Process for development of healthier meat products

Technical bulletin

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The institute's second campus was established on 19th March, 1993 at Abohar, Punjab, India that is primarily responsible for conducting research and development activities on fruits and vegetables, and commercial horticultural crops. ICAR-CIPHET, Ludhiana is also the headquarter for two All India Coordinated Research Projects (AICRPs) viz. AICRP on Post-Harvest Engineering and Technology (PHET) with 31 Centres and AICRP on Plasticulture Engineering in Agriculture Structure and Environmental Management (PEASEM) with 14 Centres across the country.

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भाकृअनुप–केन्द्रीय कटाई–उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान
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Contents

Introduction

Meat products contain many essential minerals and vitamins of high biological values. The protein of animal origin also provides essential amino acids for human nutrition. Thus, the products from animal origin provide essential nutrients as well as decrease the intensity of protein malnutrition to a greater extent. Raw meat is processed to increase the shelf life as well as other eating qualities in various ways. However, certain ingredients which are added during processing of raw meat into processed meat products negatively correlated with the human health. The consumption of high-fat meat products may negatively affect the physiological health status of human by altering cardiovascular functioning. Obesity, high blood pressure, diabetes etc. are some common cardiovascular and physiological disorders which have been correlated with the higher consumption of full-fat processed meat products. Hence, to reduce the burden of these problems among the human population many health organizations around the world have made certain recommendations which suggest to cut the portion size and limit the intake of high-fat meat products.

The recommendations to reduce the consumption of meat products may affect the growth and economics of meat industry. Thus, meat industry is finding solutions by development of healthier processed meat products which do not negatively affect the health status of consumers. The research for development of healthier processed meat products is now gaining importance all over the world. The market of healthier processed meat product is expected to grow enormously in the next few years, being

> **"The present technology relates to a process for producing low-fat, high-fibre processed meat products. In this process, a combination of edible fat replacers are developed and used appropriately. Fat replacers are processed for improvement of emulsifying properties in the meat matrix. The dietary fibre is also activated to improve water and fat-binding properties. The final processed meat product is having low fat and high fibre contents with excellent water binding properties, textural properties, and sensory properties."**

mainly driven by ongoing health concerns. The product claims that are associated with the food products are now the preferences of consumers and these product claims are now the main deciding factor for buying of such food products. Thus, consumers are now preferring meat products that contain low-fat, high-fibre and certain functional properties. The price is now at second place with respect to the deciding factors that affect the purchasing behavior of consumers. In developing counties, like in India, price, purchasing power and health claims all are important factors which determine the purchasing behavior of the consumers. Moreover, the sensory properties are also critical factors which are associated with the consumer acceptability of newer meat products.

Processed meat products: types, principle, technological aspects

There are different types of processed meat products in the market. These products are broadly divided into following categories:

Ready-to-cook processed meat products

Some processed meat and poultry products are ready-to-cook, like fresh breakfast sausages that contain meat ground with spices or other flavorful ingredients, or a turkey breast that is marinated and ready-to-cook. The ready-to-cook category also includes uncooked smoked sausages that are mildly cured through the addition of sodium nitrite, an ingredient that imparts a characteristic pink color and distinct taste.

Ready-to-eat processed meat products

Some processed meat products are ready-to-eat e.g. cured and fermented meat products using seasonings, sodium nitrite, and lactic acid, which provide a tangy taste. These products include salami, pepperoni, and summer sausage. Some are called dry and some are called semi-dry products depending upon the moisture level in the final product.

Basic steps for development of processed meat products

All processed meat products are in one way or another, physically and/or chemically treated. These treatments go beyond the simple cutting of meat into meat cuts or meat pieces with subsequent cooking for meat dishes in order to make the meat palatable. Meat processing involves a wide range of physical and chemical treatment and normally combining a variety of steps. Meat processing steps include:

-Cutting/chopping/comminuting (size reduction)
-Mixing/tumbling
-Salting/curing
-Addition of spices/non-meat ingredients
-Stuffing/filling into casings or other containers
-Fermentation and drying (if applicable)
-Smoking (if applicable)
-Heat treatment

Processed meat products: Emulsion formation: Basic principle

In general, the comminuted and emulsion-type meat products are made after mincing

and chopping of raw boneless meat through appropriate machines. Sodium chloride, phosphates, nitrites, water, oil, and other spices are added during chopping of meat. Each ingredient has its effect on the properties of emulsion. Physical disintegration during chopping of meat disrupts the sarcolemma. Salt solubilizes muscle myofibrillar proteins namely actin and myosin. The solubilization of muscle proteins converts the chopped meat mass into a viscous mass. Myofibrillar proteins are responsible for emulsifying properties and they also interact with other non-meat ingredients that affect the technological properties of a meat emulsion system. A proper emulsification results in higher water holding capacity and emulsion stability of meat matrix. Oil is added in the end to form an oil-in-water emulsion. In this meat emulsion, the hydrophilic groups of proteins are oriented toward the aqueous phase and the hydrophobic groups are toward the lipid phase. After making of emulsion, the cooking is done that converts the viscous mass in gel form which provides texture and stabilizes the fat-water in the protein network of cooked meat emulsion. The functional properties of meat proteins differ among various animal species; thus, the formation of viscous meat emulsion and

