UNIT 9  PLANT SANITATION AND MEAT REGULATIONS

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9.0 OBJECTIVES

After reading this unit, you will be able to:

- create comfortable and hygienic conditions for stay of the livestock and birds in lairage;
- establish hygienic atmosphere and structures in meat processing units;
- narrate the functions of different cleaning and sanitizing agents for the meat plant;
- illustrate good manufacturing practices and standard operating procedures for a meat plant;
- describe the steps of hazard analysis and critical control point (HACCP);
- identify the critical points of poultry processing and large animal slaughter; and
- state regulations and standards related with meat and meat products.

9.1 INTRODUCTION

The meaning of the word ‘Sanitation’ is the science of safeguarding health. According to the World Health Organization, environmental sanitation embraces the control of all those factors in man’s (in our context animals) physical environment which exercise a deleterious effect on the physical development (to productivity), health and survival. The physical environment encompasses the non-living objects and physical factors affecting the animals, viz., air, ventilation, lighting, noise, climate and water. In fact, the term sanitation covers the whole field of controlling the environment of animals
with a view to prevent from diseases and promote health. A good sanitation program will maintain a clean and sanitary environment for all areas of food production, right from receiving to processing, storage and transportation.

The basic problems encountered during the maintenance of sanitation in animal houses include the lack of awareness and ignorance among nearly 72% of our population living in the rural areas, about the role of environmental sanitation in the protection and promotion of their own health and safety. Problems relating to availability of safe water for use on farm and abattoir and disposal of excreta are of major concern. The task remains to eliminate other factors of environment which livestock are exposed to the challenge of potential pathogens such as sheds, pens, parlours and brooders. The pathogens are brought from outside by wind (viral agents can travel a great distance through air), dust (Q fever, brucellosis, tuberculosis), vectors (mosquitoes, lice, ticks, fleas). The infective agents voided by diseased animals serve as source of infection to healthy stock, and many cases to man as well. Different methods of spread of infections includes following:

(i) Contact e.g., Leptospirosis, Salmonellosis, Shigellosis,

(ii) Ingestion e.g., Rinderpest, New Castle Disease, Brucellosis and Haemorrhagic Septicaemia etc.,

(iii) Inhalation e.g., Tuberculosis, Brooder Pneumonia, and Food and Mouth Disease.

### 9.2 GMPS, SSOPs AND HACCP SYSTEMS IN MEAT PLANT

Sanitary and processing requirements in the form of Good Manufacturing Practices (GMPs) are necessary to ensure the production of wholesome food. Therefore, the sanitation programme of every meat processing establishment should be systematically organized for quality assurance and public health protection. To prevent harmful microbes entering the food chain, Hazard Analysis and Critical Control Point (HACCP) is widely used in abattoir during post slaughter processing and in service operations. Proper implementation of control measures at critical points identified through the HACCP system will ensure that finished products are safe. The programs established for GMPs and Standard Operating Procedures (SOPs) will provide the basis for ensuring product safety in the HACCP system, thereby, the high level of product quality conforming to standards such as ISO 9000 system (Fig.9.1). Therefore, it becomes evident that GMP and SOP are two essential tools required in a meat processing facility to help the production of high quality and safe meat products.

![Figure 9.1: GMPS and SOPs form the foundation for the Hazard Analysis and Critical Control Point (HACCP) system and ISO 9000.](image-url)
9.2.1 Good Manufacturing Practices

(1) Personnel

All employees who work in the food production areas of the plant should be aware of the plant. GMPs for personnel cover disease control, cleanliness, education and training, and supervision of the working personnel.

Disease control of the working personnel is an important aspect of food safety. Meat handlers having illness could be a source of microbial contamination to meat and meat based products. Therefore, person with illness or having open lesions including boils, sores or infected wounds should not be engaged in food production. Personnel in the production area need to practice many things related to cleanliness (Fig.9.2). This include personal cleanliness, washing hands, wearing of gloves and hairnets, storing of personal belongings properly and removing jewellery that might fall into food products and result in a physical hazard. At the same time practices like chewing a gum/tobacco, smoking and makeup in the food production area should be avoided.

![Figure 9.2: Practice proper personnel cleanliness](image)

Information, skills, and/or attitudes to be acquired by slaughterhouse personnel through education and/or training. Training or education is required for following reasons:

- Understanding that their work must be conducted in a hygienic way as it is essential to produce meats and meat products which are safe for the consumer public.
- Awareness, throughout their working time, that they are working with food products.
- Understanding the consequences of possible mistakes during processing and cleaning procedures (e.g., which might cause unintended contamination).
- Understanding the necessity of personal hygiene and the significance of frequent hand-washing.
- Knowledge of procedures for cleaning of knives, other utensils and work surfaces must be well understood and practiced.
- Motivation to collaborate with inspectors and technicians in the cleanliness of operations and of premises.
- Understanding the need to inform managers/inspectors of any symptoms of disease.
- Understanding that the personnel themselves can become infected during the handling of meat or in close association with animals and the means by which such infections can be avoided.
(2) **Buildings and Facilities**

The general principles of plant design and construction assure adequate lighting and ventilation etc. These are necessary for maintaining sanitary conditions. These also include the handling of cleaned equipment and utensils, proper use and storage of cleaning and sanitizing agents and other toxic substances, and pest control (Fig. 9.3).

The requirements for sanitary facilities and control include water supply, plumbing, sewage disposal, toilet facilities, hand-washing facilities and disposal of rubbish and offal.

![Figure 9.3: Proper storage of chemicals in a food production facility](image)

(3) **Equipment**

The general principles of design, construction and maintenance of equipment and utensils should be followed to provide protection to food from contamination with lubricants, fuel, metal fragments, contaminated water and others. The conditions facilitating easiness of cleaning and maintenance of clean conditions are also very important for sanitation. Instrumentation used to control critical parameters like pH, temperature and water activity must be accurate and adequately maintained.

### 9.2.2 Sanitation Standard Operating Procedure (SSOP)

The manager of abattoir is responsible for implementing and daily monitoring of the Sanitation SOP, and recording the findings and any corrective actions. All records pertaining to this SSOP should be maintained on file and made available to Meat Inspection personnel.

I. **Pre-Operational Sanitation:** It is concerned with the cleaning of equipment and facilities before starting the main operation i.e., slaughter or product processing.

A. **Cleaning of Equipment:** All equipment used for meat processing should be cleaned and sanitized prior to start of production, as per the following procedures:

1. **Established cleaning procedures:** These include following steps:
   a. Equipment is disassembled, as necessary.
   b. Food debris is removed from equipment.
   c. Equipment parts are rinsed with water to remove remaining food debris.
   d. Equipment/parts are rinsed with potable water 53-60°C (120-140°F).
   e. Equipment/parts are inspected for cleanliness, and re-cleaned if necessary.
   f. Equipment is reassembled, re-sanitized and re-rinsed, if necessary.
2. **Implementation, Monitoring and Record keeping:** The manager should perform daily organoleptic, sanitation inspection after pre-operational cleaning and sanitizing. If inspector finds that equipment is acceptably clean, then it is approved for work.

3. **Corrective Actions:** When manager determines that equipment or parts are not properly cleaned, the cleaning procedure and inspection are repeated, and the employees doing the cleaning are re-trained, if necessary.

### B. Cleaning of facilities including floors, walls and ceilings

1. **Established Cleaning procedures:**
   - Debris is swept up and discarded.
   - Facilities are rinsed with potable water.

2. **Cleaning Frequency:** Floors and walls are cleaned at the end of each day of processing. Ceilings are cleaned as needed, but at least once a week.

3. **Implementation, Monitoring and Record keeping:** The manager should perform daily organoleptic, sanitation inspection after pre-operational cleaning of facilities, as described above.

4. **Corrective Actions:** When the facilities are not found properly cleaned, the cleaning procedure and inspection are repeated.

### II. Operational Sanitation:

It is concerned with the cleaning of equipment and facilities during main operation like slaughter and dressing operations.

#### A. Established methods/Standard operating procedures (SOP) for carcass slaughter/dressing:

The following standard procedures help in achieving high levels of hygiene during slaughter operations.

