SLAUGHTER PROCESS

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Flesh of healthy animal is free from pathogenic and spoilage microorganisms and also from toxins. Microorganisms gain access in to meat from live animal during slaughter operations, from environment and from personnel. The toxicants enter in to the animal through feeds, grazing soil, air and water. In India meat and poultry industry mainly depends on sheep, goats, pigs, buffaloes, cattle and chicken. Meat is produced in about 3600 traditional slaughter houses and in a few modern abattoirs. The quality of meat produced in traditional slaughter houses is not satisfactory. Increased consumer awareness for hygienic meat has emphasized the need to produce meat under carefully controlled conditions in modern abattoirs. Meat production practices differ from country to country and region to region. Hence the production of hygienic meat depends on animal management practices, type of transport of animals, abattoir design, slaughter practices, environmental conditions and personnel associated with animal handling and processing.

A modern abattoir is not merely a slaughterhouse where animals are killed for meat, but it is also a food factory, where all the operations are dictated by standards of hygiene and animal welfare.

The following aspects are dealt with in this topic to understand the various steps necessary to produce safe meat for consumption.

1. Design of abattoir
2. Abattoir building
3. Abattoir operations
4. Hazard Analysis Critical Control Points (HACCP) System
5. Grading of carcasses / meat

1. DESIGN OF ABATTOIR

In modern abattoir all the operations are dictated by standards of hygiene and animal welfare. Location, design, layout and operations of an abattoir should conform to certain specifications and standards. These are briefly discussed.

Location: The location of the abattoir is based on three major factors, *viz.* (i) Raw material availability, (ii) Market and (iii) Infrastructure facilities.

Meat animals come from rural areas while the meat produce finds market in cities. The outskirts of the city are preferred for establishing abattoirs. Some of the major considerations are listed below.

- Availability of road / rail transport facilities
- Adequate water and electricity supply
- Elevation of site to facilitate drainage of effluent water
- The site should be fenced to prevent access by animals or unauthorized persons.
- Sufficient surplus land for possible expansion program for future
- Susceptibilities of the community around the construction site
- Abattoirs should be located away from the public places and also airports to prevent bird menace to aircraft.

Construction and layout: The design of construction and layout of the abattoirs are governed by the size and method of operations. The essential steps involved in a model abattoir practice include:

- Holding animals in lairage
- Antemortem inspection
- Stunning
- Bleeding
- Skinning and evisceration
- Postmortem inspection
- Washing with clean water
- Holding the carcass prior to transportation to meat stalls or to cold room.

The important components of the abattoir are (i) Lairage, (ii) Slaughter hall, (iii) Cold storage and (iv) Rendering unit (Fig. 1).

Lairage: The important considerations are adequate space to accommodate animals, easy cleaning facility, easy access for livestock, facilities for watering and antemortem inspection.

Slaughter hall: The slaughter hall is the main component in the complex where slaughter and dressing of animal take place. The important components of this unit are: (i) Stunning pen, (ii) Hoist and overhead rail systems for bleeding, skinning and evisceration, (iii) Byproducts section and (iv) Condemned carcass room. The salient considerations for the design of this unit are:

- Unidirectional flow of carcasses
- Separate sections for slaughter, skinning and dressing
- Spacing between lines to facilitate easy movement of carcasses and personnel
- Facilities for collection / disposal of byproducts and wastes

- Washing facilities
- Carcass hanging room
- Meat cutting room
- Lockers for equipment
- Adequate toilet facilities for personnel

2. ABATTOIR BUILDING

As far as possible, local materials should be used in construction. Floors and drains should be impervious to water and floor bases must be pest proof against rodents. The floor must be easy to clean and smooth but not slippery. Floors should be sloped towards open drain. Interior walls should be made impervious with smooth cement plaster. Junctions at all walls and floors should be covered.

