuum skin pack:** Vacuum skin packaging is a variant of vacuum chamber packaging. Meat cuts or sliced processed meats are placed on trays of flexible barrier material before being introduced into a vacuum chamber. A flexible barrier film is fed from a stock rolled over the trayed product. The upper film material is softened by heating; the skin is formed by drawing a high vacuum on the inner and outer sides of a barrier film and subsequently venting the upper side to atmosphere, forcing the softened film down so that the soft film moulds itself to the shape of the product and adheres to the lower film or tray to produce a skin tight leak proof package. Vacuum skin packaging is particularly useful for irregularly shaped product when the product shape needs to be maintained.

e. Modified-atmosphere packaging: In modified atmosphere packaging (MAP), the gaseous environment around the meat is modified before heat sealing, and then gradually changes as a result of the interaction between the product and the packaging. For meat, the in-pack environment is usually altered by evacuation followed by flushing with the desired gas mixture. For fresh meat, oxygen mixtures are used for retail display packs, whereas oxygen free mixtures are used for transport/storage packs. Subsequently, changes in the composition of the in-pack atmosphere are determined by the gas barrier properties of the packaging material; the metabolic activities of the product; its microflora; and the solubility of components of the gas mix in the product. For processed meats, where meat bloom is not an issue, oxygen free mixtures (N_2, CO_2) are used.

Gas mixture used in modified atmosphere packaging for meat and meat products

Product	Gas Mixture (%)		
	O_2	CO_2	N_2
Red meat	60-85	15-40	-
Pork steak	80	20	-
Game meat	20	30	50
Cooked meat	-	30	70
Poultry	-	75	25
Processed meat	-	-	100

Source: Scetar *et al*. (2010)

Shelf life of meat and meat products

Product	Packaging material/method	Shelf life	Reference
Beef and pork	Air: PE Vacuum PA/PE	10-11 days, 4 °C 11 days, 4 °C	Mayr *et al*. (2003)
Beef steaks	Expanded PS Tray+ PE/PA MAP: 70% O_2,10% CO_2,20% N_2	22-28days,1 °C	Djenane *et al*. (2005)
Sausages, heat treated	Vacuum packed	6-11 wks, 7 °C	Mantis *et al*. (2005)
Cooked ham & frankfurters	PA/PE	4 wks, 4 °C	Samelis *et al*. (2000)
Pork sausage	Tray: PS, overwrap: PE MAP_1: 20%CO_2, 80% N_2 MAP_2: 20%CO_2, 80% N_2+ O_2 absorber	8 days, 2 °C 16 days, 2 °C >20 days, 2 °C	Martinez *et al*. (2006)
Chicken wings	Vacuum packed and cooked (*sous vide*)	7 wks, 2 °C	Wang *et al*. (2004)

PA – Polyamide; PE –Polyethylene; PS - Polystyrene

4.3 Packaging of fresh meat

Fresh meat is highly perishable and a biologically active item. The quality of fresh meat is affected by the growth of micro-organisms, enzyme activity and by oxidation. The microbiological activity continues even after refrigeration and packaging, though at a reduced rate. The factors that make fresh meat unsaleble are changes in colour, odour, taste and texture. The pigments present in fresh meat are proteins like hemoglobin and myoglobin. Hemoglobin does the function of transfer of oxygen from the blood and myoglobin acts as a storage mechanism of oxygen in cells. Myoglobin has a purple red colour, which is the characteristic colour of fresh meat when it is first cut. In presence of oxygen, there is formation of oxymyoglobin, which imparts a bright red colour to the meat. In the absence of oxygen, oxymyoglobin gets reconverted to myoglobin. An undesirable brown colour is formed due to metamyoglobin when meat gets exposed to air for a few days. Yet another form of discolouration on the surface of the meat, which is dark reddish-brown colour is due to loss of moisture. Dehydration of meat on the surface results in concentration of the pigments. Further concentration of pigments occurs, when the interior moisture containing dissolved pigments

migrates to the surface and evaporates. Another factor, which accelerates desiccation and oxidation of meat, is ultraviolet light. Undesirable flavours, odours and textures can occur due to the action of enzymes, molds, bacteria and oxygen if they are not properly controlled. During the storage of fresh meat, the flavour / odour may get affected due to the pick-up of foreign odours or as a result of oxidative rancidity. Hence, the principal role of fresh meat package is:

- To prevent moisture loss
- To offer the product to the consumers in most desirable colour-red bloom
- To prevent further bacterial contamination of meat
- To arrest pick up of foreign flavour and odour by meat
- To control oxygen transfer

To prevent dehydration, a relative humidity of 85% to 95% is required during storage. This can be achieved by use of a packaging material, which has a good water vapour barrier. Fresh meat should be stored at 0°C and 85 to 90% RH.

4.4 Packaging of frozen meat

Major portion of exports of meat from India is in frozen form. Preservation of meat by freezing, offers the greatest advantages of increase in shelf-life, inhibition of bacterial growth and preservation of fresh texture and flavour. If frozen meat is not properly packed there is continuous dehydration from the surface resulting in freezer burn. This condition affects the surface texture and colour. Meat fat is also prone to the development of oxidative rancidity if a good oxygen barrier is not used. Hence, frozen meat needs protection against:

- Dehydration and loss of surface texture
- Moisture loss
- Temperature fluctuations
- Rancidification
- Pick up of odours / flavours
- Expansion and contractions which occur during freezing and thawing

Packaging requirements

A suitable packaging material must, therefore, have a very low moisture vapour and oxygen transmission rate. The material should also be durable at freezer temperature, have very high wet strength and be impermeable to odour and flavours. Packaging Materials Plastics are amongst the most commonly used materials for packaging of frozen meat Generally, low density polyethylene (150 - 200 gauge) is used for this purpose as it provides adequate clarity and is stable at low temperatures and is available at low cost. Polyester or Nylon / PE laminates and heat shrinkable low density polyethylene and PVC / PVDC co-polymer films also provide functional properties, besides giving neat appearance to the frozen meat cuts. Shrink packaging also allows convenient handling of the product. Frozen meat may be in the form of chunks, minced or various cuts. The unit packs consist of 1, 2, 4 or 8 lbs in LDPE bags of 250 - 350 gauge. After placing the meat in the bags, the bag is folded and then the packed product is blast frozen at - 40°C for a period of 4 to 12 hrs depending upon the size and shape of the package. After freezing, unit packages are packed and stored in corrugated boxes made of either paper or plastic, which are either waxed internally, or on both the surfaces. These boxes are stored at -20°C and the expected shelf-life for the product is around one year.

4.5 Packaging of cured meat

Cured meat like ham, bacon, luncheon meat and frankfurters have a shelf-life of 12-15 days at 4°C depending upon the degree of curing. The attractive pink colour present in cured meat is due to a pigment called nitrosomyoglobin. Although this enzyme is more stable than oxymyoglobin, it is readily oxidised to metamyglobin. The colour of the meat can fade due to the action of light. Packaging Requirements: The role of package for cured meat is to minimise light fading by preventing the entry of oxygen and loss of moisture. The spoilage due to growth of bacteria and yeast is expected to be reduced by freezing or refrigeration. The package must be able to withstand low storage temperatures and also present an attractive appearance. The packaging material should be a good oxygen and water vapour barrier. It should be flexible enough to make a close surface contact with meat. The packaging film should be capable of lamination or co-extrusion and hermetical sealing.

4.6 Packaging of dehydrated meat

Dehydration is a successful means of preserving many meat products with proper packaging because they are highly susceptible to oxidation resulting in rancid odour. The packaging materials used are tinplate cans. Metal foil / plastic film laminates are used to

pack compressed bars of dehydrated minced meat with inner cellophane and outer paper / aluminum foil / PE laminate. This pack is said to be shelf-stable for one year. Flexible pouches suitable for vacuum and modified atmosphere packages made from polyester / PE / Aluminium foil / PE or cellophane / PE / Aluminium foil / PE laminates are also used.

4.7 Recent advance in packing

4.7.1 Active and Intelligent packaging: Packaging in this group is characterized by its ability to extend product life over that achieved by simple overwrap technology. This is achieved by creating and maintaining in-pack conditions that differ markedly from the ambient environment, thus, creating conditions that modify or restrict microbial growth. Active packaging systems include oxygen scavengers, carbon dioxide scavengers or emitters, ethanol or ethylene emitters, temperature control and monitoring systems, and time–temperature integrated monitors. Oxygen-scavenging films have the potential to eliminate oxygen from a package providing a long shelf life. These triple-layer films have a middle layer that scavenges oxygen and plastic layers on either side for product contact and consumer handling. Antimicrobial packaging is receiving much interest; a long list of possible ingredients for this purpose include bacteriocins, antimicrobial enzymes, silver ions, zeolite products, sorbic acids, and different combinations. New innovations using essential oils, such as thyme, oregano, rosemary in a packaging system have shown promise as antimicrobials. New packaging innovations have also resulted in the development of intelligent packaging. These products may feature time and temperature indicators to detect mishandling or temperature abuse of a product or to indicate when a cook-in bag product has reached a proper temperature. Other possibilities include freshness indicators in packaging that may detect levels of volatiles in a product. Other 'active' possibilities are odor removers or odor emitters.

Aerobic packaging

Vacuum packaging

Vacuum skin pack

Intelligent packaging with freshness detector

Classification of active packaging

Absorbing System	Releasing System	Other System
Oxygen absorbers Carbon dioxide absorbers Ethylene absorbers Humidity absorbers Absorbers of off flavours Lactose remover Cholesterol remover	Carbon dioxide emitters Ethanol emitters Antimicrobial releasers Antioxidant releasers	Self-heating aluminum or steel cans and Containers Self-cooling aluminum or steel cans

Active packaging system for food products

Active packaging components	Scavengers/absorbers	Purpose
O_2 absorbers (sachet, labels, films, corks)	Ferro-compound (iron powders), ascorbic acid, metal salt, glucose oxidase, alcohol oxidase	Reducing respiration rate, mould, yeast and aerobic bacterial growth, prevention of oxidation of fats, oil, vitamins, and colors. Prevention of damage by worms, insects and insect eggs.
CO_2 absorbers (sachets)	$Ca(OH)_2$ and NaOH or KOH, CaO, MgO, activated charcoal and silica gel	Removing excess CO_2 formed during storage to prevent fruit damage and bursting of package.
Ethylene absorbers (sachets/ films	Aluminum oxide and Potassium permanganate (sachets), activated hydrocarbon (squalane, apiezon) + metal catalyst (sachets), Builder- clay powders (films), zeolite films, japaneseoya stone (films) and other compound like silicones (phenyl- methyl silicone)	Prevention fast ripening and softening. Ethylene scavengers are useful for preserving ethylene sensitive fruits and vegetables such as apples, bananas, mangoes, tomatoes, onions and carrots.