1. **Established hygienic procedures for employees in slaughter/dressing section:** It includes:

   a. Employees should clean hands, arms, gloves, aprons, boots, etc., as often as necessary during the slaughter/dressing process.

   b. Employees should clean and sterilize knives, other hand tools, saws, etc., with hot water (82°C) as often as necessary during the slaughter/dressing process to prevent cross contamination of carcasses.

   c. Brisket saw should be sterilized with hot water (82°C), after use on each carcass.

   d. Employees doing evisceration should keep hands, arms, clothes, aprons, boots, knives, etc., clean during the process. If contamination occurs, the employee must step away from the carcass to clean and sanitize their apron, boots and knives. They should wash hands and arms with soap and water.

2. **Monitoring and Record Keeping:** The manager is responsible for ensuring that employee hygiene practices, sanitary conditions and cleaning procedures are maintained during a production shift.

3. **Corrective Actions:** On identification of some sanitation problems in the operation, employees should be notified by the manager to take appropriate action to correct the sanitation problems. Manager should attempt to determine the cause of contamination, and take corrective actions. If necessary, slaughter is stopped and/or employees are re-trained.

#### B. Meat processing operations:

Meat processing is performed under sanitary conditions to prevent direct and cross-contamination of meat products.
1. **Established hygienic procedures for employees processing meat products:** It includes—

   - All employees handling meat should wear hairnets during processing.
   - All employees should clean and sanitize hands, gloves, knives, spatulas, cutting boards, etc., as necessary during processing to prevent contamination of meat products.
   - All equipment, table or countertops should be cleaned and sanitized throughout the day, as and when needed.
   - Employees should take appropriate precautions when going from a raw product area to a cooked product area, to prevent cross contamination of cooked products. Employees should change outer garments, wash hands and sanitize hands with an approved hand sanitizer (equivalent to 50 ppm chlorine), and put on clean gloves for that room or area.

2. **Established procedures for meat product handling and storage:** It includes—

   - Raw and cooked processing areas should be separate. There should not be any cross use of equipment between raw and cooked meat product.
   - Outer garments, such as aprons and gloves, should be identified and designated specifically for either raw or cooked meat processing. Outer garments should be maintained in a clean and sanitary manner and changed at least once a day, and if necessary, more often.

3. **Established procedures for insect and rodent control:** It includes—

   - Insect and rodent traps should be maintained in non-food handling areas. All areas (dry storage rooms, coolers, processing rooms, etc.) should be checked for visible rodent droppings and insects.

4. **Established procedures for mid-shift clean-up:** It includes

   - A full clean-up should be done for the meat processing areas and equipment, in the event that processing time exceeds 5 hours.

5. **Implementation, Monitoring and Record keeping:** The manager should be responsible for ensuring that employee hygiene practices, sanitary product handling procedures, pest and rodent control, and midshift cleaning procedures should be maintained during a processing shift.

6. **Corrective Action:** In case some sanitation problem is identified in processing, employees should be notified by the manager to take appropriate action. If necessary, processing should be stopped and/or employees should be retrained. The corrective actions should be recorded on form.

**9.2.3 Hazard Analysis and Critical Control Point (HACCP)**

This is a system of food quality control to render foods safe for human consumption. Emphasis is laid on controlling foodborne hazards particularly the foodborne infections and intoxications during production itself. Hazard refers to unacceptable contamination, survival and/or growth of hazardous microorganisms. In case of slaughter house hygiene, it should also be extended to any pathological condition of carcasses. Hazard Analysis (HA) includes factors affecting possible microbial multiplication in food production and can be used to prescribe microbiological specifications for safety and thereby monitoring food quality. Microbiological status and the sanitary conditions of processing and storage are two important aspects of HACCP.
The introduction of specific HACCP concept involves the following:

a. Identifying hygienic hazards
b. Ranking these hazards
c. Defining the critical limit
d. Identifying the critical control points
e. Recommending necessary control
f. Record keeping
g. Verification procedures to ensure efficiency
h. Tests to ensure that the concept is working.

HACCP has been successfully used in food safety activities.

The seven principles of a HACCP program as defined by the National Advisory Committee in Microbiological Criteria for Foods are as follows:

1. **Conduct a hazard analysis**

   Assess hazards associated with each operational step of growing, harvesting raw materials and ingredients, processing, manufacturing, distributing, marketing, preparing, and consuming food; and identify the prevention measures that can be taken at each step to reduce the risk to acceptable levels.

   A food safety hazard is any biological, chemical or physical property that may cause a food to be unsafe for human consumption.

2. **Identify critical control points**

   A critical control point is a point, step or procedure in a food process at which control can be applied and, as a result, a food safety hazard can be prevented, eliminated or reduced to an acceptable level. So determine critical control points (CCPs).

3. **Establish critical limits for each CCP**

   A critical limit is the maximum or minimum value to which a physical, biological or chemical hazard must be controlled at a critical control point to prevent, eliminate or reduce to an acceptable level. So define critical limits.

4. **Establish procedures to monitor each CCP**

   Monitoring is necessary to ensure that the process is under control at each critical control point.

5. **Establish corrective actions**

   Corrective actions are to be taken when monitoring indicates a deviation from an established critical limit. These are intended to ensure that no product injurious to health or otherwise adulterated as a result of deviation.

6. **Establish effective record keeping procedure**

   HACCP regulation requires that all plants maintain certain documents, including its hazard analysis and written HACCP plan and records documenting the monitoring of critical control points, critical limits, verification activities and the handling of processing deviations.
7. **Establish procedures for verifying the HACCP system is working correctly**

Verification ensures the HACCP plan is adequate, i.e., working as intended. Verification measures may include biological, physical, chemical, and sensory methods, and, when needed, establishment of necessary criteria.

The HACCP principles should be applied to livestock slaughtering and dressing. It identifies several potential CCPs in the livestock slaughtering environment, as well as the measures to be taken at those points to assure the cleanliness and integrity of dressed carcasses. These measures involve the elimination of contamination and application of good manufacturing practices (GMP) before, during as well as immediately after slaughter. For example, the stress, handling and holding during the transport of animals to slaughter may increase the shedding of bacteria by healthy carriers and the spread of surface contamination by pathogenic organisms. The likelihood of carcass contamination during slaughter and dressing becomes greater. Thus, surface hygiene is of major importance in sanitary dressing and preventive measures must be taken to minimize and eliminate stress during transport.

Ideally only healthy animals should be slaughtered for food. Sick animals or animals suspected of being infected should be identified as suspects and should be butchered only at conclusion of regular slaughter. Animals that are visibly dirty with dust or soil, mud, faeces, urine and other debris associated with husbandry, handling and transport should be subjected to pre-slaughter washing to eliminate potential contaminants during the slaughter and dressing process.

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**Figure 9.4: Identification, control and monitoring of hazards in food plants**

- Determine stages of HACCP
  - Raw material
  - Processing
  - Storage
  - Distribution

- Identification of hazards (along with levels)
  - Microbiological (severe/moderate/low)
  - Chemical
  - Physical

- Determine CCPs (Complete or partial)

- Monitoring of CCPs

- Verification of HACCP system
Figure 9.5: Critical control points in a poultry processing line
9.3 CLEANING AND SANITATION IN MEAT PLANT

We quite often use the term “clean” to define a surface which is visibly free from any type of dirt or soil. However, in terms of hygiene, it may be of following three types:

1. Physically clean: free from visible soil,
2. Chemically clean: free from cleaning compounds and other chemical residues, and
3. Microbiologically clean: free from bacteria or an undesirable number of bacteria.

In meat plants, the term ‘clean’ is used to denote ‘freedom of a work surface, equipments or meat and meat products from all the materials that may be contaminant or potentially hazardous such as meat scraps, fat, blood, manure, rust, dust, and even cleaning compounds’. Clean working conditions in a meat plant provide immense satisfaction to the staff and augment their efficiency. The food products manufactured under high standards of hygiene leads to improved consumer acceptance and sales.

