

Training book 3

MEAT VALUE ADDITION

List of Modules

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Introduction:

Pakistan is an agrarian economy and livestock is vital part of this sector. Livestock sector not only ensures food security, increasing per capita income of small, landless and subsistence level of farmers, but also contributing to the GDP of the country. There is a huge potential in meat sector including meat production, processing and value addition. However there is a gap in skilled human resource in this sector. In an era of rapid change across global consumers, Pakistan's valuable meat production/processing/retail industries need skilled professionals who can apply knowledge and skills to meet the demands of consumers and solve complex industry problems.

Keeping in view the demand of the meat sector, this curriculum developed. The contents of this curriculum booklet will develop an in-depth understanding of various aspects of meat value addition, which introduces the course participants/trainees to key features of meat value addition and product processing. This booklet encompasses all stages of meat products processing including meat by-products & their processing, local beef products, processed meat theory, processed meat manufacturing, packaging of meat products and chilling and storage.

Background

The Government of Japan, in partnership with the Japan International Cooperation Agency (JICA), has indicated its interest to work together with UNIDO on an agri-business capacity building initiative to be implemented in two provinces of Pakistan, namely Khyber Pakhtunkhwa (K.P.) and Baluchistan. As a result of preliminary assessments and stakeholder consultations with the involvement of the Government of Pakistan and its relevant provincial bodies, the Project for Agri-food and Agro-industry Development Assistance in Pakistan (SAP ID: 180109) was finalized, aiming to pilot the enhancement of productive and compliance capacities of relevant actors in the cattle meat value chain in selected districts of K.P. (Peshawar, Abbottabad, Kohistan, and D.I. Khan) and apple value chain in Baluchistan (Killa Saifullah, Killa Abdullah, Pishin and Quetta).

The project will simultaneously support the relevant governmental bodies to offer adequate services to the industry sustainably and ensure the possibility of upscale best practices. The project is implemented in close cooperation with Livestock and Agriculture Departments in Khyber Pakhtunkhwa and Baluchistan and under the Ministry of National Food Security and Research's overall supervision. In particular, UNIDO will provide technical support to value chain actors to improve competitiveness by improving the quality and safety, and value of their products. This, in turn, can contribute to better marketability, higher profit, productivity, and access to high-end markets.

In this regard, a service agreement was signed between the Department of Meat Science and Technology, UVAS, Lahore and UNIDO for undertaking various cattle meat value chain related technical assistance in selected districts of Khyber Pakhtunkhwa, such as technical assessment of slaughterhouses, advisory support for related policy-making platform, research and capacity building training as part of the "Project on Agri-Food and Agro-Industry Development Assistance in Pakistan."

How the curriculum developed

This curriculum was developed as part of the "Project on Agri-Food and Agro-Industry Development Assistance in Pakistan" (PAFAID). And technically lead by the United Nations Industrial Development Organization (UNIDO). The task was completed by the curriculum development team at the Department of Meat Science and Technology, University of Veterinary and Animal Sciences, Lahore, Pakistan after detailed discussions/consultations between project partners i.e. Animal Husbandry In-Service Training Institute (AHITI) and KP Livestock and Dairy Development Department (L&DD).

Module: 01

Meat By-products & their Processing

Module: 01 Meat By-products & their Processing

Learning objectives

Through these modules, trainees will be able to understand about

1. Importance of by-products in the meat processing
2. blood coagulation and processing
3. fat processing
4. Bone processing
5. Tripe processing
6. Omasum processing
7. Economically important by-products

Enormous quantities of by-products are generated at each meat processing and distribution step. Yields of by-products vary greatly, depending upon the processing method and the weight, grade, sex, and animal species. For example, whether beef tallow is saved and processed for edible or inedible use markedly influences its price. The value of by-products is more significant when these products are processed immediately after slaughter. The greater the distance from the slaughtering plant or the longer the elapsed time after slaughter, the greater the probability of edible materials being degraded to inedible products. In the case of inedible materials such as fats, the grade may be lowered because of free fatty acid buildup and the development of rancidity.

By-products are divided into edible and inedible, although the distinction is not absolute. The bovine liver is a valuable edible by-product when passed as fit for human consumption, but when passed as fit for human consumption, it is inedible when affected with fascioliasis, although it can still be utilized in the pharmaceutical and pet food industries.

Edible By-products:

The yield from meat animals ranges from 20% to 30% of the live weight for beef and lamb. Biologically, most non-carcass material is edible, with appropriate cleaning, handling, or processing, but variable use is made throughout the world owing to custom, religion, palatability, and reputation of the product. The most commonly used organs for human consumption are the liver, heart, tongue, kidney, tripe, and areas free from BSE, sausage casings, sweetbreads, and brain.

Additional non-carcass material is usually separated into categories of decreasing value to provide sausage material and other edible by-products, e.g., fat; pet food; animal feed; and fertilizer.

The pet food industry utilizes many materials which are not suitable for human consumption and those which, although edible, have a low monetary value. The handling and storage should be as for products intended for human consumption, but there must be complete separation from edible material as some of the pet food products will not have passed veterinary inspection, e.g., bovine liver with fascioliasis could pose a potential risk.

Raw By-Products	Principal use
Brains	Variety meat
Heart	Variety meat

Kidneys	Variety meat
Liver	Variety meat
Spleen(melt)	Variety meat
Sweetbreads	Variety meat
Tongue	Variety meat
Oxtails	Soup stock
Cheek & head trimmings	Sausage ingredient
Beef extract	Soups & bouillion
Blood	Sausage component
Stomach	
a)suckling calves	Rennet for cheese making
b)beef(1 st and 2 nd)	Sausage container, sausage ingredient
	Sausage ingredient, variety meat (tripe)
Bones	Gelatin for confectioneries, ice cream, and jellied food products
Fats	
a)cattle, calves,	Shortening
	candies, chewing gum
	Shortening (lard)
Intestines, small	Sausage casings
Intestine, large	Sausage casings
Esophagus (weasand)	Sausage ingredient
Skins	Gelatin for confectioneries, ice cream, and jellied food products
Calfskin trimmings	Gelatin for confectioneries, ice cream, and jellied food products

In recent years there has been a decline in the general acceptance of variety meats. This may be due to the image held by some people that variety meats are foods for poor people who cannot afford steak. However, various ethnic groups have traditionally been large consumers of variety meats. Variety meats are also popular menu items in many of the finer restaurants. They could potentially become a pleasurable food source for large segments of the population who do not now eat them.

1. Blood coagulation:

Blood can be separated into several fractions that have therapeutic properties. Liquid plasma is the most significant fraction (63.0%). It consists of albumin (3.5%), globulin, and fibrinogen (4.0%). Many blood products are used in the laboratory as a nutrient for tissue culture media, as a necessary ingredient in blood agar, and as peptones for microbial use. Glycerophosphates, albumins, globulins, sphingomyelins, and catalase are also used for the biological assay. Many blood components are isolated for chemical or medical uses, such as fibrinogen, fibrinolysin, serotonin, kallikreins, immunoglobulins, and plasminogen. Purified bovine albumin is used to help replenish blood or fluid loss in animals. It tests the Rh factor in human beings and as a stabilizer for vaccines. It is also used in antibiotic sensitivity tests.

Blood also has industrial uses, as an adhesive and in the manufacture of paper, plywood, fiber, plastics, and glue. It is used in sprays, insecticides, fungicides, and cosmetics stabilizers. It is also used as a foaming agent in fire extinguishers.

In addition to its industrial uses, blood yields many pharmaceutical products. Purified bovine albumen is used as a reagent in testing for the presence of Rh factor in human blood, as a stabilizer for vaccine and other sensitive biological products, in antibiotic sensitivity tests, and in microbiological culture media. Blood is also a source of amino acids used in the intravenous feeding of hospital patients.

Approximately 4.5% of the live weight of an animal is collectible blood, which represents around 10% of the protein available in an animal. Dried blood is high in protein (80-90%) and rich in lysine and commands a reasonable price. Thus, efficient collection and processing would ensure that the slaughterhouse obtains a profitable return from blood. On the other hand, inefficient collection and processing are bound to present effluent disposal problems as blood causes an increase in BOD (biochemical oxygen demand), and its red color is highly recognizable as a highly polluting waste stream.

Animal blood consists of plasma and red cells (also called hemoglobin). The plasma usually is yellowish in color and constitutes up to 60% of the raw blood – and is a functional protein with commercial potential. The red blood cells are usually used for non-edible use but can also be dried into functional and flavour edible protein powder.

To be sold as high-value products, edible proteins in plasma powder or concentrated plasma must be processed with the utmost care. This means minimizing any air and water present and avoiding any shear effect that might rupture red blood cells and turn plasma red.

Blood collection:

The efficiency of blood collection depends on two factors; i) the length of time for bleeding ii) the manner in which the drained blood is collected.

Blood can be collected very easily by placing troughs below the carcass. These troughs should be designed to easily dry-cleaned with rubber squeegees. Ingress of water must be prevented. The sides of these troughs must be as high as possible to minimize splashing on the floors and walls. The troughs should be rinsed with as little water as possible at the end of the kill. After rinsing, the trough must be closed, and the outsides of the troughs should be hosed down, with the wash water being directed to the effluent collection system.



Blood from the sticking area can be either pumped or blown to the storage tanks. These tanks should be agitated to keep clots and contaminants in suspension, such as stomach ingesta, hair and wool. These contaminants are undesirable as they tend to clog the blood-processing system. Thus, it is good practice to screen blood before it enters the storage tank. The screenings should be recovered and sent to the rendering raw material bin.

If the slaughterhouse does not have a blood processing system on site, then blood has to be transported by tanker trucks to the blood-processing plant. The tanker must be designed for easy cleaning and quick loading and unloading. Also, thought must be given to the removal of large clots from the tanker.

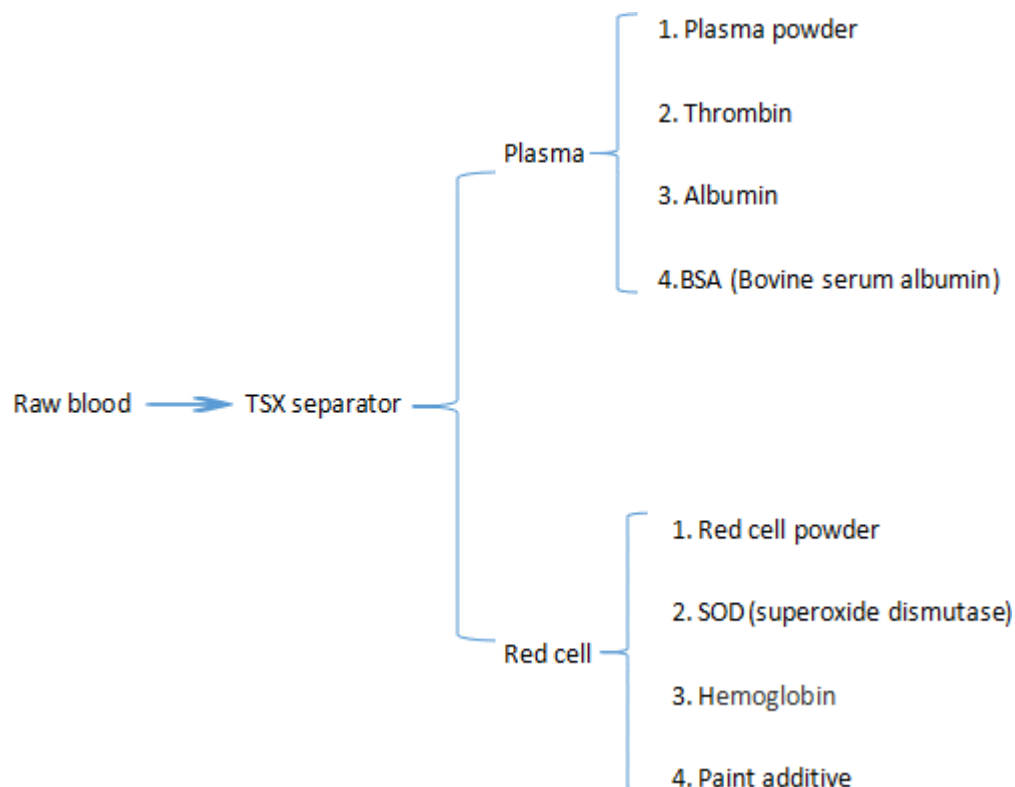
Blood Processing:

Blood processing aims to obtain a dry, stable product of a high nutritive value that is ground to even particle size and is free of contaminants, such as wool, hair, and ingesta. There are several alternative processes for producing dried blood.