Moisture/ Humidity absorbers (drip absorbent sheets, films, sachets)	Silica gel (sachets), clays (sachets), sucrose, xylitol, sorbitol, potassium chloride, calcium chloride and sodium chloride	Excess moisture control in packed produce. Water activity reduction on food surface to check moulds, yeast and spoilage bacteria.
Release or absorption of flavours and odours	Cellulose triacetate, acetylated paper, citric acid, ferrous salt, activated carbon, clays and zeolites	Flavor absorber can be used to scavenge undesirable flavors, aromas and odor present in headspace.
Antimicrobial releasing system	Acid anhydride, antibiotic, bacteriocin, organic acid, polysaccharide, chitosan coating films	Antimicrobial packaging is done to control or even prevent the growth of undesired or spoilage microorganisms by releasing antimicrobial substances.
Antioxidant release	Herbs and aromatic plants, natural vitamins (vitamin C and vitamin E) and polyphenol, BHA and BHT	Antioxidant compounds scavenge free radicals by inhibiting initiation and breaking chain propagation or suppressing formation of free radicals by binding to the metal ions, reducing hydrogen peroxide, and quenching superoxide and singlet oxygen.

4.7.2 Nano-packaging: Nanotechnology has proven most promising innovative technique by introducing latest enhancements in food packaging by providing mechanical and barrier properties, detecting pathogens and introducing smart and active packaging keeping in consideration food quality and safety aspects.Nanomaterials produced by the methods of solvent extraction/ evaporation, crystallization, self assembly, layer-by-layer deposition, microbial synthesis, and biomass reactions are being tested for their applications in food packaging (Doyle, 2006). Among the various nanomaterials, the most promising for food packaging is nanocomposites. Nanocomposites are main and major invention of nanotechnology in which nanomaterials are used to improve the barrier properties of plastic wrapping for foods and dairy products. Detection of chemicals, pathogens, and toxins in foods

can also be done by nanosensors. Presently, the nanotechnology that is playing part in the market is the nanolayer of aluminum that coats the interior of many snack food packages.

4.7.3 Biodegradable active packaging: Eco-friendly packaging can play a key role in prevention of food waste to protect human health, environment and in preserving natural resources. The ideal packaging material should not possess any environmental issues and should have recycling potential. Essential qualities for eco-friendly material includes reduce, recycle, renew, reuse and repurpose. They can be material derived from natural resources like starches (such as cellulose, chitin), proteins (such as gluten, soy protein, whey protein) etc. Polylactic acid plastic (PLA), a biodegradable thermoplastic derived from lactic acid is currently entering the marketplace. New eco-friendly AJI-NO-MOTO® jar made from sugarcane is also available.

4.8 Current Indian scenario in food packaging

In a cost-sensitive market such as India, the pressure to reduce packaging costs is intense. While the demand for more sophisticated packaging is on the rise in India, with it come additional pressures on cost for packaging suppliers. The government has taken steps to promote recycling under the *National Action Plan on Climate Change*. While recycling has been the mantra that both governments and manufacturers are learning to live by, reusability is an area where the packaging sector has much to offer by way of innovation. Eco-friendly sustainable packaging program should aim for ***Remove***, ***Reduce***, ***Reuse***, ***Recycle***, ***Renew***, ***Revenue***, and ***Read***.

Consumer awareness and education is a challenge that will need to be met for the drive towards reusable packaging to be truly successful. Sincere efforts should be made to get customers into the habit of recycling and reducing packaging waste. The demand for thin walled containers in India is on the rise as processed foods such as meat products are increasingly consumed. These thin walled containers are lightweight and appropriate for refrigeration. Production of thin walled containers, does not require significant investment and presents a significant opportunity for smaller players.

The *AIDC* (automatic identification and data capture) industry is one of the most rapidly growing segments in packaging with huge potential for India to build on its IT strengths to capture a large share of the global market for the software, solutions and products. As a key player in the supply chain for multinationals, Indian firms too are adopting RFID-Electronic Product Code (EPC) technology to allow for tracking of products as they travel through the supply chain.

The Food Safety and Standards Authority of India proposed to make Food Safety and Standards Regulations in 2011 and came out with its guidelines regarding the same. The regulation provides clearly defined labelling requirements for all the foods packaged in India. It gives clear guidelines on labelling a packaged food, covering particulars like date of manufacture and best used by, date of packaging, etc. The law also covers the general requirements for packaging a food product and gives clear legal guidelines regarding this. To meet new food packaging industry norms, Indian companies will need to look at technological innovation, to meet higher quality standards. While it was earlier required only to meet certain technical guidelines on material usage, the process of packaging was not under the scanner, as it will now be. This may be a challenge at first for smaller players who might need to upgrade their processes and infrastructure to meet the newer, more stringent norms of standardization. Players who are able to rise to the challenge, have a lot to gain as this presents an opportunity to improve India's footing in the global market as well, on the perception front, as this marks a shift to quality management from quality control. Currently meat and meat products are marketed in India by following the regulations called the Food Safety and Standards (Packaging and labelling) Regulations, 2011. These regulations came into force on or after 5th August, 2011.

4.9 Important FSSAI regulations on food packaging

4.9.1 Definitions: Some of the definitions under this regulation is mentioned as below:

1. "Best before" means the date which signifies the end of the period under any stated storage conditions during which the food shall remain fully marketable and shall retain any specific qualities for which claims have been made and beyond that date, the food may still be perfectly safe to consume, though its quality may have diminished. However the food shall not be sold if at any stage the product becomes unsafe.

2. "Date of manufacture" means the date on which the food becomes the product as described;

3. "Date of packaging" means the date on which the food is placed in the immediate container in which it will be ultimately sold;

4. "Infant" means a child not more than twelve months of age;

5. "Lot number" or "code number" or "batch number" means the number either in numericals or alphabets or in combination thereof, representing the lot number or code number or batch number, being preceded by the words "Lot No." or "Lot" or "code

number" or "Code" or Batch No" or "Batch" or any distinguishing prefix by which the food can be traced in manufacture and identified in distribution.

6. "Multipiece package" means a package containing two or more individually packaged or labelled pieces of the same commodity of identical quantity, intended for retail either in individual pieces or packages as a whole.

7. "Non- Vegetarian Food" means an article of food which contains whole or part of any animal including birds, fresh water or marine animals or eggs or products of any animal origin, but excluding milk or milk products, as an ingredient;

8. "Prepackaged" or "Pre-packed food", means food, which is placed in a package of any nature, in such a manner that the contents cannot be changed without tampering it and which is ready for sale to the consumer.

9. "Principal Display Panel" means that part of the container/package which is intended or likely to be displayed or presented or shown or examined by the customer under normal and customary conditions of display, sale or purchase of the commodity contained therein.

10. "Use–by date" or "Recommended last consumption date" or "Expiry date" means the date which signifies the end of the estimated period under any stated storage conditions, after which the food probably will not have the quality and safety attributes normally expected by the consumers and the food shall not be sold;

11. "Wholesale package" means a package containing —

(*a*) a number of retail packages, where such first mentioned package is intended for sale, distribution or delivery to an intermediary and is not intended for sale direct to a single consumer; or

(*b*) a commodity of food sold to an intermediary in bulk to enable such intermediary to sell, distribute or deliver such commodity of food to the consumer in smaller quantities.

4.9.2 Labelling

a. General Requirements

1. Every prepackaged food shall carry a label containing information as required here under, namely—

2. The particulars of declaration required under these Regulations to be specified on the label shall be in English or Hindi in Devnagari script:

   Provided that nothing herein contained shall prevent the use of any other language in addition to the language required under this regulation.

3. Pre-packaged food shall not be described or presented on any label or in any labelling manner that is false, misleading or deceptive or is likely to create an erroneous impression regarding its character in any respect;

4. Label in pre-packaged foods shall be applied in such a manner that they will not become separated from the container;

5. Contents on the label shall be clear, prominent, indelible and readily legible by the consumer under normal conditions of purchase and use;

6. Where the container is covered by a wrapper, the wrapper shall carry the necessary information or the label on the container shall be readily legible through the outer wrapper and not obscured by it;

7. License number shall be displayed on the principal display panel in the following format, namely:-

b. Labelling of Pre-packaged Foods

In addition to the General Labelling requirements specified above every package of food shall carry the following information on the label, namely,—

1. The Name of Food: The name of the food shall include trade name or description of food contained in the package.

2. List of Ingredients: Except for single ingredient foods, a list of ingredients shall be declared on the label in the following manner:—

(a) The list of ingredients shall contain an appropriate title, such as the term “Ingredients”;

(b) The name of Ingredients used in the product shall be listed in descending order of their composition by weight or volume, as the case may be, at the time of its manufacture;

(c) A specific name shall be used for ingredients in the list of Ingredients;

Provided that for Ingredients falling in the respective classes, the following class titles may be used, namely:–

Classes	Class Titles
Animal fat / oil other than milk fat	Give name of the source of fat. Pork fat, lard and beef fat or extracts thereof shall be declared by specific names.
All types of poultry meat where such meat constitutes an ingredient of another food and provided that the labelling and presentation of such a food does not refer to a specific type of poultry meat	Poultry meat

(*d*) Where an ingredient itself is the product of two or more ingredients, such a compound ingredients shall be declared in the list of ingredients, and shall be accompanied by a list, in brackets, of its ingredients in descending order of weight or volume, as the case may be:

Provided that where a compound ingredient, constitutes less than five percent of the food, the list of ingredients of the compound ingredient, other than food additive, need not to be declared;

(*e*) Added water shall be declared in the list of ingredients except in cases where water forms part of an ingredient, such as, brine, syrup or broth, used in the compound food and so declared in the list of ingredients:

c. Nutritional information

Nutritional Information or nutritional facts per 100 gm or 100ml or per serving of the product shall be given on the label containing the following:—

(i) energy value in kcal;

(*ii*) the amounts of protein, carbohydrate (specify quantity of sugar) and fat in gram (g);

(*iii*) the amount of any other nutrient for which a nutrition or health claim is made:

Provided that where a claim is made regarding the amount or type of fatty acids or the amount of cholesterol, the amount of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids in gram (g) and cholesterol in milligram (mg) shall be declared, and the amount of trans fatty acid in gram (g) shall be declared in addition to the other requirement stipulated above;

(*iv*) Wherever, numerical information on vitamins and minerals is declared, it shall be expressed in metric units;

(*v*) Where the nutrition declaration is made per serving, the amount in gram (g) or milli-liter (ml) shall be included for reference beside the serving measure;

Provided that the food claimed to be enriched with nutrients, such as, minerals, proteins, vitamins, metals or their compounds, amino acids or enzymes shall give the quantities of such added nutrients on the label.

Provided further that, a health claim of 'trans fat free' may be made in cases where the trans fat is less than 0.2 gm per serving of food and the claim 'saturated fat free' may be made in cases where the saturated fat does not exceed 0.1 gm per 100 gm or 100 ml of food.

