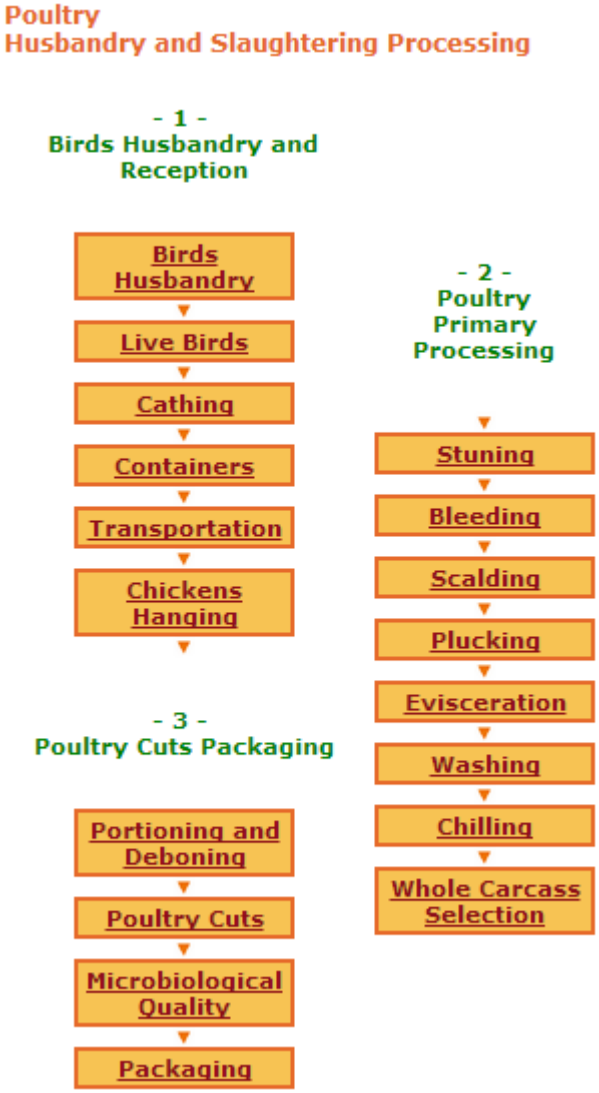
# POULTRY

Food and Agriculture Organization of the United Nations

Meat Processing Toolkit

# POULTRY

## 1.- Poultry Meat production - General information




Poultry products are universally popular, because they are not subject to cultural or religious constraints and the meat itself is perceived as wholesome, healthy and nutritious, being relatively low in fat and with a more desirable unsaturated fatty-acid content than other meats. Most importantly, high-quality poultry products are available to many people at affordable prices, although production costs vary widely around the world.

Over the last few decades, the poultry meat consume has increased in popularity and among the reasons for this increased consumption are the relatively low costs of production (relative to beef and pork), the rapid growth rate of poultry, the high nutritional value of the meat and

changing consumer preferences on health (low in fat) or social (convenient, fast food) grounds and the introduction of many new further processed products.

In the early 1900s, most poultry was produced in small flocks mainly to supply eggs to support small farm units, and the eggs and live birds by product of the egg enterprise were sold live in local markets. Today, the poultry industry is highly integrated and managed by a number of large corporations.

At this time, the same chicken breed was used for both meat and egg production, with little or no selection. Over the years, the poultry industry has grown and specialized in meat production and egg production breeds. Farmers have started to specialize in certain aspects of raising poultry and, today, it is common to find operations specializing in only one phase of the growing stage (e.g., breeding, hatching or meat production). Modern growing operations are usually fairly large and house a few hundred thousand to a few million birds at one location.

In developed countries, poultry production and processing practices are controlled, at least in part, by legislation, and good practices may be further specified in various quality schemes that are efforts to co-ordinate quality requirements at specific stages of the supply chain. Such schemes can be led by producers, retailers, industry associations or government agencies.

The optimum amount of rest required by meat animals before they are slaughtered depends on the climate, the distance they have travelled, their method of transport and their general health. In some countries, where animals are auctioned at stock yards before they are taken to an abattoir, the rest periods are sometimes inadequate.

There are several criteria for a good slaughter method:

(1) animals must not be treated cruelly,

(2) animals must not be unnecessarily stressed,

(3) exsanguination must be as fast and as complete as possible,

(4) damage to the carcass must be minimal.

And the method of slaughter must be :

(5) hygienic,

(6) economical,

(7) safe for slaughtering workers.

## 2.-Husbandy and Slaughtering Processing

### 2.1.-Birds Husbandry and Reception

Birds Husbandry and Reception

- Birds Husbandry
- Live Birds
- Cathing
- Containers
- Transportation
- Chickens Hanging

### A.-Birds Husbandry

Husbandry employed during live-bird production of fowl readily affects the amount of meat produced and its quality. The relevance of the term `meat' is not limited to those who actually eat the product, but pertains to characteristics of the live bird, as well as all intermediate aspects of processing, marketing, etc., until consumption. In turn, the whole carcass, its cut parts, skinless, boneless meat, cooking effects and sensory attributes are all appropriate considerations. While genetics, sex and age determine each bird's yield and quality potential at any one time throughout live-bird production, the existing environment and all aspects of feed modify and provide for their expression. Simplistically, the environment represents a complex of conditions that are imposed externally, whereas feed, with its uniqueness of feedstuffs, nutrient balance and non-nutrient additives, must be consumed before expression. Flooring, temperature, humidity and pen density are obvious environmental concerns, whereas nutritional support is the central objective of feeding.

Microbial aspects have been excluded other than those that are implicit in the expression of husbandry. Broiler chickens and turkeys are the focus of attention, from initiation of formal production until the last feed is withdrawn in preparation for processing. Finally, any aspect of husbandry must also consider its impact on the welfare of the animal and consequences for the environment and society at large.

### B.-Live Birds

At the end of the growing phase, birds are caught, loaded into cages or coops and transferred to a processing plant. Transferring the live birds from the farm to the processing plant is a relatively short operation; however, significant problems may occur at this stage that potentially increase the rate of downgrading. Catching, loading and transportation exposes the birds to a number of new/unfamiliar conditions and environments. This, in turn, may increase stress/anxiety and negatively affect meat quality.