1. Direct batch drying
2. Batch coagulation followed by batch drying
3. Continuous coagulation before drying
4. Pneumatic dryers
5. Direct-fired rotary dryers
6. Novel blood processing systems

Tubular Separator:

It is a high-speed centrifuge used in a variety of biological processes: from cellular harvesting up to the separation and purification of chemicals, food, blood, and even medicine.



The separation of the blood fractions is accomplished with a high-speed centrifuge or separator. After separation, the plasma is frozen or spray-dried at a low temperature to maintain its solubility and functional ability. To freeze blood plasma, it is typically placed on a vertical rotating drum with a temperature between -10 and -40 . The frozen plasma is scraped from the surface in the form of flakes. When blood is dried, great care must be taken to prevent denaturation of the protein since this lowers the quality of the dried fraction. Concentration is the first step in most plants' blood plasma drying process. This is generally accomplished by membrane filtration and evaporation. The drying of the concentrated plasma is finished by a spray system or a fluidized bed drying system. Dried blood plasma can be produced with a 96.4% protein content and a 2.4% moisture content.

2. Fats processing:

With the exception of the hide, the most important abattoir by-product is the fat trimmed from the intestines, kidney area, channel, and other internal organs of cattle. Fats are graded 1 edible fat and 2-6 inedible fat. The grades are dependent on free fatty acid (FFA) content and color. Grades 2-6 are used in animal feeds, soaps (mainly 2-4), and the chemical industry (predominately 6). The latter uses them in such diverse products as toothpaste, lubricating oils (where they can be used in two-stroke marine biodegradable fuel), plastic, cotton, and liquid washing detergents. More traditionally, they have been used in the dressing of leather and production of commercial glycerin, which itself is used in medicinal preparations, nitroglycerine, gun powder, cordite, and dynamite.

Rendering of Edible-fat:

High-quality fats have low FFA values. Efficient rendering processes ensure that the FFA content remains low by utilizing initial cold storage of the raw material where it is not immediately used, followed by keeping the processing temperatures as low as possible and the cooking times minimized. There are three main methods of processing edible fat: wet rendering, dry rendering, and continuous low-temperature rendering.

The wet rendering method involves the use of pressure batch cookers in which the pre-cut raw material is injected with a live steam to a temperature of 140°C under pressure, for 3-4 h. after this time, the pressure is slowly released, and the fat is run into a receiver and further purified by gravity or centrifugation to settle out the water and fines. The proteinaceous solids or greaves are emptied from the cooker, and the fat is removed by pressure and solvent extraction. They are then ground and dried.

The dry rendering process uses heat in the form of steam and water over a period of $1\frac{1}{2}$ h at atmospheric pressure to drive off water indirectly from the fat in the cooker. The rest of the process is the same as the wet rendering method.

The continuous low-temperature wet rendering system uses heating, separation, and cooling continuously and is usually regarded as the ideal process. The principle involves mincing the raw material; melting by live steam injection at 90°C; continuous separation of solids from the liquid fat in a decanter centrifuge; further heating; centrifugation to remove the fines; and cooling in a plate heat exchanger to below solidification point.

An important principle in the rendering of fat is the prevention of the breakdown of fat into fatty acids and glycerides by the action of the enzyme lipase, which is active at temperatures of 40-60°C. Above 60°C lipases is inactivated. The continuous low-temperature system utilizes this action and at the same time minimizes undesirable chemical activity, burning, oxidation, and off-flavors.

2.1 Tallows and Greases:

Inedible fats are classified as tallow or grease mainly based on their titer, which is the congealing or solidification point of the fatty acids in the fat. Any fat having titer above 40 °C is classes as tallow. Fat with a titer below 40⁰C is classed as grease. Most cattle and sheep fats are tallow.

Mainly, inedible fats are processed by the dry rendering process. The fatty tissues are ground and placed into a horizontal, steam-jacketed cylinder equipped with a set of internal rotating

blades. Rendering may be accomplished at atmospheric pressure, at elevated pressure, or under a partial vacuum. The fat cells are ruptured, and the melted fat is released from the supporting tissues. When sufficient moisture has cooked out, the mixture is filtered or strained to remove the cracklings from the rendered tallow or grease.

Many uses have been found for the products obtained from inedible tallows and greases. These fats can be split into glycerin and fatty acids by the action of acids or bases. Glycerin is used to manufacture pharmaceuticals, explosives, cosmetics, transparent wrapping materials, paints, and many other products. Likewise, fatty acids have many industrial uses, such as in the manufacture of soaps and detergents, wetting agents, insecticides, and herbicides, cutting oils, paints, lubricants, and even as an additive asphalt.

The mixed feed industry uses large quantities of stabilized inedible tallows and greases. Fats make feed stuffs less dusty, more palatable, and facilitate the pelleting process. They also add energy to the feed. Fats used in animal feeds are stabilized against rancidity by adding antioxidants, such as butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT), during the chilling that follows the rendering process.

3. Bones processing

The amount of bone available for processing depends on the type of operation being carried out, i.e., whether or not deboning is performed. If the abattoir is concerned solely with slaughter, the small amount of bone produced is usually consigned to an outside inedible rendering plant, mixed with other raw materials, such as fallen animals, condemned meat, and offal, and meat and fat trimmings.

The bone may be classified as 'edible' or 'inedible' depending on its source and handling. 'Edible' bone must be handled speedily in a hygienic manner. Today there is an increasing amount of 'edible' bone available because of the large amount of boneless meat produced at the source. The end-products of edible bone processing are fat, bone meal, and gelatin, with the meat-and-bone meal produced when there is meat in the original raw material.

Owing to its high calcium and phosphorous content, bone meal is used as a constituent of poultry feeds and fertilizer. Calcined bone, obtained by roasting in air, is used to manufacture high-class pottery and china, refining silver and copper smelting. Bone charcoal is utilized in bleaching, sugar refining, and case-hardening of compounds in steel manufacture. Special bone powders are employed for the removal of fluorine from drinking water.

Gelatin is produced from 'edible' bones after extracting fat and under carefully controlled pressure. It is used in making brawn, pies, ice cream, and capsules for medicines, in photography, as a culture medium for bacteria, and in the production of smokeless gunpowder. Some of the gelatin used for these purposes comes from veal and a smaller amount from beef.

Animal bone products have a wide variety, divided into two broad categories: extractive products and all-bone-using products.

1. All-bone-using Animal Bone Products

The all-bone-using product grinds the fresh animal bones into particles of different sizes and then processes the particle into special products based on manufacturing requirements. And the

major productions include bone paste and bone powder that can be an alternative to meats or nutrition additives to be added into meat-based products to improve their flavors.

1. Gelatin

Gelatin is a protein derived from collagen, a natural protein present in mammals' tendons, ligaments, and tissues. It is produced by boiling the connective tissues, bones, and skins of animals, usually cows and pigs. Gelatin's ability to form strong, transparent gels and flexible films that are easily digested, soluble in hot water, and capable of forming a positive binding action has made it a valuable commodity in food processing, pharmaceuticals, photography, and paper production.

As a foodstuff, gelatin is the basis for jellied desserts, used to preserve fruit and meat and make powdered milk, meringue, taffy, marshmallow, and fondant. It is also used to clarify beer and wine. Gelatin's industrial applications include medicine capsules, photographic plate coatings, and dyeing and tanning supplies.

Raw Materials

Animal bones, skins, and tissue are obtained from slaughterhouses. Gelatin processing plants are usually located nearby so that these animal by-products can be quickly processed.

Acids and alkalines such as caustic lime or sodium carbonate extract minerals and bacteria from the animal parts. They are either produced in the food processing plant or purchased from outside vendors.

Sweeteners, flavorings, and colorings are added in the preparation of food gelatin. These can be liquid or powdered and purchased from outside vendors.

The manufacturing process

Inspection and cutting

- When the animal parts arrive at the food processing plant, they are inspected for quality. Rotted parts are discarded. Then, the bones, tissues, and skins are loaded into chopping machines that cut the parts into small pieces of about 12.7cm in diameter.

Degreasing and roasting

- The animal parts are passed under high-pressure water sprays to wash away debris. They are then degreased by soaking them in hot water to reduce the fat content to about 2%. A conveyor belt moves the degreased bones and skins to an industrial dryer, where they are roasted for approximately 30 minutes at about 200° F (100° C).

Acid and alkaline treatment

- The animal parts are soaked in vats of lime or some other type of acid or alkali for approximately five days. This process removes most of the minerals and bacteria and facilitates the release of collagen. The acid wash is typically a 4% hydrochloric acid with a pH of less than 1.5. The alkaline wash is a potassium or sodium carbonate with a pH above 7.

Boiling

- 4 The pieces of bone, tissue, and skin are loaded into large aluminum extractors and boiled in distilled water. A tube running from the extractor allows workers to draw off the liquid containing gelatin. The liquid is sterilized by flash-heating it to about 375° F (140° C) for approximately four seconds.

Evaporating and grinding

- The liquid is piped through filters from the extractor to separate pieces of bone, tissue, or skin still attached. From the filters, the liquid is piped into evaporators, machines that separate the liquid from the solid gelatin. The liquid is piped out and discarded. The gelatin is passed through machines that press it into sheets. Depending on its final application, the gelatin sheets are passed through a grinder that reduces them to a fine powder.

Flavoring and coloring

- If the gelatin is to be used by the food industry, sweeteners, flavorings, and colorings may be added at this point. Pre-set amounts of these additives are thoroughly mixed into the powdered gelatin.

Packaging

- The packaging process is automated, with preset amounts of gelatin poured into overhead funnels through which the gelatin flows down into bags made of either polypropylene or multi-ply paper. The bags are then vacuumed sealed.

2. Bone Paste

Processing animal bones into a bone paste is an ideal and widely-adopted method to take advantage of animal bones that are preferred to be discarded in the first place. The research of using fresh animal bones to make edible bone paste dates from the 1970s, which first succeeds in Denmark, Sweden, etc., developed countries, then has a rapid spread in Japan, America, etc., and Japan especially has an outstanding achievement.