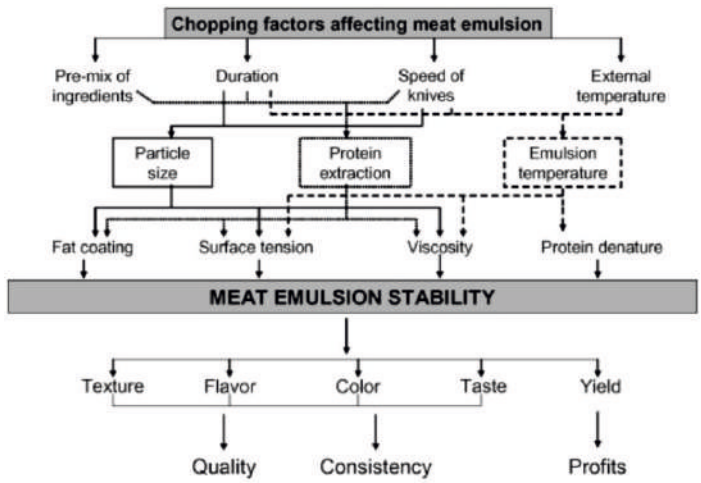

Figure 1. Factors affecting the qualities of meat emulsion.

cooked gel differ in their characteristics. Due to this reason, pork and chicken muscles are converted into viscous emulsion more easily (strong gel) than the beef and lamb muscles (weak gel).

It is important for a good meat emulsion that all the necessary ingredients are added at right step and in right quantity; otherwise, emulsion properties deviate which results in a lower product yield and a rubbery texture. The formation of a good meat emulsion is a step by step procedure which involves many scientific concepts to be followed. It is evident that the addition of fat is a necessary step for development of good meat emulsion and ultimately a good final meat product with desired textural and sensory attributes. Traditional processed meat products contain up to 30% fat which provides typical sensory characteristics to that product.

Healthier meat products

Traditional meat products contain high amount of fat and are very popular in different part of world. However, the regular consumption of high-fat diet is associated with physiological disorders including obesity, high blood pressure, diabetes etc. These disorders may be responsible for other ailments in human body if not corrected in time. Thus, several health organizations have made recommendations to reduce the consumption of high-fat food products especially high-fat processed meat products.

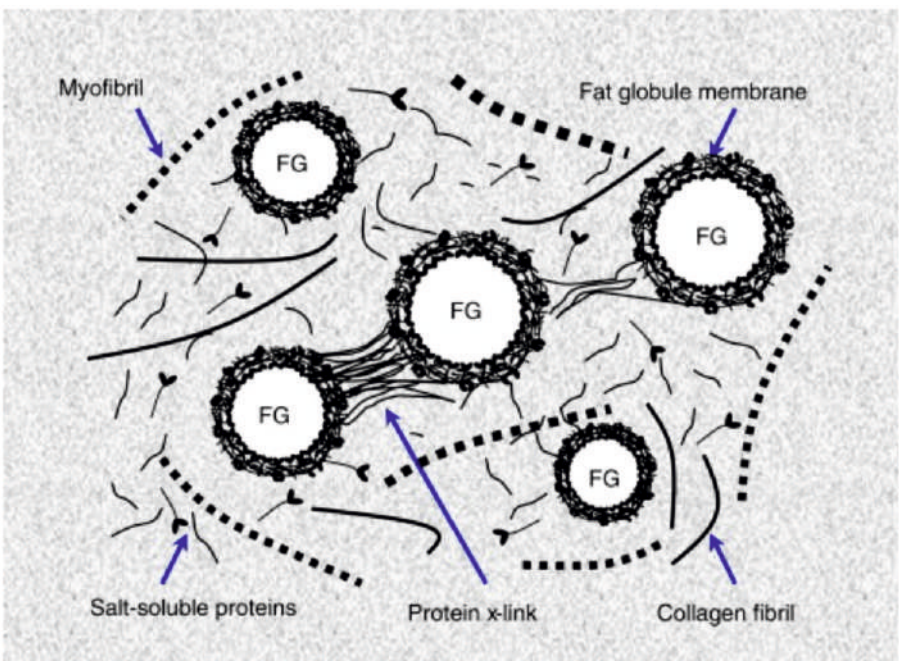

Figure 2. Meat emulsion matrix.

This led to the development of low-fat meat products with all desired sensory attributes comparable to that of traditional meat product. The simple reduction of fat content during processing of meat product results in inferior product quality in terms of technological (water holding capacity, cooking losses, emulsion stability, texture, etc.) and sensory (taste, odor, mouth feel, juiciness, overall acceptability, etc.) attributes which affects the marketability and consumer acceptance of newer low-fat meat products. To overcome this problem, the use of fat replacer is preferred to reduce in the fat content of processed meat products.

Technological aspect of fat and fat replacers in processed meat products

Fats are composed mainly of triglycerides and are important ingredients in manufacturing of processed meat products. Typically, 20-30% fat is necessary to develop quality processed meat products with desired functional and sensory properties. The type of fat also affects the quality of meat products. Fat affects the gastro-nervous-hormonal pathway which is responsible for flavor perception and lubrication effect. However, the regular consumption of fat is not considered safe for human health as discussed earlier. Hence, the research and development is directed towards development of low-fat meat products.