(*i*) "Health claims" means any representation that states, suggests or implies that a re-lationship exists between a food or a constituent of that food and health and include nutrition claims which describe the physiological role of the nutrient in growth, devel-opment and normal functions of the body, other functional claims concerning specific beneficial effect of the consumption of food or its constituents, in the context of the total diet, on normal functions or biological activities of the body and such claims relate to a positive contribution to health or to the improvement of function or to modi-fying or preserving health, or disease risk reduction claim relating to the consumption

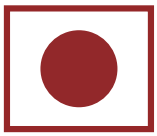
of a food or food constituents, in the context of the total diet, to the reduced risk of developing a disease or health related condition;

(*ii*) "Nutrition claim" means any representation which states, suggests or implies that a food has particular nutritional properties which are not limited to the energy value but include protein, fat carbohydrates, vitamins and minerals;

(*iii*) "Risk reduction" in the context of health claims means significantly altering a major risk factor for a disease or health-related condition;

d. Declaration regarding Veg or Non veg –

(*i*) Every package of "Non-Vegetarian" food shall bear a declaration to this effect made by a symbol and color code as stipulated below to indicate that the product is Non-Vegetarian Food. The symbol shall consist of a brown color filled circle having a diameter not less than the minimum size specified in the Table 1., inside a square with brown outline having sides double the diameter of the circle as indicated below:



Brown color

Size of the logo

Sl No.	Area of principal display panel	Minimum size of diameters in mm
1.	Upto 100 cm^2	3
2.	Above 100 cm^2 upto 500 cm^2.	4
3.	Above 500 cm^2 upto 2500 cm^2	6
4.	Above 2500 cm^2	8

The symbol shall be prominently displayed

(*i*) on the package having contrast background on principal display panel;

(*ii*) just close in proximity to the name or brand name of the product;

(*iii*) on the labels, containers, pamphlets, leaflets, advertisements in any media;

e. Name and complete address of the manufacturer

(*i*) The name and complete address of the manufacturer and the manufacturing unit if these are located at different places and in case the manufacturer is not the packer or bottler,

the name and complete address of the packing or bottling unit as the case may be shall be declared on every package of food;

(*ii*) Where an article of food is manufactured or packed or bottled by a person or a company under the written authority of some other manufacturer or company, under his or its brand name, the label shall carry the name and complete address of the manufacturing or packing or bottling unit as the case may be, and also the name and complete address of the manufacturer or the company, for and on whose behalf it is manufactured or packed or bottled;

(*iii*) Where an article of food is imported into India, the package of food shall also carry the name and complete address of the importer in India.

Provided further that where any food article manufactured outside India is packed or bottled in India, the package containing such food article shall also bear on the label, the name of the country of origin of the food article and the name and complete address of the importer and the premises of packing or bottling in India.

f. Net quantity

(*i*) Net quantity by weight or volume or number, as the case may be, shall be declared on every package of food; and

(*ii*) In addition to the declaration of net quantity, a food packed in a liquid medium shall carry a declaration of the drained weight of the food.

Explanation 1— For the purposes of this requirement the expression “liquid medium” include water, aqueous solutions of sugar and salt, fruit and vegetable juices or vinegar, either singly or in combination.

Explanation 2— In declaring the net quantity of the commodity contained in the package, the weight of the wrappers and packaging materials shall be excluded:

(*iii*) Where a package contains a large number of small items of confectionery, each of which is separately wrapped and it is not reasonably practicable to exclude from the net weight of the commodity, the weight of such immediate wrappers of all the items of the confectionery contained in the package, the net weight declared on the package containing such confectionary or on the label thereof may include the weight of such immediate wrapper if the total weight of such immediate wrapper does not exceed –

(*a*) eight per cent, Where such immediate wrapper is a waxed paper or other paper with wax or aluminium foil under strip; or

(*b*) six per cent. In case of other paper of the total net weight of all the items of confectionery contained in the package minus the weight of immediate wrapper.

g. Lot/Code/Batch identification

A batch number or code number or lot number which is a mark of identification by which the food can be traced in the manufacture and identified in the distribution, shall be given on the label.

h. Date of manufacture or packing

The date, month and year in which the commodity is manufactured, packed or pre-packed, shall be given on the label:

Provided that the month and the year of manufacture, packing or pre-packing shall be given if the “Best Before Date” of the products is more than three months:

Provided further that in case any package contains commodity which has a short shelf life of less than three months, the date, month and year in which the commodity is manufactured or prepared or pre-packed shall be mentioned on the label.

i. Best Before and Use By Date

(*i*) the month and year in capital letters upto which the product is best for consumption, in the following manner:

“BEST BEFORE ..... MONTHS AND YEAR

OR

“BEST BEFORE ..... MONTHS FROM PACKAGING

OR

“BEST BEFORE .....MONTHS FROM MANUFACTURE

(*ii*) In case of any package containing meat or any other like commodity, the declaration be made as follows:

"BEST BEFORE …….DATE/MONTH/YEAR"

OR

"BEST BEFORE.....DAYS FROM PACKAGING"

OR

"BEST BEFORE …….. DAYS FROM MANUFACTURE"

j. Country of origin for imported food

(i) The country of origin of the food shall be declared on the label of food imported into India.

(*ii*) When a food undergoes processing in a second country which changes its nature, the country in which the processing is performed shall be considered to be the country of origin for the purposes of labelling.

k. Instructions for use

(*i*) Instructions for use, including reconstitution, where applicable, shall be included on the label, if necessary, to ensure correct utilization of the food.

l. Manner of declaration

General Conditions

1. Any information or pictorial device written, printed, or graphic matter may be displayed in the label provided that it is not in conflict with the requirements of these Regulations.

2. Every declaration which is required to be made on package under these regulations shall be:

(*i*) Legible and prominent, definite, plain and unambiguous (*ii*) Conspicuous as to size number and color,

(*iii*) as far as practicable, in such style or type of lettering as to be boldly, clearly and conspicuously present in distinct contrast to the other type, lettering or graphic material used on the package, and shall be printed or inscribed on the package in a color that contrasts conspicuously with the background of the label

Provided that —

(*a*) Where any label information is blown, formed or molded on a glass or plastic surface or where such information is embossed or perforated on a package that information shall not be required to be presented in contrasting colors:

(*b*) Where any declaration on a package is printed either in the form of a handwriting or hand script, such declaration shall be clear, unambiguous and legible.

3. No declaration shall be made so as to require it to be read through any liquid commodity contained in the package.

4. Where a package is provided with an outside container or wrapper, such container or wrapper shall also contain all the declarations which are required to appear on the package except where such container or wrapper itself is transparent and the declarations on the package are easily readable through such outside container or wrapper.

5. Labels not to contain false or misleading statements: A label shall not contain any statement, claim, design, device, fancy name or abbreviation which is false or misleading in any particular concerning the food contained in the package, or concerning the quantity or the nutritive value or in relation to the place of origin of the said food:

Provided that this regulation shall not apply in respect of established trade or fancy names of confectionery, biscuits and sweets, such as, barley, sugar, bull's eye, cream cracker or in respect of aerated waters, such as, Ginger Beer or Gold-Spot or any other name in existence in international trade practice.

Principal display panel: The information required under these Regulations shall be given on the principal display panel of the package or container and such information may be given in the following manner.

(a) All information should be grouped together and given at one place. OR

The pre-printed information be grouped together and given in one place and,

(*b*) Online information or those not pre-printed be grouped together in another place. 1. Area of the principal display panel

The area of principal Display panel shall not be less than —

(*a*) In the case of a rectangular container, forty percent of the product of height and width of the panel of such container having the largest area;

(*b*) In case of cylindrical or nearly cylindrical, round or nearly round, oval or nearly oval container, twenty percent of the product of the height and average circumference of such container; or

(*c*) In the case of container of any other shape, twenty percent of the total surface area of the container except where there is label, securely affixed to the container, such label shall give a surface area of not less than ten percent of the total surface area of the container.

Provided that in the case of package having a capacity of five cubic centimeters or less, the principal display panel may be card or tape affixed firmly to the package or container and bearing the required information under these regulations.

m. Exemptions from labelling requirements

1. Where the surface area of the package is not more than 100 square centimeters, the label of such package shall be exempted from the requirements of list of ingredients, Lot Number or Batch Number or Code Number, nutritional information and instructions for use, but these information shall be given on the wholesale packages or multi piece packages, as the case may be.

2. the 'date of manufacture' or 'best before date' or 'expiry date' may not be required to be mentioned on the package having surface area of less than 30 square centimeters but these information shall be given on the wholesale packages or multipiece packages, as the case may be;

4. in case of food with shelf-life of not more than seven days, the 'date of manufacture' may not be required to be mentioned on the label of packaged food articles, but the 'use by date' shall be mentioned on the label by the manufacturer or packer.

5. In case of multi piece packages the particulars regarding list of ingredients, nutritional information , Date of manufacture/ packing, best before, expiry date labelling of irradiated food and vegetarian logo/non vegetarian logo, may not be specified.

Compliance of FSSAI regulation on packaging, labeling and nutritional information by the food business operators will ensure safe, wholesome and nutritious meat and meat products to the consumers.

CHAPTER-5

MEAT FOOD SAFETY REGULATION AND CERTIFICATION

5.1 Need and various aspects of food testing and notified NABL, Referral and Reference labs

Access to safe, reliable and nutritious food supplies is a basic need for all people. Food industry in India is evolving every day. There are thousands of food companies, manufacturers, restaurants, processing companies, food carts and cloud kitchens that are catering to the demands of rapidly growing urban and semi-urban cities across India. Hence it is of utmost importance that the food production process should pass through stringent quality tests to ensure that what we consume is safe across all parameters.

The safety of the food supply appropriately remains a high priority for industry stakeholders, regulatory agencies and consumers. In such instances, accurate data derived from sound, validated analytical methods are required to enable industry stakeholders and regulators to make sound scientific decisions.

Food testing laboratories play a very important role in this whole process. Food products tested can range from agricultural commodities to processed foods, from the field to the store. The testing can be done on raw materials, the product during its processing and production, as well as the finished products. Food testing is integral to the efficient production of safe, quality products. With the food industry increasingly subject to scrutiny, testing to ensure compliance with food safety regulations and to protect public health, is a must.

5.1.2 Food control system in India: Food control plays an important role in assuring a high quality, safe and nutritious food supply for the public, for their good health and for the economic benefits derived from trade in safe and high quality food. What makes food safe is through an effective food control system. Food control system is a mandatory regulatory activity of enforcement by national and local authorities to provide consumer protection and ensure that all foods during production, handling, storage, processing and distribution are safe, wholesome and fit for human consumption; confirm to safety and quality requirements; and are honestly and accurately labelled as prescribed by law (FAO). There are primarily three facets of the national food control system imports, exports and domestic. In India, domestic and import food trade is covered under Food Safety Standards Act (2006) and export trade is

covered primarily under the Export (Quality Control and Inspection) Act (1963).

There are four important pillars for an effective food control system

- Legislation/Regulation
- Inspection
- Testing
- Enforcement

Food testing is all about Quality and Integrity of data. The growth and infrastructure of the modern global food distribution system heavily relies on food analysis (beyond simple characterization) as a tool for new product development, quality control, regulatory enforcement, and problem-solving. Laboratories are an essential component of a food control system.

