



PM Formalisation of Micro Food Processing Enterprises Scheme

Processing of Frozen Chicken



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CHAPTER -1

INTRODUCTION

1.1. Poultry meat

Poultry is domesticated birds kept by humans for their eggs, their meat, or their feathers. The word "poultry" comes from the french/norman word poule, itself derived from the latin word “pullus”, which means small animal. Poultry meat is one of the most important sources of protein for human consumption worldwide. Chicken is the most common type of poultry in the world. Owing to the relative ease and low cost of raising them in comparison to animals such as cattle or hogs, chickens have become prevalent throughout the cuisine of cultures around the world, and their meat has been variously adapted to regional tastes. Chicken can be prepared in a vast range of ways, including baking, grilling, barbequing, frying, and boiling, among many others, depending on its purpose. Since the latter half of the 20th century, prepared chicken has become a staple of fast food. Chicken is sometimes cited as being more healthful than red meat, with lower concentrations of cholesterol and saturated fat. The poultry farming industry that accounts for chicken production takes on a range of forms across different parts of the world. In developed countries, chickens are typically subject to intensive farming methods, while less-developed areas raise chickens using more traditional farming techniques.



1.2. Terms related poultry

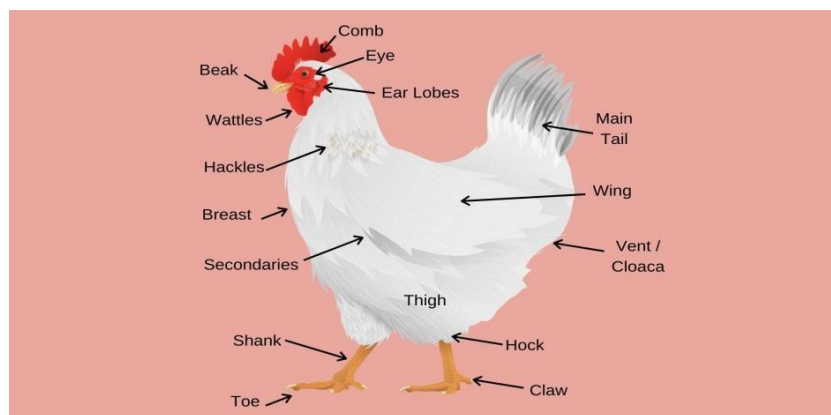
Chicken can be classified as follows:

1. **Broiler/fryer:** young chickens that are usually 6 to 10 weeks of age with a dressed weight of 1.13 kg or more.
2. **Roaster:** chickens that are usually 7 to 12 weeks of age with a dressed weight of 2.27 kg or more.
3. **Heavy fowl:** breeding hens and roosters also called baking hens that are usually more than 10 months of age with an approximate dressed weight of 1.81 kg.
4. **Light fowl:** hens that have produced table eggs, also called stewing hens, which are usually more than 10 months of age with an approximate dressed weight of 1.13 kg.
5. **Capon:** neutered male chickens that are usually less than 4 months of age.

6. **Rooster:** mature male chickens that are usually more than 10 months of age with a dressed weight of 2.72 kg or more.
7. **Cornish game hen:** young chickens that are usually less than 5 weeks of age with a dressed weight of 0.91 kg or less.

1.3. Body segment of poultry

Individual carcasses of ready-to-cook poultry, parts of ready-to-cook poultry, and individual units of specified poultry food products are categorized as noted below. Clear to semi clear marinades or sauces may be added to ready-to-cook poultry products, provided that the



ingredients do not alter or affect the appearance or definition of the product. Poultry parts are:

- Backs
- Breasts are separated from the back at the shoulder joint and by a cut running backward and downward from that point along the junction of the vertebral and sternal ribs. The ribs may be removed from the breasts, and the breasts may be cut along the breastbone to make two approximately equal halves; or the wishbone portion may be removed before cutting the remainder along the breastbone to make three parts. Pieces cut in this manner may be substituted for lighter or heavier pieces for exact weight-making purposes, and the package may contain two or more such parts without affecting the appropriateness of the labeling (e.g., “chicken breasts”). Neck skin will not be included with the breasts, except that “turkey breasts” may include neck skin up to the whisker.
- Breasts with ribs are separated from the back at the junction of the vertebral ribs and back. Breasts with ribs may be cut along the breastbone to make two approximately equal halves; or the wishbone portion may be removed before cutting the remainder along the breastbone to make three parts. Pieces cut in this manner may be substituted for lighter or heavier pieces for exact weight-making purposes, and the package may contain two or more such parts without affecting the appropriateness of the labeling (e.g., “breasts with

ribs”). Neck skin will not be included, except that “turkey breasts with ribs” may include neck skin up to the whisker.

- Drumsticks are separated from the thigh by a cut through the knee joint (femorotibial and patellar joint) and from the hock joint (tarsal joint). \
- Halves are prepared by making a full-length back and breast split of an eviscerated poultry carcass so as to produce approximately equal right and left sides.
- Front poultry halves include the full breast with corresponding back portion, and may or may not include wings, wing meat, or portions of wing.
- Rear poultry halves include both legs and adjoining portion of the back attached.
- Legs include the whole leg (i.e., the thigh and the drumstick), whether jointed or disjointed. Back skin is not included.
- Legs with pelvic bone consist of a poultry leg with adhering meat and skin and pelvic bone.
- Quarters consist of the entire eviscerated poultry carcass which has been cut into four equal parts, but excluding the neck.
- Breast quarters consist of half a breast with the wing and a portion of the back attached.
- Breast quarters without wing consist of a front quarter of a poultry carcass from which the wing has been removed.
- Leg quarters consist of a poultry thigh and drumstick with a portion of the back attached.
- Tenderloins consist of the inner pectoral muscle, which lies alongside the sternum (breast bone) of the poultry carcass.
- Thighs are disjointed at the hip joint and may include the pelvic meat but not the pelvic bones. Back skin is not included.
- Thighs with back portion consist of a poultry thigh with a back portion attached.
- Wings include the entire wing (consisting of three segments) with all muscle and skin tissue intact, except that the wing tip (third segment) may be removed.
- Wing drumette consist of the humerus (first segment) of a poultry wing with adhering skin and meat attached.
- Wing portions consist of a poultry wing with adhering skin and meat attached; except that the drumette (the first segment) has been removed the wing portion may consist of the second segment only, or the second and third segments.
- Wishbones (pulley bones), with covering muscle and skin tissue, are severed from the breast approximately halfway between the end of the wishbone (hypocondrium) and from

the point of the breastbone (cranial process of the sternal crest) to a point where the wishbone joins the shoulder. Neck skin is not included with the wishbone.