For roof construction, either wood or steel is used for the framework. To cover the roof, corrugated aluminum, corrugated iron or asbestos sheets are used. If wood is used for doors, galvanized steel plate should be fixed to the bottom of the door on the outside for protection against rodents. Slaughterhouses should have free access to air. Doors and windows should be covered with netting to prevent the entry of insects. Building should have fly - proof system. The grills in the roof ridging are important as they will allow warm air to escape and cooler air to be drawn in through the doors and windows.

Lighting: Adequate natural or artificial lighting must be provided throughout the abattoir. Every abattoir should be constructed in a way that meat inspection can be easily done in daylight. Sockets for the use of inspection lamps should be provided at convenient places. Abattoir should be provided with well - distributed artificial light. The overall intensity should not be less than 540 lux (50 foot candles) at all inspection points, not less than 220 lux (20 foot candles) in workrooms and not less than 110 lux (10 foot candles) in other areas.

Ventilation: Abattoir should be provided with sufficient means of ventilation to the outside air. Adequate ventilation prevents excessive heat and steam condensation. It also prevents the accumulation of odors and dust. The slaughter hall should not have direct sunlight on carcasses. Opening of ventilators and windows should be screened.

Water supply: A safe, potable and constant supply of water should be available. Water requirement in an abattoir is: 450 liters / day / pig, 270 liters / day / cattle and 50 liters / day / sheep or goat. Supply of clean hot water should be available in the slaughter hall and work rooms. Every sanitary convenience in an abattoir should be supplied with water by suitable flushing appliance. Facilities for washing of hands should be provided for persons working in an abattoir.

Equipment: The equipment have to be kept as simple as possible to keep costs down. The equipment and fittings should be easy to clean. Self - draining type of equipment are recommended. The implements should be of corrosion resistant metal. Suitable facilities should be provided in convenient places within abattoirs for the sterilization of wiping cloths, knives and other equipment used in the abattoir.

The necessary equipment for a small scale abattoir for sheep are listed below:

- Water trough
- Electric stunner
- Skinning cradle
- Overhead rails
- Blood bins
- Gambrels
- Offal bins
- S - hooks
- Weighing scale
- Hose pipes
- Splitting saw
- Knives
- Hanging beams
- Hoist
- Head washer hose
- Tripe table
- Trolleys
- Buckets
- Sterilizer for hand tools
- Water storage tank
- Septic tank
- Wash basins

Facilities for personnel in the abattoir to be provided are:

- Showers
- Toilets
- Lockers
- Aprons
- First aid kit
- Hats
- Overalls
- Gum boots
- Gloves

Abattoir management

The following points should be borne in mind in abattoir management.

- Livestock maintenance in stock yards or in lairages
- Organization of animal owners: There are two categories, namely,
  - Butchers slaughtering their own animals and pay fees to the abattoir owners
  - Butchers handing over the animals to the abattoir authorities for slaughtering
- Antemortem examination and disease control
- Physical structures and equipment for better upkeep of abattoir
- Personnel management including training
- Organizing production schedules and achieving production targets
- Proper handling of carcasses, byproducts and wastes
- Postmortem examination
- Maintenance of sanitation and hygiene in abattoir
- Effluent treatment
- Social welfare measures for the staff
- Follow up of stipulated regulations and specifications
- Regulating inputs and outputs and supervision of critical quality control points.

Personnel qualified in veterinary science and meat technology should manage the abattoir.

3. ABATTOIR OPERATIONS

Essential steps in the modern abattoir practices involved in processing of sheep (Fig. 2) and poultry (Fig. 3) are briefly described below.

Antemortem inspection: Animals are examined for diseases or abnormalities by the veterinarian. Healthy animals are selected as per the regulations. Washing the animals prior to slaughter reduces the microbial contamination.

Stunning: The animal is placed on a stunning cradle and then it is rendered unconscious by an electrical stunning device (70 V for 10 sec) for sheep, goats and pigs and by captive bolt pistol for cattle and buffaloes.