Challenges faced in food testing

- Dynamic standards and its harmonization
- Fit for purpose of analytical methods is critical in building trust in control systems
- A critical issue will be how to detect untargeted compounds and determine their identity in foods
- Food authenticity and food fraud

5.1.3 Accreditation body and the need for accreditation

Accreditation is a formal declaration by a neutral third party that the certification program is administered in a way that meets the relevant norms or standard of certification program. Accreditation is a procedure by which an Authoritative Body (Accreditation body) gives formal recognition that a Body (laboratory) is competent to carry out a specific task (testing/calibration). Accreditation uses specific criteria developed to determine technical competency of the laboratory. This is generally an independent evaluation of laboratory's technical competence

a. Benefits of accreditation

- International recognition (Once tested may not be checked further)
- Access to Global market
- Saving in terms of time and money as it reduces or eliminate the need of re-testing

- Increased confidence in the test reports generated
- Customer needs and enhanced confidence and satisfaction
- Lab can demonstrate its commitment to quality with robust Quality management system
- Systematic and better operational control of lab work
- Assurance of accurate and reliable results
- Regulatory and importing countries requirements
- Use of NABL symbol as indication of accreditation
- Accreditation gives equivalency to laboratories
- Rise in business

b. Importance of accreditation for Food Business operators

- Minimizing Risk of producing Faulty Food Products entering the market
- Avoid expensive retesting
- Eases export and import issues regarding Food safety

In India National Accreditation Board for Testing and Calibration (NABL) is the national accreditation body under Quality Council of India, Ministry of Commerce and Industry, Govt. of India. NABL grants accreditation to testing & calibration laboratories as per ISO/IEC 17025. NABL operates its own system as per ISO/IEC 17011:2004 Conformity Assessment: General Requirements for Accreditation Bodies accrediting Conformity Assessment Bodies. NABL Accreditation is a voluntary program except in case of regulatory bodies it may be mandatory to have accreditation

c. Need for Accreditation in food testing laboratories

- To ensure accurate, reliable and reproducible test results
- To achieve consistency and uniformity in test results
- To meet customer requirements
- To meet regulatory requirement and Government agencies

- To ensure equivalence of results produced by different laboratories
- Global acceptance of test reports generated

d. Pre-requisite for Accreditation

Pre-requisite for Accreditation through NABL is given schematically

General Information Brochure (**NABL-100**)

Appropriate documentation (ISO 17025)

Training of laboratory staff on technical and management requirement (ISO 17025)

Preparation of QM, System procedures, SOP as per ISO 17025 (**NABL-160**)

Ensure training of personnel and Accommodation and environment

Ensure measurement traceability through calibration of equipment used (**NABL-142**)

Participate in PT and ILC programs (**NABL-163**)

Conduct Internal Audit and MRM (**NABL-161**)

Meet regulatory requirement (**NABL-127**)

Apply for Accreditation (**NABL-151**)

5.1.4 Compliance Requirements in a food testing lab

- Personnel: Qualified, suitably trained, experienced and motivated personnel in sampling and testing. The sampler shall have the minimum qualification of graduation.
- Sampling: Laboratory should be able to demonstrate that the sample drawn is true representative of the lot/consignment.
- Handling of Samples: Appropriate procedures and implementation to ensure that the samples are drawn, transported and received in lab and thus ensuring chain of custody.
- Equipment: Adequately equipped to carry out sampling, sample homogenization and analysis as per various regulatory requirements. Expertise to interpret the data generated as per the regulatory requirement. Availability of traceable Reference standards.
- Methods:Adopting appropriate method for sample preparation and analysis.
- Analysis:Preparation of Reference standards. Intermediate checks of Reference standards. Use of appropriate method calibration with due care on dilution factors applied, criticalities of the steps involved in extraction. Recovery correction in results.
- Method Validation ("fit for purpose methods"):As per the regulatory/importing countries requirement. Access of Validation document to the concerned analyst. Validity of a method Validation? Changes in Man, Machine and Method calls for revalidation/verification.
- Applicability of method:Same method being used for different matrices without any verification/without checking the applicability.
- Internal Quality Control:A strong internal Quality control programme to ascertain that the methods are in control and to decide whether the results are reliable

enough to be released. The use of control charts to monitor QC results.

- QC Samples:The cost/availability of CRM (in matrix) necessitates the use of QC materials (inhouse/external). QC samples analysed at intervals in an analytical batch, Blanks & duplicate analysis.
- Traceability in activities: Ensuring audit trails (If you didn't write it down, it NEVER happened).
- Measurement Uncertainty (MU):Reporting of MU with the results in order to facilitate customer/decision making authority to take and appropriate decision and prevent loss in trade.
- Accreditation in compliance to ISO/IEC 17025:2017
- Regulatory approval to comply with importing countries requirement

5.1.5 Role of referral and reference laboratories

In India there are about 200 notified food testing laboratories under FSSAI, eighteen FSSAI Notified National Referral Laboratories under section 43 (2) of FSS Act, 2006, Twelve national Reference laboratories and two ancillary national reference laboratories under regulation 3 of FSSR, 2018

a. Role of referral laboratories

- R&D activities, providing training and to perform other functions like analysis of samples, and investigation in collaboration with other labs.
- Surveillance samples on specified food commodities as decided by FSSAI
- Testing of food on appeal in case of a challenged analytical result at primary level.

b. Role of reference laboratories

a) Be resource center for provision of information for certified reference material and reference materials

b) Develop standards for routine testing procedures and reliable testing methods

c) Provide technical support in their area of competence

d) Evaluate performance of other notified laboratories

e) Coordinate and exchange of information among notified laboratories

f) Collaborated for data generation of specific areas among network of notified and referral laboratories

g) Ancillary NRL would support NRL in providing PT to notified laboratories in specific areas

h) Ancillary NRL Assist NRL in method development/method validation/interlaboratory comparison

5.2 List of Notified Reference Laboratories, Referral Laboratories and State/Public Food Laboratories in India

5.2.1 List of Notified Reference Laboratories

S. No.	Name of the laboratory/ Institution/Organization	Address	Specific area
1.	Central Food Technological Research Institute	FS & AQCL Department, CFTRI, Mysore-570020	Nutritional Information and labelling
2.	Export Inspection Agency	27/1767A, Shipyard Quarters Road Panampilly Nagar, Kochi, Kerala 682036	GMO testing
3.	Punjab Biotechnology Incubator	SCO 7-8 Phase-V, SAS Nagar, Mohali-160059, Punjab	Sweets and confectionary including honey
4.	ICAR-National Research Centre for Grapes	P.O. Manjiri Farm, Solapur Road, Pune - 412307	Pesticide Residues and Mycotoxins
5.	Central Institute of Fisheries Technology	CIFT Junction, Wellingdon Island, Matsyapuri, PO - Kochi	Fish and Fish Products

6.	Centre for Analysis and Learning in Livestock and Food-National Dairy Development Board	Opposite IRMA main gate, Near Anadalaya Nagar, Anand 388001.	Dairy and Dairy products
7.	CSIR-Indian Institute of Toxicological Research	Vishvigyan Bhawan, 31 Mahatma Gandhi Marg Lucknow-226001	Toxicological Evaluation/Risk Assessment for Nutraceuticals, functional foods and novel/ emerging food/food ingredients
8.	Trilogy Analytical Laboratory, Pvt. Ltd.	Plot No.7, C.F. Area, Phase II, IDA, Cherlapally, Hyderabad	Mycotoxins and PT services
9.	Edward Food Research and Analysis Centre Limited	Subhash Nagar, Nilgunj Bazar, Kolkata	Veterinary Drugs, Antibiotics and Hormones
10.	Vimta Labs Limited	Life Sciences Campus, 5, MN Park, Genome Valley, Hyderabad-500101	Water, Alcoholic and Non Alcoholic Beverages
11.	Fare labs Pvt Ltd	L-17/3, DLF, Ph-II, IFFCO Chowk, Gurugram-122002	Oils and Fats
12.	Neogen Food and Animal Secuity (India) Private Limited	Uchikkal Lane, Poonithura, PO- Kochi	Food Allergens

5.2.2 List of Notified Referral Laboratories in India

S. No.	Name of the Referral Food Laboratory	Local Areas or States or Union Territories
1.	(i) Director, Central Food Laboratory, 3 Kyd Street, Kolkata - 700016.	West Bengal, Orissa, Bihar, Jharkhand, Assam, Arunachal Pradesh, Chhattisgarh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura, Union Territories of Andaman and Nicobar Island
	(ii) Director, Food Research and Standardization Laboratory, Ahinsa Khand-II, Indirapuram, Ghaziabad-201014.	
2.	(i) Director, Food Safety and Analytical Quality Control Laboratory, C/o. Central Food Technological Research Institute, Mysore –570013.	Andhra Pradesh, Karnataka, Kerala Tamil Nadu, Telangana, Puducherry and Lakshadweep
	(ii) Director, State Public Health Laboratory, Stavely Road, Cantonment Water Works Compound, Pune-411 001.	
3.	(i) Director, State Public Health Laboratory, Stavely Road, Cantonment Water Works Compound, Pune-411 001.	Gujarat, Maharashtra, Madhya Pradesh, Rajasthan, Dadar and Nagar Haveli, , Goa and Daman and Diu
	(ii) Director, Food Safety and Analytical Quality Control Laboratory, C/o. Central Food Technological Research Institute, Mysore –570013	
4.	(i) Director, Food Research and Standardization Laboratory, Ahinsa Khand-II, Indirapuram, Ghaziabad-201014.	Delhi, Haryana, Himachal Pradesh, Punjab, Union Territory of Chandigarh, Uttar Pradesh, Uttarakhand and Jammu & Kashmir
	(ii) Director, Central Food Laboratory, 3 Kyd Street, Kolkata 700016.	