According to National Sanitation Foundation of USA, “Sanitation is a way of life. It is the quality of living that is expressed in the clean home, the clean farm, the clean business and industry, the clean neighbourhood, the clean community and clean people. Being a way of life, it must come from within the people. It is nourished by knowledge and is an ideal in human relations”. Good sanitation in any food industry contributes significantly to the product quality and through restricting the microbial activity, preserving the freshness and palatability and enhancing the shelf life.

In view of above, it becomes evident that the cleaning and sanitation are integral parts of slaughtering and handling of meat. Accordingly, these should be taken into consideration while planning the construction of slaughter facilities. The standard of hygiene and management in a slaughterhouse can be judged by both bacteriological and visual methods. These methods, if used together, will help in identifying the points where hygiene must be improved. In other words, the visual methods will judge the efficiency of cleaning process while the bacteriological methods will reflect at the efficacy of disinfection (sanitation) process.

**Essential requirements for the cleaning and sanitation in meat processing units are:**

- Water supply
- Electricity supply
- Energy for boilers, incinerator etc.
- Machines, equipment etc.
- Detergents and disinfectants
- Climate
- Buildings
- Trained staff
- Organization of slaughtering
- Types of animals slaughtered.

**General steps in cleaning and sanitation of meat premises**

Step 1: “Physically pick up” all big chunks of wastes on floors and equipments.

Step 2: “Dry sweep” the floors to remove all particles of meat, fat and scraps.

These two steps are essential to decrease the load on the waste water treatment plant and to prevent clogging of the drain pipes.

Step 3: “Pre-rinse” the floors and equipments with warm water 49-54\(^\circ\)C (120-130\(^\circ\)F) to loosen the soil.

Step 4: “Clean with detergent” selection of detergent, concentration, time, temperature and pressure of application must conform to standard norms.
Step 5: “Rinse with hot water” 66-77°C (150-170°F).
Step 6: “Sanitize with appropriate sanitizer and wash thoroughly” to remove all traces of chemicals particularly from those surfaces which come in direct contact with products.

Ways to improve the standards and efficiency of cleaning and sanitation in meat premises:

Decision 1: Emphasize on dry sweeping before carrying out the wet sweeping.
Decision 2: Emphasize on practicing hygiene at process, product and personal levels.
Decision 3: Identify and demarcate the clean and unclean areas and operations.
Decision 4: Check the type of material used in equipment or surface to be cleaned.
Decision 5: Check the type of soil or dirt to be cleaned.
Decision 6: Choose the suitable detergent(s) according to the soil.
Decision 7: Decide on use of sequestering agents and temperature of the water to be used.
Decision 8: Choose the suitable sanitizers(s) according to the surface to be sanitized.
Decision 9: Wash/rinse thoroughly to avoid residues on contact surfaces
Decision 10: Verify the efficiency of the cleaning and sanitation.

Types of materials used in fabricating equipment or surface in meat plant:
Stainless steel, Aluminum, Zinc, Copper and Tin, Rubber, Plastic, Concrete, Cement Glass, Painted surfaces, Galvanized iron and Wood.

Demarcation of clean and unclean operations:
The main hygienic principle in processing is that clean and unclean operations are efficiently separated. This requires a well planned plant layout, where the purpose of any structure should be to protect the products against unintended contamination.

Processing principle is shown in the following flow-diagram.

![Flow-diagram showing the demarcation between clean and dirty operations in a slaughtering process](image-url)
9.3.1 Cleaning

Cleaning principle and materials are as follow:

(A) Soil (dirt): Before planning a cleaning programme one of the essentials is to know which types of soil are present in the area to be cleaned. Fat and protein are the most common types of soil in the meat industry. The cleaning of different types of soil is described below:

i) Carbohydrates: These are not a usual type of soil in slaughterhouses, but may occur in meat processing plants (sausage production). Normally carbohydrates are easily removed with water. Detergents may increase the cleaning effects.

ii) Fat: It can be removed to give an optically clean surface using water at a temperature of more than 50°C for pork fat and more than 55°C for beef fat. The efficiency can be improved by adding a detergent.

iii) Protein: Removal of protein depends on the treatment to which the proteinaceous soil has been exposed before the cleaning procedure. Protein will coagulate and be difficult to remove when exposed to hot water (more than 60°C) for a long time. The surfaces soiled with protein should be kept wet until the cleaning procedure can start.

iv) Mixed types of soil: Often the soil type is a mixture of protein and fat. The fat may be removed when using hot water, but hot water may coagulate the protein. The water temperature must therefore not exceed 60°C. A reasonably good effect will be obtained using detergent and water with a temperature between 45-55°C and even cold water with a suitable detergent. If cold water is used, the dosage of detergent must be larger for most detergents than when used with hot water.

v) Smears: Besides protein and fat, smears are often blended with mineral salts from water, especially calcium and magnesium and to a lesser extent iron. Mineral salts are best removed with acids or acidic detergents. The acidic detergents have a reduced cleaning effect and have a corrosive effect against some types of surfaces. They must, therefore, be used carefully with regular frequency when the water has a large content of mineral salts.

Another type of smear may be described as “a waxy mass”. This kind of smear consists of an undefined mixture of fat, protein, mineral salts and residues of detergents. This type of smear will often be found where the cleaning procedure has been irregular, for example wrong working routines, wrong dosage of detergents or wrong detergents. This waxy mass will not be alkali or acid-soluble. The only way to remove this smear type is by using mechanical force. Often scrubbing by hand and scrubbing brushes or scrubbing tools (nylon pads etc.) will be the only way to remove this kind of deposit. It is important to be aware of the difference between deposits of mineral salts and those of a waxy mass.

(B) Detergents: A substance which assists in cleaning when added to water is called the detergent. Water alone is not a very efficient cleaning agent because of its high surface tension. Adding of detergent to water facilitates the contact between water and surface soil because detergents enable water to penetrate soil by lowering the surface tension. Detergents, especially in combination and hot waters, remarkably increase the efficacy of cleaning system.

I. Properties of a good detergent: An ideal detergent should have the following properties:

a) Water softening ability

b) Complete water solubility
c) Non-corrosive to surfaces (metals and buildings)

d) Non-toxic and biodegradable

e) Economical in use

f) Good wetting or penetration ability

g) Emulsifying ability on fat

h) Dissolving ability of food solids

i) Deflocculating, dispersing or suspending ability

j) Good rinsing properties

k) Scale and rust removing properties.

No detergent or cleaning compound can be called an all-purpose detergent. None of the alkalis, acids or surface-active agents fulfills the requirements of a good detergent when used alone. Certain mixtures of these chemicals will combine several properties in one product which will be effective for a particular cleaning operation.

II. Types of detergents

a) Alkalis and alkaline salts

- Sodium hydroxide (caustic soda) is a cheap, common and powerful detergent for the food industry. It is used to suspend protein and to convert fats to soap.

- Sodium carbonate (soda ash) is not as efficient a cleaning agent as sodium hydroxide, but it is a cheap source of alkalinity and is used as detergent filler.

- Sodium metasilicate is an effective detergent for many purposes. It is an excellent emulsifying and suspending agent, and has reasonable wetting and rinsing properties.

b) Surface active agent: This kind of agent is employed in a variety of cleaning applications such as wetting, emulsifying and penetrating agents. Its main function is to lower the surface tension.

(i) Anionic surface active agents dissociate in solution to give a negatively charged surface active ion and a small inactive cation. Most commercial surface active detergents belong to this group. Several agents of this type are available but the alkyl aryl sulphonates are the most common surface active agents.

(ii) Nonionic surface active agents do not yield ions in aqueous solutions and are compatible with either cationic or anionic materials. Mixtures of anionic and nonionic surface active agents in a ratio of 2:1 in detergent formulations appear to be suitable for the food industry. These are more expensive than anionic surface active agents. Ex- Lauryl alcohol ethoxylate.

(iii) Cationic surface active agents dissociate in a solution to yield a positively charged surface active ion and a small inactive anion. Their performance as detergents is only fair but they exhibit anti-microbial activity and can be used as disinfectants or in mixed detergent-disinfecting agent mixtures. Ex- QAL.
(iv) *Amphoteric surface active agents* can dissociate into positively or negatively charged surface active ions depending on the nature of solution. They are very good emulsifier, stable in acid and alkalis, tolerant to hard water and have bactericidal properties. They are expensive and have low saponification and sequestration power. Ex: dodecyl diaminoethyl glycine, ethyl B-oxypropionic acid imidazole.