Broilers are usually processed at 4.5 lbs. live weight. Feed is withheld for 8 to 12 hours before slaughter to reduce the amount of feed in the gut and the possibility of tearing it during processing, which would cause fecal contamination of the carcass. Withholding the feed too long will result in watery guts that leak.

## C.-Cathing

Currently, the majority of birds are caught and loaded into cages by hand. In order to achieve the desired catching rate of chickens from a litter floor, it is necessary for the birds to be picked up by the legs. While picking up the birds by the sides is an "ideal" way, in respect to animal welfare, it is not commercially feasible due to the high catching rate required. Some of the recent welfare guidelines include a description of how birds should be caught and loaded. Chickens should be caught individually by grasping both legs, just above the feet. If carried in groups, care must be taken to ensure birds can be held comfortably without distress or injury, and carrying distance must be kept to a minimum. No more than three birds should be carried in one hand.

In theory, it is possible to catch and crate the birds by hand with virtually no damage to the birds. However, this is not always the case, because this physically demanding job makes it difficult on the workers to maintain the attitude and concentration required to handle birds carefully over an 8- hour shift. Therefore, where problems occur, management should pay attention to training and motivating people to ensure proper bird handling. There are different approaches to employing a catching crew, ranging from employing a permanent crew to hiring people off the street for a single assignment; the former gets much more training and incentives to do the job right. Overall, a significant amount of damage can be inflicted on the birds if the job is not done right, and the workers' motivation is to just get the job over with in the shortest possible time.

In order to keep injuries to a minimum, clear guidelines should be established and enforced by farmers, catching supervisors and processors. It is difficult to assess injury, except gross insults, to birds prior to loading, as the operation precludes easy inspection of the birds at the farm after they have been loaded. It is sometimes possible to ascribe retrospectively any injury or downgrading that might have occurred at the farm, but this is detected at unloading rather than on the farm.

## D.-Containers

Overall, there are three basic types of containers: loose crates, fixed crates and the new style of modular containers. Loose crates are the oldest type of transport container initially made of wood and string/wire. These are still used today in different parts of the world, but are constantly replaced by plastic crates of varying sizes (typical size for a chicken crate is 80 x 60 x 30 cm). The small size container, which can hold about 14 birds, makes it easy to handle. Plastic crates have either solid or perforated floors. While crates with solid floors are cheaper to buy and prevent droppings from one layer of birds from contaminating birds in the layer below, there are several reasons why perforated floors are often preferred. These are:1-) there is better ventilation of the birds; 2-)· temperature conditions are more favourable, especially in summer, and 3-) · respiratory moisture from the birds is discharged, so that the birds can remain dry thoughout the journey.These feature help to maintain bird quality and reduce the incidence of D "dead on arrival" (DOAs) at the processing plant.

Normal loading procedures require that birds be carried from the barn to the truck, rather than by taking the containers into the barn for loading; however, in some cases, the crates are carried to the truck or placed on a palette and later moved by special loading equipment. The birds are loaded into the crates through a relatively small opening, which limits their ability to "escape." This limited aperture size, however, also means that when loading groups of birds, there is a chance for physical injury, especially to the wings. Overall, the system offers a flexible, low equipment cost approach to loading and transporting the birds the processing

plant. At the plant, the crates are usually unloaded onto a conveyor system that moves the crates to the shackling line where birds are removed from the crates. Also at this stage, care should be exercised as to not hurt the birds, damage wings, etc

Fixed crates are built onto a truck and represent an integral part of the trailer. The crates are usually arranged in two banks with loading openings facing outside the trailer. The number of crates depends on the size of the birds (e.g., chickens, turkeys), truck size, etc. Typically, there are eight layers of 12 crates, making 96 crates. The loading is done from each side of the trailer and requires that the birds be carried from the house and either loaded directly or passed to another person positioned on the truck to allow the filling of the upper level crates.

Modules represent a fairly new development in transporting poultry. This system relies on larger containers requiring mechanical handling moving off and on the truck. This system represents a fundamental change from the two previous systems, where mechanization and improved welfare are taken into consideration. Overall, there are two basic modules that include the loose drawer and tipping modules. The loose drawer module comprises a number of plastic drawers positioned within a metal framework. The number of drawers depend on the size of the birds, where a typical size for broilers would be 1.2 m wide, 2.4 m long (equivalent to the full width of the transport vehicle) and 0.22 m high.

## E.-Transportation

Optimum conditions during transport from the growing shed to the processing plant are of vital importance in ensuring that birds arrive at the processing plant in good shape. Having selected the preferred method of transport of slaughter animals, it is necessary to take into account numerous factors in order to ensure the health and welfare of the animals. Broilers and other poultry are best transported by road. Any vehicles used for the tranport of slaughter livestock should have adequate ventilation, have a floor with proper drainage and provide protection from the sun and rain. No vehicles should be totaly enclose. Lack of ventilation cause undue stress and even suffovation, particularly if the weather is hot. Poor ventilation may cause accumulation of exhaust fumes in road vehicles with subsequent poisoning.

Minimizing stress during transport is an important issue from both an animal welfare and meat quality aspect. The birds are raised on large farms geographically dispersed and necessitates being transported, often over long distances, to processing plants. During transportation the birds may be exposed to different stressors during transit including thermal variations, vibration, motion, acceleration, withdrawal of feed and water, noise and social disruption. The combined effect of these factors may range from mild discomfort and aversion to death.

The major stress factor, during transportation, seems to result from changes in environmental temperature. That stress could be minimized by an appropriate control of airflow within the truck, both in motion and at rest (i.e., minimal natural ventilation during rest/stop time). Overall, the potential heat stress increases when the outside temperature and/or humidity are elevated, when the vehicle stops, curtains are drawn, etc. The risk is reduced when stocking density is reduced and when vapor density and temperature rise are minimized by adequate airflow. In the winter when curtains are closed, a "paradoxical heat stress" may occur within the "thermal core" even when the temperature outside is very cold.

## F.-Hanging Chickens on the Processing Line

The live-bird store at the processing plant, the lairage, should be big enough to store at least two hours production. It should allow birds to be protected from the weather in a well-ventilated environment with subdued lighting.

The next step is to hang the birds on the first of several processing lines, the killing line. On-farm and small plants unload birds from the crates and placing them on the shackle lineis often done manually. Modular systems introduce a degree of mechanisation into this process.These systems now predominate in high-capacity processing plants. At large plants, broilers are unloaded onto conveyor belts.Care must be taken when unloading the birds from the crates to prevent bruises and broken bones.