Slaughter: The traditional methods of slaughter followed in India are Halal and Jhatka. Halal method is an Islamic method commonly practiced for sheep, goat and cattle. In this method, a transverse cut is made with a knife over the throat to severe jugular veins, carotid arteries, trachea and oesophagus. Oesophagus is tied. Jhatka method is a Sikh method. The head is cut off by one stroke of a sword. In all parts of Northern India, skilled operators can slaughter buffaloes by a single stroke of a special sword. Halal method of slaughter is normally followed in India.

In the humane method of slaughter, the animal is not subjected to suffering during slaughter. Slaughter of animal in unconscious state is a humane method. This is done by stunning the animal prior to slaughter. Stunning is done in cattle by captive bolt pistol, in sheep or goat by electrical method and in pigs by electrical method or by carbon dioxide.

Bleeding: Animal is allowed to bleed for 2 - 3 minutes.

Hoisting on to overhead rail: A gambrel is introduced between the two hind legs and the animal is hoisted over the on - rail system. Dressing and evisceration operations are carried out while dead animal is hung on the rail.

Dressing: Head is removed. A cut is made down the centre of the loose skin covering the belly and the skinning proceeds over the flanks. The skin is pulled down over the backbone towards the neck and removed. Skinning operation is done manually with the help of a knife. The skin is retained on the carcass in the case of pigs as pig skin is edible.

Evisceration: Removal of visceral organs of an animal during slaughter and dressing is called evisceration. The rectum is loosened and tied. A small cut is made in the belly wall just above the brisket and the fingers of the left hand are inserted to protect the viscera. The belly wall is opened with right hand using a knife. The stomach, intestine and rectum are removed. The bladder is taken out. Oesophagus is pulled up through the diaphragm. The breast bone is split and the pluck (trachea, lungs, heart, spleen and liver) is removed.

Postmortem inspection: Carcass and the organs are inspected for disease conditions and abnormalities. The condemned carcasses, if any, are diverted to the sections earmarked.

Washing: Carcasses and organs fit for consumption are thoroughly cleaned with a spray of water. Decontaminating treatments is carried out on the carcass at this stage.

Chilling and cold storage: Chilling is optional in India since hot carcasses are sold directly to the customer. If there is a need for further storage, hot carcasses are chilled at 2 - 4 °C for further use. To avoid "Cold shortening" and consequent development of toughness, the pre -

rigor carcass is held initially at 15 °C until the pH falls below 6.0 and then cooled to 2 - 4 °C. The cold storage capacity decides the total capacity of the plant. There should be arrangement for hanging of carcasses with adequate space between them for proper air circulation and rate of chilling.

Rendering: Rendering unit is an essential unit in modern abattoir. Thermal processing of byproducts for the production of animal feed ingredient is referred to as rendering. Rendering is advocated to process fats, blood, offals, condemned carcasses, feathers, bones and trimmings. The three types of rendering are wet, dry and continuous low temperature rendering.

Wet rendering: This process is also referred to as steam rendering in which raw material is loaded in a large tank and the tank is sealed. Steam is introduced into the material and maintained at 2 kg / cm^2 pressure till the fats are freed from the tissues. Three layers form in the tank – fats on top, water layer in the middle and slush at the bottom. Water and fat are removed to obtain rendered solid material.

Dry rendering: Dry rendering refers to the process in which raw material is cooked in steam jacketed kettle. Dry rendering system is usually more advantageous because of maximum recovery of protein and minimal contribution to pollution.

Continuous low temperature rendering: The system uses low temperature heating, separation and cooling on a continuous flow basis and is usually regarded as an ideal process.

4. HAZARD ANALYSIS CRITICAL CONTROL POINTS (HACCP) SYSTEM

Food animals are the primary sources of pathogens that cause food - borne infections and intoxications in humans. For production of safe meat with better shelf life, the HACCP system is recognized as a process control system during the meat production operations in abattoirs. Good manufacturing practices (GMP), good hygienic practices (GHP) and standard operating procedures (SOP) are essential for successful development and implementation of HACCP system. The HACCP system is a proactive process control system for minimizing or eliminating hazards (biological, physical and chemical) and for producing safe meat in abattoir.