Some factors that detract from quality:

- Feathers
- Exposed flesh (resulting from cuts, tears, and missing skin)
- Discolorations (whether or not caused by dressing operations and bruises)
- Disjointed and broken bones
- Freezing defects

1.4. Frozen chicken

Meat may be presented chilled, chilled with ice or CO₂ packed in a container, hard chilled, frozen, frozen individually without ice glazing, or frozen individually with ice glazing. Product storage temperatures should be such throughout the supply chain as to ensure uniform internal product temperatures as follows:

- a. **Chilled:** the internal product temperature is between -2.8 and 4.44°C at all times following the post-slaughter chilling process.
- b. **Chilled, ice-packed:** the product is packed in a container with ice (frozen water, not dry ice) to maintain the internal product temperature between -2.8 and 4.44°C (27 to 40°F) at all times following the post slaughter chilling process.
- c. **Chilled, CO₂:** the product is packaged (must be placed in an internal package) and packed in a container with solid carbon dioxide (dry ice) to maintain the internal product temperature between -2.8 and 4.44°C at all times following the post-slaughter chilling process.
- d. **Hard chilled:** the internal product temperature is between -18 and -2.8°C at all times following the post-slaughter chilling process.
- e. **Frozen.** The internal product temperature is -18°C or lower (also known as deep-frozen) at all times after freezing.
- f. **Frozen individually without ice glazing:** the product is individually frozen so that the pieces do not stick together when packaged. The internal product temperature is -18°C or lower at all times after freezing. This option is available for parts only.
- g. **Frozen individually with ice glazing:** the product is individually frozen and glazed with water to assist in protecting the individual pieces from freezer burn. The internal product temperature is -18°C or lower at all times after freezing. This option is available for parts only.

The most common slaughter systems include:

- **Traditional:** poultry products are slaughtered and processed in accordance with industry-standard processing practices.
- **Kosher:** poultry products are certified as meeting jewish dietary laws and standards regarding slaughter and processing.
- **Halal:** poultry products are certified as meeting islamic dietary laws and standards regarding slaughter and processing.

The most common post-slaughter systems include:

- **Immersion chilled:** the product is chilled by immersing it in cold water immediately after slaughter.
- **Air chilled:** the product is chilled by exposing it to cold air immediately after slaughter.

1.5. Current status of meat industry in India

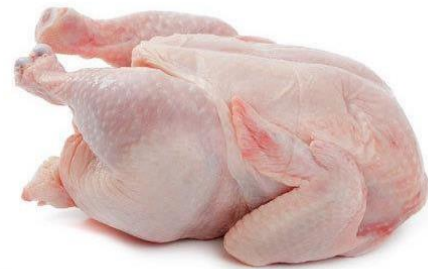
Animal food is considered a good source of quality nutrients viz. Fat, protein, carbohydrates, and minerals. The digestibility of animal-source protein is 90-97% while vegetable origin proteins have 75-99%. However, proteins of animal origin are more completely digested and nutritionally superior to those of plant origin. On the other hand, plant origin proteins are deficient in at least one of more essential amino-acids e.g. Some cereals in lysine and some legumes in methionine but the animal proteins contain all essential amino acids. Nearly three million tonnes of broiler meat and about 2.86 million tonnes of eggs are produced annually in india. Growing at about 20 per cent annually the domestic poultry market is currently estimated at about rs. 49,000 crore. India is the ninth-largest producer of poultry meat in the world. Poultry exports are mostly to Maldives and Oman. Indian poultry meat products have good markets in japan, Malaysia, Indonesia, and Singapore. Both public and private sector organizations have played important role in the poultry industry. There is a huge scope for the growth of the poultry industry as the country's annual per capita consumption is only 2.4 kgs. The national institute of nutrition has recommended 180 eggs and 11 kg of meat per capita consumption for our country.

CHAPTER -2

PROCESSING OF FROZEN CHICKENS

2.1. Pre-mortem handling

Handling birds before slaughter is a critical point in maintaining adequate standards of poultry meat quality. Under this premise, some factors should be observed and considered during the pre-slaughter period, such as catching, transport, environment temperature, or fasting, but certainly, all of these conditions have a common point: they cause stress. In fact, it is widely known that stress conditions are the detonator of a series of alterations that can modify the structure and characteristics of carcass



and, consequently, of meat. Moreover, animal welfare demands the humane handling of birds prior to slaughter. Nowadays, consumers are particularly sensitive to how birds are handled before and during slaughter, as well as to stunning methods used to produce the meat they buy in the market. There are campaigns against animal cruelty around the world, all of them attempting to stop any practice that might cause animal's pain or unnecessary suffering. It is evident that most of these practices would be carried out between bird catching and slaughtering. Therefore, any preventive action must be taken during this time, referred to as the pre-mortem handling period, and must be considered an important factor in obtaining high-quality meat. Establishing conditions that prevent unnecessary suffering of birds will render high-quality meat. Future research on this topic must be carried out to reduce to a minimum any stress, pain, or suffering of birds prior to humane slaughter.

2.1.1. Stress

Stress is defined as the condition where a bird is exposed to an unpleasant situation with negative effects on its behaviour, metabolism, or even in the carcass and meat. Therefore, the “unpleasant” situation could be a wide series of “situations” with a large series of “responses,” depending on the environment, management, or handling. Therefore, the point at which birds enter a given stressful condition could be difficult to establish. However, conditions such as fear, hunger, thirst, extreme environmental conditions, or any harmful agent that can change the physiological status of birds are all sources of stressful conditions that can modify the homeostatic balance of the body; if these conditions are maintained for an

excessive length of time, they can evolve into a pathology. On the other hand, birds have mechanisms of defense when exposed to stress factors. That is, they can adapt to adverse conditions, although this mechanism is limited and depends on time, physiological status, and the intensity of the stressor. Adaptation implies the presence of several physiological reactions in a bird's organism as a response to an adverse situation, to avoid negative effects. Therefore, secretions of adrenal glucocorticoids should be reduced or minimized, as these secretions are responsible, at least in part, for chemical and metabolic reactions associated with the negative effects of stress. In general, adaptation has limits; when a stressor affects the bird's condition, time is required to reach a controlled stress situation. Therefore, it is obvious that depending on the stressful condition, birds are able to adapt and avoid negative stressor effects.