(c) *Sequestering agents:* These are used to bind calcium and magnesium and prevent the formation of insoluble calcium and magnesium salts by the interaction of hard water or dirt with the detergent. In addition to removing the minerals causing water hardness, they have varying functions in emulsification, protein peptization and dispersion. The amount of sequestering agents needed depends on the hardness of the water, the composition of the detergent and the composition of the soil.

Common sequestering agents in use are EDTA (ethylene diamin tetraacetate), NTA (nitrilotriacetic acid) and different phosphates. Sodium tripolyphosphate, sodium tetratophosphate and sodium hexametaphosphate are phosphates mainly used in detergent formulations.

(d) *Inhibitors:* These neutralize the corrosive effect of some chemicals. Silicates may be used as anti-corrosive agents in alkaline detergents but will deposit on stainless steel and it is therefore important to know on which materials they will be used.

(e) *Acids:* These are used to remove mineral deposits but they have reduced cleaning effects and are corrosive to different materials (especially galvanized iron and aluminum). The inorganic acids are principally more corrosive than the organic acids. Acidic detergents are mixtures of one or more acids and surface active agents, and may be inhibitors too. These detergents have a reasonable cleaning effect. If the mineral deposits are removed by acids alone, the cleaning effect will be minimal and it may be necessary to remove fat and protein with an alkaline detergent before removing the deposits with acid.

(f) *Filler:* The purpose of fillers is to make detergents fluid or to turn fluidized detergents into powders. As fillers, sodium chloride or sodium sulphate may be used. The last mentioned is cheap and has some cleaning effect, especially when mixed with chemicals with a better cleaning effect.

### 9.3.2 Disinfection/Sanitization

The ultimate objective of a cleaning programme is to control microbial activity. Although an adequate cleaning programme will eliminate nearly all the soil present, it will not destroy or remove all the microorganisms. This requires a second step-disinfection. Disinfection is defined as the destruction of microorganisms but not usually bacterial spores; this does not necessarily involve killing all microorganisms, but reducing their number to a level not normally harmful to health. In a commercial context, the term disinfection is solely used to define the treatment of inanimate objects and materials, either by a chemical or non-chemical disinfectant. In medical terms, the ‘disinfectant’ has been originally defined as ‘a chemical agent which destroys disease-producing organisms’. Subsequently, it was more correctly defined as ‘an agent capable of destroying a very wide range of microorganisms but not necessarily bacterial spores’.

In context of meat hygiene, a disinfectant is called as ‘sanitizer’ and it is used to disinfect (i.e., sanitize) the work surfaces which come in contact of meat, the equipment used to handle or process meat, the hands of worker or the surface of product (carcass sanitation). It is assumed that on a sanitized (disinfected) surface, the total numbers of surviving microorganisms would be within the acceptable limits/standards i.e., too small to cause the food spoilage or the disease.
Quality Assurance

**Methods of disinfection:**

These can be divided into two groups:

I. Non-chemical methods

II. Chemical methods

I. *Non-chemical methods*

(A) Heat/steam: In many cases, steam is very good for disinfection but it may be inconvenient or impractical due to the following reasons:

- It is expensive and may cause materials to deteriorate and equipment to distort.
- It takes considerable time to heat and cool the equipment used for steaming.
- It may cause baking-on of food and other residues.
- It gives condensation problems, and the visibility is reduced in the environment thus reducing the effectiveness of the sanitizing procedures.
- Insufficient heating may result in the incubation of micro-organisms in the inaccessible parts of machines and equipments.

II. *Chemical methods*

The chemical disinfection programme must be thorough, compatible and totally effective to satisfactorily minimize the microbial growth on a clean surface. However, a disinfectant may not be effective on a dirty or 'partially clean' surface on account of faulty cleaning practices.

**The choice of chemical disinfectants:**

It is determined by the following factors

i. Acceptability for use in food industry, as per the public health regulation

ii. The type of surface and processing area to be disinfected.

iii. The presence or absence of load of organic matter on the surface

iii. High efficiency under the conditions of use

iv. Broad spectrum of effectiveness, i.e., ability to kill many types of microorganisms.

**Properties of a sanitizer:**

An ideal sanitizer for use in food industry should be

- Quick in action
- Non-corrosive
- Non-toxic and gentle to the skin
- Inexpensive
- Must not affect the odour or flavour of the food processed in the equipment disinfected
- Must be easily rinsed away and leave no toxic residues
- Easy to dispense and to handle
- Must be safe in use and must not affect the operators who use it.
Types of Sanitizers

The disinfectants suitable for the food industry (i.e., sanitizers) contain chemicals of one of the following groups:

(a) Chlorine and chlorine-releasing compounds: Chlorine is the most effective disinfectant available, and sodium (or calcium) hypochlorite is a cheap disinfectant commonly in use. The hypochlorites have a characteristic smell produced by free hypochlorous acid, which is considered to be the germicidal active form of chlorine. A practical disadvantage of sodium hypochlorite is the risk of corrosion to all common metals (especially aluminium and galvanized iron), except perhaps high quality stainless steel.

(b) Quaternary ammonium compounds (QATS): These odour-free, colour-free, less corrosive and highly stable cationic synthetic surface active agents are excellent disinfectants. They are more effective against gram-positive bacteria, with advantage of being more active in the presence of small amounts of organic matter than any other class of disinfectants, but are inactivated by soaps, anionic detergents and inorganic polyphosphates. They are widely used throughout the meat industries and commonly formulated with detergents to form detergent/sanitizers, which clean and kill bacteria in one operation. They are more expensive than hypochlorites. Utensils and equipment should be thoroughly rinsed after applying these compounds as disinfectants.

Example: cetyltrimethyl ammonium bromide, lauryl dimethylbenzyl ammonium chloride.

(c) Iodophores: The iodophores are basically a combination of iodine and a solubilizing agent that releases free iodine when diluted with water. They possess quick microbial action against a wide variety of microorganisms. They are relatively non toxic (at lower concentration), non-irritating, non-staining and stable. They penetrate soil rapidly and are highly germicidal at virtually all concentrations. Iodophores are not affected by hard water. At low concentration (25 ppm), no potable rinse is required. The germicidal performance of different iodophores formulations may differ greatly. Products yielding the same pH and iodine concentration may produce widely different germicidal activities at equivalent dilutions.

(d) Amphoteric (ampholytic) compounds: Amphoteric compounds are essentially alkyl or acyl amino acids. They combine detergent and disinfectant properties. They are of low toxicity, are non-corrosive and are expensive. They are effective against both gram-positive and gram-negative bacteria.

Example: Imidazole derivatives such as ethyl-B-oxypropionic imidazole.

(e) Phenolic compounds: Phenolic compounds are not generally suitable for use in the food industry because of offensive adour (strong). Some halogenated phenol derivatives can be used in the meat industry. They are effective against spores, viruses, moulds and gram-positive and gram-negative bacteria. They are corrosive and can irritate the skin of personnel.

(f) Peracetic acid: A quite new disinfectant is a mixture of peracetic acid, hydrogen peroxide and acetic acid, which is stable and is effective against bacteria, spores, yeasts, moulds and viruses. The active agent is peracetic acid. The mixture is non-corrosive. Besides these hot water (80-90°C) and steam is very commonly used disinfectant in food plants.

Emergency disinfection

The emergency disinfection refers to the disinfection of the all sites when by mistake an animal suffering from a disease like anthrax, foot and mouth disease etc. enters the processing line. The following disinfectants are recommended:
Quality Assurance

(a) Sodium hydroxide (caustic soda or lye) in a hot solution of approximately 2% for foot and mouth disease and 5% for anthrax.

(b) Sodium hypochlorite solution: 0.5% available chlorine

(c) Hot water (90°C or more) or steam

(d) Chloride of lime for lairages, stables and transport vehicles: approximately 5% solution.