The development of low-fat meat product using lean meat results in lower sensory properties as well as increases the cost of production. A higher water content also negatively affects the product quality in terms of textural, microbiological and technological properties. The concept of fat replacers for development of low-fat food products is desirable because it not only reduce the fat content but also does not affect

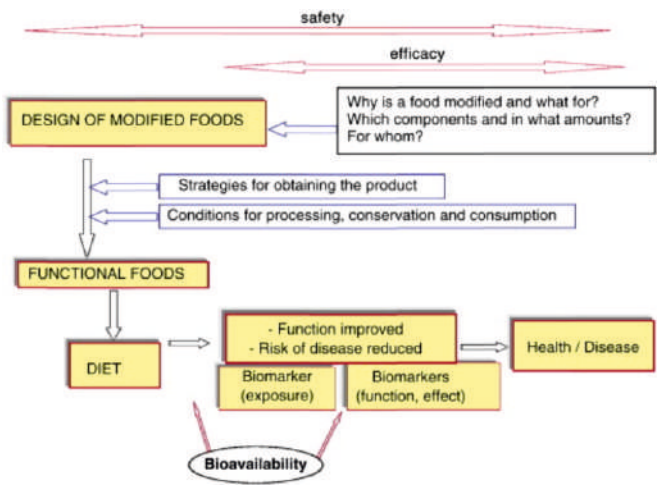

Figure 3. Basics of development of healthier meat products.

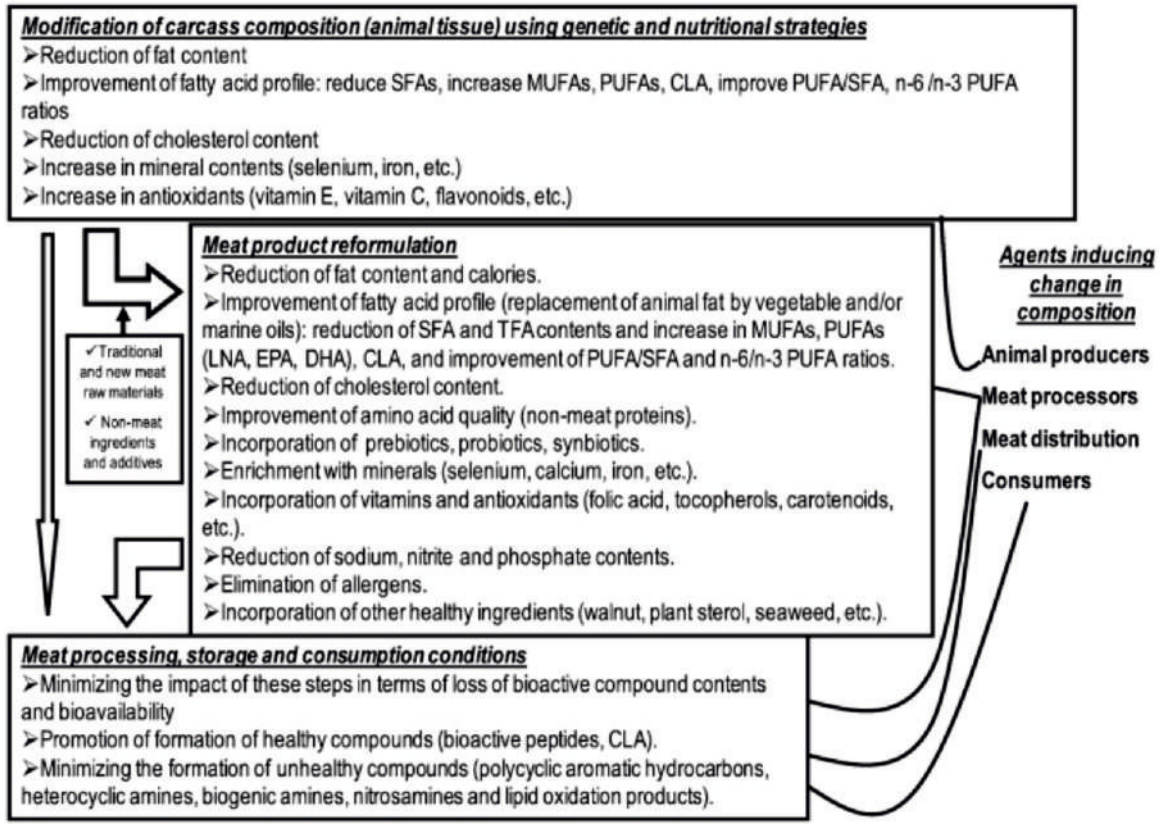

Figure 4. Strategies for development of healthier meat products.

the product qualities significantly. Recently, some fat replacers have been used in place of fat (partial/full) as dispersed phase for manufacturing of low-fat meat products. A worthy fat replacer is a compound or mixture of compound/ingredients which interacts with the proteins (continuous phase) of viscous meat emulsion and provides functional properties in absence of regular fat content. Thus, a good fat replacer acts as an emulsifier during formation of meat matrix (two phase stable emulsion system) in emulsion type meat products.