5.2.3 List of Notified Referral Laboratories and their scope

S. No.	Name of the Referral Food Laboratory	All over India - as per Scope of Testing defined here under
5.	Director, Indian Institute of Horticultural Research, Hessaraghatta lake post, Bangalore - 560 089.	Pesticide residue analysis of fruits and vegetables, cereals and pulses, water, spices (curry leaves), Nutritional, Proximate and microbiological analysis of fresh and processed food products.
6.	Director, Indian Institute of Vegetable Research, Post Bag No. 01; P.O. Jakhini, (Shahanshapur), Varanasi - 221 305.	Analysis of pesticide residue, heavy metals, microbial contaminations, mycotoxins, antibiotics, disinfectants, colouring agents, adulterants, food additives, phytohaemagglutinin, allergens etc. in Vegetables.
7.	Director, Quality Evaluation Laboratory, Spices Board, Palarivattom P.O., Kochi – 682025.	Analysis of chemical contaminants (pesticide residues, heavy metals, illegal dyes and any other chemical contaminant), mycotoxins (aflatoxins, ochratoxin etc.), microbial contaminants, physical contaminants and adulterants in Spices.
8.	Director, Quality Evaluation Laboratory, Spices Board, Chuttugunta Center, GT Road, Guntur – 522004.	-Do-
9.	Director, Quality Evaluation Laboratory, Spices Board, Plot No. R-11, Sipcot Industrial Complex, Gummidipoondi, Thiruvallur District, Chennai – 601201.	-Do-

10.	Director, Quality Evaluation Laboratory, Spices Board, First Floor, Banking Complex II, Sector 19A, Vashi, Navi Mumbai – 400703	-Do-
11.	Acting Director, Centre for Analysis and Learning in Livestock in Food (CALF), National Dairy Development Board (NDDB), Anand – 388001, Gujarat	Milk and Milk Products, Analysis of pesticides, antibiotics and veterinary drugs, microbial contaminants and mycotoxins, heavy metals, Polycyclic Aromatic Hydrocarbons, dioxin, other emerging contaminants and Microbial parameters in milk and milk products.
12.	Director, Council of Scientific and Industrial Research - Indian Institute of Chemical Technology, Uppal Road, Tarnaka, Hyderabad – 500007	Analysis of moisture, hexane insoluble matter, acid value, unsaponifiable matter, iodine value, saponification value, allyl isothiocyanate, Reichert Meissl value, peroxide value, fatty acid composition, presence of animal body fat in the vegetable fat, cold test, test for Physical properties, nickel in vanaspati, phosphorous in soyabean oil, presence rancidity, soluble colors, presence of beef fat, phospholipids, tocopherol, trans fatty acid determination, Pesticide Residues, Heavy metal analysis in fats and oils.
13.	Director, ICAR-National Research Centre on Meat, Chengicherla, Buduppal, Hyderabad – 500092	Physico-chemical analysis (meat species identification, proximate composition, pH value, water holding capacity, meat pigments, emulsifying capacity, free fatty acid, peroxide value, TBA value, cholesterol content, nitrite content, sensory evaluation, texture & tenderness of meat & meat products, instrumental colour value, COD level of slaughter house effluent), Microbiological analysis, Pesticide Residues and Fatty acid profiles of meat and meat products.

14.	Director, Indian Institute of Crop Processing Technology, Food Safety and Quality Testing Laboratory, Pudukkottai Road, Thanjavur – 613005, Tamil Nadu	Nutritional, Proximate and Microbiological analysis of fresh and processed food products; Packaged Drinking Water analysis; Analysis of pesticide residues, heavy metals and microbiological analysis of Cereals and Cereal Products and Spices.
15.	Director, Central Institute of Fisheries Technology, Indian Council of Agricultural Research, Willingdon Island, CIFT Junction, Matsyapuri P.O., Cochin – 682029, Kerala	Physio-chemical analysis, Bacteriological Tests, detection of Viruses, Bacterial toxins, Antibacterial substances, other microbiological tests, analysis of pesticide residues & heavy metals in Fish & Fishery Products.
16.	Director, Indian Institute of Integrative Medicine, Council of Scientific & Industrial Research, Canal Road, Jammu-Tawi-180001	Analysis of Aflatoxins, Free fatty Acids, Peroxide value, Iodine value, Pesticide residues, Metals & Other soluble Residues in Nuts; Presence of Moisture content, Specific gravity, Reducing sugar, Fructose-Glucose Ratio, Acidity, Ash content, Analysis of Heavy Metals, Pesticide residues in Honey; Analysis of Aflatoxins, Energy Organics, Vitamins, Total fatty Acids, Total Saturated Fatty & Unsaturated Fatty acids, pesticide residues & heavy metals in Nutraceuticals.

5.2.4 List of State/ Public Food Laboratories

S. No.	State/UT	Laboratory Address
1.	Andaman & Nicobar Island	State Food Laboratory, G.B. Pant Hospital Campus, Andaman & Nicobar Islands, Port Blair – 744103
2.	Andhra Pradesh (Telangana)	State Food Laboratory, Nacharam Industrial Area, Hyderabad – 501507
3.	Andhra Pradesh	Regional Public Health Laboratory, Govt Hospital Complex, Pedda Waltair, Visakhapatnam - 530017
4.	Assam	State Public Health Laboratory, Bamuni Maidam, Guwahati 21, Assam
5.	Bihar	Combined Food & Drugs Laboratory, Agamkuan, Patna - 800 007
6.	Chhattisgarh	State Food Testing Laboratory, Near Mahila Police Station, Opp. Nagar Nigam Office, Kalibari, Raipur
7.	Delhi	Combined Food & Drugs Laboratory, Directorate of PFA, NCT of Delhi, A- 20, Lawrence Road, Industrial Area, Delhi-110035
8.	Jharkhand	State Food & Drug Laboratory, Namkum, Ranchi Tata Road, Ranchi – 834010
9.	Goa	Food and Drug Laboratory, Directorate of Food & Drugs Admn. DHANWANTARI, Opp, the Shrine of Holy Cross, Bambolim – Goa – 403202
10.	Gujarat	Public Health Laboratory, Urban Health Centre Bldg, Nr. Lal Bungalow, C.G. Road, Navarangpura, Ahmedabad 380009
11.	Gujarat	Food and Drugs Laboratory, Near Polytechnic College, Nizampura, Vadodara – 390 002
12.	Gujarat	Public Health Laboratory, Municipal Corporation, Laheripura Road, Vadodara - 390 001
13.	Gujarat	Regional Food Laboratory, New Lotus Ring Road, Nr. Mahakali Temple, Opp. District Panchayat Staff Quarters, Bhuj, Kutch - 370001

14.	Gujarat	Regional Food Laboratory, University Road, Nr. Forensic Lab, Opp. Kidney Hospital, Rajkot, Gujarat - 360005
15.	Gujarat	Public Health Laboratory, Surat Municipal Corporation, 304, Ambedkar Shopping Centre, Mann Darwaza, Ring Road, Surat – 395003
16.	Haryana	District Food Laboratory, Civil Hospital, Karnal – 132001
17.	Haryana	State Food, Water and Excise Laboratory, Govt. of Haryana, Ground Floor, Sector – 11 D, Chandigarh
18.	Himachal Pradesh	Composite Testing Laboratory, Kandaghat, Distt. Solan, Himachal Pradesh
19.	Jammu & Kashmir	Public Health Laboratory, PatoliMangotrian, Jammu
20.	Jammu & Kashmir	Public Health Laboratory, Nr. CD Hospital, Dalgate, Srinagar
21.	Karnataka	State Water and Food Laboratory, Public Health Institute, Sheshadri Road, Bangalore- 560 001
22.	Karnataka	Bruhat Bangalore MahanagaraPalike Laboratory, Dasappa Hospital Compound, N R Circle, Silver Jubilee Park Road, Bangalore - 560002
23.	Karnataka	Divisional Food Laboratory, Umar Khayam Road, Tilak Nagar, Mysore- 570001
24.	Karnataka	Corporation Laboratory, Corporation of the city of Mysore, Corporation office Building, Mysore
25.	Kerala	Regional Analytical Laboratory, Kakkanand, P.O. Ernakulam, Kochi
26.	Kerala	Regional Analytical Laboratory, Malaparamba, Kozhikode – 673009
27.	Kerala	Government Analyst Laboratory, Vanchiyoor P.O Red Cross Road, Thiruvananthapuram - 695035
28.	Madhya Pradesh	State Food Laboratory, Controller Food and Drug Administration, Idgah Hills, Bhopal - 462001

29.	Madhya Pradesh	Food Laboratory, Municipal, Corporation, Shivaji Market, Nagar Nigam Road, Indore
30.	Madhya Pradesh	State Food Testing Laboratory, Municipal Corporation, Chhatrapati Shivaji Bhavan, Agar Road, Ujjain
31.	Maharashtra	Regional Public Health Laboratory, Nizam Bunglow, Cantonment Area, Aurangabad - 431002
32.	Maharashtra	District Public Health Laboratory, Dhobhi Ghat Building, General Hospital Compound, Jalgaon – 425001
33.	Maharashtra	District Public Health Laboratory, 330/2, B, Y.P. Powar Nagar, Bendre Building, Kolhapur - 416002
34.	Maharashtra	Municipal Laboratory, Room No. 49, 2nd Floor, G North Ward Office, J.K. Sawant Marg, Dadar, Dadar West, Mumbai-400 028
35.	Maharashtra	Room No. 606, Public Health Laboratory, Konkan Bhawan, 6th Floor, CBD Belapur, District Thane, New Mumbai - 400 614
36.	Maharashtra	District Public Health Laboratory, New Civil Hospital Compound, Nashik – 422 002
37.	Maharashtra	State Public Health Laboratory, Stavely Road, Cantonment Water Works Compound, Pulgate, Near St. Mary's School, Pune - 411001
38.	Maharashtra	District Public Health Laboratory, Vasantdada Co-op. Industrial Estate, Madhavnagar Road, Nr. R.T.O., Sangli – 416416
39.	Maharashtra	District Public Health Laboratory, Sai Darshan, 5 – Babanagar, Near Polytechnic College, Nanded - 431602
40.	Maharashtra	Regional Public Health Laboratory, Mental Hospital Compound, Chindwada Road, Nagpur- 440 029
41.	Maharashtra	District Public Health Laboratory, Opposite Irvin General Hospital, Amravati-444601
42.	Meghalaya	Combined Food and Drug Laboratory, Pasteur Institute, Shillong - 793001
43.	Nagaland	State Public Health Laboratory, Merhuliesta Colony, Near CMO Office, Kohima, Nagaland

44.	Odisha	State Public Health Laboratory, In front of Ram Mandir, Convent Square, Bhubaneswar - 751001
45.	Puducherry	Public Health Laboratory, Indira Nagar, Gorimedu, Puducherry – 605006
46.	Punjab	State Food, Drugs and Excise Laboratory, Govt. of Punjab, Second Floor, Sector – 11 D, Chandigarh
47.	Punjab	District Public Health, Laboratory, Nehru Garden, Jullundhar (Punjab)
48.	Punjab	District Public Health, Laboratory, Old Civil Hospital, Bhatinda (Punjab)
49.	Rajasthan	Food Safety and Standards Laboratory, E-1, Behind Kamla Nehru T.B. Hospital, Jaipur Road, Ajmer
50.	Rajasthan	State Public Health Laboratory, Mini Swasthya Bhawan, Mandir Marg, Sethi Colony, Behind Mental Hospital, Jaipur - 302004
51.	Rajasthan	Regional Public Health Laboratory, C-27, Railway Road, Jodhpur - 342001
52.	Rajasthan	Food Safety and Standards Laboratory, Rajiv Gandhi Hospital Campus, Alwar – 301001
53.	Rajasthan	Public Health Laboratory, Maharana Bhopal Cancer Hospital, Near Dhobighat, Udaipur
54.	Rajasthan	Public Health Laboratory, P.B.M. Hospital Premises, Bikaner (Rajasthan)
55.	Rajasthan	Public Health Laboratory, Sriganganagar (Rajasthan)
56.	Rajasthan	Public Health Laboratory, Banswara (Rajasthan)
57.	Tamil Nadu	Food Analysis Laboratory, No.219, Race Course Road, Coimbatore -641018
58.	Tamil Nadu	Food Analysis Laboratory, King Institute Campus, Guindy, Chennai -600032
59.	Tamil Nadu	Food Analysis Laboratory, Gandhi Nagaram, Near Gandhi Musiam, Poor Home Campus, Madurai – 625 020