The bone paste is produced by an ultra-fine bone grinding machine, grinding the animal bone into particles sized by 200-400 mesh. The bone paste tastes as good as meat, but with more nutrients, like calcium, protein, fat, vitamin, collagen, chondroitin, and micro-elements. Also, the bone paste consists of the phospholipid and phosphoprotein for human brain need; the chondroitin ossein for supplementing body energy and delaying senescence. The bone paste can be employed as raw material to make bone paste cookies, high-calcium rice noodles, meatballs, meat stuffing, sausage, rice dumplings, and bone paste floss.

Bone paste production process

Fresh animal bones---bones pre-treatment---bones freezing---bones crushing---water adding--
-bones grinding

3. Bone Powder

The bone powder is high in calcium, calcium, phosphorus, iron, protein, micro-element, amino acid, etc. The ratio of calcium and phosphorus is 2:1, which is close to the ratio for human body

needs; the bone powder is an ideal product for calcium supplements. The edible superfine bone powder can be used as a food nutritive fortifier; the crude bone powder can be used as an additive for animal feed to help animal growing or can be used as efficient organic fertilizer to improve acid soil and promote crop growth.

The superfine bone powder is easy to be absorbed by the human body to make better use of its nutrition. The superfine bone powder is preferred for fast food, snack food, puffed food, catering food, health food, and seasoning, etc.

Crude bone powder production process

Fresh animal bones---bones degreasing---bones drying---bones crushing---finished bone powder

Edible superfine bone powder production process

Fresh animal bones---bones cleaning---bones dehydrating---bones crushing---crude bones grinding---fine bones grinding---bones degreasing---superfine bones grinding---cooling and packing---finished bone powder.

4. Tripe/omasum processing

The contents of the rumen/reticulum are generally emptied in the gut room, and the intestines are separated from the stomachs.

Tripe is produced from the first stomach (rumen, paunch) and second stomach (reticulum) of the ruminant. First, the stomachs are emptied and washed, and the fat is trimmed off. The rumen pillars (mountain chain) may be removed, trimmed, packaged, and frozen for consumption in Japan and other countries. The remaining material is cleaned in one 'Parmentier' and then



transferred to a second 'Parmentier' (which has a roughened interior) where the external fat is removed. A 'Parmentier' is a stainless steel drum that operates like a cylindrical washing machine. The stomachs are then scalded in water containing washing soda, scraped and placed in cold water to clean them, and finally cooked for $3-3\frac{1}{2}$ hours at a temperature of $49-60^{\circ}\text{C}$ in some countries, the omasum is made into tripes, in others, it is considered uneconomical

because of the difficulty of removing the mucous membrane. Rennet is manufactured from the abomasum of the calf.

After emptying and cleaning the tripe/omasum, it is salted usually in underdeveloped and developing countries where chilling facilities are not well established to ensure safety and for avoiding the purification and rancidity

After that, packaging and dispatch are performed to the destined countries primarily.



Module # 02
Local Beef Products

Module # 02 Local Beef Products

Learning Objectives:

- Trainees will learn about processing of making Chapli and Seekh Kabab
- Trainees will learn about processing of making burger patties and kofta

Chapli Kabab

Ingredients:

For 1.0 KG Beef Mince
Beef mince 1000 g
Tomatoes (chopped) 01 cup
Onion (chopped) 01 cup
Coriander leaves (chopped) 01 cup
Green chilies (chopped) 02 tbsp
Ginger garlic paste 102tbsp
Butter 04 tbsp
Eggs 02
Gram flour 04 tbsp
Coriander seeds powder 04 tbsp
Pomegranate seeds 02 tbsp
Red chili flakes 04 tbsp
Garam masala powder 05 tbsp
Salt 03 tbsp

Processing:

In a bowl, add beef mince, tomatoes, Onion, coriander leaves, green chilies, ginger-garlic paste, butter, egg, gram flour, coriander seed powder, pomegranate seed, red chili flakes, garam masala powder, and salt. Mix all these ingredients nicely and marinate this mixture for at least 1 to 2 hours.

Grease your hands and make thin circle shapes from mince. Cook on a hot plate for 4 to 5 minutes on each side.





Beef Seekh Kabab

Ingredients:

700g Beef mince
2 tbsp Coriander leaves chopped
2 tbsp green chili chopped
2 tbsp mint chopped
1 tsp Coriander seed powder
3 tbsp dry milk powder
1 tsp Cumin powder
2 tbsp Ginger garlic paste
3 tbsp gram flour
2 eggs (beaten)
1 tbsp Oil
1 tsp Salt
2 tsp red chili powder
½ cup onion chopped (compressed to remove water)
1 tsp Garam masala powder
1 tbsp lemon juice

Processing:

In a bowl, add beef mince, salt, red chili powder, coriander powder, cumin powder, garam masala powder, dry milk powder, eggs, ginger garlic paste, green chilies chopped, coriander and mint chopped, and Onion (water removed).

Mix all the ingredients well and keep them in the refrigerator for 30 minutes. Rub oil on hands, take a hand full ball of mixture and shape the Kebab on a skewer. Place the skewer on charcoal cook it on charcoal until fully tender.





Burger Patties

Ingredients:

700g Beef mince
1 cup Onion (chopped)
2 tbsp Ginger garlic paste
2 tbsp green chili (chopped)
2 tbsp Coriander (chopped)
2 tbsp Mint (chopped)
2 Eggs (beaten)
1/4 cup Breadcrumbs
2 tsp Salt
1 tbsp red chili powder
1 tsp Cumin powder
1 tsp Coriander powder
1 tbsp red Chili flakes
1 tsp Garam masala powder
Burger bun as required
Cheese slice as required
Salad leaves as required
Cucumber slices as required
Mayonnaise as required
Onion rings
Tomatoes sliced

Ingredients for sauce:

1 ½ cup Mayonnaise
1 tbsp mustard paste
2 tbsp Ketchup
2 tbsp tomato paste
2 tbsp Lemon juice
2 tbsp Ice burg (chopped)
3 tbsp Cucumber (chopped)

Processing: In a bowl, add beef mince, chopped Onion, ginger garlic paste, chopped green chilies, chopped coriander, chopped mint, eggs, breadcrumb, salt, red chili powder, red chili flakes, coriander seed powder, cumin seed powder, and garam masala powder.

Mix all the ingredients well and marinate for 1 hour. Make burger patties using a burger patty module and keep patties in the freezer for 30 minutes.

Processing of sauce: In a bowl, add mayonnaise, mustard paste, ketchup, tomato paste, lemon juice, chopped ice burg, and chopped cucumber.

Mix all the ingredients well, and your sauce is ready.

Assembling: Take beef patties and cook from both sides. Finally, add a cheese slice on top and remove it from the hot plate. Take burger buns and toast from both sides, on bun spread mayonnaise, onion ring, tomatoes, ice burg leaf, and cucumber. Place patty on top, drizzle some sauce, cover with bun, and your burger is ready.



Beef Kofta

Ingredients:

500g Beef mince
½ cup Onion (chopped)
1 tsp red chili powder
1 tsp Garam masala powder
1 tsp Cumin powder
1 tsp Salt
1 tsp Coriander seed powder
2 eggs beaten
3 tbsp gram flour
1 tbsp Ginger garlic paste
2 tsp green chili chopped
½ cup Coriander chopped
½ cup Mint chopped

Processing:

In a chopper, add beef mince, coriander, mint, cumin powder, green chilies, onion, red chili powder, garam masala, salt, gram flour, coriander seed powder, ginger/garlic paste, and blend well.

Apply oil on hands, take a hand full of the beef mixture and make balls.



Module # 03
Processed Meat Theory

Module # 03 Processed Meat Theory

Learning Objectives:

- Trainees will learn about processed meat theory and the classification of processed meat products
- Trainees will learn about processes like heating, curing, drying, aging, filling, and binding

1. Processed Meat

Processed meat is said to have originated in Europe. When there was no refrigeration facility, it was sprinkled with rock salt and pickled to preserve the pork slaughtered by farmers in their gardens from autumn to winter. Then, the nitrate contained in rock salt brought out the unique flavour of pork and made the meat colour vivid. It was a preserved food called 'pickled meat,' and its taste was unique to each household.

Processed beef products include roast beef, corned beef, smoked beef, and beef jerky. On the other hand, sausages are rarely made from beef alone and are mainly mixed with meat of other species. Beef fat has a high melting point due to its high content of saturated fatty acids such as stearic acid, and it is difficult to melt in the human mouth, resulting in a sloppy texture. Therefore, lard is used exclusively for the fat of sausage. If you do not eat pork, it is a good idea to choose beef fat with a low melting point as a raw material for sausages. As a result of the testing by the FMA, the surface fat of the primal cuts of Australian grain-fed beef was less sloppy than the kidney fat of Japanese Holstein cows, and the texture was also better.

2. Zoning

The processed meat production line is divided into a dirty zone and a clean zone. The raw materials, primal cuts of beef, are accepted in the dirty zone and stored in the chiller or the freezer. After unpacking the cardboard box, store the primal cuts in the clean zone. In the clean zone, the meat is trimmed, processed, packaged, labelled, and metal-inspected. The packaging work is performed called a 'clean room' and requires stricter hygiene management than other clean zones. The latter process from the boxing up to the shipping is done in the dirty zone. In other words, zoning is determined by the presence or absence of cardboard boxes. It is desirable to maintain positive pressure in the clean zone and negative pressure in the dirty zone, and workers' movement from the dirty zone to the clean zone is prohibited.

3. Classification of processed meat

According to the Food Sanitation Law of Japan, processed meat is classified into the following four types, mainly from the aspect of controlling microorganisms.

(1) Cooked processed meat

Those that heat the core temperature at 63 °C for 30 minutes or more or equivalent.

(2) Specified cooked processed meat

Those that heat the core temperature at 63 °C instantly or equivalently.

(3) Uncooked processed meat

Generally, they have a water activity of less than 0.95 and are unheated. However, further explanation will be omitted here because the definition is detailed and diverse.

(4) Dried processed meat

They are smoked and dried at the temperature of 50 °C or higher, or 20 °C or lower and have a water activity of less than 0.87.

4. Meat as Raw Materials

(1) Red meat

- ① A chunk of red meat that becomes one single processed product as it is; Fat is properly trimmed, and sinews are removed.
- ② Red meat that is a single processed product made by collecting several chunks of meat; Fat and sinews are removed.
- ③ Small pieces of meat for coarse grinding; Fat is properly trimmed, and sinews are removed.
- ④ Small pieces of meat for emulsions; Fat is removed, but sinews are not.

(2) Fat

- ① Fat with a low melting point; Subcutaneous fat can be used as a raw material for sausages.
- ② Fat with a high melting point; Kidney fat, etc. can be used for purposes other than sausages.

5. Auxiliary raw material

(1) Sheep intestine

Use the fascia part of the sheep's small intestine as a casing for sausages. Store in salt and rehydrate with water when using.

(2) Ice water

When making an emulsion, ice water is used as water, one of the raw materials. It is also used as ice for cooling the frictional heat of the silent cutter blades.

6. Food Materials and Additives

(1) Salt

Salt is used for the purpose of flavouring, improving water holding capacity and binding capacity, and reducing water activity to improve storage stability. For the raw material, 1.4 to 2.0% is added.