Traditionally, animal fat was used for preparation of processed meat products. However, animal fat is composed mainly of saturated fatty acids and is not a healthy option. Thus, the use of fat with healthier fatty acid profile is preferred for development of healthier meat products. This has led to the use of vegetable oils and fish oils for development of healthier processed meat products. However, the oxidative stability of vegetable oil is lesser than animal fat. Thus, the improvement in the oxidative stability of final meat products is also needed to enhance the shelf-life of final product. Pre-emulsification, encapsulation and use of synthetic antioxidants are the strategies to overcome the problem of lipid oxidation. The use of synthetic antioxidants like butylated hydroxyl toluene (BHT) for controlling the oxidation in various meat products is again questioned by many researchers and health organizations due to their carcinogenic effects. Hence, the meat industry is now facing another problem of finding natural antioxidants for improving the oxidative stability of MUFA/PUFA enriched meat products.

Processing equipment/machines for development of healthier processed meat products

Most of the meat processing steps can be mechanized. In fact, modern meat processing would not be possible without the utilization of specialized equipment. Such equipment is available for small-, medium- or large-scale operations. The meat processing equipment to develop commonly available meat products are briefly described hereunder.

Meat grinder (Mincer)

A meat grinder is a machine used to force meat or meat trimmings by means of a feeding worm (auger) under pressure through a horizontally mounted cylinder (barrel) (Fig. 5). At the end of the barrel there is a cutting system consisting of star-shaped knives rotating with the feeding worm and a stationary perforated disc (grinding plates) (Fig. 6). The perforations of the grinding plates normally range from 1 to 13 mm. The meat is compressed by the rotating feeding auger, pushed through the cutting system and extruded through the holes in the grinding plates after being cut by the revolving star knives. Simple equipment has only one star knife and grinder plate, but normally a

Figure 5. Meat mincer.

Figure 6. Different parts of meat mincer: plate, blade, and barrel.

series of plates and rotary knives is used. The degree of mincing is determined by the size of the holes in the last grinding plate.

Bowl cutter (bowl chopper)

The bowl cutter (Fig. 7) is the commonly used meat chopping equipment designed to produce small or very small ("finely comminuted") lean meat and fat particles. Bowl cutters consist of a horizontally revolving bowl and a set of curved knives rotating vertically on a horizontal axle (Fig. 8) at high speeds of up to 5,000 rpm. Many types and sizes exist with bowl volumes ranging from 10 to 2000 liters. The most useful size for small- to medium-scale processing is 20 to 60 liters. In bigger models, bowl and knife speed can be regulated by changing gears. Bowl cutters are equipped with a strong cover. This lid protects against accidents and its design plays a crucial role in the efficiency of the chopping process by routing the mixture flow. Number, shape, arrangement, and speed of knives are the main factors determining the performance of

Figure 7. Bowl cutter or bowl chopper.

Figure 8. Blades of bowl chopper.

the cutter. Bowl cutters may also be equipped with a thermometer displaying the temperature of the meat mixture in the bowl during chopping.

Filling machine (sausage stuffer)

These machines are used for filling all types of meat batter in containers such as casings, glass jars, cans etc (Fig. 9). The most common type of filling machine in small and medium size operations is the piston type. A piston is moved (Fig. 10) inside a cylinder forcing the meat material through the filling nozzle (funnel, stuffing horn) into the containers. Piston stuffers are either attached to the filling table or designed as floor models (Fig. 9). In small-scale operations, manual stuffers are usually sufficient, sometimes even simple hand-held funnels are used to push meat mixes into casings.

Modern filling machines for larger operations are designed as continuous vacuum stuffers. During the filling process a substantial part of the enclosed air is removed from

Figure 9. Sausage stuffer.

the product, which helps to improve color and texture of the finished products. These models are usually equipped with a portioning and twisting device and have a casing grip device attached for filling of “shirred” (folded) uncut collagen and plastic casings. This type of continuous filling equipment is relatively expensive and is thus not used in small- to medium-size establishments.

Clipping machine

Clipping machines place small aluminium sealing clips on the sausage ends and replace the manual tying of sausages. They can be used for artificial or natural casings. Clipping machines can also be connected to filling machines. Clipping machines are mainly used in larger operations and in most cases operated by compressed air. For medium-scale operations manually operated hand clippers are available.

Smokehouses

Simple smokehouses are used for smoking only. In traditional and small-scale operations the most common methods of smoke generation include burning damp hardwood sawdust, heating dry sawdust or heating pieces of log. But technological progress has changed the smoke generation and application techniques. Methods used in modern meat processing include the following:

In modern smokehouses, smoke generation takes place outside the smoking chamber

Figure 10. Sausage stuffer: parts.

in special smoke generators with electrical or gas ignition. Separate smoke generators allow better control of the quantity and temperature of the smoke produced. The sawdust or chip material is moved from the receptacle to the burning zone by a stirrer or shaker. It is ignited by means of an electrically heated plate or by gas flame.

Smoke generation through steam

Superheated steam at approximately 300 °C is injected into a compact layer of sawdust, which causes thermal destruction of the wood and smoke is generated. This method allows the control of smoke generation temperature by choosing the adequate steam temperature. Impurities in the smoke caused by particles of tar or ash are minimal.