Full and empty crates are weighed to determine live-bird weight and the empty crates given a thorough wash before being restacked either manually or automatically. Clean crates or containers are stored separately from full crates or containers. In this case the lairage or live-bird arrival area can be divided into "dirty" and "clean" areas. Transport vehicles will have been washed down before being loaded with clean crates or containers for another run.

## 2.2.-Birds Husbandry and Reception


## A.-Stunning

Stunning is common in most plants except when religious considerations are involved (e.g., according to the Jewish and Islamic laws known as Kosher and Halal, respectively) and was originally done to immobilize the animal and allow for easier and safer handling of the animal. For poultry, immobilization was not as critical for manual slaughtering, but was necessary for the development of automated equipment. Stunning methods induce transient loss of consciousness and sensibility, and they rely solely on slaughter to cause death. Therefore, humane slaughter regulations require that the duration of unconsciousness induced by a particular stunning method should be longer than the sum of the time intervals between the end of stun and neck cutting, and the time it takes for bleeding to cause death.

Stun/kill methods include induction of cardiac arrest at stunning in a water-bath stunner, exposure to gas mixtures until the birds are dead, and penetrating or non-penetrating captive bolts. Electrical stunning of poultry is performed by passing an electric current either across the head (head-only stunning) or through the whole body using an electrified water bath (water-bath stunning) supplied with high-frequency currents (usually above 200 Hz) that do not induce death via cardiac arrest or ventricular fibrillation at stunning. The amount of current (mA) applied during electrical stunning must be sufficient to induce immediate loss of consciousness, typically in less than one second. Gas stunning of poultry in transport containers, as they arrive at the processing plant, eliminates the need for live-bird handling and the problems associated with electrical stunning. Gas stunning poultry on a conveyor would eliminate the problems associated with electrical water-bath stunning.

Poultry can be stunned by exposing them to either an anoxic (< 2% oxygen by volume) atmosphere created with nitrogen, argon or other inert gases, a minimum of 30% by volume of carbon dioxide in air, or a mixture of a low concentration of carbon dioxide (maximum of 30% by volume) with nitrogen or argon, leaving a maximum of 2% residual oxygen. Another method of stunning use captive bolts. There are penetrating or non-penetrating captive bolt devices that are fired using either cartridges or compressed air. Captive bolts induce immediate and severe structural damage to the brain, leading to death.

### B.-Bleeding

After birds have been stunned, a cut is applied to the blood vessels in neck to allow birds to bleed out. The time between stunning and neck cutting should be closely monitored to ensure adequate bleeding. Usually, it is recommended that neck cutting be done within 1 minute of electrical stunning. A long delay between the stunning and bleeding operations could increase the prevalence of downgrading associated with poor bleeding. Birds not bleed-out adequately, resulting in stagnation of blood in their wing veins. Such situations could exacerbate the presence of engorged wing veins; it could cause hemorrhages in the wings. In fact, stunning currents that induce ventricular fibrillation in a high proportion of broilers are associated with a high incidence of red wing tips and hemorrhaging in the shoulder and wing areas.

The bleed cut can be applied either manually or automatically. Manual cutting is obligatory in ritual slaughter when no stunning is applied, where the carotid veins and arteries on both sides of the neck must be cut through. Automatic cutting will usually sever the carotid vein and artery on one side of the neck only. This procedure does not damage the oesophagus or trachea, allowing these to be removed later in the process during evisceration. Blood drains from the bird into a bleeding trough. Ensuring rapid blood drainage causes anoxia and often prevents birds from regaining consciousness during the subsequent 80-90 second bleed time.

Bleed times will vary from 90 seconds for birds killed ritually or by automatic machines that cut the carotid vein and artery on both sides of the neck, to some 150 seconds when the bleed cut is applied automatically to one side of the neck only. This type of cut often leaves some blood supply to the brain, giving birds the opportunity to regain consciousness if the cut or bleeding is incomplete. This potential for regaining consciousness has been a major reason (from an animal welfare standpoint) that current levels of 120-150 mA per bird have been suggested as way to ensure an instantaneous and irreversible stun. Blood is pumped from the bleed trough to a storage tank. The blood loss represents about 4-5% of the total body weight.

### C.-Scalding

Scalding involves submerging the carcass in hot water. In this process turbulent hot water is used to transfer heat to the feather follicles, which then relax allowing feathers to be removed

mechanically in the pluckers. In a small plant, scalding can be performed manually in a large bucket. i.e., placing the carcasses in and removing them from a tank. In large plants, it is done in a continuous manner employing a single stage or multistage scalding bath while the birds are suspended from a moving shackle line. The scald water can be heated by direct steam injection or by low pressure steam or hot water circulated through integral heating panels mounted in the scald tank. The temperature of the scald water is monitored and controlled electronically. There are, however, many older scalders still in everyday operation, where turbulence is induced mechanically by electrically or hydraulically driven impellers. For birds that are difficult to scald (waterfowl, in particular) a wetting agent or detergent may need to be added to the water.

In all of the scalding procedures, adequate agitation of the water and uniform water temperature are essential to ensure good feather removal. To improve meat hygiene, careful scalding equipment design is required. Because one gram of soil material (e.g., dirt, fecal material) attached to the feathers can contain 108-109 microorganisms per gram, it is important to minimize cross-contamination in this common bath. Maintaining and controlling the temperature is one of the key features to keep bacteria load under control. Another means is the use of a counterflow design. The design results in clean water being introduced at the exit end of the tank and water flow toward the entrance where the more contaminated birds are introduced.

There are three commonly employed scalding schemes and selection of the scheme to employ depends on factors such as the degree of difficulty in removing the feathers, chilling method to follow (water, air) and age of the bird. Semi-scald or slack scald is the name given to scalding for 60-180 seconds in 50-53oC water. By using this time and temperature the epidermal layer is left intact. Birds that are being slaughtered for an exhibit should be scalded in this way to improve the appearance of the carcass. Water that is too hot will cause the outer layer of skin to loosen and be lost. Loss of that skin also results in loss of some yellow pigment on the skin. Sub-scald is the use of water at 54-58oC for 60-120 seconds. The epidermal layer is broken down by this time-temperature combination but the feathers are usually much easier to remove. For home processing this method of scalding is recommended.