(2) Sugars

Sugars are used for the purpose of sweetening, alleviating saltiness, tenderising meat, reducing water activity, and improving storage stability. For the raw material, 0.4 to 0.8% is added.

(3) Spices

Spices are used for seasoning, flavouring, deodorising, and antiseptic purposes. Various spices are combined and for the raw material, 0.3 to 0.7% is added.

(4) Starter

Starter is used for uncooked salami sausages, etc. for the purpose of imparting lactic acid bacteria fermentation flavour and lowering pH to improve storage stability. For the raw material, 0.5% is added.

(5) Sodium nitrite

Sodium nitrite is used for the purpose of developing cured meat colour, cultivating cured meat flavour, and improving storage stability. In particular, it is the only substance that suppresses *Clostridium botulinum*. The Japanese Food Sanitation Law permits the use of sodium nitrite, potassium nitrite, and sodium nitrate. However, the residual amount of nitrite in the product is legally regulated to be 70 ppm or less as nitrogen dioxide. For the raw material, 100 to 200 ppm is added.

(6) Antioxidant

Usually, sodium L-ascorbic acid is used, and it works to suppress discolouration and lipid oxidation, and help colour development. Add 0.1% to the raw material.

(7) Phosphate

Phosphate is used for the purpose of improving water holding capacity and binding capacity, and stabilising the meat colour. Add 0.3 to 0.4% to the raw material. It is used by mixing sodium polyphosphate, sodium metaphosphate, disodium dihydrogen pyrophosphate, and tetrasodium pyrophosphate.

(8) Seasoning

A seasoning refers to umami flavour seasonings such as monosodium L-glutamate. It is used to bring out the synergistic effect of umami flavour. Add 0.1 % to the raw material.

7. Materials

(1) Smoke chip

Smoke chip is used for the purpose of improving storage stability, suppressing lipid oxidation, imparting flavour, imparting smoke colour, and stabilising meat colour. Hardwoods such as cherry, oak, beech, and hickory are used.

(2) Casing

Casing can be divided into two types: natural casing such as sheep intestine and artificial casing. Of these, the natural casing has excellent breathability and elasticity, adheres well to meat, and has a crispy texture. Artificial casings are divided into breathable and non-breathable ones. They are also divided into edible collagen casings and non-edible cellulose casings.

A breathable, non-edible casing is the fibrous casing. It is sturdy, breathable, and allows smoke to pass through well. It is used to keep the diameter of processed meat constant.

8. Packaging Materials

(1) Purpose

The purpose of packaging is to prevent oxidation and dryness, maintain meat colour, prevent secondary pollution, prevent foreign objects from adhering, prevent odour from adhering, prevent the diffusion of flavour components, and for designing and labelling.

(2) Function

The functions of the film include gas barrier property, moisture resistance, light shielding property, impact resistance, cold resistance, moldability, heat shrinkage, oil resistance, heat adhesion, etc., and are made by combining materials so as to have these functions.

(3) Packaging method

Packaging methods include vacuum packaging, thermoforming packaging, skin packaging, and gas replacement packaging.

9. Machines

(1) Mincer

A mincer is a meat grinding machine, and you can roughly and finely grind with plates of 8 mm, 5 mm, 3 mm, etc. There are also devices that can eliminate cartilage.



(2) Mixer

A mixer mixes minced meat and dough with curing agents and spices to add stickiness to the minced meat.



(3) Silent cutter

A silent cutter creates an emulsion by slowly rotating the bowl and rotating the 6-blade at high speed (4,800 to 6,000 rpm). If you rotate the 6-blade at low speed, you can also shred and mix.



(4) Stuffer

A stuffer fills a casing such as sheep intestine with meat paste. Some of them can perform a series of operations at high speed, such as quantity filling, twisting, and rod hanging.



(5) Pickle injector

A pickle injector injects a pickling liquid in which a curing agent is dissolved in water into meat.

(6) Tumbler

A tumbler promotes curing by letting the injected pickle blend into the meat in a vacuum and keeping it on the meat to prevent it from leaking out.

(7) Smoke house

A smoke house is a chamber that automatically performs a series of heating processes of maturing, drying, smoking, and boiling. You can also make uncooked processed meat by cold smoking with air conditioning.



(8) Boiling tank

A boiling tank is used only for boiling process, secondary sterilisation, vacuum cooking, etc.

(9) Drum cutter

A drum cutter cuts the cooked and cooled wiener sausages that are still connected one by one.

(10) Automatic scale (Computer scale)

An automatic scale is a machine that quantitatively measures wiener sausages.

(11) Vacuum packaging machine

A vacuum packaging machine packs processed meat in a bag and vacuum-packs them. We also have packaging machines for thermoforming packaging, skin pack vacuum packaging, and gas replacement packaging.

(12) Vertical pillow packaging machine

A vertical pillow packaging machine wraps wiener sausages while making the wrapping film into a bag. It is usually located under an automatic scale, weighs, and packages, and also fills with nitrogen gas.

(13) Metal detector

A metal detector detects metallic foreign objects. The metal detectors on the processed meat production line are more accurate than those on the primal cuts production line, so the detection frequency is not low. Especially, it reacts with burrs and rust on the carcass rails.

(14) X-ray foreign object locator

An X-ray foreign object locator detects hard bones and plastic pieces. However, please note that cartilage cannot be detected.

(15) Weighing & label issuing machine

A weighing and label issuing machine weighs products and issues labels. Some have subtotal and total calculation functions. It is also possible to issue only the labels of the fixed weight products.

10. Basic Production Process

(1) Cooked processed meat (single meat chunks)

© Raw material trimming

After removing residual hair, cartilage, blood clots, etc., the fat is trimmed, and the red meat is shaped. We should do it while imagining the shape of the end products.

② Curing

The purpose of curing is to season, develop colour, cured meat flavour, improve storage stability, and improve water holding capacity and binding capacity.

A. Dry curing method

This is a method of rubbing the curing agent directly into the meat. The curing agent is a mixture of salt, sugars, spices, sodium nitrite, antioxidants, phosphates, and seasonings. Curing the meat in a refrigerator at 5 °C for 1 to 2 weeks will bring out the original rich cured flavour of the meat. It is essential to add sodium nitrite to the curing agent.

B. Pickle curing method

This is a method of soaking meat in a pickling solution in which a curing agent is dissolved in water.

C. Pickle injecting method

Use a needle to inject the pickling fluid into the meat. Usually, a pickle injector and a tumbler are used, and it can be cured faster than the above methods of A and B.

© Filling, ligation, and rod hanging

The cured meat is washed with water, and after the final trimming, the red meat is shaped, filled in a fibrous casing, etc., and ligated. It is important to make the diameter of the meat uniform so that there is no uneven heating. For unfilled products such as bacon, even out the thickness of the meat. It may be wrapped in cooking paper and placed in the retainer. Then, hang it on a rod or place it on a wire mesh and store it in a trolley.

③ Cooking

The purpose of cooking is to eliminate free water, add smoked flavour, stabilise cured meat colour (colour development), improve storage stability, suppress lipid oxidation, coagulate proteins, generate aroma components, and sterilise (core temperature: 63 °C for 30 minutes or more).

Put the smoke trolley with the semi-processed product in the smoke house and pierce the semi-processed product with the central thermometer to heat it. In order to remove the moisture in the meat from the centre, the temperature is gradually raised from a low temperature. If you

raise the temperature all at once, the proteins on the surface will coagulate and moisture will remain in the meat. In the case of smoking, the meat needs to have a moderately dry surface, so make sure it is dry before doing so. If the surface is not dry, the smoke will not penetrate or smoke unevenness will occur. On the contrary, if the surface is too dry, it will be made darker. Therefore, while conducting a storage test, we will search for the best heating conditions at a core temperature of 63 °C for 30 minutes or more. The heating process corresponds to CCP of HACCP.

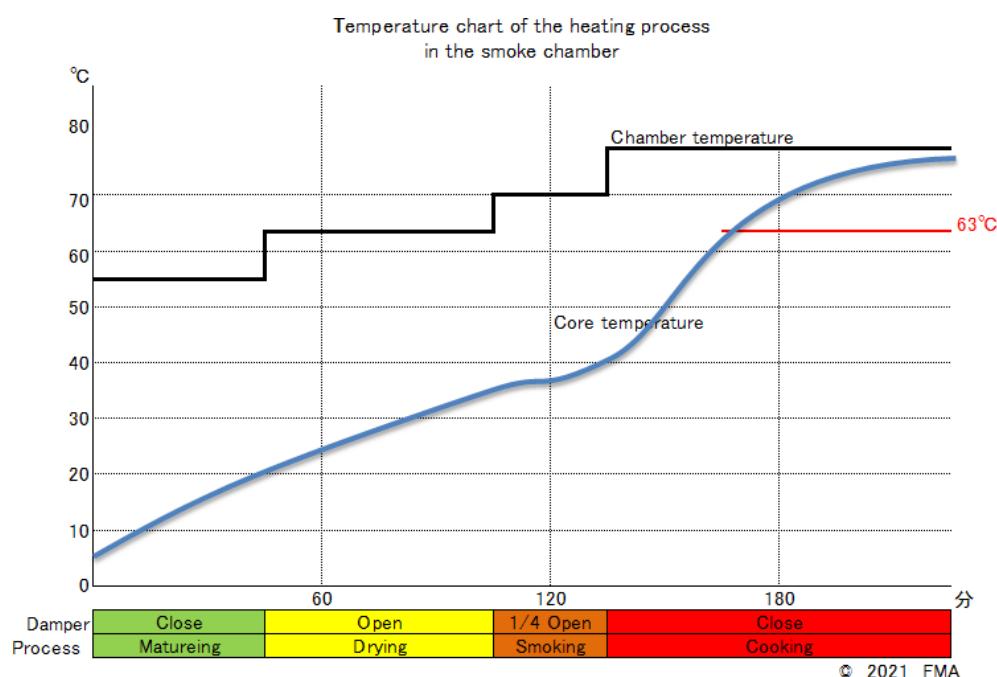
The following is an example of the heating process and an image of the temperature rise.

- i. Maturing: 55 °C 45 min.
- ii. Drying: 65 °C 60 min.
- iii. Smoking: 70 °C 30 min.
- iv. Cooking: 78 °C, core temperature up to 75

Cooked processed meat

63 °C 30 minutes and equivalent

Core temperature (°C)	Minutes	Core temperature (°C)
60	129	
61	8	
62		
6		



⑤Cooling

The purpose of cooling is to evaporate excess moisture and suppress the growth of microorganisms (spore-forming bacteria). If necessary, remove the rough heat on the surface by showering or drying at room temperature, and then immediately cool it in the refrigerator overnight.

⑥Packaging

No further packaging is required for post-packaging heating. In the case of packaging after heating, peel off the filled fibrous casing, etc., and cut and slice as necessary for packaging.

⑦Inspection

In addition to visual inspection, we also inspect with metal detectors and X-ray foreign object locators. Please refer to 'Retail cutter curriculum' for further inspection methods.

⑧Weighing and labelling

Finally, weigh and display. The required display items in Japan are as follows.

- i Classification of processed meat
- ii Product name and form (such as leg ham, slice)
- iii Ingredients (also the origin of raw materials, for each food material, food additive, and allergy)
- iv Net weight
- v Best-before date
- vi Storage method
- vii Manufacturer
- viii Nutrition standards (such as energy, protein, etc.)