2.1.2. Handling before slaughter

Premortem handling involves three different points of view, usually interrelated but sometimes opposite: processing efficiency, workers' safety, and humane attitudes. At present, handling and slaughtering methods are developed taking into consideration the effect of stress on meat quality. However, the cost-benefit and humane considerations are increasing in importance during the entire process.

It is well known that premortem mishandling could be a source of stress, causing alterations in the muscle glycogen metabolism as well as increasing muscle pH; therefore, meat is susceptible to developing undesirable characteristics such as discolorations, microbial contamination, and fast spoilage conditions. Prevention of any stressful conditions prior to slaughtering is necessary to avoid these undesirable responses.

2.1.3. Catching

An important premortem stage is an action of catching birds. When they reach the expected weight, or at the end of the growing phase, birds are loaded into crates and transported to the slaughterhouse.

This practice could affect carcass and meat quality, due mainly to mishandling when collected before loading in trucks. This may produce bruises or, in extreme cases, bone-breaking. Birds are usually caught by hand, held by a leg, inverted, and carried in groups of four or five animals by a worker. It is clear that these conditions may be the cause of birds injuries, with negative effects on the carcass and meat. Catching and loading in crates cause severe stress, with negative consequences on poultry, due to the body-inverted position. It

promotes an increase in epinephrine and glucocorticoid production, both chemicals that affect meat quality.

2.1.5. Transportation

One of the most stressful factors in handling animals is transportation from the farm to the slaughterhouse. Several stressing factors are involved: temperature, acceleration and speed of the vehicle, animal immobility, vibration, motion, impacts, fasting, water deprivation, noise, and in general, welfare alterations. All these conditions produce a wide range of consequences, from discomfort to death. It is reported that mortality is lower in small slaughter plants than in medium-sized and large plants. The number of dead birds on arrival at a slaughterhouse can be around 5% of the total, but if handling is not adequate or if any stressor factor is present, the losses can be up to 65% or even more in hot environments.

Transport is usually carried out in trucks, sometimes for long distances. Under these conditions, poor ventilation is another detrimental factor, which may increase the negative effects of temperature and relative humidity.

2.1.7. Fasting

Feed withdrawal before slaughtering is a common practice used to reduce or prevent microbial carcass contamination, to decrease the chance of excreta coming into contact with the carcass during evisceration and washing. The fasting time must be long enough to clean the gastrointestinal tract but not so long as to cause weight loss or to affect the carcass yield. Usually, 8 to 12 h is enough to meet these goals. Fasting notably reduces the energy contained in muscles, affecting pH level and post-slaughter muscle reactions, such as glycolysis, which, in turn, affects meat colors and other meat quality characteristics.

2.1.8. Dehydration

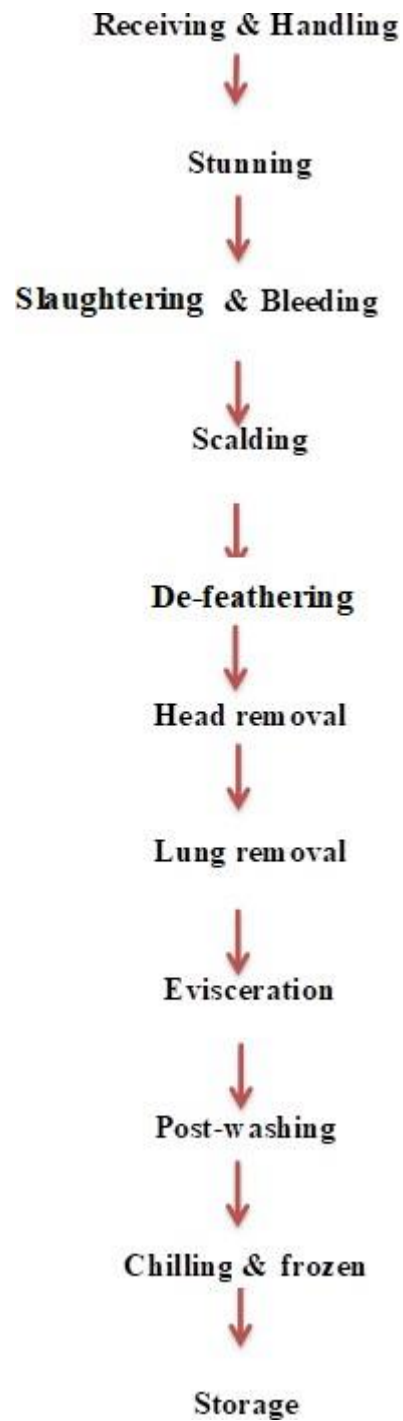
In general, birds do not receive water during transport or at the abattoir before slaughtering. Depending on the journey's duration, poultry could present dehydration symptoms, such as severe thirst, hot and dry body, dry tongue, loss of coordination, and even death. As these conditions are severe stressing factors and cause alterations in blood and plasma volume, they can result in deterioration in meat quality, mainly as to texture and water retention.

2.1.9. Bruising

Bruising is a result of mishandling, usually resulting in broken wings or legs, with birds suffering consequent pain and inflammation. This condition severely affects carcass yield, grading, and meat quality, not to mention the lack of humane handling, and must be avoided at all times during preslaughter handling.

2.2. Slaughtering operation

2.2.1. Flow Chart



2.2.2. Reception and handling

Birds are usually transported to the processing plant in crates stacked on a truck or in cages mounted permanently on a truck. It goes without saying that transporting vehicles and crates should be kept in a clean, hygienic, and safe manner. Upon arrival at the plant, a short rest period for the birds is usually recommended. The birds are then unloaded from the crates and placed on the shackle line manually. Automatic unloading systems have also been developed and are usually part of a modular crate system, which can be lifted and tilted slowly so that the birds can pass onto a conveyor belt. In plants where gas stunning is employed, the birds can be left in the crates, where they are stunned by the selected gas, and later removed from the crates. In the case of poultry, stunning can be done using an electric current, gas, or mechanical means.

2.2.3. Slaughtering and bleeding

After being stunned, general slaughter procedures are used to exsanguinate broilers. One method consists of cutting both the jugular and carotid arteries in the neck, to ensure rapid death. During bleeding only 40 to 60% of total blood is removed, the rest remaining in the body, where it is distributed within the viscera (20 to 25%) and carcass (15 to 20%; muscles, fat, bones, etc.). The duration of bleeding depends on the stunning method applied and the time elapsing between stunning and bleeding. If electric stunning is used, 40% of blood is eliminated in 60 to 90 seconds, while after gas stunning the bleeding period must be increased to 2 to 2.5 min.