Follow these do’s and don’ts while using sanitizers:

Do: 1. Measure the sanitizer correctly.

2. Add the sanitizer to the correct amount of water to make the correct solution for use.

3. Use a clean, dry container for the sanitizer solution.

4. Wash away all dirt before using the sanitizer.

5. Discard the solution when the day’s work is finished.

Don’t: 1. Use a sanitizer for sterilization.

2. Store cleaning tools in a sanitizer solution.

3. Use previous day’s solution, make up a fresh one each day.

4. Mix sanitizers and detergents, it may inactivate both.

9.3.3 Types of Cleaning and Sanitation Procedure

A. Manual cleaning:

Manual cleaning is adaptable to all types and sizes of buildings, equipments and tools but its effectiveness depends heavily on the worker. Manual cleaning will always require considerable input of manpower. Nevertheless, it may be the cheapest method.

When cleaning manually, great care must be taken to assure that brushes and equipments are cleaned to avoid cross-contamination. Essential will be frequent changes of water and water/detergent solutions. It is recommended that smaller equipment and items are collected for central cleaning by hand and in this respect the following 3-tank system can be recommended:

1. Remove soil from the equipment by scraping the surfaces.

2. Transfer the equipment to tank no. 1 which contains a suitable solution of water and detergent. Loosening the soil may require soaking for a period.

3. The equipment is then transferred from tank no. 1 to tank no. 2 which contains a solution of water and detergent. The equipment is scrubbed clean.

4. The equipment is rinsed in water (from pails or running water from hoses).

5. The next step is transferring the equipment to tank no. 3 containing hot water (77°C) for at least one-half minute to have a disinfecting effect. The equipment is stacked to drain and dry quickly.

An alternative to step 5 is to use a solution of chemical disinfectant and allow contact for several minutes. Post-rinsing in clean water is required after chemical disinfection.

For chemical disinfection, a solution containing 200 ppm of available chlorine may be recommended. If the equipment is made of wood, the solution should contain 500-1000 ppm of available chlorine. If the water supplies are insufficient, step 2 may be omitted.
Thorough removal of soil from surfaces will then be required. If manual cleaning with brushes is used for cleaning large freestanding equipment and buildings, the water has to be brought to the parts. The best solution will be to use running water from water hoses. Where water supplies do not allow running water, a 3-pail system is recommended for cleaning. Two pails should contain a solution of water and detergent, and the third, clean water. The pails and brushes etc. should be placed in a trolley.

1. The first pail containing water and detergent is used for dipping and cleaning of the brushes.

2. The water/detergent solution in the second pail is used for cleaning. A measuring cup or a small container may be used for application of the water/detergent solution to the surfaces. The surfaces will then be cleaned by a clean water/detergent solution.

3. The clean water in the third pail is used for rinsing purposes. If the rinsing can be done with running water, it should be preferred, and then the three-pail system will be reduced to a two-pail system.

Figure 9.6: Manual cleaning by 3-tank system
B. **Specialized cleaning techniques**

1. **Foam and Gel Cleaning**

   The foam and gel cleaning agents enhance the efficiency of the detergents through increasing the contact time of detergents with the soil. While the foam collapses, the gel does not and can be applied in a hot form. The advantages of foam cleaning are:

   - It is labour saving.
   - Large surface area can be covered in a relatively short time.
   - Can penetrate insensible areas often eliminating the need for dismantling of equipments.

   The foam and gel cleaning solutions are applied through a lance from a unit operated pneumatically. Of late, enzyme-based cleansing systems have been developed. These are extensively used in meat industry of most developed nations like New Zealand. The enzyme softens and breaks up the protein soil, the detergent emulsifies to the particles and the foam ensures penetrating the lasting action. Usually, a residency time of 10-15 minutes is allowed and then the foam is washed off with high pressure water at 43°C.

2. **Automated cleaning methods**

   These consist of machinery for high pressure cleaning with considerable degree of automation for the mixing of chemicals. Three main types have been developed.

   - **Cleaning-in-place (CIP):** This is designed basically for the cleaning of internal surfaces and can be advantageously used for mixers, choppers and equipments that necessitate the use of tanks.

   - **Central cleaning system (CCS):** It consists of a central pumping source supplying either the formulated cleaning solution or the detergent solution to remote locations of the plant; in the later case, the detergent is mixed with the high-pressure water systems before use. The chief disadvantage of CCS is that the whole sanitation process will stop, if the central pumping source fails to function.

   - **The self-contained cleaning system (SCCS):** It consists of a pumping source, detergent tank and cleaning gun, mounted on a portable base and has leads for connecting to the sources of electricity, compressed air and water. The unit can be transported from one department to other and is very handy. Presently, many plants in developed countries use SCCS.

   The basic sequence of operation is:

   1. Pre rinse (5 min) with cold water to move grease and oil.
   2. Detergent wash (alkali) 15 min at 80°C for removal of residual soil.
   3. Intermediate rinse (3 min) with cold water to flush out detergent.
   4. The circulation of detergent and disinfectant to kill any residual micro-organisms (10 min).
   5. A final cold water rinse to flush out disinfectants. The velocity of water through pipes maintained at 1.5 m/sec to obtain desired turbulence.

**Cleaning of meat plant equipments and machinery parts:**

Good maintenance of plant equipments promotes good sanitation. Designing equipment and deciding its layout within the plant is an engineering function; it should be ensured that the interior and / or exterior of various equipments and machinery parts including the following are easily accessible for cleaning.
a) Overhead rails, b) trolleys and gambrels c) ham moulds, d) luncheon moulds, and smoke sticks, and e) smoke houses.

Check Your Progress 1

1) Enlist the principles of HACCP

2) Out of the Central cleaning system (CCS) and the self-contained cleaning system (SCCS), which system is preferred in developed countries and why?

3) What are covered under good manufacturing practices for personnel working in a meat plant?

4) What should be the properties of a good sanitizer?

5) What will be your strategy to clean mixed type of soil usually found in a meat plant?

6) Match the following.
   a. Sodium hydroxide
   b. Lauryl alcohol ethoxylate
   c. EDTA
   d. Iodophores
   i. Sanitizer
   ii. Sequestering agents
   iii. Surface active agent
   iv. Alkali detergent
9.4 STANDARDS FOR MEAT INDUSTRY AND MEAT REGULATIONS

9.4.1 Standards for Meats

The ‘standards’ or ‘specifications’ in meat industry are the ‘defined limits or set of procedures’ for ensuring the safe production, handling, processing, storage and distribution of meat and meat products. For example, the microbiological standards, limits or specifications refer to the ‘safe microbiological limits’ for a particular type of meat or meat product. So long as the product did not exceed the suggested limit, it is believed to be free from microbial hazards arising as a result of its consumption. Likewise, standards have been worked out for other procedures/conditions that may affect the ultimate acceptability and safety of the meat, such as conditions for transport and slaughter of meat animals. These standards are formulated and implemented by various regulatory agencies at national and international levels (described later in this chapter). However, these standards vary from country-to-country according to the levels of hygiene observed in the food chain.

In the past, the decisions on the acceptability of meat lots were generally based on the examination of one or few samples taken from the batch. However, now-a-days, the attributes schemes suggested by International Commission on Microbiological Specification for Foods, 1974 (ICMSF) are followed, as these are simple to operate. These widely accepted schemes are based on 2 and 3 class sampling plans, and the concept of case whereby changes in the level of hazard during subsequent handling or processing of foods are considered.

Attribute sampling schemes: The schemes state the criteria for acceptance of a food lot on the basis of examination of certain required number of sample units by defined methods, i.e., the schemes comprise sampling procedures and decision criteria. There are two types of attribute schemes.

(i) Two class plan: These denote two attributes, i.e., presence or absence of an organism in a given sample unit. It is applied to more hazardous type of organisms like *Clostridium botulinum*. According to this plan (also called two-attribute scheme), a lot can be either accepted or rejected on the basis of presence or absence of the infectious or toxicogenic agent. The conditions applicable are designated as m, n and c later described in this chapter.