(2) Cooked processed meat (non-single meat chunks)

①Raw material sorting

Raw material trimming is the same as in the case of a single meat chunk, and in addition, the sorting work described in "4. Raw Meat" is necessary. In the case of sausages, the basic composition is 50% of red meat, 30% of fat, and 20% of ice water, and the raw materials are sorted according to the lean rate.

②Curing, meat grinding, and mixing

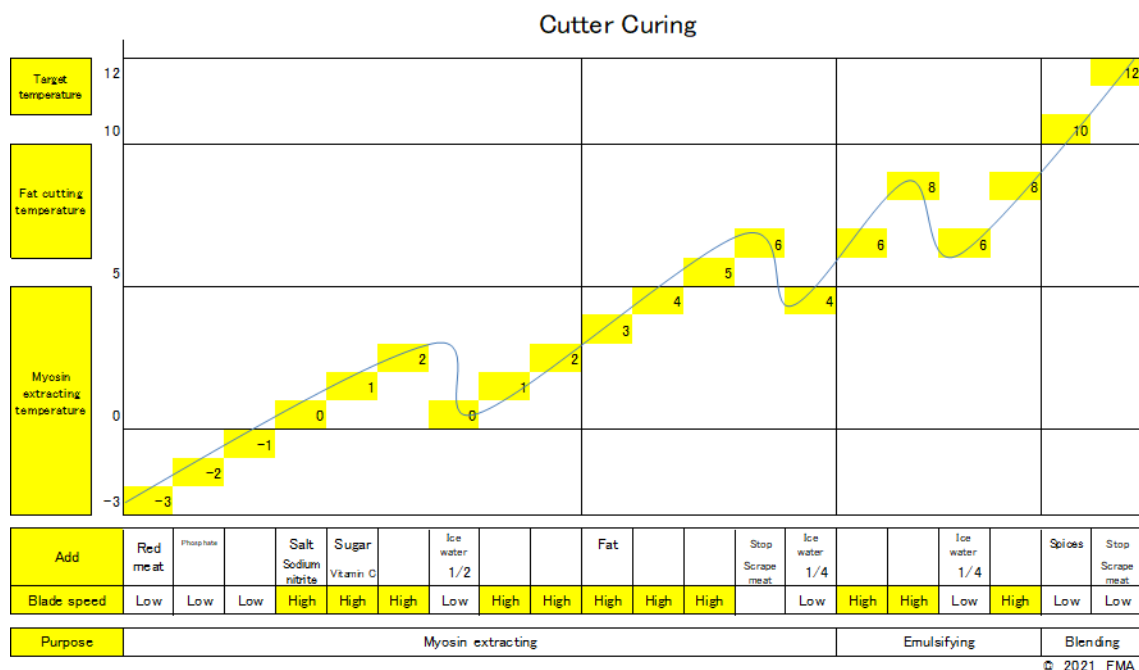
At this stage, meat grinding and mixing work is added. When the mincer plate has a mesh size of 5 mm or larger, it is called coarse grinding. When it is smaller than that, it is called fine grinding. By mixing at a low temperature with a mixer, myosin (salt-soluble protein) is extracted and the binding capacity is brought out. This gives a crispy texture when eating sausages.

③Emulsion formation

When making fine grinds, use a silent cutter to form an emulsion by cutting at high speed.

④Cutter curing

Cutter curing is the process of dice-cut raw meat from curing to emulsion formation at once. At this time, the raw meat is cut at the lowest possible temperature to extract myosin and form a good emulsion. Carefully control the temperature of meat where the final temperature is kept between 10 and 12 °C, by paying attention to the order of input of red meat, curing agent, ice water, fat, etc. The emulsion will cause fat separation if this is neglected and cannot be commercialised. The image of cutter curing is as follows.



⑤Filling, ligation, rod hanging, and washing with water

When using sheep intestines for the casing, soak the salted sheep intestines in water the night before. Pour the meat paste into the stuffer, being careful not to let air get in.

The following items are the same as in the case of a single meat chunk.

⑥Cooking, ③Cooling, ⑧Packaging, ⑨Inspection, ⑩Weighing, and labeling

The following is an example of the heating process and an image of the temperature rise.

- i. Maturing: 55 °C, 20 min.
- ii. Drying: 65 °C, 30 min.
- iii. Smoking: 70 °C, 20 min.
- iv. Cooking: 75 °C, 30 min.

(3) Specific cooked processed meat

① Cooking

The difference from cooked, processed meat is that the final core temperature is lower, and the condition is the core temperature needs to be heated at 63 °C instantly. Due to the temperature difference, roast beef etc is tender and the meat colour is slightly pink. Since delicate temperature control is required, the vacuum cooking method with a more stable temperature is usually performed. For the raw meat, therefore, after seasoned, the surface is baked to add a roasted flavour, vacuum-packed, and placed in a constant temperature tank (boiled tank) with a hot water temperature of 55 °C to 65 °C to cook. However, since the core temperature from 35 °C to 52 °C should not exceed 170 minutes, pay close attention to the relationship between the diameter of the meat and the temperature of the hot water.

Specific cooked processed meat

63°C for an instant and equivalent

Core temperature (°C)	Minutes	Core temperature (°C)	Minutes
55	97	60	12
56	64	61	9
57	43	62	6
58	28	63	0
59	19		

*Core temperature from 35°C to 52°C should not exceed 170 minutes

©Cooling

Cooling is also very important, and the meat is cooled by immersing it in ice water immediately after heating is completed.

©Packaging

In order to extend the shelf life, it is better to commercialise the product in vacuum packaging before cooking.

(4) Uncooked processed meat (single meat chunks)

©Curing

Add 200 ppm or more sodium nitrite, 6% or more of salt, and 0.5% of starter for the raw material meat, and cure it for 3 weeks or more.

©Smoking

If necessary, smoke the cured meat at between 8 and 14 °C and 70% humidity for 24 hours.

©Drying

Dry at 18 °C and 68 % of humidity for about 4 months.

④Completion

Finish with a water activity of less than A_w 0.95 and 70–80% of yield.

(5) Uncooked processed meat (non-single meat chunks)

©Meat grinding, mixing, and curing

Grind the raw material meat with a mincer or shred it with a silent cutter. Then, add 200 ppm or more of sodium nitrite, 3.3% or more of salt, and 0.5% of starter for the raw material meat, and cure it for 24 hours. The remaining curing process is performed during the drying period as stated at ④.

©Filling

Fill the cured meat into a 50 mm or a 24 mm fibrous casing.

©Smoking

If necessary, smoke the cured meat at between 8 and 14 °C and 70% of humidity for 24 hours.

④Drying

The 50 mm one is dried at 18° C and 70% of humidity at the beginning and gradually down to 68% for about 6 weeks, and the 24 mm one is dried for about 3 weeks.

⑤Completion

Finish with water activity of less than Aw 0.91, pH 5.0, and 70% of yield.

(6) Dried processed meat

©Meat grinding, mixing, and curing

Grind the raw material meat with a mincer or shred it with a silent cutter. Then, add 200 ppm or more of sodium nitrite, 3.3% or more of salt, and 0.5% of starter for the raw material meat, and cure it for 24 hours. The remaining curing process is performed during the drying period as stated at ④.

©Filling

Fill the cured meat into a 24 mm fibrous casing.

©Smoking

If necessary, smoke the cured meat at between 8 and 14 ° C and 70% of humidity for 24 hours.

④Drying

Dry at 18 ° C and 70% of humidity at the beginning and gradually down to 68% for about 7 weeks.

⑤Completion

Finish with water activity of less than Aw 0.87 and 60% of yield.

11. Test

(1) Significance of hygiene target bacteria

The significance of hygiene target bacteria is shown in the table below.

Meaning of hygiene target bacteria

Target bacteria	Meaning
Coliform	Proper cooking
E.coli	Cross contamination before and after cooking
Clostridium	Proper cooling after cooking
Staphylococcus aureus	Cross contamination of workers
Salmonella	Hygiene standard of raw material
Listeria monocytogenes	Proper process control

(2) Individual standard

The following table shows the individual standard for processed meat under the Japanese Food Sanitation Law.

Module # 04 Processed Meat Manufacturing

Learning Objectives:

- Trainees will learn about processing of making sausages, beef jerky, corned beef
- Trainees will learn about processing of making cooked beef, raw beef and salami

1. Smoked Beef

(1) Raw materials

- ① Beef 100%
- ② Pickle 50% (for the beef)
- ③ Pickle concentration (for pickle)

Salt 6.5%

Sugar 3.0%

Sodium nitrite 0.06%

Sodium L-ascorbate 0.6%

Phosphate 0.9%

Water 88.94% (15% of the water is infusion.)

Total 100%



④ Infusion

Juniper berry - appropriate amount

Clove - appropriate amount

Laurel - appropriate amount

Garlic - appropriate amount



(2) Process

① Making infusion and cooling

Boil spices and herbs in a pot to make infusion and cool it.

② Raw material shaping

Trim and shape the beef into a cylindrical shape. You can leave some fat in the meat but remove sinews.

③ Pickle creation

Make a pickle that weighs 50% of the beef.

About 15% of water comprises the cooled infusion.

Dissolve in water in order from the most insoluble phosphate among the additives.

The concept of additive concentration is as follows, taking salt as an example.

Salt = pickle x concentration = 50% x 6.5% = 3.25%

Overall = beef + pickle = 100% + 50% = 150%

Total salt concentration = salt ÷ total = 3.25% ÷ 150% = 2.1667%

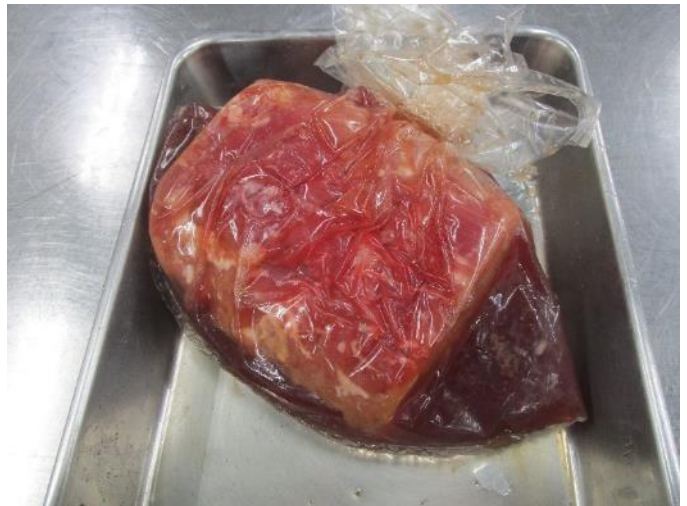
In other words, the amount of salt added needs to be calculated assuming that the total concentration of salt (in pickle and beef) is equal.

④Curing

Pickle curing method is used for curing. It is important to keep the beef out of the open air.

⑤Filling

Fill a fibrous casing with the cured meat to make the diameter uniform. You may wind the thread around.