2.2.4. Scalding

Scalding softens the skin and facilitates plucking. The tail feathers, remnant feathers, and skin colors are the most important items for further processing. Two types of scalding system can be used: hot-water scalding or steam scalding. In turn, hot-water scalding may involve immersion of the carcass in the water or spraying water on the carcass surface. Standard scalding involves submerging the carcass in hot water when still on the slaughtering chain. Scalding temperatures should be determined by the type of poultry and plucking difficulty. For waterfowl and mature birds, a higher temperature and longer submersion time should be used, while younger birds need a lower temperature and shorter immersion time.

Method of scalding

➤ **Soft scalding/semi scalding:**

Soft scalding entails scalding for 60 to 180 s in the water at 50 to 53° c. This method leaves the epidermal layer intact, which is why it is commonly used for young broilers and turkeys but still allows for relatively easy feather removal. Birds slaughtered for display should be scalded in this way to improve the appearance of the carcass.

➤ **Medium scalding**

Medium scalding is used for mature birds, and involves using water at 54 to 58° c for 60 to 120 second. The epidermal layer is broken down by this time-temperature combination, and the feathers are usually much easier to remove.

➤ **Hard scalding**

Hard scalding requires a water temperature above 60°c for 45 to 90 s. This method is faster and eliminates pinfeathers, but the birds tend to dry out and have a less desirable appearance. It is easier to remove the feathers from carcasses scalded at this temperature than from those scalded at a lower temperature, but the flesh of such poultry is “doughy” and lifeless and the skin becomes discoloured soon after processing.

2.2.5. De-feathering

Birds should be plucked immediately after scalding. In large processing plants, feather removal is done by mechanical pickers or puckers equipped with rubber fingers that rub the feathers off the carcass. In a continuous operation, this is done while the carcass is hanging upside down and moved forward (by the shackle line) between two or three sets of rotating disks equipped with rubber fingers.

2.2.6. Head removal

After de-feathering and before evisceration, the head must be removed if decapitation was not used as the slaughtering method. Automatic machines remove the head, esophagus, and trachea, an essential stage for subsequent automatic evisceration.

2.2.7. Lung removal

Lungs can be removed manually or by automated equipment. The lungs must be cut at the tarsus joint, and it is important that the cut be made between the bones and not through a bone since the latter will appear dark or red in a chilled bird and almost black in a cooked product. After removal of the legs, the carcasses are usually moved to another line. This can be done manually as the carcasses fall onto a sorting table, or by automatic transfer. The advantages of using automated re-hanging equipment include labour-saving, better hygiene (since the birds are not piled onto a sorting table), and a more even rigor mortis process.

2.2.8. Evisceration

This stage refers to opening the body cavity and withdrawing the viscera (i.e., intestines, gizzard, gallbladder, and crop). Different operations form part of evisceration:

- Repositioning on the conveying line,
- Cutting the neck skin,
- Cutting the cloaca,
- Opening the abdominal cavity, and
- Withdrawing the viscera.

This can be done manually, semi-automatically or fully automatically. In all cases, special care should be taken not to pierce the viscera and contaminate the carcass.

Leakage of ingesta during evisceration is problematic because

The quality of the carcass is decreased;

- Production efficiency decreases because of the extra labor required to reprocess carcasses, with the corresponding loss of product quality and yield during trimming.
- There is a strong likelihood that the carcass will become contaminated with populations of pathogenic and spoilage bacteria.

several studies have demonstrated that cross-contamination frequently occurs during evisceration. Farmers who supply birds to poultry-processing plants withdraw feeding 24 hours before processing to minimize the possibility of accidental spillage of gastrointestinal contents onto the carcasses.

2.2.9. Post washing

Prior to refrigeration, a final internal and external washing of the carcass is necessary to remove debris and blood or fat clots. The remaining material in the intestinal crop due to problems during evisceration may also mean that the carcass must be washed. Washing involves spraying the carcasses (spray washing) in cabinet washers with cold or hot water. The washing effect can also be improved by using brushes and rubber fingers. Where permitted, bactericidal rinses can be used. To date, chlorine remains the most widely used antimicrobial chemical in the poultry industry. The washed carcasses, with an internal temperature of approximately 30⁰ c, now go to a refrigeration process.

2.3. Chilling and freezing methods

Common freezing and chilling methods used by the poultry industry include the following:

- Still air is the method commonly employed in domestic refrigerators and in some large refrigerated rooms in meat-processing plants. The temperature of the freezer usually ranges between -10 and -40°C , and heat is slowly removed from the product.
- **Blast freezing:** blast freezing uses high-velocity cold air circulated by fans to provide rapid air movement. The rate of heat transfer is greatly improved over that of still air, and the freezing rate is higher. Air velocities commonly used in a commercial air-blast freezer can range from 30 to 1100 m/min, and the temperature can range from -10 to -40°C .
- **Plate freezing:** plate freezing is used for wrapped meat placed in trays in direct contact with metal freezer plates or shelves. The temperature of the plates can range from -10 to -30°C . Plate freezing is generally used for thinly packed fillets or ground meat patties.
- **Liquid immersion/spray:** this is used for poultry pieces and sometimes for whole carcasses. The products to be frozen are packaged in plastic bags and immersed in a freezing liquid such as sodium chloride brine, glycol, or propylene glycol.
- **Cryogenic freezing:** cryogenic freezing uses liquid or condensed gases such as nitrogen (N_2) and carbon dioxide (CO_2); both can be used in liquid or vapor form. The freezing rate is very fast because the boiling points of liquid nitrogen and carbon dioxides are -196 and -78.5°C , respectively.

Poultry carcasses are commonly chilled by water immersion or cold air immediately after evisceration. This process allows a reduction in body heat from around 39°C to about 5°C within a few hours. Regulations require the temperature of frozen poultry to be down to -18°C within 72 h of being chilled and packaged. The resulting product is relatively stable. The cooling rate is the most important condition in food freezing and chilling. Temperature declines during the process depend on factors such as bird size, chilling method, amount of insulating fat, refrigeration equipment, and product load.

2.4. Refrigeration and freezing

2.4.1. Refrigeration:

Refrigeration is defined as any process intended for heat removal and is the branch of engineering dealing with the processes of temperature reduction and maintenance of a given space or material at a lower temperature relative to its surroundings. To achieve this, heat

from the body to be refrigerated must be removed and transferred to another body (primary or secondary refrigerant), the temperature of which is lower than that of the refrigerated body.