Hard-scald or full scald requires a water temperature of 59-61oC for 45-90 seconds. This method is faster and eliminates pinfeathers, but the birds have a less desirable appearance. In the case of hard scalding, the outer layer of the skin, epidermis becomes loose and is later removed during the plucking operation, where rubber fingers are used to rub the skin. The removal of the epidermis can result in the skin becoming discolored if dehydrated during later air chilling. This method is the only satisfactory way to release the feathers of waterfowl. Whatever method is used the birds must be properly bled.

### D.-Plucking, Removal of Head, Oil Glands and Feet

Pluckers are installed immediately after the scalding process so that carcasses remain warm during feather removal. They are equipped with rubber fingers that rub the feathers off the carcass. The defeathering equipment is composed of a few units of these disks, and the carcass is passed between the rotating disks. The fingers can also be mounted on drums that rotate toward the center. When religious requirements dictate that scalding cannot be used, automatic plucking is not satisfactory and then the feathers must be removed manually. If mechanical pickers are used they should be adjusted for the size birds being picked. Mechanical pickers make the job much faster. Birds that are to be exhibited should be plucked by hand being sure that all pinfeathers are removed, and that there is no damage to the skin.

This procedure requires a good deal of time if done correctly. Rubbing the feathers from the skin is frequently more effective than a picking motion.

After feather removal, the heads, oil glands, and feet are removed. On-farm and small processors usually cut the head off; large plants have machines that pull heads off so that the esophagus is also removed. Birds preen their feathers with an oil gland located on top of the tail. It is almost 1% of the carcass, but because of its odor and taste it is removed. Asian markets may prefer a carcass with the oil gland intact; government regulations permit it to remain under religious kill exemptions.

The feet are removed at the knee joint. In small plants, birds are put on evisceration shackles after scalding and picking. In large plants, after the feet are removed, the birds are rehung on the shackles. When birds are first hung, it is easiest to hang them by the feet, but during rehanging, they are hung by the knee joint. This process also keeps the dirtier kill shackles separate from the cleaner evisceration shackles. One kill line feeds several evisceration lines, since evisceration is relatively slow. In a small plant, nine shackles per minute is a good rate during evisceration.

### E.-Evisceration

Evisceration involves the removal of the contents of the body cavity plus the feet and head. To remove the head cut around the neck just behind the head, and twist. The neck skin should then be split down the back. A second cut made around the base of the neck followed by a twist will usually separate the neck from the body. Next the esophagus, trachea and crop should be separated from the neck skin. They can be left attached and be pulled from the body with the viscera. The body cavity can be opened by making a small cut near the vent, extending the cut around the vent, being careful not to cut the intestine or contaminate the carcass with fecal material. For exhibition birds the abdominal opening should be as small as possible to improve the appearance of the finished product. After the abdomen is open the viscera can be removed through the opening. It is very important to remove all the viscera, including the lungs that are attached to the back. After all the contents of the cavity are removed the bird should be thoroughly washed inside and out.

After the viscera have been removed the heart, liver, and gizzard should be separated and saved. The ends of any parts of the vascular system that may be attached to the heart should be removed by trimming off the top to expose the chambers. The heart should be washed and squeezed to force out any remaining blood. The green gall bladder should be carefully trimmed away from the liver. Next the gizzard should be split lengthwise and the contents washed away. The lining should then be peeled away from the rest of the gizzard.

### F.-Washing

Washing can occur at different points in the slaughter process. The most common point is before chilling, when the carcass is washed inside and out. Rinsing helps to remove any debris left on the carcass after scalding, feather removal and evisceration. On-farm processors usually use hoses to wash. Small and large plants use foodgrade hoses and sprayers. Where permitted, bactericidal rinses, such as chlorine and organic acids, can be used. Chlorine, in levels up to 20 ppm, is one of the most commonly used chemicals (where permitted). Bactericides, such as organic acids and phosphates, are more commonly used prior to chilling.

Sanitizing agents may greatly reduce the levels of surface bacteria when the carcass is washed, but at the risk of hiding poor sanitation at earlier stages of processing. There is much

to commend the philosophy of preventing initial contamination rather then removing it once it is present.

## G.-Chilling

After the evisceration procedure has been completed the carcass should be cooled as soon as possible. Ice water or a refrigerator can be used, however, the ice water will do the job a little faster. If birds are to be frozen the gizzard, heart, and liver can be wrapped in waxed paper and placed inside the body cavity. The birds can then be placed in a moisture-vapor proof bag and frozen. For birds that are to be exhibited an effective way to preserve the carcass is to bag it and store it in finely crushed slush ice. Packing too tightly in ice, particularly ice that has large pieces can cause the carcass to have dents or distortions in the meat. This does not influence the flavor but does change the appearance that is important for exhibited birds. The most common methods include water-immersion chilling, air chilling and spray chilling (which includes air and water).

For immersion chilling, it is common to use long chillers with a counterflow of cold water, sometimes supplemented with crushed ice, to bring the carcass temperature to about 4-5°C within 30-75 minutes. The carcasses are dumped into a trough-like structure that usually contains a large diameter auger that moves the birds forward Another design employs large paddles that move the product slowly forward. Parallel flow chillers (i.e., product and water flow in the same direction) and chillers with cold water added along the chilling tank are still used in various plants. However, the most common design used today is the counterflow design, where the product moves counter to the flow of the cold clean water. This is a more efficient way of cooling the carcasses (i.e., coldest temperature at the end of the tank) that also assists in improving hygienic conditions. The chilling tank length and diameter are determined by the product flow requirements. The average dwell time is 30-40 minutes, but dwell time can be changed by slowing down or speeding up the auger movement.

To increase cooling efficiency, agitation and turbulence are used. A simple and economical way of achieving turbulence is by blowing low-pressure air into the tank at various points at the bottom of the tank. The amount of air can be adjusted to increase/decrease mixing. It is important to remember that only clean air, preferably from outside of the plant, should be used cleaner product. In the pre-chiller, fresh water is used for the initial chilling and washing of the carcasses. A counterflow design assists in the removal of blood and small pieces of loose tissue from the product that is moving toward cleaner water. The product is then lifted, drained and passed into a postchiller, where clean, cold water is used to further cool the product. Ice can be added at different locations, but is usually added toward the second half or the end of the chilling tank. The product emerging from the chiller is allowed to drip for a few minutes so that excess water will come out. In many countries, the amount of water picked up during the chilling process is regulated and is based on a certain percentage of the body weight.