⑥Cooking

Put the filled and cured meat on a rod, hang it on a trolley, and shower to wash the surface. Then, put the trolley into the smoke house, pierce the thickest one with the centre thermometer, and record it together with the inner temperature of the chamber on a temperature chart paper

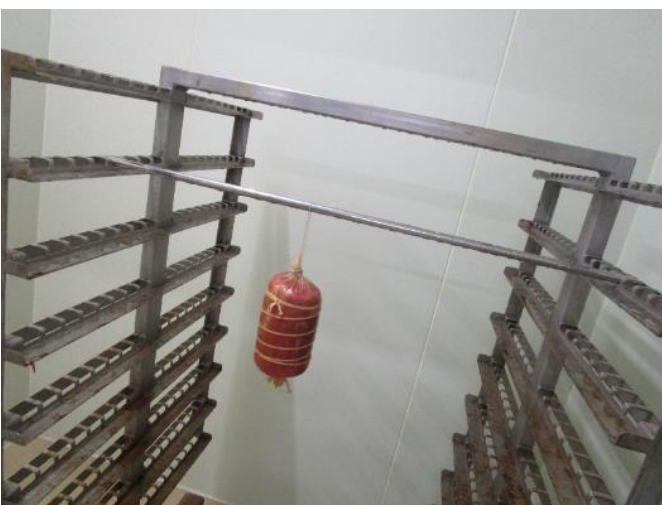
for automatic recording. It is cooked in the following process. However, the degree of drying and smoking will differ depending on the humidity and the amount of input on the day, so adjust the time while observing the situation. When the core temperature reaches 70 °C and is kept for 1 minute, the heating should be finished, and the surplus heat needs to be lowered with a shower. From the viewpoint of HACCP, pierce with another handheld centre thermometer before showering to check and record 70 °C for 1 minute. Do not touch the semi-finished product with bare hands after heating until the packing is completed.

- i Maturing 55 °C, for 45 min.
- ii Drying 65 °C, for 60 min.
- iii Smoking 70 °C, for 30 min.
- iv Cooking 75 °C, Core temperature up to 70 °C

⑦Cooling and later process

Refer to the cooked processed meat of Module#3.

*Please note that smoked tongue can be produced in the same process when beef tongue is used instead of regular beef.



2. Corned Beef

(1) Raw materials

① Beef

② Curing agent(for the beef)

Salt 2.6%

Sodium nitrite 0.01%

Sodium L-ascorbate 0.1%

③ Herbs when boiling

Celery - appropriate amount

Laurel - appropriate amount

④ Spices when mixing

White pepper 0.2%

Onion 0.3%

In addition to these, use 50% of boiled celery and laurel stock.



(2) Process

① Raw material trimming

Cut the raw material meat into cubes of about 5 cm. You can leave both fat and sinews.

② Curing

Cure the meat for 2-3 days using the dry curing method.

③ Boiling

Add celery and laurel and cook (boil) at 85 °C. When the cured meat is soft enough to loosen, it is finished. Do not throw away the boiled stock at this time as it is used in the later process. In addition, the subsequent process is also performed while the cured meat is still warm.

④ Loosening

Loosen the cured meat so as to leave as much muscle fibre as possible. It can also be loosened by rotating a silent cutter at low speed.

⑤ Mixing

Add 20% of boiled stock to the loosened meat and spices and mix them.



⑥ Filling

Fill a non-breathable casing with the mixed meat and tie it tight.

⑦ Cooking

Cook(Boil) it at 75 °C, and finish when the core temperature reaches 70 °C.

⑧ Cooling

Cooling is extremely important for controlling spore-forming bacteria, and it is quickly cooled with ice water.

⑨ Packaging

It can be commercialised that way as it is filled in a non-breathable casing before cooking. It is classified as a cooked processed meat (cooked after packing).



3. Roast Beef

Roast beef is generally cooked in an oven in restaurants and the like. That is fine as a dish to serve on the spot, but vacuum cooking is the most suitable when individually packing and

distributing roast beef of stable quality requires delicate temperature control. Here, we will explain how to produce roast beef by vacuum cooking.

(1) Raw materials

① Beef

② Seasonings

Salt - appropriate amount

Black pepper - appropriate amount

Nutmeg - appropriate amount



(2) Process

① Raw material shaping

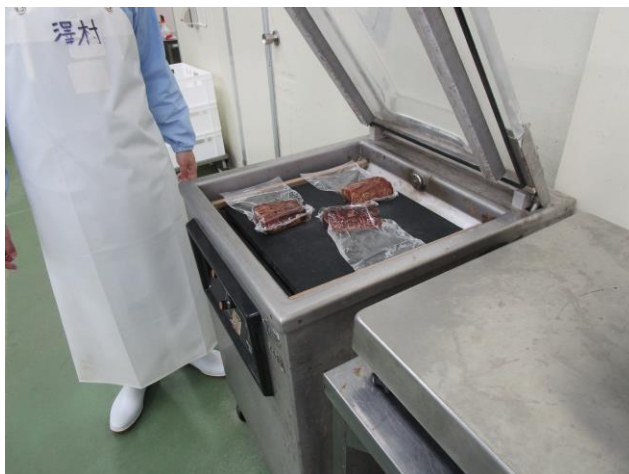
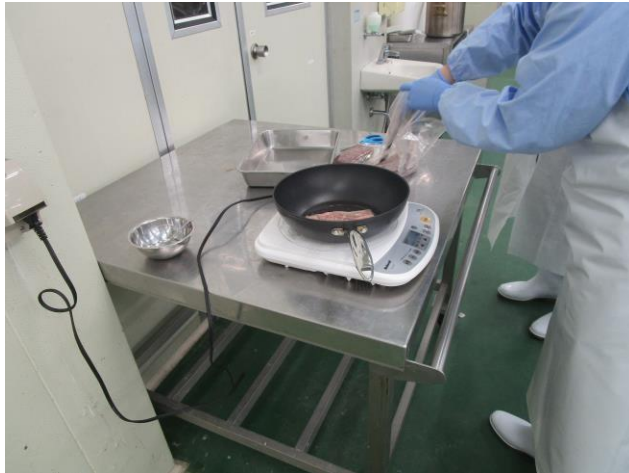
Trim and shape the beef into a rectangular parallelepiped form and cut it into chunks. You can leave some fat but remove the sinews. Pay attention to the thickness of the beef so that the heat is quickly transferred to the centre when you boil it in hot water (approximately within 5 cm in thickness).

② Sprinkle with seasonings

Sprinkle an appropriate amount of salt and spices on the surface of the beef and let it absorb them.

③ Baking the surface

The surface of the beef is baked to give it a brown colour, and the Maillard reaction (amino-carbonyl reaction) gives it a savoury baked flavour.



④ Vacuum packaging

Immediately vacuum-pack the surface-baked beef.

⑤ Putting in hot water

Heat in a constant temperature tank (boiling tank) with a hot water temperature of 63 to 65 °C. However, care should be taken to pass the core temperature between 35 and 52 °C within 170 minutes. It ends when the core temperature reaches 63 °C instantaneously or equivalent (already described). Refer to the specific cooked processed meat of Module#3.

⑥ Cooling

Immediately cool with ice water.

⑨ Packaging

It can be commercialised that way as it is vacuum-packed before cooking. If you are concerned about the drip inside the vacuum pack, open it, wipe off the drip, and then vacuum-pack it again.



4. Beef Jerky

(1) Raw materials

① Beef

② Curing agent(for the beef)

Salt	1.6%
Sodium nitrite	0.01%
Sodium L-ascorbate	0.1%
White pepper	0.3%
Garlic	0.1%
Ginger	0.05%
Chili powder	0.05%
Water	10.0%

(2) Process

① Raw material trimming

Trim the beef. You can leave some fat but remove the sinews.



② Slicing

Slice the meat to the thickness of 5 mm parallel to the muscle fibre

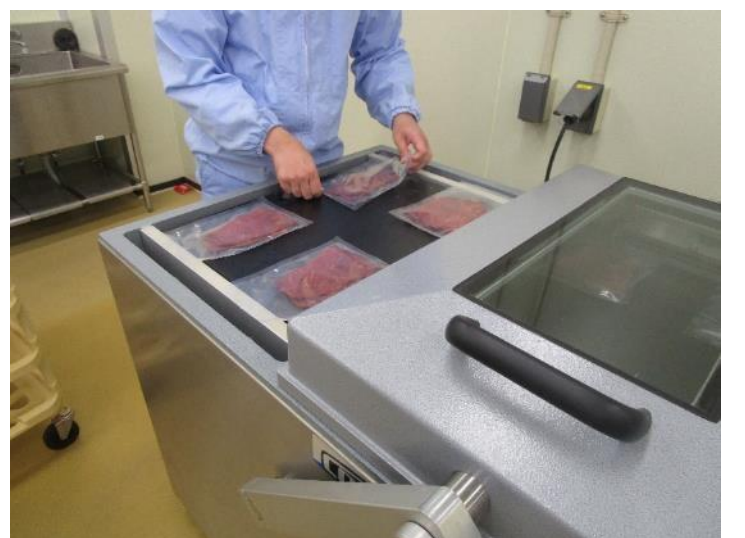
③ Curing

Dissolve the curing agent in water and cure it for 24 hours using the pickle curing method.

④ Putting on the mesh

Place a specialised cooking paper on the mesh and place the cured and sliced meat on it. Put the mesh on the trolley; and put it in the smoke house.

⑤ Cooking



A core temperature of 63 °C for 30 minutes or more as a cooked processed meat can be achieved by drying at 80 °C for about 1 hour, but it depends on the thickness of the slice. For dried processed meat, dry up to a water activity of less than A_w 0.87.

⑥ Cooling

Immediately cool in the refrigerator.

⑦ Packaging

Cut the beef jerky into pieces with scissors to shape and pack it. If it is commercialised as cooked processed meat, it will be vacuum-packed and refrigerated. If it is commercialised as dried processed meat, it can be stored at room temperature in aerated packing.

5. Salami (Cooked processed meat)

(1) Raw materials

- ① A: Beef 50%
- B: Beef fat 30% (subcutaneous fat with low melting point)
- C: Beef (for binder) 20%
- Total: 100%

② Curing agent(for the total)

Salt	1.7% (3.3% or more when uncooked)
Sugar	1.0%
Sodium nitrite	0.01% (0.02% or more when uncooked)
Sodium L-ascorbate	0.1%
Phosphate	0.4% (0% when uncooked and 0.5% of starter instead)
Black pepper	0.2%
White pepper	0.2%
Onion	0.3%
Garlic	0.1%

(2) Process

① Raw material processing

Raw material A: Both fat and sinews are removed. Cut into strips, put them in a bag, freeze them flat, and then split them by hand.

Raw material B: Cut into strips, put them in a bag, freeze them flat, and split them by hand.

Raw material C: Fat is trimmed, but sinews are not removed. It can be an end material. Grind with a 3 mm plate of a mincer.

The reason why A and B are frozen is to emphasise the graininess that is typical of salami.



② Cutting

Set the silent cutter with 3 blades, cut C at high speed until it becomes fine, and take it out. Then, cut A and B into 3 to 5 mm cubes at low speed. On top of them, put the C that was cut first, and the curing agent, and mix them all together at low speed.



③ Filling

Fill the fibrous casing with the cut and mixed materials, tie it tightly, hang it on a rod, hang it on a trolley, and shower it to wash the surface.



④ Cooking and later process

Same as smoked beef. For uncooked processed meat and dried processed meat, dry at the above-stated temperature and humidity conditions in the Module #3.