2.4.2. Freezing:

Freezing is one of the processes most commonly used for food preservation because a broad range of microorganisms fails to grow at low temperatures, and when food is frozen, part of the water contained in it becomes ice, so that the food's water activity drops, thus affecting microbial growth. In the case of food, refrigeration involves cooling of materials from environmental temperature to -2°C , since the presence of solids reduces the freezing point of food. Cooling treatment operations, either by refrigeration or freezing, followed by storage at low temperatures, can kill some microorganisms present in food. Under proper freezing operations, storage at a temperature below -10°C inhibits microbial growth almost totally. Although it fails to kill all microorganisms, it is considered an effective method to protect food from microbial spoilage.

2.4.3. Freezing temperature:

In industry and commerce, the term freezing is frequently adopted for products such as meat and poultry kept at a temperature from -2 to -18°C during storage and distribution. Occasionally, the term ultra-freezing is used for conservation at a temperature of -18°C or lower, with the smallest fluctuations possible; this term also implies that the freezing velocity has been adequate for the product, generally taking place faster than the conventional freezing process. The difference between refrigeration and freezing processes lies in the fact that the temperature, humidity, time, and equipment used for both processes are essentially different. These differences are useful for establishing the two types of processes commonly used to preserve meat products.

2.4.4. Freezing methods

Ground ice, mechanical refrigeration, or a combination can be used to achieve refrigeration temperatures. This makes it possible to preserve poultry for short periods of time. In the case of freezing, the use of freezing fluids combined with mechanical refrigeration is recommended, thereby ensuring that the required temperatures will be reached. Preservation under these conditions makes it possible to retain optimum quality for several weeks. Poultry may be frozen using air, liquid, or frozen plates and by deep-immersion cooling at -15 to -28.8°C with no air circulation for 3 to 72 h. Rapid freezing also called quickly frozen, takes place by retaining a mean freezing velocity of 0.3 cm/min , passing through the crystal-formation zone in 30 min at most; under these conditions, the product will be totally frozen in

less than 90 min. The main difference between products frozen using this method is the smaller ice crystal size formed relative to the size when using deep freeze. Crystal size has a direct effect on frozen food, making small crystals desirable, as is the case with quick freezing. The use of air-blast tunnels with air temperatures ranging from -30 to -40°C and air velocities of at least 2.5 m/s also result in rapid freezing. The temperature range -3.8 to -0.5°C , known as the zone of maximum crystal formation, results in the formation of large ice crystals under slow freezing conditions. The faster this zone is passed through, the smaller the ice crystals, hence minimizing meat exudates or drops. Rapid freezing leads to lighter-colored carcasses that result from slow freezing. During slow freezing the skin dries up, shrinks, and becomes clearer; consequently, the carcass appears darker than with rapid freezing. During slow freezing, large ice crystals form, due to the clear surface layer, and frozen carcasses become darker at the surface. Darkening occurs mostly at the skin and in the remaining meat surface layers. The freezing velocity of meat below the skin has no effect on color. Although carcasses with a proper appearance are preferable, fat acts as an isolator, slowing down freezing velocity. Poultry meat softness may be improved using maturation plus freezing. Three stages are observed during freezing. First, the temperature drops gradually to the freezing point; second, the product freezes; and third, the product is overcooled. After poultry freezing, it is recommended that the product be stored in chambers at temperatures of -17.73°C or lower. Most freezing warehouses keep poultry chambers at -23.3°C or lower.

2.5. Refrigerants

A refrigerant is anybody or substance acting as a coolant, absorbing heat from another body or substance. With regard to the compression–vapor cycle, the refrigerant is a cycle’s working fluid, which alternates vaporizing and condensing, absorbing and releasing heat, respectively. A refrigerant can be used in a compression–vapor cycle provided that it possesses chemical, physical, and thermodynamic characteristics that make it a safe and economical option. Refrigerant fluids used in vapor–compression systems are called primary refrigerants; those used in low-temperature transportation are called secondary refrigerants. Solutions with freezing temperatures below 0°C are used as secondary refrigerants. Of them, the most commonly used are aqueous solutions of ethylene glycol, propylene glycol, and calcium chloride. All share similar properties, although propylene glycol has the advantage of being innocuous for contact with food. Primary refrigerants include halocarbons, hydrocarbons, inorganic substances, and fluorocarbons (fluorinated hydrocarbons, or CFCs). The choice of

refrigerant type depends on the process to be used. Refrigeration systems may have leaks and may contaminate food if the refrigerant comes in contact with it.

2.5.1. Colour in poultry

The pigmentation in poultry skin depends on the genetic capability of the bird, the presence of pigments in the diet, the health of the bird, and meat processing. Meat color is due to heme pigments and their derivatives. In a live animal, hemoglobin is the predominant pigment, but in a slaughtered and bled animal, myoglobin accounts for some 95% of the remaining heme pigments.

The effect of chilling on poultry heme pigments is not clear. Muscle pH and meat color are highly correlated; high muscle pH is associated with darker meat, whereas low muscle pH is associated with lighter meat. At the extremes, high-pH meat is often characterized as being dark, firm, and dry (dfd), and low pH results in pale, soft, and exudative (pse) meat. Muscle pH affects both light reflectance properties of the meat and myoglobin chemical reactions.

2.5.2. Texture in poultry

Tenderness is the most valued attribute of meat. Meat texture is affected primarily by protein structure and integrity. Although it seems contradictory, both tenderization and increased toughness have been related to the freezing of poultry, depending on the freezing and thawing temperature, the aging conditions before freezing, and the quality of the raw meat. Tenderization due to freezing and frozen storage appears to be due to myofibrillar fragmentation. Protein denaturation during frozen storage may be caused by one or more of the following factors:

- Ice crystal damage to cells and membranes.
- Dehydration of protein molecules.
- Increase in solute concentration in the unfrozen water phase.
- Enzymatic activity.
- Reaction of proteins with free fatty acids and other intact lipids.
- Reaction of proteins with oxidizing lipids.

2.6. Equipment involved

▪ Slaughtering equipment

2.6.1. Conveying Line

The high degree of automation involved in industrial poultry slaughtering implies the need for an elevated conveying line, which is used to hang the birds and convey them to the slaughter procedure. The line is composed of stainless-steel chains and hooks.

2.6.2. Stunning Equipment:

It is important to emphasize that stunning, neck cutting (killing), and bleeding operations are inseparable and interrelated steps in the slaughter process. The evolution of stunning technology in modern-day broiler plants has, for the most part, been driven by other factors in the slaughter process, such as the type of neck cut performed, bleeding time, scalding and plucking efficiency, and the extent of automation in evisceration.