Cold air is used as a chilling medium, so care should be taken not to dry the product surface. This is usually achieved by increasing the air humidity (which also improves heat transfer) and/or wetting the product at some point(s) along the chilling process. By doing so, dehydration losses can be reduced to about 1%. Air-chilling equipment requires more space and uses more energy than water-chilling equipment, and costs more. However, water use is low. Air-chilled poultry is usually sold fresh. Birds that are air-chilled should be softscalded, if they are hard-scalded, the meat may discolor. Spray chilling is a hybrid between water and air chilling. Cold water is constantly sprayed over the carcasses while they are moving on a shackle line. Moisture pickup is less than during water chilling, but it is higher than during air

chilling. Overall, choosing one chilling method over another depends on many factors. Among the key factors are market demand, water cost and availability, electricity costs and capital investment available.

### H.-Whole Carcass Selection

Once carcasses have been chilled, they are now ready for packing as whole carcasses, portions or deboned meat. Each individual carcass must now be graded by weight and quality, so that it can be allocated to the correct process as dictated by the marketplace. The correct allocation of carcasses is essential, if a processing plant is to operate profitably. Carcasses are transferred either manually or automatically to a pre-selection line, on which they are graded by weight and quality. The grade standards, developed by each country or trading community, are applied to a specific kind and class of poultry. However, some general criteria are considered in assessing most poultry. Factors such as overall conformation, presence of pinfeathers, discoloration and missing parts are fairly universal criteria applied to all kinds of poultry.

## 2.3.- Poultry Cuts Packaging


## A.- Portioning and Deboning

There are different ways to cut up a poultry carcass. Depending on market demand, poultry can be sold as a whole, ready-to-cook bird, split into two halves, separated into different parts (wings, legs) and sold with/without skin and bones (e.g., boneless breast). In high volume markets, a large percentage of carcasses is cut into portions for retail sale, for use in restaurant and catering outlets and as a raw material for an increasingly wide range of fast-food products. On-farm processors generally sell carcasses whole. They do not offer cut-up. In low throughput plants carcasses can still be cut manually. In this plants, about 16 to 30% of the birds need to be cut-up because of bruises, broken bones in the picker, etc. In most medium and high throughput plants, however, birds are cut automatically by modular systems able to operate at hourly throughputs of 5000 carcasses or more.

More and more carcasses are being deboned to satisfy the rapidly increasing demand for deboned meat for use both at home and in the preparation of an ever wider range of further processed convenience and catering products. Whilst many lower volume plants still debone by hand, labour cost and availability will often dictate that deboning is done automatically. Cut-up includes removal of the wings, legs, and front halves (breast). Whole legs and leg quarters can be cut into thighs and drumsticks. Common cut-up configurations consist of eight pieces (wings, breasts, thighs, drumsticks). The wings can also be cut into drumettes. The remaining racks are a by-product.

## B.-Poultry Cuts

The descriptions and definitions of meat cuts and their proper names (nomenclature) are obviously very important for the seller and buyer. The following are definitions used by the Canadian Food Inspection Agency (CFIA, 2006) provided as an example:

**Poultry:** refers to a meat derived from dressed carcasses of birds. Note: the name of the bird from which the meat is derived is required to appear in the product description in lieu of the word poultry.

Dressed poultry carcass (whole poultry): refers to a poultry carcass from which the feathers, head, the feet at the tarsal joints and uropygial gland have been removed and which has been eviscerated.

**Half poultry:** refers to one of the two approximately equal portions of a dressed poultry carcass obtained, excluding the neck, by cutting through the backbones, pelvic bones and keel bone (sternum) along the median line.

**Front quarter:** refers to the front (anterior) portion of a poultry half obtained by cutting immediately behind (posterior to) and parallel to the rib.

**Hindquarter:** refers to the hind (posterior) portion of a poultry half that is separated from the front quarter. (Note: the term leg, back attached, may also be used to identify this cut.).

**Wing:** refers to that portion of the whole poultry obtained by cutting through the shoulder joint. It includes the wing drumette and the winglet and may include the wing tip.

**Wing drumette:** refers to the proximal portion of the wing that is separated from the whole poultry by cutting through the shoulder joint as described, and from the winglet by cutting through the elbow joint. (Note: the wing drumette shall not be referred to as drumstick.

**Winglet:** refers to that distal portion of the wing obtained by cutting through the elbow joint. Part of the wing tip may be removed.

**Leg:** means that portion of the whole poultry obtained by cutting at the natural seam through the hip joint. It includes the thigh and drumstick jointed or disjointed and may include pelvic meat. It excludes pelvic bones, back skin, abdominal skin and excess fat.

**Thigh:** means that proximal portion of the leg that is separated from the whole poultry by cutting at the natural seam through the hip joint as described, and from the drumstick by a straight cut through the knee joint. It may include pelvic meat but shall exclude pelvic bones, back skin, abdominal skin and excess fat.

**Drumstick:** means that distal portion of the leg that is separated from the thigh by a straight cut through the knee joint as described in the thigh section.

**Breast:** means that portion of the whole poultry that is separated from the wing by cutting through the shoulder joint, from the neck by cutting approximately through the twelfth (12th) neck bone, from the back by cutting through the ribs at the junction of the vertebral ribs and back and from the hindquarter by cutting immediately behind (posterior to) the rib cage. The breast includes the "Y"- shaped ends of the ribs and excludes the neck skin. The breast may be portioned in two approximately equal parts (half breast) as described or in three parts by first removing the wishbone portion then by cutting the breastbone (sternum) along the median line. For exact weight-making purposes, these parts may be substituted for lighter or heavier pieces, and the package may contain two or more of such parts without affecting the appropriateness of the product description as breast.

**Half Breast:** means one of the two approximately equal portions of a breast obtained by cutting through the breastbone (sternum) along the median line.

**Wishbone:** refers to the front (anterior) portion of the breast obtained by cutting through the hypocledial ligament located between the tip of the wishbone and the front point of the breastbone, then between the wishbone (clavicle) and coracoid up to a point where the wishbone (clavicle) joins the shoulder. The neck skin is excluded.