(ii) Three class plan: The plan has three attributes and can divide a lot into 3 categories: acceptable (n, m); unacceptable (>M) and marginally acceptable (c). The higher limit (M) is safety limit and values beyond this may be hazardous. “m” represents the lowest possible count that may occur under good manufacturing practices (GMP) (FAO, 1977). The notations used in defining these plans are as follows:

- **n** = number of sample units to be examined.
- **m** = the level of bacteria/g. This is a microbiological criterion which separates good quality from defective quality in a 2 class plan. This is acceptable limit. In a 3-class plan, it separates good quality from a marginally acceptable quality.
- **M** = a criterion (bacteria/g) which separates marginally acceptable quality from defective quality in a 3 class plan. It is not applicable in a 2-class plan. Values at or above M are unacceptable in terms of sampling scheme. This is maximum permissible safety limit.
- **c** = maximum allowable number of sample units that may exceed microbiological criterion, i.e., permissible number of samples between m and M.
Criteria for devising sampling scheme: There are three most important factors that should be considered for devising attributes sampling schemes.

(a) **Microbial incidence:** It is essential to know the pattern of distribution of microorganisms in foods. Since microbial population may not be uniformly distributed, a factual mean of microbial counts should be obtained after deciding the appropriate sample size.

(b) **Hazard:** The type of hazard posed by a given food has to be determined. If a product poses potentially severe hazard, a two-attribute scheme (presence/absence) has to be devised. In case of moderate or low hazard, a three-class plan can serve the purpose. Clinical severity should be taken as most important criteria for devising a sampling scheme.

(c) **Processing technique:** Meat, egg, poultry and other foods are subjected to a variety of processing techniques. In an abattoir or meat processing plant, the carcasses may be subjected to cutting, deboning, mincing, chilling, freezing etc. Others may require pasteurization, ultra-heat treatment, scalding, radiation, and incorporation of additives, chemical preservatives, and vacuum or modified atmospheric packaging and canning. Hence, it is essential to investigate the survival or growth of the organism before finalizing the sampling scheme.

It may be underlined that all the specification or criteria cannot be legally enforced. These suggested specifications could be adopted by processing units for internal quality control.

**Principles of determining specifications:** The following points need to be kept in mind while determining the specification for a food product

(i) These should be based on real observations (surveys).

(ii) It should be cheap and simple to opt.

(iii) These should be able to assess expected storage life of the commodity.

(iv) It should be able to evaluate hygienic conditions of processing.

(v) The proposed criterion should be capable of eliminating or minimizing health hazard.

(vi) The objective should be attainable under routine production and processing.

(vii) Separate specifications will have to be formulated for separate products.

(viii) These should describe the sampling scheme along with the analytical methods.

(ix) Microbiological limits should be fixed allowing certain variations, i.e., permitting certain number of defective samples having permissible marginal variations.

(x) It must define the number and size of the sample units to be examined.

**Sanitary indices:** The ‘indices’ refer to ‘certain organisms or group of organisms’ which (when present) indicate likely presence of other potentially pathogenic or spoilage organisms in the foods. For example, the presence of coliforms or faecal coliforms in foods indicates poor sanitary practices and likely presence of other hazardous organisms like *Salmonella*, *E. coli* etc. However, it is important to reiterate that the presence of even substantial numbers of indicator organisms does not, in itself, indicate with certainty that direct faecal contamination of processed foods has occurred; it may equally well suggest inadequate processing, post-process contamination or insanitary processing conditions especially where foods have subsequently been stored at temperatures permitting microbial growth.
Quality Assurance

The sanitary indices that can be used in food industries to assess sanitary practices, food safety or keeping quality are summarized as follows:

(i) **Coliforms**: Presence of this group in a sample of food or water indicates poor sanitary practices. This functional group mainly includes *E. coli* and *Klebsiella* are also included. *E. coli* is normally found in the gastrointestinal tract of man and other animals and is rarely found elsewhere, whereas, *E. aerogenes* is normally associated with the vegetation and is occasionally found in the intestine. If *E. coli* is present, then it definitely indicates faecal pollution/contamination. In water testing, *E. coli* is the classical indicator for the possible presence of enteric pathogens. Hence, there is direct relationship between the numbers of *E. coli* present and the extent of faecal pollution, the higher the numbers the greater the pollution; this because the organisms cannot multiply in water and, in fact, numbers slowly decline unless renewed pollution occurs.

(ii) **Enterococci**: Streptococci belonging to Lancefield group D are mostly used as indicators of sanitation. These include *S. faecium*, *S. faecalis*, *S. bovis*, (including sub spp.) and *S. equines*. Due to their resistance to heat and freezing, these are also used as good indicators of poor hygienic practices in frozen foods and inadequate thermal processing of some canned products. The enterococci are sometimes used indicators of faecal pollution in water testing, one of the advantages being that they die rapidly than *E. coli*. However, a disadvantage of this group is that they are found more frequently than *E. coli* in non-faecal environments and hence their isolation is less conclusive evidence of faecal contamination.

(iii) **Enterobacteriaceae**: This is a better defined group of indicators because it may include non-lactose fermenting strains of *Salmonella*, *Shigella* and some heat resistant strains of *Klebsiella* and *Citrobacter*. Presence of this group not only indicates defective processing but also marginal failure of heat process.

(iv) **Staphylococcus aureus**: All *S. aureus* are not enterotoxigenic. This has been suggested to be good indicator of contamination of foods from skin and nasopharyngeal sources of handlers. The examining methods for *S. aureus* can be grouped into two distinct areas: first, the enumeration of *staphylococci* and, second, testing for the presence of the enterotoxin in the food. As only about 50% of *S. aureus* strains are enterotoxin producers it will be appreciated that the latter test is more conclusive when investigating food poisoning outbreaks.

(v) **Aerobic plate counts (APC)**: There are many types of aerobic plate counts like total mesophilic aerobes (TMA), psychrotrophs, lipolytics, proteolytics etc. However, the most commonly used indicator is TMA or standard plate count (SPC). The counts are sometimes called ‘total viable counts’ or ‘total plate counts’. Total counts indicate whether or not, a product has been processed under hygienic conditions and stored properly. APC can reflect handling history, state of freshness or expected storage life of the food products. Similarly, some other defined group of organisms like proteolytics and lipolytics indicate the presence of protein and fat degrading organisms, respectively. Psychrotrophs indicate population of microbes capable of growing at lower temperatures. These are important because they not only affect the shelf life of product but also include some of the well documented pathogens, viz., *L. monocytogenes* and *Y. enterocolitica* that can grow at refrigeration temperatures and make the food hazardous.

(vi) **Yeast and moulds**: Estimation of yeast and moulds can be done to assess the potential of mouldy spoilage. In addition to these, there are many other indicator organisms which can be used from time-to-time to evaluate food quality depending on the need, e.g., total anaerobes and saccharolytic (carbohydrate degrading) organisms to assess the spoilage potential or safety of the product. The
microbiological specifications or limits defined for a particular food may vary from country to country, and even among the meat processing units within a country. Therefore, in order to have uniformity and acceptance, these specifications/limits have been developed in the form of ‘meat standards/regulations’ by the regulatory agencies at national and international levels.

9.4.2 Meat Regulations

The objectives of regulations, specifications, standards or inspection of foods are to ensure wholesomeness, purity, safety and quality of food supplies to the consumer.

Regulatory agencies may be national or international functioning within the control of government, public or the private sectors.

A. International Standards/Regulations

Organizations mainly concerned with recommending specifications or regulating food trade at international level are as follows:

(a) Food and Agricultural Organization (FAO) of the United Nations: This is mainly concerned with food production and suggests guidelines for healthy and safe foods.

(b) World Health Organization (WHO) of the United Nations: This is mainly concerned with the health of the consumers and formulation of various specifications for hygienic food production.

(c) Office International des Epizooties (OIE): This organization has prescribed international animal health code, which consists of 6 parts. Part I deals with definitions, epizootiological information/notification, veterinary ethics and import/export procedures.

(d) Commission of European Communities: It has laid down certain requirements/regulations for the import of animal foods and feeds.