The main principles of design for HACCP system are:

- *Critical control points (CCP):* These are the steps to prevent or eliminate meat safety hazard or reduce it to an acceptable level.
- *Critical limits:* These are maximum or minimum values to control a hazard at CCP to prevent or reduce safety hazards.
- *Monitoring procedures:* This will ascertain whether a CCP is under control.
- *Corrective actions:* When there is a failure in the specified action to meet a critical limit, an alternative (corrective) action is necessary to meet a critical point.
- *Verification procedure:* This will help find out that HACCP system is implemented as intended.
- *Documentation:* Records related to the procedures followed need to be maintained.

Sanitation: Sanitation relates to all the cleanliness activities in abattoir and surrounding environment for eliminating or limiting the pathogenic and spoilage microorganisms. Essential

facilities needed include ample supply of cold and hot water, wash basins, hoses, hose pipes, sterilizers, sterilizing rooms, detergents and sanitizers. General cleaning procedure involves removal of soil, gross fat and meat scrapings, washing with hot water and treatment with a sanitizer such as chlorine.

5. GRADING OF CARCASSES / MEAT

The carcass or meat can be graded as Prime, Choice, Standard, Commercial and Utility, which are characterized as below.

Prime: This is meat produced from young and well fed animal, highly acceptable and palatable, has better marbling, juiciness, tenderness and flavor. Such meat is most useful for roasts and steaks.

Choice: It is meat of high quality with slightly less fat than prime grade meat. This meat is more useful for braising and pot roasting.

Good: Meat has little fat with acceptable degree of quality. It is less juicy and less tender.

Standard: This meat has very thin covering of fat and has mild flavor and lacks juiciness.

Commercial: This is meat from old animals, lacks tenderness and requires long and slow cooking with moist heat.

Utility: This is meat from old animals, lacks tenderness and juiciness with very little fat. It is palatable and economical source of meat for pot roasting, stewing and boiling or ground meat dishes.

Further, meat from sheep is labeled as Veal (< 3 months), Calf (3 – 8 months), Lamb (1 - 2 year, yearling mutton) and Mutton (> 2 years) depending on the age of the animal.

CONCLUSION

Microorganisms gain access in to meat from live animal during slaughter operations, from environment and from personnel. The toxicants enter in to the animal through feeds, grazing soil, air and water. Consumers look for clean and safe meat that does not cause health hazards. The quality of meat produced in traditional slaughter houses is not satisfactory. Hygienic processing of animals is a necessity for the production of safe meat. This is made possible in modern abattoir where specified standards are applied in every step in the operations of handling of animals and processing of carcass / meat. Application of hazard analysis critical control points system coupled with good manufacturing practices and sanitary measures controlled the sources of microbial contamination of carcasses in modern abattoirs.