- Electrical Stunners
- Controlled-Atmosphere Stunners

2.6.3. Slaughtering

Birds are killed manually (using knives) or by a mechanical rotary knife that cuts the jugular and carotid arteries at the neck. In the case of kosher and halal slaughter, only manual cutting of blood vessels is permitted. The automatic slaughtering machines are designed for high efficiency and to avoid human manipulation. After the birds have been stunned, their heads are guided to a circular cutter by a bar directly in line with the overhead conveyor.

2.6.4. Scalders

- **Tank Scalders:** These are used for scalding by water immersion, the most commonly used systems in poultry-slaughtering plants. Scalding tanks or containers should be resistant to corrosion. The temperature of the scalding water is maintained at approximately 60°C with a volume of 2.5 L per bird, depending on the scalding system selected. Air or steam can be used to agitate the water, which contributes to maintaining a constant temperature and guarantees optimal plucking results.
- **Spray Scalders:** These scalders are used to reduce problems related to water contamination. In this system the birds are sprayed with clean hot water, which avoids contamination, but a large amount of water is required. Because of this and high energy costs, the system has little practical application.

2.6.5. Defeathering or Plucking Machines

➤ Dry-Plucking Machines

The suction developed at the plucking head draws the feathers into a set of rotating plates, where they are gripped and pulled from the body. They are then channelled through a suction unit and into a collection sack to await disposal. The grip on the feathers can be adjusted to obtain optimum plucking times for various species of bird. The finish of the plucked bird compares with that obtained by wet plucking. No special skill is required.

➤ Wet-Plucking Machines

Birds are de-feathered mechanically using plucking machines in a wet procedure. For complete defeathering, two plucking machines in series are used. The first plucking machine is an automatic online rubber-fingered feather picker. The long fingers are located in rotatable plucking disks. At the top of the plucking machine, water sprayers help eliminate the shed feathers and skin. This first machine releases more than 70% of the feathers. The second plucking machine removes the remaining feathers located in different areas. Plucking machines are designed to control the scatter of feathers as much as possible. Feathers should be stored in suitable clean containers, which must be removed at least once daily. Feathers conveyed by continuous running water should be removed from the water and the water preferably run to waste.

➤ **Head and Trachea Puller**

This machine removes the head, trachea, and esophagus of a bird automatically. After proper positioning, the head and trachea puller breaks the spine at its weakest point, after which the head, trachea, and esophagus are stretched out gradually and severed from the product.

➤ **Evisceration Equipment**

Evisceration can be done manually using a knife and a pair of scissors.

2.6.6. Carcass Washer:

Inside/outside carcass washers are traditionally used after evisceration machines. These washers consist of a stainless-steel cabinet equipped with various spray nozzles sited in different areas to provide strong water streams. The washing effect of water is improved by using brushes and rubber fingers. A pressure pump and a pressure regulator are provided with the cabinet to control the process.

2.6.7. Freezing equipment

Freezers used in the poultry meat industry and other food industries can be characterized primarily according to their cooling system or cold source. Vapour compression refrigeration and cryogenics are the two main artificial cooling techniques used in the industrial freezing of foods: Artificial cooling consists of getting temperatures below that of the local environment, which requires energy expenditure. Freezers using vapour compression are commonly called **mechanical freezers**; the second class of freezers is **cryogenic freezers or cryo-freezers**. The majority of conventional mechanical vapours-compression refrigeration systems operate down to -40°C , with special applications down to -80°C . Officially, the term cryogenics is applied to temperatures below -150°C , but in food processing, the term cryogenic freezing is widely used to identify freezers using either liquid nitrogen (-196°C) or carbon dioxide

(-78°C as a solid). Blast freezers are commonly used in the view of financial, functional, and feasibility factors.

2.6.8. Freezing Rooms

Freezing rooms are basically cold storage rooms that although not properly considered freezers, are sometimes used for this purpose. There is no standard design equipment. The design and size of the freezer room are determined by the volume and type of product to be frozen, the packaging, the method of pelletization, the accessibility required, and the equipment used for handling these freezers.

Consist basically of an insulated room provided with a mechanical refrigeration system wherein the foods are hanged manually or placed on shelves and bulk stacked.

CHAPTER -3

PACKAGING OF POLUTRY

3.1. Importance of packaging

Poultry packaging is one of the most widely employed ways to extend shelf life and is normally employed in combination with other technologies. Packaging of raw poultry meat limits the use of some processes, such as curing or heat since changes produced by such treatments limit further processing of cured or cooked poultry meat. Modified atmospheres or vacuum packaging are more suitable alternatives.

3.2. Material used for poultry packaging

- There are two important aspects in the selection of packaging: the shape and form of a poultry carcass or cuts, and the material employed in the packaging.
- The oldest method of packaging and distributing fresh poultry meat is via a wet shipper, a waxy-coated corrugated box in which whole birds are placed together with ice.
- A dry shipper is similar but without the ice.
- More recently, whole carcasses have been placed in polymer bags and sealed or clipped. Almost 90% of all chicken parts, including breast, thigh, drum, and wing portions, are packaged directly into consumer portions using highly oxygen permeable polystyrene foam trays with a highly oxygen permeable poly(vinyl chloride) (PVC) or polymer-based stretch-film overlap.
- Most of the remaining portions of poultry meat are packaged in bulk ice packs at the central processor but end up in a similar stretch-wrap package at the retail level.

The main concern in the packaging of raw poultry meat is the microbiological quality, as thermal or chemical processing can affect the properties of raw poultry. Preserving good microbiological quality is thus the main target when packaging raw poultry meat.

3.3. Microbiological implications

Raw poultry is highly perishable even when stored under chilled conditions. The growth of psychotropic spoilage bacteria is most often the cause of spoilage. Hygiene and sanitation play a role in any effective disease control program for poultry production and processing premises. A microbiological risk assessment during production processing and treatment of food constitutes an important basis for judgment of the safety of food products. A poultry site must be prepared methodologically for the entry of each new batch (removal birds; litter and manure; vector and rodent control; dry and wet cleaning; disinfection; fumigation), and particular care should be exercised in the performance of sanitary procedures after a disease

outbreak. Poultry can be packaged whole before slaughtering or can be cut up. Handling operations increase microbiological counts, due to extra handling in the cutting process. Cut-up poultry generally spoiled at a faster rate than did whole birds, and the odor was more marked from cavities of whole carcasses than from cut-up chicken. Besides packaging, alternative treatments to raw poultry can be employed to reduce microbial activity. These treatments can be chemical or physical.