(e) International Commission of Microbiological Specification for Foods (ICMSF): It has suggested microbiological specifications under 2-3 attribute schemes and HACCP systems for meat and meat products, poultry, sea foods, eggs, milk and milk products.

(f) International Organization for Standardization (ISO): Many international standards have been formulated by ISO in relation to food hygiene, food microbiology and food quality assurance covering a wide range of foods (including foods of animal origin). India (Bureau of Indian Standards) is a member of this organization having voting right.

B. Indian Standards/Regulations

(a) Agricultural and Processed food products Export Development Authority (APEDA): This agency working under Government of India, Ministry of Commerce has come out with following notifications in the Gazette of India, part II, section III, sub-section II.

Notification on processed meat products: It has the regulations for animals, slaughter procedures, abattoir requirements, inspection, personal hygiene, layout plans sampling, testing and specifications for transport and information regarding application for veterinary health certificate by exporter.

(i) Schedule I states laws for sampling of canned processed meat, opening of packing cases and microbiological requirements.
(a) Selection of cans for testing

<table>
<thead>
<tr>
<th>Lot size</th>
<th>No. to be tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>6</td>
</tr>
<tr>
<td>500-1000</td>
<td>7</td>
</tr>
<tr>
<td>1000-5000</td>
<td>8</td>
</tr>
<tr>
<td>5000-10,000</td>
<td>9</td>
</tr>
<tr>
<td>&gt; 10,000</td>
<td>10</td>
</tr>
</tbody>
</table>

(b) Opening of packing cases

<table>
<thead>
<tr>
<th>Lot size</th>
<th>No. to be opened</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>100-500</td>
<td>3</td>
</tr>
<tr>
<td>500-1000</td>
<td>4</td>
</tr>
<tr>
<td>1000-5000</td>
<td>5</td>
</tr>
<tr>
<td>&gt; 5000</td>
<td>6</td>
</tr>
</tbody>
</table>

(ii) *Schedule II* states standards for canned beef,

(iii) *Schedule III* for luncheon meat,

(iv) *Schedule IV* for chopped meat and

(v) *Schedule V* prescribes minimum requirements for an abattoir (also refer to IS: 4393-1979).

(b) *AGMARK grading*: The Directorate of Marketing and Inspection (DMI), Ministry of Agriculture has important function in the filed of standardization, grading and quality control of agricultural and allied commodities. To meet these objectives, it implemented “Agricultural Produce Grading and Marketing (APGM)” Act in 1937. New grading and marketing rules, 1988 were notified in 1989. This Act deals mainly with agricultural products and some animal products like egg, ghee. The amended Act has taken care of consumer protection, licensing, laboratory analysis and penalty for non compliance.

(c) *Prevention of Food Adulteration (PFA) Act*: PFA-1954 Act of Government of India prescribes standards for edible fat, saponification and iodine values for lard, beef, mutton and goat fats, use of preservatives like sulphur dioxide, sodium or potassium nitrite in sausages, cooked meat, pickled meats, ham and bacon and toxic metals like lead, copper, arsenic, tin and zinc in canned meats, meat extracts and unspecified foods. It prescribes restriction on use of anti oxidants and flavouring agents like BHT, BHA, citric acid and monosodium glutamate under various clauses. Similarly, use of insecticides, e.g., aldrin, dialdrin, D.D.T. and lindane etc. in meat, egg, poultry and fish has been restricted above certain limit (PFA, 1954).

(d) *Meat Food Products Order (MFPO) 1973*: Govt. of India made this order under Section 3 of Essential Commodity Act, 1955 and this order is enforced by Ministry of Agriculture.

First Schedule deals with application for licence/renewal of licence under the Meat Food Products Order, 1973.
Second Schedule states minimum sanitary and other requirements to be complied with by a licensee in a factory fit for manufacturing the class or classes of meat food products for which the licence is granted.

Third Schedule deals with hygienic and other requirements to be complied with by a licensee who also slaughters animals in his factory.

Fourth Schedule covers requirements to be complied with in regard to packing, marking, and labelling containers of meat food products.

This prescribes that no meat food product shall contain any poisonous chemical in excess of permitted quantity. These are lead, copper, arsenic and zinc which shall not exceed the levels of 2.5, 2.0, 2.0, 250 and 50 ppm respectively.

(e) Bureau of Indian Standards (BIS): Formerly known as Indian Standards Institution (ISI), this bureau is engaged in formulating standards for a number of items including all foods of animal origin. A list of standards (specifications) formulated and marketed by BIS, New Delhi is given below in respect of meat products and related items.

_list_of_indian_standards_

IS: 3061-1965 Specification for Pork sausages, fresh.
IS: 4393-1979 Basic requirements for an abattoir.
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IS: 7049-1973</td>
<td>Code for handling, processing, quality evaluation and storage of poultry.</td>
</tr>
<tr>
<td>7053-1973</td>
<td>Basic requirements for a stall for sale of meat of small animals.</td>
</tr>
<tr>
<td>7891-1975</td>
<td>Inedible offals trolley.</td>
</tr>
<tr>
<td>7909-1975</td>
<td>Electrical stunning tongs for pigs.</td>
</tr>
<tr>
<td>8700-1977</td>
<td>Basic requirements for a stall for sale of meat of large animals.</td>
</tr>
<tr>
<td>8895-1978</td>
<td>Guidelines for handling, storage and transport of slaughterhouse by-products.</td>
</tr>
<tr>
<td>8182-1976</td>
<td>Code of hygienic conditions for processed meat products.</td>
</tr>
<tr>
<td>5887 (Part I) - 1976</td>
<td>Isolation, identification and enumeration of <em>Escherichia coli</em>.</td>
</tr>
<tr>
<td>5887 (Part II) -1976</td>
<td>Isolation, identification and enumeration of <em>Staphylococcus aureus</em> and faecal streptococci.</td>
</tr>
<tr>
<td>5887 (Part III) - 1976</td>
<td>Isolation and identification of <em>Salmonella</em> and <em>Shigella</em>.</td>
</tr>
<tr>
<td>5887 (Part IV)-1976</td>
<td>Isolation and identification of <em>Clostridium welchii</em>, <em>Clostridium botulinum</em> and <em>Bacillus cereus</em> and enumeration of <em>Clostridium welchii</em> and <em>Bacillus cereus</em>.</td>
</tr>
<tr>
<td>5887 (Part V) -1976</td>
<td>Isolation, identification and enumeration of <em>Vibrio cholerae</em> and <em>Vibrio parahaemolyticus</em>.</td>
</tr>
<tr>
<td>IS:15000: 1998</td>
<td>HACCP.</td>
</tr>
</tbody>
</table>

(f) *State and local self Governments:* Every state of Indian Union has a system of food inspection and mechanism of enforcing the laws. These are generally under Directorate of Health Services. Similarly, at local level, Municipal Corporation or Town Areas have authority to inspect and enforce public health laws through sanitary inspectors and veterinarians. These include ante-mortem and post-mortem inspection of animals. The authorized veterinary officer only certifies meat from healthy animals. The reader should refer to the laws/by-laws prescribed by concerned local and state Governments from time to time.

(g) *Memorandum of understanding (MOUs).* Many MOUs exist between government of India and food importing countries which specify regulations of export of foods from India to their countries. Regulations of meat export from India to Iran for example, have prescribed the conditions for chilling, deboning, freezing, storage, packaging, transportation and inspection by Iran Veterinary Organization.
Check Your Progress 2

1) Name important national regulatory agencies engaged in formulating the meat standards in India.

2) Out of Coliforms and Enterococci, which is the better indicator of faecal pollution of water and why?

3) Fill in the blanks.
   (a) The meaning of the word………………. is the science of safeguarding health.
   (b) Knives, other hand tools, saws, etc., should be cleaned and sterilized with …….°C water.
   (c) To prevent harmful microbes entering the food chain ……….. system is widely used in abattoir.
   (d) Two essential tools required in a meat processing facility to help the production of high quality and safe meat products are………….. and …………..
   (e) The most common types of soil in the meat industry are ……………. and ………..
   (f) The main hygienic principle in processing is that ……… and ……… operations are efficiently separated.
   (g) A substance which assists in cleaning when added to water is called the ……………
   (h) …………… belonging to Lancefield group D are mostly used as indicators of sanitation.
   (i) The Enterococci are sometimes used indicators of ……… in water testing.
   (j) …………………….., …………. and …………….. are the important Indian standards used for inspection of foods to ensure wholesomeness and quality which supplies to the consumer.