**Trimmed breast:** means that portion of the breast obtained by cutting along the junction of the vertebral and sternal ribs. The sternal ribs may be removed, and the neck skin shall be excluded. The trimmed breast may be portioned in two approximately equal parts (half-trimmed breast) as described or in three parts by first removing the wishbone portion as described, then by cutting the breastbone (sternum) along the median line. For exact weight making purposes, these parts may be substituted for lighter or heavier pieces, and the

package may contain two or more such parts without affecting the appropriateness of the product description as trimmed breast.

**Half-trimmed breast:** means one of the two approximately equal portions of a trimmed breast obtained by cutting through the breastbone (sternum) along the median line.

**Breast fillet:** is the round, elongated fusiform muscle found on each side of the keel bone (sternum).

**Whole back:** means the portion of the whole poultry that is separated from the breast as described in the breast section. It includes the neck, thoracic vertebrae, pelvic bones and tail. It may include parts of the vertebral ribs.

**Back:** means that portion of the whole back that is separated from the neck by cutting in the vicinity of the shoulder joint. It includes the thoracic vertebrae, pelvic bones and tail, skin and adhering meat. The vertebral ribs and/or scapula may be removed.

**Stripped back:** means the back from which the meat adhering to the pelvic bones has been removed.

**Neck:** means that front (anterior) portion of the whole back or carcass obtained by cutting near the shoulder joint. It may include the skin.

**Poultry giblets:** means the liver, the heart or the gizzard or any combination thereof of the same species, obtained from a dressed poultry carcass.

## C.-Microbiological Quality

Aerobic storage of poultry meat under chill conditions leads to the development of a characteristic microflora. The organisms concerned are generally termed "psychrotrophs", because they can multiply at chill temperatures, but have temperature optima above 20°C. a few fail to grow at 30°C. At spoilage, the predominant organisms are invariably Pseudomonas spp., accompanied by lower numbers of Acinetobacter, Moraxella and Psychrobacter spp., including Ac. johnsoni and Psychr. immobilis. These bacteria show the fastest growth rates under the prevailing conditions and include strains with the greatest spoilage potential. Other Gram-negative bacteria that can be isolated sometimes from spoiled poultry include Shewanella putrefaciens and various cold-tolerant strains of Enterobacteriaceae, such as Enterobacter and Serratia spp. All the above organisms are likely to originate in the environment of the live bird, and most are common in soil and water. While Pseudomonas spp. predominate at spoilage on chilled poultry meat stored in air, any marked temperature abuse of the product can lead to the development of a different microbial association.

The changes in microflora that result from storage of poultry at temperatures above the chill range will affect the pattern of microbial metabolites associated with spoilage. The composition of the spoilage microflora also changes when raw-meat products are treated in a manner that seeks to extend shelf-life by reducing populations of pseudomonas and other Gram-negative psychrotrophs or inhibit their growth by modifying the environmental conditions. In the latter case, the organisms that predominate at spoilage are usually lactic acid bacteria, including those referred to previously as "atypical lactobacilli".

## D.-Packaging

The need for fresh food to be supplied to distant markets has increased interest in methods of extending product shelf-life. Shelf-life requirements should include not only the time needed to reach the market, but an additional period of refrigerated display and consumer holding time. Microorganisms exist in the environments in which meat is produced, processed, packaged and stored. Merely covering food prevents microorganisms from gaining access and thus acts as a physical barrier to cross-contamination. With packaging systems aimed at extending shelf-life, one goal is to prevent pathogens from growing to dangerous levels before product spoilage becomes obvious to the consumer.

The conditions under which poultry are offered for sale differ widely around the world, but only in more developed regions is there extensive use of refrigeration for the raw meat. Elsewhere, marketing may involve the sale of live birds, on- the-spot slaughter or same-day slaughter and sale. In all cases, however, it is recognised that poultry meat is a highly perishable commodity, the main reason being that it provides an excellent medium for microbial growth. While freezing and frozen storage can be expected to prevent the multiplication of microbes on the meat, holding the product under chill conditions merely serves to delay the growth of cold-tolerant organisms. Nevertheless, the establishment of an appropriate cold chain, from

production to the point of sale, ensures that the meat has a shelf-life that is sufficiently long to satisfy consumer needs.

The functions of a food package can be considered further under four headings: containment, information, convenience and protection. Containment includes holding multiple portions of chicken parts, such as legs, thighs, wings or breasts, allowing them to be sold in various amounts or combinations. Information includes nutritional labeling, proper handling practices, product information and identifiers of source, etc., required by law. The package also contains the product price, claims made for the product, cooking suggestions and pack recycling instructions. Convenience allows single-serving amounts of sliced meat and microwaveable packs for cooking/reheating and serving of the product in the pack. Protection includes that from rodents, dust, microorganisms, chemical contaminants, environmental humidity, light and oxygen. The pack should also protect the product from tampering, physical damage and moisture loss during handling.

Although there are relatively few different food-packaging materials, there are many variations within some types of material and many combinations of materials. The types and forms of materials used for poultry-meat products include fiber-based (paper, paperboard), glass and metal. In addition, many poultry packages have plastic materials as coatings, linings, overwraps or bags.

| Polymer type | Use | Features |
|---|---|---|
| EVA-LDPE copolymer | Seal layer, films, wraps | Heat shrinkable |
| Ionomer | Heat-seal layer | Resists seal contamination |
| LLDPE | Heat-seal layer | Good clarity |
| Nylon (PVdC coated) | Films, thermoformed trays | |
| Nylon (uncoated) | Films, thermoformed trays | Also used as bone guards |
| PET (PVdC coated) | Films | |
| PET (uncoated) | Films, trays | Good clarity |
| PP (non-oriented) | Semi-rigid containers | |
| PVC | Fresh-meat wrap | Gas transmission rate depends on plasticization |
| PVdC | Barrier layer | Barrier less affected by moisture |
| EVA: ethylene vinyl acetate; LDPE: low-density polyethylene; LLDPE: linear low-density polyethylene; PVdC: polyvinyldiene chloride | | |

## 3.-Processed products

### Poultry Meat Products

WITHIN the last couple of decades, many new processed poultry products have been introduced in the market. The poultry industry has taken the initiative to develop fresh, marinated and fully cooked products and has adopted some red meat recipes. All have helped to increase consumption and move away from seasonal demand. In the beginning, red meat recipes were modified to manufacture poultry products (e.g., frankfurters), and later, new technologies were developed exclusively for poultry (e.g., chicken nuggets). Overall, the poultry industry successfully responded to consumer demand for more convenient food items including semi- and fully prepared items. The increase in poultry meat consumption has been the result of aggressive marketing, the favorable nutrition profile of the meat and the competitive price of poultry meat.