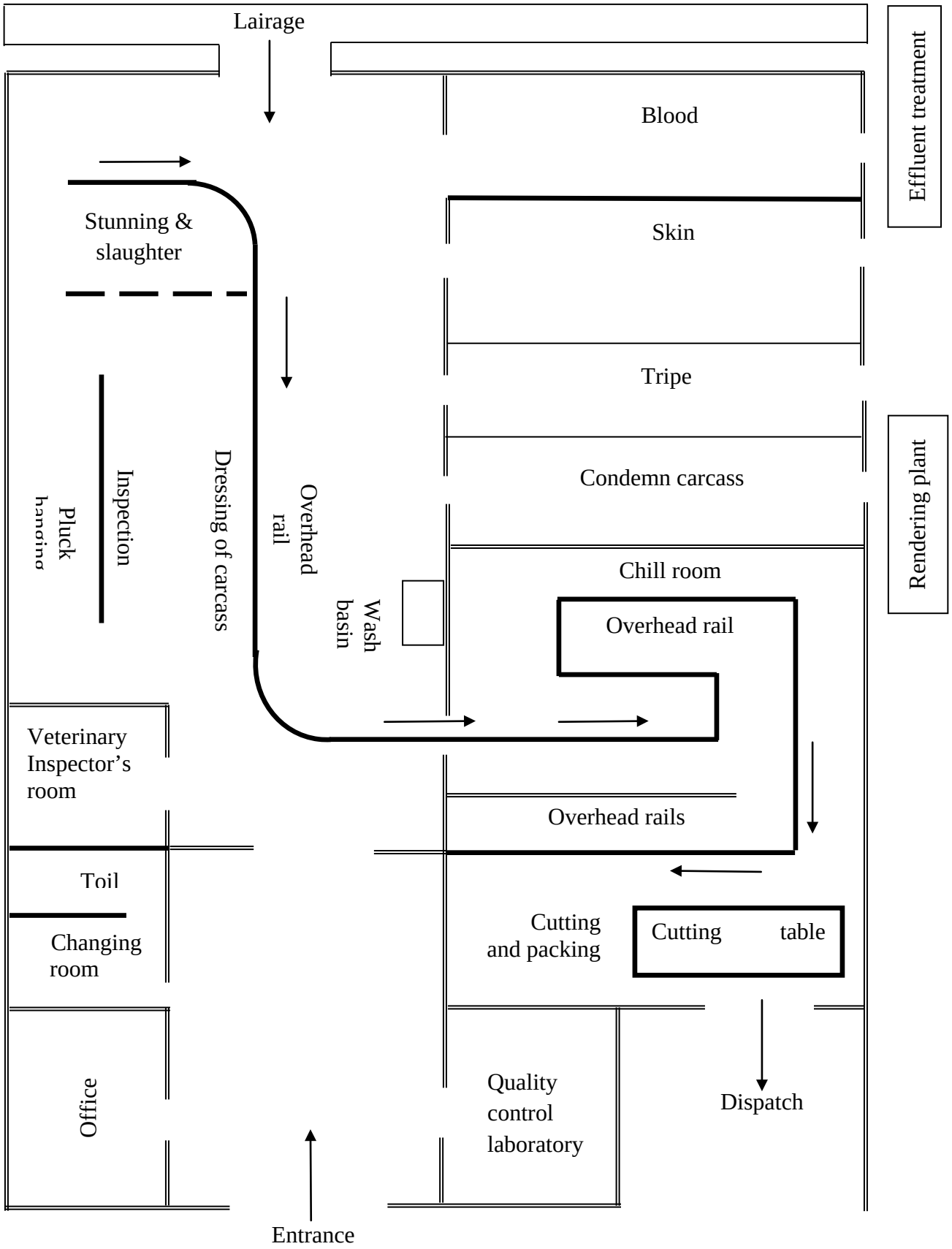

Fig. 1. Abattoir layout

Source: Sakhare 2007.

Rest animal in lairage ↓	
Stunning ↓	
Bleeding → ↓	Blood – separate room
Skinning of hind and fore legs and removal of feet → ↓	Feet - separate room
Tying oesophagus ↓	
Removal of head → ↓	Head – separate room
Carcass to overhead rail and removal of skin ↓	
Washing carcass with water spray ↓	
Clipping of anus and rectum ↓	
Open abdomen and evisceration → ↓	Viscera – separate room
Split brisket, removal of pluck and hanging on overhead rail ↓	
Postmortem inspection ↓	
Trimming and washing of carcass with water spray and removal of pluck ↓	
Transfer carcass to chill room (4 ºC) ↓	
Cut up of carcass in cool room (7 ºC) for retail cuts ↓	
Packing of retail cuts	

Fig. 2. Processing steps for the production of hygienic sheep meat in abattoir

Source: Narasimha Rao 2011.