3.4. Chemical treatments

- **Chlorine Immersion:** in chlorine solutions (20 ppm) could help to enhance the microbiological quality of tray-packed stretch-wrapped packaging. Chlorine decreased the incidence of Salmonella and coagulase-positive Staphylococcus, in both whole and cut-up poultry.
- **Potassium Sorbate:** Potassium sorbate has also been employed to enhance the microbiological quality of raw poultry during packaging. However, the effectiveness of potassium sorbate depends on microorganism sensitivity to this compound. Pseudomonas and lactic acid bacteria are not inhibited by potassium sorbate, creating premature souring of the poultry meat.
- **Hypochlorous Acid:** Hypochlorous acid is used in poultry slaughterhouses to ensure that all the Salmonella are eradicated, but since some strains isolated from different stages in a local poultry abattoir grow in the presence of this chemical, effective concentrations must be employed.
- **Disodium Ethylenediaminetetraacetate and Nisine:** A combination of disodium ethylenediaminetetraacetate and nisine and vacuum or modified-atmosphere packaging has the potential to increase significantly the shelf life of raw processed poultry.
- **Trisodium Phosphate:** Trisodium phosphate can be employed to assess the reduction of microbial populations on poultry: Salmonella, Escherichia coli, Campylobacter, Pseudomonas, total counts, Listeria, Staphylococcus aureus, and Lactobacillus.
- **Acid or Alkaline Solution :** Dipping treatment with lactic acid (1%), sugars, foodstuff phosphates, ascorbic/is ascorbic acid, and 10% trisodium phosphate can be employed for the decontamination of poultry carcasses, achieving significant reductions of log₁₀ CFU/mL for aerobic plate counts of Enterobacteriaceae, Pseudomonas, and Lactobacillus.
- **Acid or Alkaline Solution:** Dipping treatment with lactic acid (1%), sugars, foodstuff phosphates, ascorbic/is ascorbic acid, and 10% trisodium phosphate can be employed for

the decontamination of poultry carcasses, achieving significant reductions of log₁₀ CFU/mL for aerobic plate counts of Enterobacteriaceae, Pseudomonas, and Lactobacillus.

- **Peracetic Acid and Quaternary Ammonium:** Peracetic acid and quaternary ammonium can be employed as disinfectants in poultry-processing plants, reducing the contamination of poultry carcasses

3.5. Physical treatments

- **Vacuum Packaging:** Vacuum packaging of poultry meat change microflora but will not inhibit bacterial growth, since some strains (*Aerobacter aerogenes*, *Escherichia coli*, and *Proteus mirabilis*) could survive and grow in vacuum-packaged sterilized poultry meat upon refrigerated storage. Moreover, many species of Enterobacteriaceae are primarily environmental saprophytes and scavengers; some of them are well known as pathogens. On the other hand, although total bacterial counts were lower in cavities, off-odors were generally stronger and more objectionable from cavities than from the surfaces of chickens. Compared with tray-packed stretch-wrapped packaging, whole poultry carcasses decreased bacterial counts, mainly mesophiles and psychotropic, when vacuum packaging was employed.

- **Immersion in Hot Water**

Immersion in hot water is one of many potential methods for reducing levels of pathogenic bacteria on the surface of poultry meat. However, if the meat is to be sold in the raw state, reductions in microbial numbers need to be achieved without changing the appearance of the meat. Changes caused by this heat treatment can be identified visually, with greater changes at higher immersion temperatures and times (e.g., 120 s at 50°C or 1 s at 100°C). No heat treatments below 90°C are capable of reducing contamination with *E. coli* or similar thermo tolerant microorganisms on poultry without causing adverse changes in the product.

CHAPTER-4

FOOD SAFETY REGULATIONS AND STANDARDS OF FROZEN CHIKEN

FOOD SAFETY AND STANDARDS (FOOD PRODUCTS STANDARDS AND FOOD ADDITIVES) REGULATIONS, 2011

2.5.2 Meat and Meat Products:

2.5.2.7. Frozen Mutton, Chicken, Goat and Buffalo Meat

4.1. Fssai Standards

Frozen Chicken means the product prepared from edible a portion of meat of animals specified under these regulations which have been subjected to ante-mortem and post-mortem inspection. The fresh meat meant for freezing shall be clean, free from any foreign matter, objectionable odor/flavour, and evidence of deterioration. Meat shall be prepared by quickly freezing in appropriate equipment in such a way that the range of temperature of maximum crystallization is passed quickly and the product attains a temperature of - 180C or colder at the thermal centre after thermal stabilization. The product shall be kept deep frozen so as to maintain its quality during transportation, storage and sale.

The product shall conform to the following requirements, namely:—

Sl. No.	Characteristics	Requirements
1.	Total Plate Count	100000 / gram maximum
2.	E.Coli	100 / gram maximum
3.	Staphylococcus aureus	100 / gram maximum
4.	Clostridium perfringens and Clostridium Botulinum	30/ gram maximum
5.	Yeast and mould count	1000/ gram maximum
6.	Salmonella	Absent in 25 gram
7.	Listeria monocytogenes	Absent in 25 gram

2.3: Residues; 2.3.1: Restriction on the use of insecticides.

1) Subject to the Provisions of regulation 2.3.1 (2),

No insecticides shall be used directly on articles of food Provided that nothing in this regulation shall apply to the fumigants which are registered and recommended for use as such on articles of food by the Registration Committee, constituted under section 5 of the Insecticides Act, 1968 (46 of 1968).