Brine injector

This equipment is used for the injection of brine into meat. Brine is water containing dissolved salt and curing substances (nitrite) as well as additives such as phosphates,

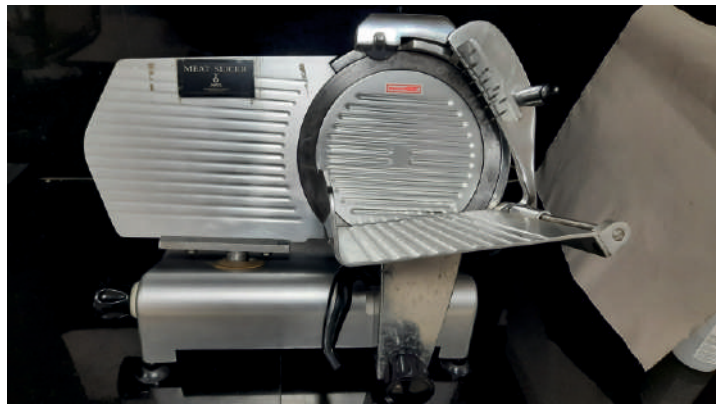

Figure 11. Meat slicer.

spices, sugar, carrageenan and/or soy proteins. The injection is done by introducing pointed needles into the muscle tissue. Brine injection is mainly used for the various types of ham, bacon and other whole muscle products.
Brine injectors are available in different sizes from manually operated single-needle devices for small-scale operations to semi-automated brine injectors with up to 32 needles and more.

Tumbler or Massager

Tumblers are used for the processing of meat products such as whole-muscle or reconstituted hams. Such machines resemble in principle a drum concrete mixer. A rotating drum with steel paddles inside slowly moves the meat pieces thus causing a mechanical massaging effect. This mechanical process is assisted by the addition of salt and phosphates to achieve equal brine distribution and liberates muscular protein from the meat tissue (protein extraction). The semi-liquid protein substances join the meat pieces firmly together during later heat treatment. For hygienic reasons, it is important to place the tumbler below 10 °C to avoid excessive microbial growth.

Vacuum packaging machine

For vacuum packaging the meat product has to be placed in a vacuum bag (multi-layer synthetic bag. Air is removed from the bag by means of the vacuum packaging machine (Fig. 12) and the bag is then sealed.

Mixer / blender

Mixers are used to blend meat and spices, or coarse and finely chopped meat. The machine generally consists of a rectangular or round bottom vessel through which two parallel shafts operate. Various paddles are mounted on those shafts to mix the meat.

The mix material is discharged by tilting at 90 degrees.

Emulsifying machine

The emulsifier is used for the preparation of very fine meat emulsions. Its functional parts are a perforated plate and two rotating edged blades (rotor blade). There is a centrifugal pump next to the blades that forces the pre-ground meat through the

Figure 12. Vacuum packaging machines.

perforated plate. Most emulsifiers are vertical units. Compared to the bowl cutter, the emulsifier operates at much higher speed, producing a finer emulsion-like mix. The emulsifier is also perfectly suited to produce semi-processed products such as pig skin emulsions.

Process for development of healthier processed meat products

The development of emulsion type processed meat products involves many steps. Each step has its own scientific merit which reflects in final product quality. The basic steps for development of emulsion-type processed meat products are:

Cutting (reducing meat particle size)

Mincing (grinding) of lean and fatty animal tissues
Larger pieces of soft edible animal tissues can be reduced in size by passing them through meat grinders. Some specially designed grinders can also cut frozen meat, and some are equipped with devices to separate "hard" tissues such as tendons and bone particles from the "soft" tissues (minced muscle meat particles).
Chopping animal tissues in bowl cutter (discontinuous process)
Bowl cutters are used to chop and mix fresh or frozen lean meat, fat (and/or edible offal, if required) together with water (often used in form of ice), functional ingredients (salt, curing agents, additives) and extenders (fillers and/or binders).
Chopping animal tissues in emulsifying machines (continuous process)
The animal tissues to be emulsified must be pre-mixed with all other raw materials, functional ingredients and seasonings and pre-cut using grinders or bowl cutters. Thereafter, they are passed through emulsifiers (also called colloid mills) in order to achieve the desired build-up of a very finely chopped or emulsified meat mix.
Salting / curing
Salting – Salt (sodium chloride NaCl) adds to the taste of the final product. The content of salt in sausages, hams, corned beef and similar products is normally 1.5-3%. Besides enhancing to flavor and taste, salt also assists in the extraction of soluble muscle proteins. This property is used for water binding and texture formation in certain meat products. Salt also acts as an antimicrobial agent and extends the shelf-life of meat products.
Curing – Consumers associate the majority of processed meat products like hams, bacon, and most sausages with an attractive pink or red color after heat treatment. However, experience shows that meat or meat mixes, after kitchen-style cooking or frying, turn brownish-grey or grey. In order to achieve the desired red or pink color, meat or meat mixes are salted with common salt (sodium chloride, NaCl), which contains a small quantity of the curing agent sodium nitrite ($NaNO_2$). Sodium nitrite has the ability to

react with the red meat pigment to form the heat stable red curing color. Only a small amount of the nitrite is needed for this purpose.

Nitrite can be safely used in tiny concentrations for food preservation and coloring purposes. Levels of 150 mg/kg in the meat product, which is 0.015%, are normally sufficient. Nitrite ($NaNO_2$), or rather nitrogen oxide, NO, which is formed from nitrite in an acidic environment, combines with myoglobin to form nitrosomyoglobin, a bright red compound. The nitrosomyoglobin is heat stable i.e. when the meat is heat treated the bright red color remains stable. The addition of nitrite curing salt in quantities of approximately 2%, which is the usual salt level, generates a nitrite content in the meat products of approximately 150 ppm (parts per million or 150 mg/kg). This nitrite content (150 ppm) is not toxic for consumers.