6. Coarsely Ground Sausage

(1) Raw materials

- ① A: Beef 60%
- B: Beef fat 20% (subcutaneous fat with low melting point)
- C: Cold water 20%
- Total: 100%

② Curing agent(for the total)

- Salt 1.4%
- Sugar 0.5%
- Sodium nitrite 0.01%
- Sodium L-ascorbate 0.1%
- Phosphate 0.4%
- White pepper 0.2%
- Onion 0.5%

(2) Process

① Raw material processing

Both fat and sinews of the raw material A are removed. Raw materials A and B are diced. Both A and B are ground with a 5 mm plate of a mincer.

② Kneading

Add C and curing agent to the ground A and B, and knead well with a mixer. By kneading at low temperature, myosin is extracted, and the binding capacity is drawn out.

③ Filling, ligation, rod hanging, and washing with water

Fill the sheep small intestine with the kneaded meat, ligate it, hang it on a rod, hang it on a trolley, and shower it with water to wash the surface.

④ Cooking

An example of the heating process is as follows. Since the sheep small intestine is thin, unlike a single meat chunk, the centre thermometer cannot pierce it, so it is not controlled by the core temperature but is managed by time. After cooking, the surplus heat needs to be lowered with a shower.

- i Maturing 55 °C, for 20 min.
- ii Drying 65 °C, for 30 min.
- iii Smoking 70 °C, for 20 min.
- iv Cooking 75 °C, for 30 min.

③ Filling, ligation, rod hanging, and washing with water





④ Cooking

It is cooled in the refrigerator, but it can be packaged if it is cold enough without cooling overnight.



⑥ Packaging

Since the sausages are connected, separate them with scissors before packing. Vacuum packing or nitrogen gas replacement packing is performed. The shelf life is shorter with aerated packing.



7. Finely Ground Sausage

(1) Raw materials

- ① A: Beef 60%
- B: Beef fat 20% (subcutaneous fat with low melting point)
- C: Ice water 20%
- Total: 100%
- ② Curing agent (for the total)
- Salt 1.6%
- Sodium nitrite 0.01%
- Sodium L-ascorbate 0.1%
- Phosphate 0.4%
- White pepper 0.2%
- Mace 0.1%
- Garlic 0.1%



Nutmeg 0.05%

(2) Process

① Raw material processing

Fat of the raw material A is trimmed, but sinews may be left. Then, cut it into cubes. Raw material B is also cut into cubes. A and B are ground separately with a 3 mm plate of a mincer, and their surface is hardened in the freezer.

② Cutting

Create an emulsion by following the procedure described already in the image diagram of 'Cutter curing' of Module #3. It does not have to be exactly the same as the instruction, but it is sufficient if the extraction of myosin and the final temperature of 12 °C or less are observed. In the video, the procedure was slightly different from this image graphic, so we will specify it as below.

- i Input of beef A
- ii Addition of curing agent
- iii Add a half amount of ice C; Keep the temperature below 5 °C for a long time to extract myosin
- iv Input of beef fat B
- v Add the remaining half of the ice C
- vi The final temperature is lowered to 12 °C; It actually exceeded this temperature in the video.

③ From filling to packaging

The process from filling to packaging is the same as for coarsely ground sausages.



Module # 05

Packaging

Module # 05

Packaging

Learning Outcomes:

- Trainees will be able to learn about objectives of the packaging and types of the packaging
- Trainees will get knowledge regarding impact of packaging on the quality of meat. Mechanism of action of the different packaging methods and their advantages
- What are various effects of packaging on color stability, microbial growth, and lipid oxidation

Introduction:

The function of packaging is to surround or wrap meat products with suitable protective material. Packaging materials were in the old day's simple natural materials, e.g., leaves, but nowadays exclusively manufactured materials such as paper or synthetic films.

Purpose of packaging

The basic purpose of packaging is to protect meat and meat products from undesirable impacts on quality, including microbiological and physiochemical alterations. Packaging protects foodstuffs during processing, storage and distribution from:

- a. **contamination by dirt** (*by contact with surfaces and hands*)
- b. **contamination by microorganisms** (*bacteria, moulds, yeasts*)
- c. **contamination by parasites** (*mainly insects*)
- d. **contamination by toxic substances** (*chemicals*)
- e. **influences affecting colour, smell and taste** (*off-odour, light, oxygen*)
- f. **loss or uptake of moisture** (*evaporation or water absorption*)

Adequate packaging can prevent the above-listed secondary contamination of meat and meat products. But the further growth of microorganisms, which are already present in meat and meat products, cannot be interrupted through packaging only. To halt or reduce microbial growth, packaging has to be combined with other treatments, such as refrigeration, which will slow down or stop the further growth of microorganisms, or with heating/sterilization, which will reduce or eliminate contaminating microorganisms.

The packaging procedure results in an inner package, where the packaging material directly contacts the product. It is sometimes combined with an outer package, often a cardboard box or other materials.

Various synthetic packaging films are available for the inner packaging, e.g., transparent or opaque, flexible or semi-rigid, gas-proof, or permeable to certain gases. These materials are selected to serve specific purposes, such as protection from unwanted impacts or attractive presentation.

Requirements for packaging materials

A range of synthetic materials suitable for meat packaging is available mainly in **plastic films or foils**.

Packaging films must be/have:

- a. flexible
- b. mechanical strength
- c. light weight

- d. odourless
- e. hygienic (clean and toxicologically harmless)
- f. easy recycling
- g. resistance to hot and cold temperatures
- h. resistance to oil and fats
- i. good barrier properties against gases
- j. sealing capability
- k. low-cost

Barrier against gases

Good barrier properties against oxygen and evaporation are the most important features to ensure:

a) Exclusion of oxygen

Air contains about 20 percent oxygen. Oxygen negatively affects unpackaged meat and meat products during prolonged storage periods. It changes the red meat colour to grey or green and causes oxidation and rancidity of fats resulting in an undesirable off-flavour.

The oxygen permeability of films used for the packaging of meat products varies. The lower the oxygen permeability the more efficient the protection of product quality. The best protection will be achieved using oxygen-proof packaging films together with vacuum packaging of the product. This ensures that practically no oxygen remains in the package and no oxygen will penetrate from the air into the packaged product.

While oxygen is generally undesirable in meat and meat products packages, there is one exception where oxygen-permeable foils are desirable, namely for fresh ready-to-sell meat portions in self-service outlets. In this specific case, the utilization of oxygen-permeable foils produces a desirable bright red meat colour.

b) Prevention of evaporation of product moisture Fresh meat or fresh sausages, cooked ham, etc. have a relatively high moisture content and will suffer considerable weight and quality losses by evaporation and drying during storage if such products remain unpacked. The packaging material must therefore be sufficiently water vapour-proof.

Barrier against light

The prolonged exposure of meat and meat products to daylight or artificial light accelerates unattractive colour changes, oxidation and rancidity because light provides the energy for these processes. Transparent packaging films normally used for meat products allow attractive product presentation as the packaged product is visible. However, such films provide no protection against light impact. Normally products in transparent packaging films are sufficiently protected when stored in the dark or moderate light conditions. For light sensitive products or products exposed to strong light, coloured or opaque films should be used. Films laminated with aluminium foil are very effective.

Sealing capability

Some packaging materials are required to have good thermoplastic properties. They are heat sealable, which means that two of these films, put closely in contact to each other under slight pressure and with simultaneous high temperature application, will melt or seal together along the heated area, resulting in hermetically closed plastic pouches or bags.

Types of packaging films

Practically all films used for meat packaging derive from synthetic "plastic" materials.

Cellulose, which is not a synthetic but a natural material derived from wood, was formerly widely used in transparent films. It is now no longer of great importance in meat packaging, although it is still used for specific purposes. However, cellulose is still vital for manufacturing certain kinds of artificial sausage casings.

The most common synthetic materials used for meat packaging are:

Polyethylene (PE) (oxygen + , water vapour -)

Polypropylene (PP) (oxygen + , water vapour -)

Polyvinylchloride (PVC) (soft) (oxygen + , water vapour -)

Polyester (PET) (oxygen $\pm$, water vapour -)

Polyamide (PA) (oxygen - , water vapour +)

+ = relatively permeable

- = relatively impermeable

Polyvinyliden chloride (PVDC) used as barrier plastics Ethylenvinyl alcohol (EVOH)

Foils made from the above synthetic materials are selected based on their different oxygen and water vapour properties. For the various purposes in the meat industry packaging films can be divided into

- a. Single-layer films or
- b. Multi-layer films

Single-layer films

One common use of single-layer films is wrapping meat pieces, processed meat products, bone-in or boneless meat cuts, or even entire carcasses. These films are usually self-adhesive, i.e., they cling together -"cling film"- in the overlapping areas. Hence they provide good protection from external contamination and, to some extent, from evaporation, but no protection from oxygen, as they are not hermetically closed or sealed packages. Foils with good self-adhesive properties are PE, PA, PVC, and PP. Another vital utilization for single-layer films is in freezer storage. For meat blocks, meat cuts or smaller portions of meat or meat products, single-layer films are stretched tightly around the meat surface before freezing.

The tight film prevents evaporation losses during freezer storage of unpacked products. The film is in tight contact with the product surface to avoid evaporation, ice formation, and freezer burn at non-contact spots. Suitable cold-resistant films for freezer storage are PA or PE.

One specific utilization for single-layer films is wrapping chilled meat portions for self-service outlets (supermarkets, etc.) Those meat pieces (beef, pork, or chicken) are placed in hygienic cellulose or plastic tray and tightly wrapped with single-layer plastic film. The ends of the foil are overlapped at the bottom side of the tray, where they firmly cling together. Films to be used should have low water vapour permeability to avoid drying the meat during storage. But for making it attractive to customers, such meat needs to retain an attractive bright red meat surface colour (oxymyoglobin), especially in the case of fresh portioned beef.

For this reason, the plastic foils to be used shall have a high oxygen permeability so that the oxygen of the air can react with the myoglobin of the meat and form the bright red oxymyoglobin. Oxymyoglobin is not a chemical compound but a loose aggregation of oxygen to the red meat pigment myoglobin, which keeps meat bright red for a number of hours. Suitable single-layer films for fresh meat packaging are PE or soft PVC. Formerly cellulose films were also used, which have the same permeability pattern but are less self-adhesive, and the overlapping ends do not cling together very well.

Multi-layer films

Practically all the other films used for meat packaging are designed as strong oxygen and water-vapor barriers. In order to fully achieve these requirements, films with good barrier properties for oxygen and water vapour, respectively, are combined.

A very efficient combination is PA/PE. For example, PA is used as the outside layer for films for vacuum bags. PA is relatively oxygen-proof but permeable to some extent to water vapour. PE has the opposite properties, it is water vapour proof but permeable to oxygen. The combination of both renders such a multi-layer film very tight against oxygen and water vapour evaporation. Moreover, the PE used as the inside layer has good thermoplastic properties and is well suited for heat sealing. The PA/PE combination is the simplest structure for a multi-layer film. The packaging industry has refined the systems by introducing additional layers which serve as strong oxygen barriers. Sealant layers consist mainly of Polyethylene (PE) or Ionomer (I). Outside layers may be Polyamide (PA), Polyester (PET), or Polypropylene (PP). Barrier layers for oxygen are made of Polyvinylidenechloride (PVDC) or materials with similar properties.