60.	Tamil Nadu	Food Analysis Laboratory, Kamaraj Nagar Colony Post, Salem - 636014
61.	Tamil Nadu	Food Analysis Laboratory, Medical College Road, Near Membalam, Thanjavur - 613001
62.	Tamil Nadu	Food Analysis Laboratory, No.5, Old Police Hospital Road, Palayamkottai, Tirunelveli – 627002
63.	Tamil Nadu	Food Analysis Laboratory, Corporation of Chennai, Chennai-600 003
64.	Tripura	Regional Food Laboratory, Pandit Nehru Office Complex, Agartala - 799006
65.	Uttar Pradesh	Regional Public Analyst Laboratory, HB Training Campus, Halwai Ki Bageechi, Agra
66.	Uttar Pradesh	State Government Laboratory, UP Behind Nehru Batika, Sector C, Aliganj, Lucknow – 226020
67.	Uttar Pradesh	Regional Public Health Laboratory, Shivpur, Varanasi – 221003
68.	West Bengal	Public Health Laboratory, 2, Convent Road, Kolkata 700015
69.	West Bengal	Central Food Laboratory, Kolkata Municipal Corporation, I-A, Hogg Street,Kolkata 700087
70.	West Bengal	District Public Health Laboratory, Murshidabad, CMO Office Campus, P.O. Berhampur, Murshidabad (W.B.)
71.	West Bengal	Public Health Laboratory, GM Hospital, P.O. Netaji Subhash, Santorium,Kalyani-741 251, Nadia (W.B.)
72.	West Bengal	Assansol Mines Board of Health Laboratory, Asansol, District Burdwan-713304

5.3 Food safety regulations and certifications

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

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

This chapter is intended to help all the stakeholders, including farmers, livestock producers, veterinarians, processors, exporters, consumers, regulatory agencies, to fully assume their responsibilities at the animal production, transportation, slaughtering, processing, storage, distribution and retailing stage of the meat food chain to produce safe and hygienic food. Information about requirements of global food safety assurance programmes, food safety management system, different food safety certifications and regulatory agencies has also been incorporated. Good production practices should also address socioeconomic, animal welfare, animal health, environmental, meat industry personnel and consumer issues in a coherent manner.

5.3.1 Accereditation/certification and auditing bodies

In the world of consumer protection, it is paramount on the producers of the third party attestation through Conformity Assessment Accreditation Bodies and other bodies in conformity

assessment in the fields of management systems, products, services, personnel and other similar programs of conformity assessment. The conformity assessment reduces the risk for business and its customers by assuring them that accredited certificates may be relied upon. Accreditation assures users of the competence and impartiality of the body accredited. There are four Primary International Organizations which forms unified system for evaluating and recognizing competent accreditation bodies worldwide and India is member in these bodies:

1. IAF (International Accreditation Forum)
2. ILAC (International Laboratory Accreditation Cooperation)
3. PAC (Pacific Accreditation Cooperation)
4. APLAC (Asia Pacific Laboratory Accreditation Cooperation)

Aforesaid four organizations evaluates and recognizes the **accreditation bodies** as mentioned below:

- GFSI (Global Food Safety Initiatives)
- IAS (International Accreditation Service)-Recognized by US-FDA
- IRCA (International Register of Certificated Auditors)
- ISO (International Organization for Standardization)

Aforesaid accreditation bodies will accredit the **certifying bodies** with few examples as below:

- BRC (British Retail Consortia)
- IFS (International Food Standards)
- FSSC (Food Safety and Standards Certificate)
- SQF (Safe Quality Food)
- Global red meat standards (GRMS)

The certification bodies will identify the **auditing agencies** with few examples for meat products categories as below that are approved by FSSAI:

1. BSI Group India Private Limited
2. TUV India Private Limited

3. Bureau Veritas (India) Private Limited
4. DNV GL Business Assurance
5. Intertek India Private Limited
6. IRCLASS Systems and Solutions Private Limited
7. RIR Certifications Private Limited
8. MS Certification Service Pvt. Ltd.
9. Lloyds Register Quality Assurance Ltd.
10. URS Certification Ltd.

5.3.2 Global food safety initiative (GFSI) benchmarked food safety audits

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

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

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

5.4 International Organization for Standardization (ISO)

The International Organization for Standardization (*ISO*) is an independent, non-governmental international organization with a membership of 162 national standards bodies. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.

5.4.1. Quality Management System: ISO 9001

- It ensures that the firm has different forms of processes and procedures in the company to guarantee good performance.
- An ISO 9001 certification helps to realize points in the system that needs better care and better planning.
- The changes within the system can be monitored and make them work towards the goal.
- Quality management system can assure a more efficient office upon implementation.
- The quality management system would give the advantage of judging the different parameters that control the overall efficiency of the system and with it the profitability of the company.

5.4.2 Environmental Management System: ISO 14001

- ISO 14001 helps to reach out the entire market that makes it a norm to follow environmental practices.
- It ensures better compliance ratings within the legal and customary requirements put forth by the Government.
- Enhancement of environmental performance

- Fulfilment of compliance obligations
- Achievement of environmental objectives.

5.4.3 Food safety management: ISO 22000 Certification

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

5.4.4 Occupational health and safety management certification: ISO 18001

OHSAS 1800:2007 Occupational Health and Safety Management Certification is an international standard which provides a framework to identify, control and decrease the risks associated with health and safety within the workplace. Implementing the standard will send a clear signal to your stakeholders that you view employee's health and safety as a priority within your organization.

5.4.5 ISO/IEC 17025 testing and calibration laboratories

- ISO/IEC 17025 enables laboratories to demonstrate that they operate competently
- It generate valid results, thereby promoting confidence in their work both nationally and around the world.
- It also helps facilitate cooperation between laboratories and other bodies by generating wider acceptance of results between countries.
- Test reports and certificates can be accepted from one country to another without the need for further testing, which, in turn, improves international trade.

a. National Accreditation Board for Testing and Calibration Laboratories (NABL)

- NABL accreditation system complies with ISO/IEC 17011:2004 and Asia Pacific Accreditation Cooperation (APAC) MR001. Based on evaluation of NABL operations by APAC in 2000, NABL has been granted signatory member status by APAC and International Laboratory Accreditation Cooperation (ILAC) under their Mutual Recognition Arrangements (MRAs).
- It provides laboratory accreditation services to laboratories that are performing tests / calibrations in accordance with ISO/IEC 17025:2005 and ISO 15189:2012 for medical laboratories.
- It provides "Accreditation of PT Providers" based on international standard ISO/IEC 17043-Conformity Assessment- General Requirements of Proficiency Testing and strive to obtain ILAC / APAC Mutual Recognition Arrangement (MRA) Signatory Status for international acceptability also.

5.5 Codex Alimentarius Commission

The Codex Alimentarius Commission (CAC) is an international food standards body established jointly by the Food and Agriculture organization (FAO, Rome) and the World Health Organization (WHO, Geneva) in May 1963 with the objective of protecting consumer's health and ensuring fair practices in food trade. Codex covers almost 99% of world's population. Codex trust funds support members to protect importers, helps exporters at global level, assures local consumers and removes barrier to trade. Codex standards are based on independent international risk assessment. The agreement on application of Sanitary and Phytosanitary Measures (SPS) and Technical Barriers to Trade (TBT) of the World Trade Organization (WTO) recognizes Codex standards, guidelines and recommendations as reference standards for international trade and trade dispute settlement. Currently the Codex Alimentarius Commission has 189 Codex Members made up of 188 Member Countries and 1 Member Organization (The European Union). India became the member of Codex Alimentarius in 1964. The CAC consists of commission, executive committee and subsidiaries with codex committees and six regional coordinating committees (Asia, Africa, Europe, Far East, South America and North America) and task forces. Codex committees consist of 10 General subject committees (horizontal committee) and seven vertical committee (commodity committee). The scope of the codex includes any principal foods (raw, semi-processed and processed), processing machineries, residues, veterinary drugs and contaminants, labelling, sampling and analysis, imports and exports.

The FSSAI has constituted National Codex Committee (NCC) in India for keeping liaison with the Codex. Shadow Committees on various subject matters corresponding to the Codex Committees have been constituted under the National Codex Committee to facilitate its functions. The shadow committees of NCC-India will assist the NCC in the study or consideration of technical matters. Currently there are 12 Shadow Committees on various subject matters.

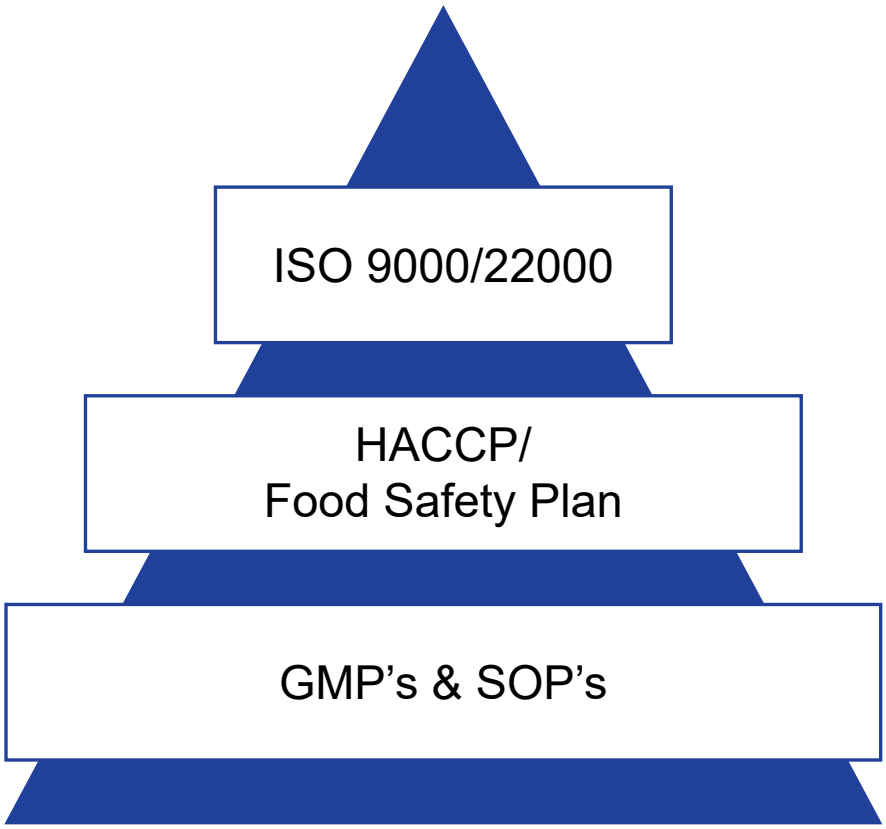
5.6 Food Safety and Standards Authority of India (FSSAI)

The rising food safety issues warrant a strong regulation of foods in the market, which is being regulated by Food Safety and Standards Authority of India (FSSAI), Ministry of Health and Family Welfare through Food Safety and Standards Act (FSSA). Food Safety and Standards Act, 2006 is an integrated food law that lays down standards and guidelines for consumer safety, protection of consumer health and regulation of the food sector. It seeks to harmonise Indian standards with the international standards like CODEX and facilitates international trade in food articles. The Act lays down general provisions for food additives and processing of food/articles as well.The Act deals with administrative mechanism at the state level. The FSSAI also specifies procedures for accreditation of laboratories and provides advice to central and state government in matters relating to food safety. It also provides for setting up of Food Safety Appellate tribunal for adjudication and trails under food standard offence. The law is significant in ensuring quality food to the consumer. It protects consumer interest by prohibiting misleading advertisement and penalising adulteration. In other words, the Act seeks to enhance quality of food related information to consumers and also by setting standards which, when effectively enforced by Commissioners in the States would result in increased consumer welfare. The law also addresses contemporary challenges facing the sector like provisions related to Genetically Modified (GM) crops, functional food, international trade in food items etc. Besides, it is a single reference point for food related matters.