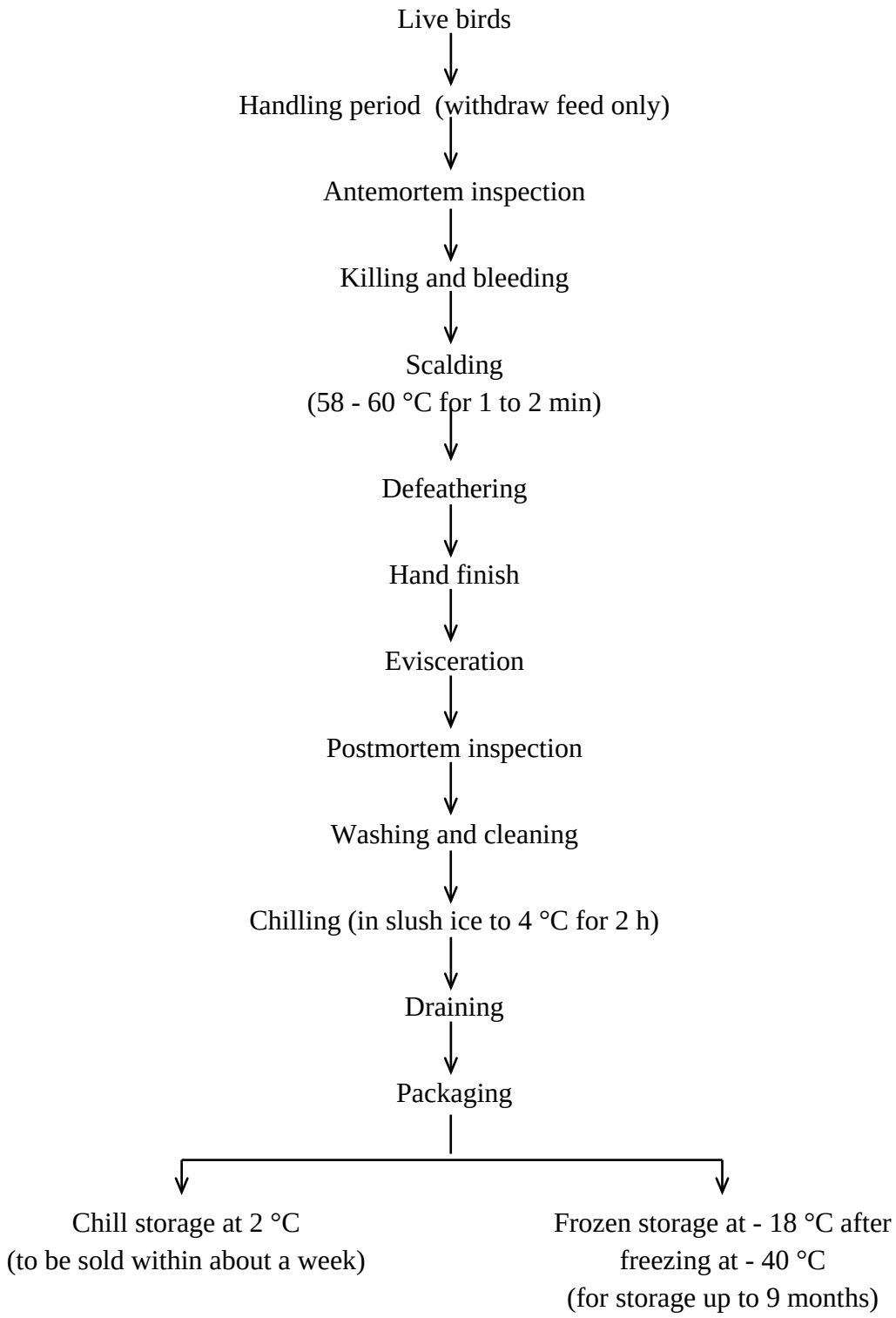

Fig. 3. Processing of poultry

Source: Jagannatha Rao 2007.