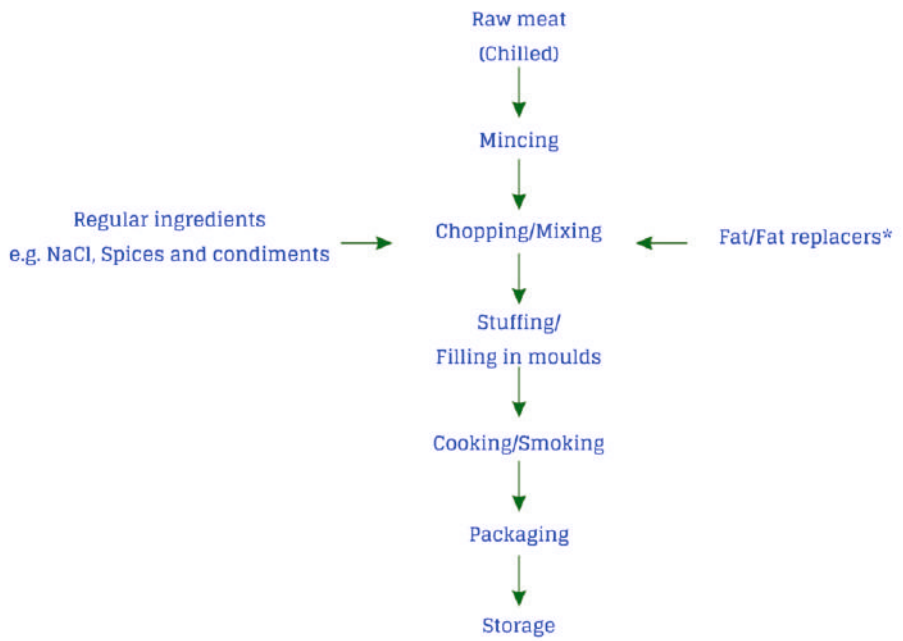

Figure 13. Process for development of healthier meat products.

"Process for development of fat replacers and other technical details are patented (Filed). This process is available for licensing at ICAR-Central Institute of Post-harvest Engineering & Technology, Ludhiana"

Nitrite is recognized a substance with multi-functional beneficial properties in meat processing:
The primary purpose of nitrite is to create a heat resistant red color in a chemical reaction with the muscle pigment, which makes cured meat products attractive for consumers.
Nitrite has a certain inhibitory effect on the growth of bacteria. This effect is particularly pronounced in canned meat products.
Nitrite has the potential of attributing a specific desirable curing flavor to cured products.
In the presence of nitrite fats are stabilized and rancidity in meat products retarded i.e., an antioxidant effect.

Curing of chopped/comminuted meat mixtures

Curing is applied for most chopped meat mixtures or sausage mixes for which a reddish color is desired. The curing agent nitrite is added in dry form as nitrite curing salt. The reaction of nitrite with the red meat pigment starts immediately. Higher temperature during processing accelerates the process.
Another accelerating or "catalytic" agent is ascorbic acid, which slightly lowers the pH of the meat mixture. However, the dosage of ascorbic acid must be low (0.05%), just to provide the slightly acidic condition for the reduction of $NaNO_2$ to NO.

Smoking

Smoke is generated through the thermal destruction of the wood components lignin and cellulose. The thermal destruction sets free more than thousand desirable or undesirable solid, liquid or gaseous components of wood.
These useful components contribute to the development of the following desirable effects on processed meat products:
Meat preservation through aldehydes, phenols and acids (anti-microbial effect)
Antioxidant impact through phenols and aldehydes (retarding fat oxidation)
Smoke flavour through phenols, carbonyls and others (smoky flavour)
Smoke color formation through carbonyls and aldehydes (attractive color)
Surface hardening of sausages/casings through aldehydes (in particular for more rigid structure of the casing)
The most known undesirable effect of smoking is the risk of residues of benzopyrene in smoked products which can be carcinogenic if the intake is in higher doses over long periods. The optimal temperature in "cold" smoking is 15 to 18 °C (up to 26 °C) and hot smoking is carried out at temperatures of +60 to 80 °C.
Smoke permeable casings can also be treated using a new technology, where a liquid smoke solution is applied on the surface. This can be done by dipping in solution, showering (outside chamber) or atomization (spraying inside chamber).

Healthier processed meat products: Quality evaluation

The effects of fat replacers on the properties of low-fat goat meat batter were evaluated. Results showed that the addition of fat replacer led to a significant ($P < 0.05$) decrease in the cooking losses (%) and shrinkage (%) with an increase ($P < 0.05$) in the emulsion stability of low-fat meat batter samples. The addition of fat replacer also led to an increase in the storage modulus and loss modulus values. Hardness, chewiness, and gumminess values were higher ($P< 0.05$) at 4% fat replacer level. Oxidative stability was higher ($P < 0.01$) in treated low-fat samples in comparison to the control samples. Microstructural (SEM) images revealed a more homogeneous structure in the treated samples.