5.6.1 Prerequisites for certification

In order to achieve successful certification, a quality management system for food safety must be established by the producers/processors or within the company, with the requirements of Good Manufacturing Practice (GMP) and Hazard Analysis and Critical Control Point (HACCP) also fulfilled. These requirements particularly relate to quality assurance of the production processes and the production environment, as well as the analysis of possible risks to food safety.

Food and Drug Administration-Food Safety Modernization Act (FDA-FSMA) was signed into law in 2011 in USA for shifting the focus from responding to food-borne illness to preventing it. The FSMA require food establishments/facilities to have a food safety plan that has been prepared by a "Preventive Controls Qualified Individual (PCQI). Under FDA-Foreign Supplier Verification Programme (FSVP), the importer will verify the Food Safety Plan and the Third Party Audit. The following section discusses Good practice guide for Agriculture (GAP), Veterinary (GVP), Manufacturing (GMP), Hygiene (GHP), Production (GPP), Distribution (GDP), and/or Trading (GTP) depending on the segment of livestock/poultry value chain. Building Integrated Food Safety System (IFSS) is mandated by FSMA. An integrated food safety system is one management system that covers multiple food safety legal and customer requirements. It leverages the participation, expertise and authorities of central, state and local agencies with food safety responsibilities to work together to ensure a safe food system.



5.7 Good Manufacturing Practices (GMP) and Standard Operating Procedures (SOP)

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

GMPs include procedures related to the following topics (but are not limited to this list):

a. Live animal/poultry production

b. Live animal/poultry transportation

c. Meat animal slaughtering

d. Receiving meat/ingredients

e. Storage of raw materials and finished products

f. Sanitary design principles for facilities (construction, maintenance, linear product flow, traffic control, etc.)

g. Supplier control (guarantees and system verification), chemical handling (segregation and proper use of cleaners, sanitizers, pesticides, etc.)

h. Specifications for ingredients, products and packaging materials

i. Sanitary design principles for equipment (construction, installation, preventive maintenance and calibration)

j. Personal hygiene

k. Training (personal hygiene, GMP, sanitation, HACCP, etc.)

l. Shipping/Dispatch

m. Recall programs, etc.

5.8 Hazard Analysis and Critical Control Point (HACCP)

Implementing Hazard Analysis and Critical Control Point (HACCP) is crucial for any food manufacturing process. A HACCP plan covers the total supply chain, from inbound logistics, through storage, processing, sanitation and maintenance to the final use by the consumer. Across the operations, it must be ensured that procedures are available for internal logistics, processing specifications, working instructions, hygiene procedures and preventive maintenance plans. These procedures must cover start-ups, shutdown and unexpected stoppages during processing. The HACCP is essential to carry out to identify the weakness of the production line and to suggest critical limits in compliance with legislation and therefore the preventive and corrective measures. Though HACCP system was designed to aim zero defect products, yet it is not feasible to achieve 100% defect free products. However, it sets a goal to minimize the associated risks during production and subsequently reduce unacceptable unsafe products. During implementation of HACCP, it is imperative to set controls at each point of the production line at which safety problems (physical, chemical and biological) are likely to occur.

a. Biological hazards

- Bacteria: Salmonella sp., Campylobacteria-Poultry; *E. coli*-Ground meat; *Listeria monocytogenes*-RTE Meats
- Viruses: Hepatitis A Virus-RTE Foods; Norovirus (Norwalk virus)-Shell fish
- Parasites: *Cryptosporidium parvum*; *Cyclospora sp.; Cysticercosis; Trichinella* etc.
- Fungi: *Aspergillus sp*. etc.
- Yeasts: Not a significant food safety hazards

b. Chemical hazards: Cleaning and sanitizing chemical residues, pesticides, antibiotics, heavy metals and veterinary drug residues, food additives above specified limits, biological toxins, chemical contaminants from packaging and food contact materials, grease etc.

c. Physical hazards: Bone pieces, hairs, stones, plastic, glass, metal etc.

The requirements for Sanitation Standard Operating Procedures (SSOPs) along with Good Manufacturing Practices (GMPs) should be considered as Pre-Requisite for HACCP. The HACCP decision tree may be constructed which will help to identify whether particular step is CCP or not. The purpose of a decision tree is to support the judgement of the team and

help you to confirm whether the hazard needs more food safety controls. A HACCP plan is required to be in place before initiating the HACCP system. A HACCP plan consists of 5 initial steps and 7 major HACCP principles.

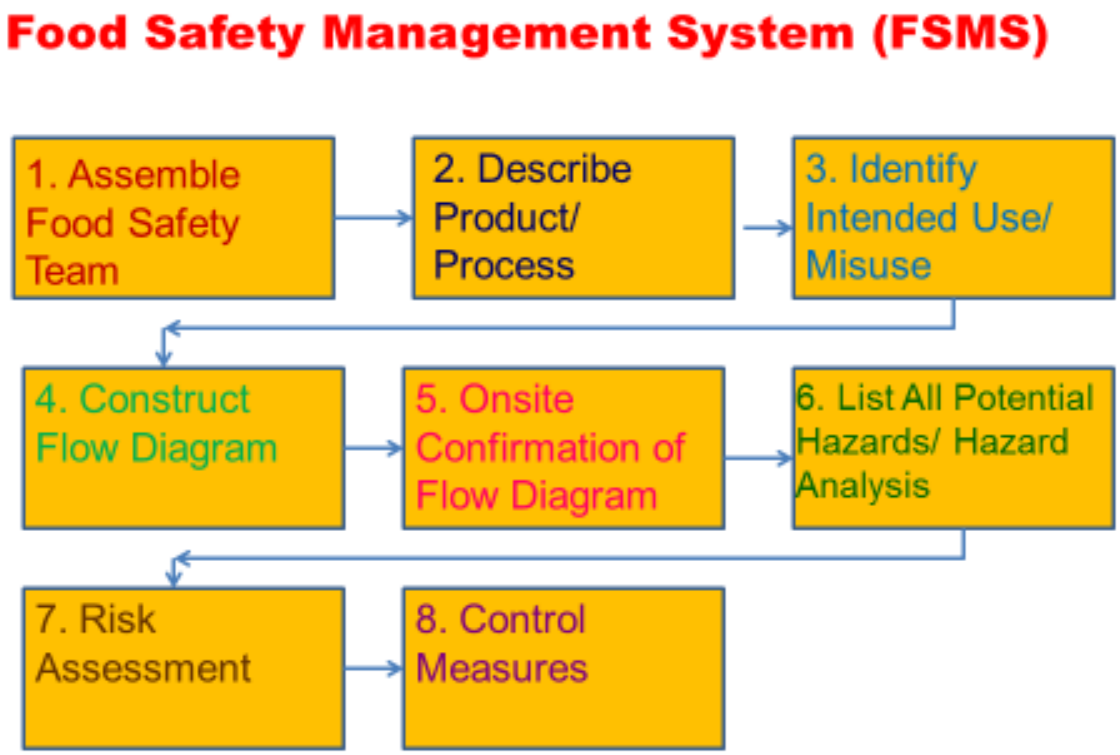
Initial steps for HACCP

1. Assemble HACCP team'
2. Describe the product
3. Document intended use of the product
4. Construct process flow diagram
5. Onsite confirmation of flow diagram

5.9 Food Safety Plan

A written hazard analysis is the first required element in a Food Safety Plan. When the hazard analysis process identifies hazards requiring a preventive control, the written preventive controls portion of the plan must address relevant process preventive controls, food allergen preventive controls, sanitation preventive controls, supply-chain or other preventive controls. These are the preventive controls needed to control the hazards identified in the hazard analysis as requiring apreventive control. Monitoring, corrective action and verification procedures for each of the preventive controls identified must also be included in your plan as

appropriate to ensure the effectiveness of the controls. A recall plan is also a required element of a Food Safety Plan when a hazard requiring a preventive control is identified. Because Food Safety Plan will be used or reviewed by regulators, employees, auditors, customers and potentially consultants, it may also be useful to include a brief description of facility or company along with a list of Food Safety Team members, a product description, a process flow diagram and a process description to help people understand the structure of the plan. The components of food safety plan include:



a. Background Information (Optional)

- Facility overview and safety team
- Product description
- Flow diagram
- Process description

b. Hazard Analysis

c. Preventive Controls

- Process preventive controls
- Food allergen preventive controls
- Accurate labeling
- Cross-contact prevention
- Sanitation preventive controls
- Environmental pathogens
- Cross-contamination
- Supply-chain preventive controls

d. Recall Plan

- Required when a hazard requiring a preventive control is identified.
- What to do when something goes wrong???

e. Implementation Procedure

- Validation studies
- Procedures for monitoring, verification and accurate action

Annexure

List of imported machineries/equipment suppliers for meat processing

Beeta Instruments & Equipment Co., No. 74, Thirunalluvar street, Jagathambigai Nagar, Padi, Chennai, 600 050 Ph.No. 044-4385 0102 Fax: 044-2654 2233 www.beetta.in	Sun Labz Equipments, New No 14, First Floor, West Sivan Koil Street, Vadapalani, Chennai, 600 026 Ph.No. 9791033496
Food Processing Equipments Co. Pvt. Ltd., A-3/6, Laxmi Building, Acharya Niketan, Mayur Vihar – I, Delhi 110 091	PRS Technologies Pvt Ltd., D – 26, 2nd floor, NDSE Part – II, New Delhi, 110049
Dr. Froeb (India) Pvt Ltd, 205 Akash Darshan Apartments, Mayur Vihar Phase I, Trilokpuri, Delhi-110091, India	Rite Equipment Pvt Ltd., G – 36, 2nd floor, Green Park Main, New Delhi, 110016
Asian Kitchen Equipmenst 6-3-608, 8/3, Thakur Mansion Ln, Durga Nagar, Somajiguda, Hyderabad, Telangana 500082	Agaram Industries, H.No. 6-3-456/9&10, Dwarakapuri Colony, Panjagutta, Hyderabad 500 082. 040-65152086 Fax: 040-23356708 www.agaramindia.com
Stadler Corporation, A 3/3, Surjit Singh Compound, Shivaji Nagar, Off Vakola bridge, Santa Cruz, East Mumbai, 400 055 Tel: 022-2668 5212, 2668 6920 Fax: 2668 5093 E mail: stadler44@hotmail.com	Mittal International (India) Pvt Ltd., 7, Netaji Subhash Marg, 1 Daryaganj, New Delhi, 110002
Stellar Gastronom Pvt Ltd., 71/5, Shivaji Marg, New Delhi, 110015	Jarvis Equipment Pvt. Ltd., Plot 93A, Sector 5-IMT Manesar, Gurgaon, Haryana, 122 050