Today, consumers can choose meat products from a wide variety consisting of a few hundred different products. Becoming a knowledgeable consumer can be a challenge. To assist the consumer, various systems have been suggested for classifying meat products. One of the most common ways to classify products is to group them into six categories:

. fresh, such as fresh poultry breakfast sausage

. uncooked and smoked, such as Italian sausage

. smoked and cooked, such as frankfurters, bologna

. cooked, such as liver sausage and pates

. dry/semidry or fermented, such as summer sausage, dry salami

. cooked meat specialities, such as luncheon meats, jellied products and loaves.

In addition, the development of new technologies represents two additional categories:

. restructured meat products, such as cutlets, where small bits and pieces of meat are made into a whole muscle fillet-like product (i.e., by using freezing, high pressure and hydrocolloid gums)

.surimi-like products, such as special chicken rolls, where minced meat is washed (to remove pigments and enzymes) and extruded to obtain a fiber muscle-like texture.

## Sausage Process

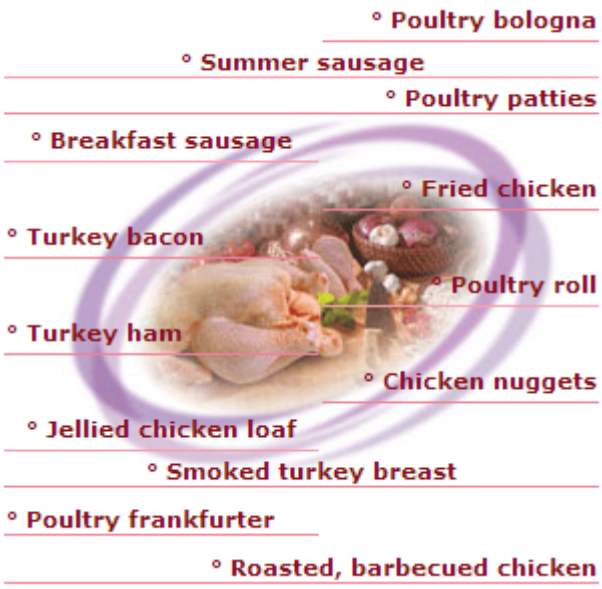
The process of sausage manufacturing originated from the necessity to increase the uses of remnants of meat, fat of clearness meat parts and less nobles cuts, adding value to these products. There are many different types of sausages. The differences between them are related with the type of meat, the size of meat grinder disk, the seasonings, the casing diameter, the buds length and the presence or not of smoking.

## Salted products Process

The salting process act in control and reduction of microorganism, increasing the product shelf-life. They are prepared in the same way, so the process is going to be explained just one time.

## Smoked products Process

The smoking process, besides adding value to the meat cuts, it also makes desirable alterations like gold outside color, smoked taste and good juiciness. The smoking process associated with salt using (sodium chloride, nitrite of sodium) and with dryer, act in the reduction and control of microorganisms, and increase the products shelf-life . The creation of new product options enables alternative chooses for the consuming market and a possible additional income source for small scale producers.




## 3.1.-Smokey Turkey Breast

Smoked breast is a premium product produced from either whole breast muscle or its portions. A brine solution (i.e., water, salt, spices and 8), prior to smoking and cooking. The meat is massaged or tumbled after brine injection to assist in moisture absorbing and achieving an even distribution of the non-meat ingredients within the muscle. The latter is important in the processing of any meat product, as an uneven distribution of salt, etc., can cause serious flavor, color and textural problems. Hydrocolloid gums such as carrageenans are often added to assist in holding the injected brine that can reach 30 - 50 %. Non-meat proteins (e.g., soy concentrate/isolate, whey proteins) can also be added for the same purpose. Additives, such as lactate, are sometimes added for preservation. The breast muscle is then stuffed into a netting (the muscle can be covered with skin), smoked and cooked in a smokehouse until an internal temperature of at least 70°C is reached.

## 3.2.-Poultry roll

Poultry rolls can be made from dark meat, white meat or their combination. The meat is obtained from breast meat, leg meat, trimmings and the skin of turkey/chicken. In this product, pieces of meat are bound together to form a coherent product. Salt is added to extract the salt-soluble protein (mainly actin and myosin) that contributes to binding the meat pieces and holding moisture and fat within the product. The skin and some of the trimmings are usually finely chopped (the term "emulsified" is often used by the industry, even though no true emulsion is formed) to facilitate the binding of the fat. Seasonings are added to provide flavor. Moisture is added to compensate for cooking losses and to improve the juiciness of the product. If added moisture exceeds a certain level (limits vary in different countries) of the raw meat, the product should be labeled as a water-added chicken/turkey roll.

The meat pieces are mixed together with the non-meat ingredients until the meat becomes sticky (i.e., used as an indication of good protein extraction) and all the added moisture is absorbed. The mix is then stuffed into casings, and the product is cooked either in a water bath or an oven, depending on the casings used, equipment available, market preference, etc.

### 3.3.-Poultry ham

Poultry ham is typically manufactured from poultry thigh meat. The product is usually leaner than the traditional pork ham. In the initial manufacturing step, a brine solution (i.e., water, salt, phosphates, flavorings and nitrite) is added either by injection or marination of small meat pieces. Tumbling is commonly used when brine is injected or used as a marinating solution to help achieve maximum absorption, even distribution of the curing ingredients and extraction of the salt-soluble proteins to the surface, which is important for binding the muscle chunks together during later heating. The meat is then stuffed into fibrous casings that determine the shape of the final product (round, oblong) and size. The ham is smoked, or smoke flavorings are added to the raw batter, and cooked to at least 68°C.

### 3.4.-Turkey bacon

Layers of light and dark meat

### 3.5.-Summer Sausage

Summer sausage represents a group of fermented meat products where commonly a lactic acid bacteria culture is added. The product can be made from dark poultry meat, skin and fat, but usually some pork meat and fat are included; pork fat is added because it is more stable and harder at room temperature. In this process, lactic acid bacteria are used to lower the pH of the product from about 5.7 - 4.8 and also to add unique flavor notes. In the past, microorganisms from a previous successful batch were introduced into a new batch, and the product was allowed to ferment. Today, the industry mainly uses commercial starter cultures with a known composition of microorganisms (predominantly lactic acid bacteria). The producer can select from cultures that grow at different temperatures and produce distinct flavor compounds. Recently, a lot of progress has been made in the field of starter cultures, mainly through the use of genetic engineering, where desirable characteristics from one strain can be moved to another.