Figure 14. Healthier meat products: Low-fat, High- fibre Meat Products.

Figure 15. Increase in the cooking yield of final product by using developed edible fat replacers.

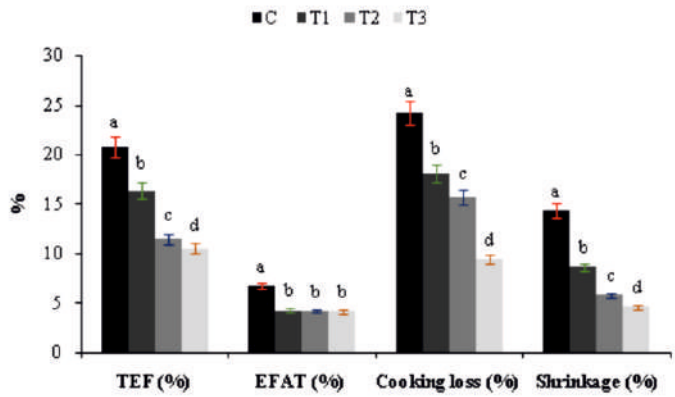

Figure 16. Emulsion stability attributes (TEF% and EFAT%), cooking loss, and shrinkage of goat meat batter formulated with fat replacers. Each data point is the average of triplicate samples. TEF: total expressible fluid, EFAT: expressible fat.

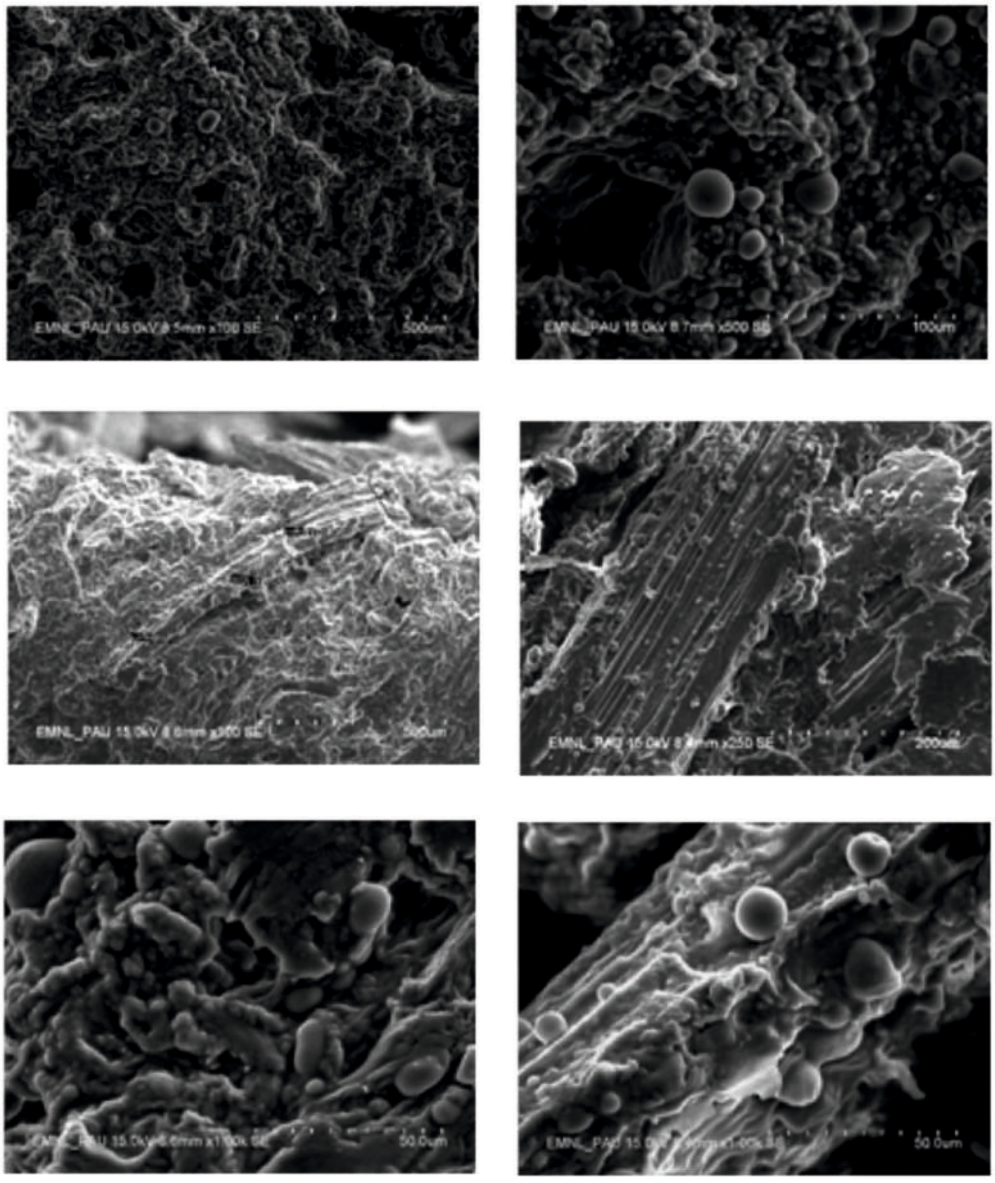

Figure 17. Scanning electron microscopic (SEM) images of low-fat, high-fibre meat product.