List of Indigenous equipment manufacturers and suppliers

Meatek Food Machineries India Pvt. Ltd. A-2/3, Chinhat Industrial Area, Dewa Road, Lucknow – 226019. Phone Number: 0522 2818658	JD Engineering Corporation No. 4, HindonVihar, Meerut Road, Ghaziabad - 201001, Uttar Pradesh, India Phone: 08068215151
Dhopeshwar Engineering Pvt. Ltd., A-16, Co-op. Industrial Estate, Balanagar, Hyderabad 500 037 Tel: 040-2377 1579, Fax: 2377 2450 www.dhopeshwar.com	Zaftech India Plot 2, Sector 5, Dwarka, New Delhi Phone No. : +91-9596553669, 8527570636 Email. : zaftechindia@gmail.com,
Kalsi products Shapur road Near chowk, Subhani Building Ludhiana-141 008 Ph.No. 0161-2223738 Fax: 2228144 www.kalsiproducts.com e-mail: juicemachines@yahoo.co.in	Lakshmi Engineering works, No 111/96, SIDCO, Ambattur, Chennai, 600098 Ph. No. 098403 27201
RND Practical Engineering, ¼, Shiva Complex, Kondhwa Bk, Pune, 411 048 Ph.No. 020- 26930100/ 26930226 Fax: 24002204	Storm Engineering India Pvt. Ltd. Survey No. 220, Ganesh Nagar, Post Kesnand, Pune - 412207
Agro Mech Industries B-7, Industrial Estate Sanathnagar, Hyderabad-500 018	Chengalva Engineers Ltd., 405, Shashank Residency, St. No. 11, Taranaka, Hyderabad, 500 017
Trinity Corporation 10-3-32/9/96, Nehru nagar Co-op. Housing society, Addagutta Road, East Marredpally, Secunderabad 500026, Mob- 9866651595, Email-Myke009@yahoo.com.	Bakers Shoppe Pvt Ltd 540 Lakshmi Venkateswara temple Road, Nanjappareddy Layout ,8th Block Koramangala, Bangalore-560 095

List of food grade chemicals and non-meat ingredients/ materials suppliers

BSA-India, F-29, AgroFoodPark, Matasya Industrial Area, Alwar, Rajastan Tel.: 0144-5132212 Cell: 09982627280 E-mail: bsaindia@bsa.ca www.bsaindia.in	Vee Tech International, FF-7, 48, Hasanpur, I.P. Extn, Delhi-110092 Cell: 09810539700 e-mail: veetechinternational@yahoo.in
Trijay Traders, #2-3-527/7, D.V. Colony, Minister Road, Secunderabad-03, A.P. Tel.: 040-66206665 Cell: 09246524225/09849943736 E-mail: trijay007@hotmail.com	DR. FROEB (I) PVT. LTD., Euromate Food Tech Pvt. Ltd., C-22, 2nd Floor, Sector-2, Noida, UP, 201301 Tel.: 0120-4283840/4283843 e-mail: info@drfroebindia.com www.drfroebindia.com
Kancor Ingredients Ltd., No. VII/138, Kanakkankadavu Road, Angamaly South, Ernakulum-683573 Tel.: 0484-2452236/3051000 www.kancor.in	Pari Chemicals 37- Nagdevi Street, Ground floor, Mumbai-400 008 Tel: 022- 2345 4561, 6631 2022, 2343 0740 E-mail: parichem@gmail.com
Sausage Casings DKSH India Pvt. Ltd., SAI Chambers, Third Floor, No. 43 (Old No. 28/B), 9th Cross, Opp. Nirmala Bus Stop, 50 Feet Road, Hanumanth Nagar, Bangalore-560050 Tel.: 9844242176 e-mail: vani.rai@dksh.com www.dksh.in	Artificial casings Dr. Froeb Laminate Foods Enromate Food Ltd, B-136, II Floor Kalkaji 110 019 Delhi Ph. No. 011-2646 3077

List of suppliers for packaging machine and packaging materials

Indvac, Saurabh Engineers, 20, Small Scale Industrial Estate, Near Gujarat Bottling, Rakhial, Ahmedabad - 380023, Tel.: 079-22911288/26930870 Cell: 09824040137 e-mail: dipak@indvacindia.com www.indvacindia.com	Sevana Electrical Appliances Pvt. Ltd. P.B. No. 5-2-391/5, Hyderbasti, RP Road, Secunderabad-500003, A.P. Tel.: 040-27540505/27544400 Cell: 9849062475 e-mail: Hyderabad@sevana.com www.sevana.com
Propack India Pvt. Ltd. 309, VikramTower, 16 Rajendra Place, New Delhi-110008 Tel.: 011-25744332 Cell: 9312276564 e-mail: info@propackindia.com www.propackonline.com	Engineers Consortium, No. 31, H.B. Colony, Baldev Nagar, Ambala-134007, Haryana, India Tel.: 0171-2540073/2552494 Cell: 9354704506
Winner Electronics, No. 124, Shri Krishna Industrial Estate, Office Dahisar Toll Plaza, Dahisar (E), Mumbai-401107, Maharashtra Cell: 09920020004/09324513961 e-mail: response@ vacuumpackagingmachine.com www.vacuumpackagingmachineindia.com	Om Chamunda Enterprises, 123/132, Diamond Industrial Estate, Ketki Pada Road, Near Dahisar Toll, Naka, Dahisar (E), Mumbai-401107 Cell: 09867385565 e-mail: rajesh@omchamunda.com www.omchamunda.net
AVI International Packaging Company, 67/H-3, Sector-11, Rohini, New Delhi-110085 Tel.: 011-27571255/25776910 Cell: 09810822611 e-mail: avi-international2004@yahoo.com www.avipackagingmachines.com	Swift Pack Packaging Systems, Shri Vinayak Packaging Machine Pvt. Ltd., 10/58 Opp. Dd. Moter, Kirti Nagar Industrial Area, New Delhi, Delhi 110015 Tel.: 011-25775244/25775401 Cell: 09818013713 e-mail: svppnd@yahoo.co.in sales@swiftpack.in
For Imported Machines: Elixir Technologies, No. 29, Ground Floor, 1st Cross, Mico Layout, Mahalakshmipuram, Bangalore-560086 Tel.: 080-23190706	For Polystyrene Trays: Selears India Door No. 118/19, Ragas Apartment, AI Block, 8th Main Rd, Shanthi Colony, Anna Nagar, Chennai, Tamil Nadu 600040 Tel.: 044 4217 1271 e-mail: sales@sealersindia.com

Multivac Laron India Pvt. Ltd., Plot No. 137, Sector 5 IMT Manesar, Gurgaon-122050 Tel.: 0124-4610000 e-mail: info@multivac.co.in	Visu Poly Products Pvt Ltd., 112/4, 12th Cross, Doddanna Industrial Estate, Near Peenya Second Stage, Bangalore, 560091 Tel.: 9686570602 e-mail: visupolyproducts@yahoo.co.in www.visu.co.in
FOR RETORT POUCHES: Saurabh Plastvac, 15, Small Scale Industrial Estate, Nr. Gujarat Bottling, Rakhial, Ahmedabad-380023 Tel.: 9825013574/9429902147 e-mail: sales@plastvac.com	Standard Machinery Marketing Co. (P) Ltd., 205 B, Brooklyn Apartments, 63, Banaswadi Main Road, Jai Bharath Nagar, Bangalore-560033 Tel.: 08025495844/9845030749 e-mail: smc@stanmac.net www.stanmac.com
Laminâtes / pouches Vacmet India Limited, AnantPlaza, II Floor, 4/117-2A, Civil Lines, Church Road, Agra-282002, UP Tel.: 0562-2525466/4050400 e-mail: vacmet@vsnl.com	Hitkari Industries Ltd., I-1(A), Dhawandeep Apartment, 6 Jantar Mantar Road, Opp. Kerala House, New Delhi-110001 Tel.: 011-43156666/43156600 e-mail: sales@hitkaripackaging.com www.hitkaripackaging.com
Pradeep Laminators Pvt. Ltd. Gat. No. 392, Talegaon-Chakan Road, Mahalungen, Opp. Bajaj Electricals, Tal Khed, Pune-410501 Tel.: 02135-678900 e-mail: pradeeplaminators@ pradeeplaminators.com www.pradeeplaminators.com	Famous Enterprises Unit No. 6, Technocrats Industrial Estate, Balanagar, Hyderabad-500037, AP Tel.: 040-23079621 Cell: 09849014836

List of suppliers for chillers, cooling chambers, blast and plate freezers

Rinac 1009, Filix, Opp. Asian Paints, LBS Marg, Bhandup (West), Mumbai-400078 Tel.: 022-25960720/25960721 e-mail: rilmumbai@rinac.com www.rinac.com	Rinac Plot No. 38, First Floor, Anand Nagar, Bowenpally, Secunderabad-11 Tel.: 040-27951563/27753043 e-mail: rilhyderabad@rinac.com
Frick India Ltd., 809, Surya Kiran, 19 K.G. Marg, New Delhi-110001 Tel.: 011-23322381 e-mail: delhi@frick.co.in www.frickweb.com	Frick India Ltd., Swapanlok, 92/93, SD Road, Secunderabad-500003, AP Tel.: 040-27813044/27813897 e-mail: hydefrick.co.in www.frickweb.com
Neptune Refrigeration Co. Pvt. Ltd. 153, Mount Road, Chennai-600002 Tel.: 044-28460283/28460374 e-mail: Neptune@md2.vsnl.net.in www.neptunerefrigeration.com	El Shaddai Refrigeration & Air Conditioning Pvt. Ltd. 18, 12th A Main Rd, KEB Colony, 1st Stage, Hongasandra, Bengaluru, Karnataka 560068 Karnataka Cell: 09740319794/08904882245
Thermolab Cold Chain Division, Thermolab House, Plot No. 40 & 41, Vasai Municipal Ind. Area, Umela Road, Vasai (W), Dist. Thane, Mumbai-401207, Maharashtra Tel.: 250-2323156 e-mail: info@thermolabscientific.com www.thermolabgroup.com	Eakcon Systems Pvt. Ltd., No. 13/1 & 13/2, Sri Krishna Jagdish Villa, Saipuri Colony, Malkajagiri, Hyderabad-47 Cell: 09490166497
Metro Refrigeration Industries, D-35, Meerut Road, Industrial Area, Ghaziabad, Uttar Pradesh, 201003 Cell: 09412223845/09810047572 e-mail: gmsingh@metrorpl.com	Blue Star, 207, Sikh Road, Bantia Estate, Secunderabad-500003 Tel.: 040-44004100 e-mail: coolingsolutions@bluestarindia.com www.bluestarindia.com

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