Overall, the use of a starter culture is highly recommended because it ensures that lactic acid bacteria dominates the fermentation (commonly added at about 107 per g), suppresses pathogens and produces the desired flavors. The degree of fermentation can be controlled by the quantity of the carbohydrate added (i.e., an energy source for the microorganisms) or by continuous pH monitoring. After the fermentation (1-2 days with a starter culture), the product is either smoked, cooked or only dried. The dry product is usually shelf stable due to its low pH (4.6 - 5.0) and low water activity (Aw - 0.90).

### 3.6.-Poultry frankfurter

Frankfurters and bologna are examples of finely comminuted meat products that have homogenous appearances. Leg meat, trimmings, skin and/or mechanically deboned meat are usually used as raw materials. When the relatively lean leg meat is used, fat and skin are added. The meat is finely chopped in a bowl chopper or an emulsion mill that efficiently chops the meat particles and emulsifies the fat. Salt is added to extract the meat proteins that are essential in binding the small meat particles and stabilizing the fat globules within the protein matrix. Nitrite is added to inhibit Clostridium botulinum growth and provide the typical cured meat color. The meat batter is then stuffed into cellulose casings, smoked and cooked in a smokehouse. Because frankfurters are such a high volume item, some processors have constructed dedicated lines to continuously make this product. As with other meat products, low microbial contamination and refrigerated temperatures are important in prolonging the shelf life, where some manufacturers guarantee a shelf life of 50 days.

### 3.7.-Poultry bologna

Bologna are examples of finely comminuted meat products that have homogenous appearances. Leg meat, trimmings, skin and/or mechanically deboned meat are usually used as raw materials. When the relatively lean leg meat is used, fat and skin are added. The meat is finely chopped in a bowl chopper or an emulsion mill that efficiently chops the meat particles and emulsifies the fat. Salt is added to extract the meat proteins that are essential in binding the small meat particles and stabilizing the fat globules within the protein matrix. Nitrite is added to inhibit Clostridium botulinum growth and provide the typical cured meat color. The meat batter is then stuffed into cellulose casings, smoked and cooked in a smokehouse. Because frankfurters are such a high volume item, some processors have constructed dedicated lines to continuously make this product. As with other meat products, low microbial contamination and refrigerated temperatures are important in prolonging the shelf life, where some manufacturers guarantee a shelf life of 50 days.

### 3.8.-Poultry patties

Hamburger type, not cured

### 3.9.-Breakfast sausage

Ground product, sold fresh or frozen

### 3.10.-Chicken nuggets

Chicken nuggets are one of the most successful poultry products introduced in the 1980s. Originally, the product was prepared from a single piece of slightly marinated breast meat that was battered and breaded. Later, nuggets made from trimmings, dark meat, skin, mechanically deboned meat and their combinations started to appear on the market. The product is usually prepared by marinating and mixing the meat pieces with a brine solution (i.e., water, salt and flavorings) until all the solution is absorbed. The meat is then put through a forming machine that creates the desired product's shape (i.e., square, oval, dinosaur), followed by battering, breading and deep-fat frying. Frying is done to preserve the product shape, assure breading adherence and to provide the typical crispy texture of the breading.

### 3.11.-Fried chicken

Battered and breaded, sold un- or pre-cooked

### 3.12.-Roasted, barbecued chicken

Prepared with dry heat, crisp skin

### 3.13.-Jellied chicken loaf

Cooked meat held in a gelatin matrix

## 4.- Poultry Meat quality and consumers prefences

Consumers define quality according to their own perceptions, goals and personal preferences, but, in practice, the quality concept has both subjective and objective components. Skin colour appears to be critical for the marketing of fresh whole birds or cut portions. The colour of the meat is more relevant to deboned and skinless, raw items and is particularly significant in relation to many cooked products, where a pink or red appearance is associated with an

impression of undercooking. Dark or black bones are recognised as a defect in cooked products and bone darkening may be observed in products that have been frozen prior to cooking. Other visual defects include bruises and haemorrhages of varying severity.

Consumer preference for skin colour shows some interesting variation for broilers, with preferred colours ranging from white, through pale yellow to deeply pigmented, and choice being based on traditional market forms Although appearance and colour are undoubtedly important in initial product selection, consumers may also make judgements on other matters. In particular, some are likely to examine the label for nutritional information, details of any colourings, preservatives or other additives, as well as taking note of instructions on storage, handling and cooking of the product. Equally, consumers will take account of any negative quality attributes that are apparent. For whole carcasses, in particular, these can include dislocated or broken bones, cuts or tears in the skin, bruises, blisters, lesions, reddening of wing tips, residual feathers and fragments of tissue that are normally removed during processing, surface discolouration and excessive weepage of fluid into the pack.

Such defects have their origin either on the farm or in the processing plant, and some may be associated with pre-slaughter handling of the birds. Generally, the most important visual defects are those due to bruises and haemorrhage the latter being more visible when the skin has been removed. The difference between the two is that bruising results from physical trauma, without laceration, and involves rupture of capillary blood vessels; haemorrhage, on the other hand, is an escape of blood from the circulatory system into the surrounding tissue and is often seen as blood spots of varying size in skinless cut portions.

Meat flavour and texture can only be appreciated when the product is consumed, but usually there are no indications at this stage of chemical and microbiological aspects of product quality, which have to be taken on trust. Included here are any possible chemical contaminants and microorganisms derived from both the rearing and processing environments. Microbes can be important for two reasons. Firstly, in those products where microbial growth is favoured, they are potentially responsible for ultimate spoilage, especially in the case of chill-stored, raw-meat and shelf-life depends partly on the numbers of spoilage organisms present initially. Secondly, microbial contaminants may sometimes include low numbers of particular foodborne human pathogens.

## 5.-Animals Welfare

Many consumers are concerned about the welfare of food animals, especially during rearing, transport and slaughter of broilers. To some people, intensive husbandry systems equate with "factory farming" and they find that the manipulation of animals to improve production performance is unacceptable. While attitudes to these issues vary widely between countries and among individuals, there can be little doubt about the importance of welfare considerations across the world and their impact in shaping modern agricultural practices.