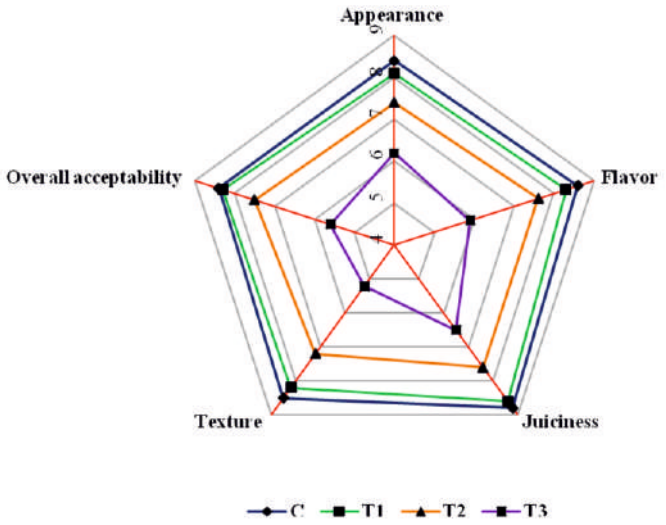

Figure 18. Sensory evaluation of low-fat, high-fibre meat product.

> **“The effects of fat replacers on proximate composition, pH, color, dynamic viscoelastic, textural, and oxidative properties of low-fat meat batter were also evaluated. The data will be shared during licensing of technology”**

Healthier processed meat products: Economics

Processing adds values to the raw produce and increases monetary returns (value addition). It is also established that the adoption of subsidiary enterprises is a key to increase the income of farmers significantly. This also creates an opportunity for farmers, livestock owners, and budding entrepreneurs. This also results in higher exports, earning of valuable foreign exchange and increase in the contribution of livestock sector in the national GDP.

There is now higher demand of healthier and functional meat products. These types of meat products are now preferred by the consumers in spite of their higher price due to their health claims.

Therefore, with the aim to harness the opportunity in global and domestic healthier and functional food market, the process for development of healthier meat product was standardized and the production cost was calculated so as to establish its economic viability.

Capital Investment

It is required for establishment of processing plant with all essential and permanent equipment for manufacturing of meat products. The details are provided in Table 1.

Table 1. Capital Investment

Particulars	Quantity	Rate (Rs.)	Cost (Rs.)
Refrigerator	2	25000.00	50000.00
Hot air oven	1	25000.00	25000.00
Meat mincer	1	40000.00	40000.00
Bowl chopper	1	200000.00	200000.00
Sealing machine	1	5000.00	5000.00
Stainless steel tables	1	4000.00	4000.00
Knife set	1	1000.00	1000.00
Moulds	10	50.00	500.00
Aluminium trays	10	100.00	1000.00
Total			**326500.00**

Table 2. Fixed Cost

Particulars	Rate (Rs.)	Amount (Rs.)
Rent of hall	180000 per annum	180000.00
Equipment depreciation		19590.00
Interest on capital (per cent)	12.00	39180.00
TFC/year		238777.00
TFC/month		19897.50
TFC/day		**654.16**

Fixed Cost

It is related to the cost of the rent of the halls used, depreciation values of the equipment, and interest on the capital investment. The details are provided in Table 2.

Variable cost

It includes the cost incurred on the variable components (raw material, electricity/water charge, packaging material etc.). The details will be provided during licensing of technology at ICAR-CIPHET, Ludhiana.

Total cost

Total cost of production was calculated by addition of fixed and variable cost.

Returns

Gross returns (total revenue) were calculated by multiplying the volume of output produced with its selling price. The selling price was assumed to be 480.00 for normal product and Rs 550.00 for healthier product (prime product). From the value of gross returns, the total cost of production (total fixed costs + total variable costs) was subtracted to arrive at an estimate of net profit/net returns.

Table 3. Total Cost (Rs.)

Particulars	Control	Healthier product
TFC/day	654.16	654.16
TVC/day	32000	36000
Total cost/day	**32654.16**	**36654.16**
TVC/kg (cooking yield taken into account)	393.42	411.84

Table 4. Return (Rs.) and B:C ratio

Particulars	Control	Healthier product
Product yield per cent	83	89
Sale price /kg	480.00	550.00
Gross return/day	**39840**	**48950**
Net returns/day	7185.84	12295.84
Net returns/kg (cooking yield taken into account)	86.57	138.15
B:C ratio	**1.22**	**1.34**

Technology Transfer EDP, and training

The process for development of healthier meat products (Low-fat meat emulsion and process for making the same) has been licensed to budding entrepreneurs. Entrepreneurship development programmes have also been conducted which were attended by many individuals including entrepreneurs, youth, farmers, and students.

The process/technology 'Low-fat Meat emulsion and process for making the same' has been transferred to M/S Thakur Poultry Forever G.T. Road Bye-Pass Phillaur, Jalandhar (Punjab).

The process/technology 'Low-fat Meat emulsion and process for making the same' has been transferred to M/S Khanna food products, Ludhiana (Punjab).

Entrepreneurship development programme on Meat processing and value addition at ICAR-CIPHET, Ludhiana attended by Mr Bhalla representative from M/S Meat Masters, a well known entrepreneur in this field.

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