Vacuum bags used for vacuum packaging machines are composed of two or more sheets of multi-layer films. By drawing the vacuum and sealing such bags, the air is excluded from the package, and the damaging effects of oxygen such as rancidity or discoloration of the packed products will be significantly slowed down or not develop at all. However, exposure to strong light may cause discoloration even under a vacuum.



Vacuum Packing Machine



Vacuum Packed Meat

Processed meat products in slices or entire pieces are packed in small to medium-size vacuum bags. For more oversized products, bags made of shrinkable films can be used where, after vacuum-packaging, the product in its package of the synthetic film is sprayed with or dipped into hot water (80°C). Vacuum packaging for fresh, chilled boneless beef cuts is mainly done to promote meat ripening. The beef meat cuts can remain for a number of weeks (maximum 3 months) in the vacuum bag, provided oxygen remains excluded, and the storage temperature is kept at -1°C (which is just above the freezing point of meat). During these storage conditions, lactic acid bacteria (which do not cause spoilage) will inhibit the growth of most other bacteria, which results in prolonged microbial stability. Beef becomes very tender during extended ripening periods without losing much of its typical flavour.

Heat treatment or cooking for some meat products can be carried out in the package after vacuum-packing. Temperatures of 60°-80°C or even higher up to sterilization temperatures (above +100°C) can be employed for hams, sausages, etc. In these cases, the uncooked packaged products' pasteurization or sterilization effect is achieved, and recontamination is avoided as long as the package is not opened.

For specific products such as entire sausages, semi-automatic vacuum packaging can be employed. A bottom film is moulded according to the shape of the sausages by using heat and force (by compressed air or mechanical). These machines are called thermo-formers. The sausages are loaded, and a rigid top film is sealed after evacuating the moulded spaces. Individual product portions are cut apart along their sealing layers.

A packaging method commonly used in larger meat industries is skin packaging. For this method, the products are placed in the packaging machine, usually on a rigid film, serving as the final package's bottom layer. Another flexible film (top layer, heated for increased flexibility) drapes itself from above around the product, resembling a tight "skin" on the product surface, avoiding wrinkles and purges. The skin-like coverage of the product takes place in a sealing station in the packaging machine, where the top and bottom film are sealed around the edges. Individual packages are separated by cutting around the bottom seal perimeter.

The latest development in this sector is the "form-shrink" packaging technology. Products, e.g., meat cuts, chicken carcasses, entire sausages, smaller portions of meat products, are placed between two shrinkable films, moulded without wrinkles around the goods. Sealing seams can be kept extremely small. This technology is very cost-effective in terms of packaging films but requires high-tech equipment and is only relevant for large-scale industries.

Modified Atmosphere Packaging (MAP) of meat and meat products is a more useful technology. The packaging materials used are gas-proof multi-layer films composed of PE, PA, and barrier layers. Rigid films may be used to mould cup or box-shaped containers filled. A flexible lid foil is then sealed on. MAP packaging can also be done for ordinary plastic bags/pouches. MAP packages are firstly subjected to a vacuum. A mixture of gases is introduced into the air-free space before sealing.

The gas mixture usually contains nitrogen (N₂) and carbon dioxide (CO₂). N₂, which is also the major constituent of atmospheric air, is inert, i.e., it does not react with meat product components such as fat or myoglobin. Its function is to replace the atmospheric oxygen (O₂) and thus prevent O₂ induced negative impacts. The other component of the gas mix, CO₂, has a protective function, as it inhibits the growth of bacteria and moulds. The gas mixture commonly used is 20%-30% CO₂ and 70%-80% N₂. This is applicable to all processed meat products. If fresh meat pieces are to be packed in gas-proof packages instead of wrapping them with oxygen-permeable foil, the bright-red fresh meat colour can be achieved by adding oxygen to the gas mix to be injected into the package and replacing the N₂ content accordingly. As sufficient oxygen is needed to maintain the bright-red colour, gas mixes for fresh meat are usually composed of 70%-80% O₂ and 20%-30% CO₂.



Modified Atmosphere Packaging

Skin- and **MAP-packaging** are often too sophisticated for the small producers but may be of increasing interest to medium-size meat plants. There are now small manual and semi-automatic packaging machines available, designed for smaller throughputs. However, the utilization of those machines implies that the necessary types of synthetic films, and in the case of MAP-packaging, also the relevant gases, are available.



Skin Packaging

Module # 06
Chilling and Storage

Module # 06

Chilling and Storage

Learning objectives:

Upon completion of this module, the trainees will have will be able to learn about:

- Principles involved in chilling of meat and meat products
- Various issues related to chilling temperature and its effects on meat safety and quality
- Cleaning and hygiene of chilling equipment, refrigerated vans and cold stores
- Importance of proper chilling in meat industry with reference to meat safety

Introduction

Healthy animals which are hygienically slaughtered after resting and fasting provide practically aseptic meat. However, following slaughter, the evisceration and dressing operations inevitably produce microbial contamination in depth, especially on the surface, through contact with equipment, tools, hands, and clothes, despite all precautions. Due to its chemical composition, which is rich in proteins, lipids, and water, meat is a particularly favourable substrate for the growth of microorganisms. The lipid content also makes it very sensitive to oxidation. This process can be retarded by cold storage. Slaughter operations and carcass dressing separate the parts of the animal which have distinct histological properties and are intended for different uses. The carcass itself incorporates mainly muscles, bones, fat and connective tissue. The offal includes some edible organs, while some glands are used in pharmaceutical preparations. These different parts must be subjected to varying cooling conditions according to their susceptibility to microbial growth, temperature effects, and surface dehydration risk.

Transportation of value added meat products:

Vehicles Used To Transport Meat Products

Design and construct vehicles to protect product.

- Vehicles should be designed and built to make locking and sealing easy, protect the cargo against extremes of heat and cold, and prevent infestation by pests.
- Vehicle design should permit effective inspection, cleaning, disinfection, and temperature control.

- Interior surfaces should be made of materials that are suitable for direct food contact. For example, the surfaces may be made with stainless steel or be coated with food-grade epoxy resins.

Sanitize and properly maintain vehicles

Meat product transportation vehicles, accessories, and connections should be kept clean and free from dirt, debris, and any other substance or odor that may contaminate the product. They should be disinfected as needed. Cleaning and sanitation procedures should be specified in writing.

Different cleaning procedures may be necessary for the different types of meat products that are to be transported. The type of product transported and the cleaning procedure used should be recorded. Generally, wash water should be at least 82 °C and an approved sanitizer may be used to reduce the number of microorganisms and dissolve any fat particles adhering to interior surfaces.

- Cargo pallets, load securing devices, and loading equipment should be kept clean and free of potential food contaminants and be regularly washed and sanitized.
- Equipment used in transferring meat products, such as hand trucks, conveyors, and forklifts, should be well maintained and kept in a sanitary condition.
- Secure transport vehicles to prevent tampering when not in use.

Use dedicated transport vehicles

- Transport vehicles, containers, and conveyances should be designated and marked “for food use only,” and be used only for transporting foods. If feasible, they should be restricted to a single commodity. This reduces the risk of cross contamination from previous cargoes.

Pre-Loading

Loading and unloading areas should be configured, cleaned, disinfected (where appropriate), and properly maintained to prevent product contamination.

- Loading or unloading facilities should be designed to permit easy access to all areas for cleaning.

- Facilities should be adequately insulated and have an adequate temperature control capacity.
- Facilities should have an effective, systematic program for preventing environmental contamination and infestation by insects, vermin, etc.

Examine vehicles before loading

- Trailer or truck body should be sufficiently insulated and be in good repair with no holes in the body that might allow heat, dust, or other adulterants to enter the cargo area.
- Check for residues of previous cargoes.
- Check for residues from cleaning and sanitizing compounds.
- The cooling unit must be in good repair and operating. Both truck drivers and plant personnel should check the functioning of the trailer refrigeration unit.
- Trailers and trucks should be pre-cooled for at least 1 hour before loading to remove residual heat from the insulation and inner lining of the trailer as well as from the air of the trailer. For pre cooling, the doors should be closed and the temperature setting of the unit should be no higher than -3 °C.
- Inspect trailers prior to loading to determine that the air chutes, if used, are properly in place and that the ribbed floors are unclogged so that adequate air circulation can occur.
- Examine trailer doors and seals to ensure that they can be secured and that there will be no air leaks.

Loading

Protect products from exposure to environmental contaminants such as microbes, dust, moisture, or other physical contamination.

Maintain the “cold chain” to ensure meat products are kept at appropriate temperatures continuously throughout all phases of transport.

- Meat products must be kept refrigerated and protected from temperature changes. All persons involved in the transportation, storage, and handling of these products are responsible for keeping them at appropriate temperatures and preventing any break in the cold chain.
- Maintain the appropriate temperature of the pre-cooled product by minimizing the time of loading or unloading, conducting the loading and unloading in an appropriately chilled

environment, and reducing the amount of surface contact of the product with floors and walls of the storage areas or loading equipment.

- Appropriately packaged meat products can be stacked, provided that air circulation is sufficient to maintain the temperature of the products during shipment.
- Product should be at the desired transit temperature before loading. The boxes and pallets should be secured within the vehicle and pallets should be center-loaded off the walls of the vehicle.
- Seal vehicles shipping egg products from one official plant to another for pasteurization, re-pasteurization, or heat treatment

Use appropriate loading procedures and equipment

- Use spacers on sidewalls and at the ends of trailers as well as pallets on the floor so that proper air circulation can be maintained.
- Keep loading time as short as possible to prevent temperature changes (increases or decreases) that could threaten the safety or quality of food products.
- Close doors immediately after the truck/trailer has pulled away from dock. Use special care with mixed or partial loads.
- Partial and mixed loads increase the frequency and duration of open doors, leading to a greater possibility of temperature fluctuations and exposure to tampering.
- Other factors affecting temperature include the time of loading and unloading, the number of stops, the total length of the haul from origin to destination, and the outside temperature.
- During periods of warm weather, loading or unloading should be done in the evening or early morning to minimize the likelihood of products warming.

In-Transit

Establish procedures to periodically check integrity of the load during transit.

- Check for leakage of heating or cooling fluid onto food products.
- Monitor the temperature and function of the refrigeration unit at least every 4 hours. If there is a unit malfunction, the problem should be corrected by an authorized refrigeration mechanic before the temperature of the load rises.

- Check for breakdown of temperature control.
- Use time-temperature recording, indicator, or integrator devices, if they are available, to monitor the condition of cargo. Check the devices every 4 hours.

Unloading

Carefully examine incoming products.

- Product should be inspected and sorted before being accepted at any point during transportation.
- Develop and implement methods to check and document condition of product and packaging upon receipt at destination. Examine checks of time-temperature recording, indicating or integrator devices or, by prior arrangement with the shipper, test to determine if bacterial growth has occurred after the product was packaged and shipped.
- Include procedures for the safe handling and disposal of contaminated products. Identify where and how to separate contaminated products.
- Establish policy and procedures for rejection of packages and products that are not acceptable, can't be verified against the delivery roster, or contain unacceptable changes to shipping documents. Have a monitoring plan and record-keeping system in place to document steps taken.
- Do not accept products known to be, or suspected of being, adulterated.