2) The amount of insecticide mentioned in Column 2 on the foods mentioned in column 3, shall not exceed the tolerance limit prescribed in column 4 of the Table given below :

Sl. No	Name of Insecticides	Food	Tolerance limit mg/kg.ppm)
1.	Aldrin, dieldrin (the limits apply to aldrin and dieldrin singly or in any combination and are expressed as dieldrin)	Meat	0.2
2.	D.D.T. (The limits apply to D.D.T., D.D.D. and D.D.E. singly or in any combination)	Meat, poultry and fish	7.0 (on a whole product basis)
3.	Fenitrothion	Meat	0.03
4.	Gamma (γ) Isomer (Known as Lindane)	Meat and poultry	2.00 (On Whole basis)
5.	Chlorienvinphos	Chlorienvinphos	0.2 (carcass fat)
6.	Chlorpyrifos	Meat and Poultry	0.1 (carcass fat)
7.	2,4D	Meat and Poultry	0.05
8.	Ethion (Residues to be determined as ethion and its oxygen analogue and expressed as ethion)	Meat and Poultry	0.2 (carcass Fat basis)
9.	. Monocrotophos	*Meat and Poultry	0.02
10.	Trichlorfon	Meat and Poultry	0.1
11.	Carbendazim	Meat & Poultry	0.10 (Carcass fat basis)
12.	Benomyl	Meat & Poultry	0.10 (carcass fat basis)
13.	Cypermethrin (sum of isomers) (fat soluble residue)	Meat and Poultry	0.20 (carcass fat basis)
14.	Edifenphos	Meat and poultry	0.02 (carcass fat basis)
15.	Fenthion (sum of fenthion, its oxygen analogue and their sulphoxides and sulphones expressed as fenthion)	Meat and Poultry	2.00 (carcass fat basis)

16.	Fenvalerate (fat soluble residue)	Meat and Poultry	1.00 (carcass fat basis)
17.	Phenthoate	Meat & Poultry	0.05 (carcass fat basis)
18.	Phorate (sum of Phorate, its oxygenanalogue and theirsulphoxides and sulphones,expressed as phorate)	Meat & Poultry	0.05 (carcass fat basis)
19.	Pirimiphos-methyl	Meat & Poultry	0.05 (carcass fat basis)

4.2. Food Safety

Part I - General Hygienic and Sanitary practices to be followed by Petty Food Business Operators applying for Registration

SANITARY AND HYGIENIC REQUIREMENTS FOR FOOD MANUFACTURER/PROCESSOR/HANDLER

The place where food is manufactured, processed or handled shall comply with the following requirements:

1. The premises shall be located in a sanitary place and free from filthy surroundings and shall maintain overall hygienic environment. All new units shall set up away from environmentally polluted areas.
2. The premises to conduct food business for manufacturing should have adequate space for manufacturing and storage to maintain overall hygienic environment.
3. The premises shall be clean, adequately lighted and ventilated and sufficient free space for movement.
4. Floors, Ceilings and walls must be maintained in a sound condition. They should be smooth and easy to clean with no flaking paint or plaster.
5. The floor and skirted walls shall be washed as per requirement with an effective disinfectant the premises shall be kept free from all insects. No spraying shall be done during the conduct of business, but instead fly swats/ flaps should be used to kill spray flies getting into the premises. Windows, doors and other openings shall be fitted with

net or screen, as appropriate to make the premise insect free The water used in the manufacturing shall be potable and if required chemical and bacteriological examination of the water shall be done at regular intervals at any recognized laboratory.

6. Continuous supply of potable water shall be ensured in the premises. In case of intermittent water supply, adequate storage arrangement for water used in food or washing shall be made.
7. Equipment and machinery when employed shall be of such design which will permit easy cleaning. Arrangements for cleaning of containers, tables, working parts of machinery, etc. shall be provided.
8. No vessel, container or other equipment, the use of which is likely to cause metallic contamination injurious to health shall be employed in the preparation, packing or storage of food. (Copper or brass vessels shall have proper lining).
9. All equipment's shall be kept clean, washed, dried and stacked at the close of business to ensure freedom from growth of mould/ fungi and infestation.
10. All equipment's shall be placed well away from the walls to allow proper inspection.
11. There should be efficient drainage system and there shall be adequate provisions for disposal of refuse.
12. The workers working in processing and preparation shall use clean aprons, hand gloves, and head wears.
13. Persons suffering from infectious diseases shall not be permitted to work. Any cuts or wounds shall remain covered at all time and the person should not be allowed to come in direct contact with food.
14. All food handlers shall keep their finger nails trimmed, clean and wash their hands with soap, or detergent and water before commencing work and every time after using toilet. Scratching of body parts, hair shall be avoided during food handling processes.
15. All food handlers should avoid wearing, false nails or other items or loose jewellery that might fall into food and also avoid touching their face or hair.

16. Eating, chewing, smoking, spitting and nose blowing shall be prohibited within the premises especially while handling food.
17. All articles that are stored or are intended for sale shall be fit for consumption and have proper cover to avoid contamination.
18. The vehicles used to transport foods must be maintained in good repair and kept clean.
19. Foods while in transport in packaged form or in containers shall maintain the required temperature.
20. Insecticides / disinfectants shall be kept and stored separately and away from food manufacturing / storing/ handling areas.

4.3. Labelling Standards

Labelling requirements for packaged food products as laid down in the Part VII of the Prevention of Food Adulteration (PFA) Rules, 1955, and the Standards of Weights and Measures (Packaged Commodities) Rules of 1977, require that the labels contain the following information:

1. Name, trade name or description
2. Name of ingredients used in the product in descending order of their composition by weight or volume
3. Name and complete address of manufacturer/packer, importer, country of origin of the imported food (if the food article is manufactured outside India, but packed in India)
4. Nutritional Information
5. Information Relating to Food Additives, Colors and Flavors
6. Instructions for Use
7. Veg or Non-Veg Symbol
8. Net weight, number or volume of contents
9. Distinctive batch, lot or code number
10. Month and year of manufacture and packaging
11. Month and year by which the product is best consumed
12. Maximum retail price

4.3.1. Wherever applicable, the product label also must contain the following

The purpose of irradiation and license number in case of irradiated food. Extraneous addition of coloring material. Non-vegetarian food – any food which contains whole or part of any animal including birds, fresh water or marine animals, eggs or product of any animal origin as an ingredient, not including milk or milk products – must have a symbol of a brown color-filled circle inside a brown square outline prominently displayed on the package, contrasting against the background on the display label in close proximity to the name or brand name of the food.

Vegetarian food must have a similar symbol of green color-filled circle inside a square with a green outline prominently displayed.

All declarations may be: Printed in English or Hindi on a label securely affixed to the package, or Made on an additional wrapper containing the imported package, or Printed on the package itself, or May be made on a card or tape affixed firmly to the package and bearing the required information prior to customs clearance.

Exporters should review the Chapter 2 of the “FSS (Packaging and Labelling) Regulation 2011” and the Compendium of Food Safety and Standards (Packaging and Labelling) Regulation before designing labels for products to be exported to India. FSSAI revised the labelling Regulation and a draft notification to that effect was published on April 11, 2018, inviting comments from WTO member countries and the comments received are under review and the publication date remains unknown.

According to the FSS Packaging and Labelling Regulation 2011, “prepackaged” or “pre packed food” including multi-piece packages, should carry mandatory information on the label.



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