4) Write True or False
   (a) The Bureau of Indian Standards (BIS) was formerly known as Indian Standards Institution (ISI).
   (b) Sanitary and processing requirements in the form of GMPs are necessary to ensure the production of wholesome food.
   (c) Carcass splitting saw should be sterilized with water at 71°C, after use on each carcass.
   (d) The manager of abattoir is responsible for implementing and daily monitoring of the Sanitation SOP.
   (e) Lairage, slaughtering, evisceration and chilling come under the clean operations in meat plant.
   (f) The foam and gel cleaning agents enhance the efficiency of the detergents through increasing the contact time of detergents with the soil.
   (g) Enzyme-based cleansing is the most extensively used methods in India.
   (h) In context of meat hygiene, a disinfectant is called as ‘sanitizer’ and it is used to disinfect (i.e., sanitize) the work surfaces.
   (i) The presence of coliforms or faecal coliforms in foods indicates poor sanitary practices.
9.5 LET US SUM UP

A good sanitation program in a meat plant will maintain a clean and sanitary environment for all areas of meat production from receiving to processing, to storage and transportation. It should be systematically organized in every meat-processing establishment for quality assurance and public health protection. The programs established for GMPs and Standard Operating Procedures (SOPs) will provide the basis for ensuring product safety in the HACCP system, thereby, the high level of product quality conforming to standards such as ISO 9000 system. The HACCP is a system of food quality control to render foods safe for human consumption.

The cleaning and sanitation are integral parts of slaughtering and handling of meat. The clean working conditions in a meat plant provide immense satisfaction to the staff and augment their efficiency. The food products manufactured under high standards of hygiene leads to improved consumer acceptance and sales. The main hygienic principle in processing is that clean and unclean operations are efficiently separated. Detergents, especially in combination with hot waters, remarkably increase the efficacy of cleaning system.

In meat hygiene, a disinfectant is called as ‘sanitizer’ and it is used to sanitize the work surfaces which come in contact of meat, the equipment used to handle or process meat, the hands of worker or the surface of product. Manual cleaning is adaptable to all types and sizes of buildings, equipment and tools but its effectiveness depends heavily on the worker. The specialized cleaning techniques are broadly divided into two methods, foam and gel cleaning, and automated cleaning methods. The second method has three types, cleaning-in-place (CIP), central cleaning system (CCS) and the self-contained cleaning system (SCCS).

The ‘standards’ or ‘specifications’ in meat industry are the ‘defined limits or set of procedures’ for ensuring the safe production, handling, processing, storage and distribution of meat and meat products. The objectives of meat regulations, specifications, standards or inspection of foods are to ensure wholesomeness, purity, safety and quality of food supplies to the consumer. The sanitary indices used in food industries to assess sanitary practices, food safety or keeping quality includes coliforms enterococci, streptococci, enterobacteriaceae, Staphylococcus aureus and aerobic plate counts (APC). The regulatory agencies may be national or international functioning within the control of government, public or the private sectors.

9.6 KEY WORDS

BHA : Butylated hydroxy anisole, it is a food additive and acts as an anti oxidative agent.

BHT : Butylated hydroxy toluene is used as an antioxidant food additive.

DDT : Dichloro-Diphenyl-Trichloroethane is a pesticide (to kill pests).

Detergents : A substance which assists in cleaning when added to water is called the detergent.

Disinfection : The destruction of microorganisms but not all and usually not the bacterial spores; it reduces their number to a level not normally harmful to health.

Disinfectant : The agent capable of destroying a very wide range of microorganisms but not necessarily bacterial spores.
Lard: Fat obtained from pig/pork carcass.
Hazard: It may be physical, microbiological or chemical which is harmful, cause damage or injury to health of animals as well as man.

Pest Control: The reduction or eradication of pests. These include flies, cockroaches, mice and rats, as well as weevils and other insects that can infest food products.

Standards for meats: The ‘standards’ or ‘specifications’ in meat industry are the ‘defined limits or set of procedures’ for ensuring the safe production, handling, processing, storage and distribution of meat and meat products.

Sanitizer: A substance that reduces the numbers of microorganisms to an acceptable level.

Sanitation: An all-embracing term covering those factors which assists in improving or maintaining man’s physical well being including the general cleanliness of his environment and the preservation of his health.

9.7 SOME USEFUL BOOKS


Slaughterhous Cleaning and Sanitation, FAO Animal Production and Health Paper 53.


9.8 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) The principles of a HACCP are as follows:
   - Conduct a hazard analysis
   - Identify critical control points
   - Establish critical limits for each CCP
   - Establish procedures to monitor each CCP
   - Establish corrective actions
   - Establish effective record keeping procedure
   - Establish procedures for verifying the HACCP system is working correctly.

2) Presently developed countries prefer self-contained cleaning system (SCCS) than central cleaning system (CCS) for cleaning in the meat plant because SCCS unit can be transported from one department to other and is very handy whereas in case of CCS, if the central pumping source fails to function, whole sanitation process will stop.
3) Following are covered under good manufacturing practices for personnel working in a meat plant:

- Personal cleanliness which includes washing hands, wearing of gloves and hairnets, storing of personal belongings properly, removing jewellery, not smoking or chewing a gum/tobacco in the working areas.
- Disease control which means not engaging the person with illness or open lesions including boils, sores or infected wounds.
- Staff training, education and supervision of the personnel.

4) The properties of a good sanitizer are as follows:

- It should be quick in action
- It must be non-corrosive, non-toxic and gentle to the skin
- It should be inexpensive
- It must not affect the odour or flavour of the food
- It must be easily rinsed away and leave no toxic residues
- It should be easy to dispense and to handle
- It must be safe in use and must not affect the operators

5) Your answer may have the following points.

To clean mixed type of soil usually found in a meat plant, the strategy should be as follows:

In a meat plant, mixed type soil mainly comprises of protein and fat. Hot water removes fat but it may coagulate protein, thus makes the removal of protein difficult. So water temperature must not exceed 60°C. A reasonably good effect can be obtained using detergent and hot water (45-55°C) and even cold water with a suitable detergent. The dosage of detergent should be determined depending upon the temperature of the water.

All these should be done in the following sequences:

(i) Physical removal of all big chunks of wastes on floors and equipments.
(ii) Dry sweeping of the floors to remove all particles of meat, fat and scraps.
(iii) Pre-rinsing the floors and equipments with warm water 49-54°C to loosen the soil.
(iv) Cleaning with detergent.
(v) Rinsing with hot water (45-55°C).
(vi) Sanitizing with appropriate sanitizer and thorough washing to remove all traces of chemicals.

6) (a) Sodium hydroxide (i) Alkali detergent
     (b) Lauryl alcohol ethoxylate (ii) Surface active agent
     (c) EDTA (iii) Sequestering agents
     (d) Iodophores (iv) Sanitizer
Check Your Progress 2

1) Important national regulatory agencies for formulating meat standards are—Agricultural and Processed food products Export Development Authority (APEDA), Bureau of Indian Standards (BIS), Ministry of Agriculture, Ministry of Health.

2) Coliforms are better indicator of faecal pollution of water than Enterococci because there is direct relationship between the numbers of E. coli (coliform) present and the extent of faecal pollution, the higher the numbers the greater the pollution as the organisms cannot multiply in water and, in fact, numbers slowly decline unless renewed pollution occurs. Enterococci also act as indicator but they are found more frequently than E. coli (coliform) in non-faecal environments and hence their isolation is less conclusive evidence of faecal contamination.

3) a) Sanitation b) 82°C c) HACCP d) GMP and SOP e) fat and protein f) clean and unclean/dirty g) detergent h) Streptococci i) faecal pollution j) PFA, BIS and APEDA/AGMARK grading.

4) a) T b) T c) F d) T e) F f) T g) F h) T i) T