

Sanitation and microbiological quality

Expected Learning Outcome

- Significance, characters and types of indicators microorganisms in assessing the sanitary quality of food.
- Importance of microbiological standards and criteria in establishing quality standards for foods.
- Importance of sanitation in fish processing industries and approaches to achieve the same.
- Importance of water quality and source for use in processing industry.

7.1. Indices of fish sanitary quality

Quality of the fish refers to wholesomeness of fish making it suitable for human consumption. Quality depends and determined by physical, chemical, organoleptic and microbiological aspects in food. Thus, the quality of a product includes factors such as intrinsic characters, nutritive value, degree of spoilage, damage to the product, deterioration during processing, storage and distribution, presence of substances hazardous to health, aesthetic aspects etc. Therefore, quality means all that attributes which consciously or unconsciously the consumer wants it to be present in food. The decision of what constitutes the quality rests ultimately with the consumers.

7.2. Quality indicators

From the microbiological point of view, the product quality (shelflife) can be assessed by determining the presence of certain microorganisms as indicators of quality, presence of metabolic products of microorganisms and total viable counts. This information will help not only in assessing the existing quality of product but also in predicting product shelflife.

7.2.1. Presence of certain microorganisms as indicators of quality

The microbiological quality of a product depends on the associated spoilage organisms whose increasing numbers results in loss of product quality, and human pathogenic microorganisms whose presence leads to health risk to consumers. Presence of pathogenic microorganisms can be assessed by detecting an organism called indicator organism which can indicate likely presence of pathogens in food. Thus, the overall microbial quality of the product is a function of number of organisms, and therefore shelflife can be increased by their control.

Microbial indicators are more often used to assess food safety and sanitation rather than quality. Among the several food associated microorganisms the most commonly used organism as indicator is faecal coliform bacteria, *E. coli* and fecal streptococci. These microorganisms are associated with human faeces and their presence in food indicates poor sanitation, likely presence of other pathogens and fecal contamination.

Characters of indicator organisms

- Present and detectable in all foods whose quality to be assessed.
- Their growth and numbers should have a direct negative relation with product quality.
- Have history of constant association with pathogen and their numbers should correlate with pathogen of concern.
- Easily detectable and distinguishable from other organisms in short period of time.
- Growth should not be affected adversely by other food-associated microorganisms.

***E. coli* or coliform criteria**

Presence of coliform or *E. coli* in foods is highly undesirable as it indicates faecal contamination, and handling and processing of food under unsanitary conditions. However, it is usually impossible to eliminate them in all foods (fresh/ frozen). Therefore, limits for coliform have been set for certain sensitive foods where coliforms are permitted in low numbers ranging from 1 - 100/g or 100 ml. These values are considered feasible and expected to ensure product safety.

Although coliforms are widely used in shellfish sanitation programme, these often fail as good predictors of sanitary quality because of presence of pathogens in waters meeting coliform standards. However, coliform criteria have been widely used in most foods as good indicator of faecal contamination.

Faecal streptococci as indicators

Faecal streptococci are a Gram positive bacteria associated with human intestine and thus encountered in faecal matter with their numbers varying from 10^5 to 10^8 /g of feces. Species of streptococci such as *Enterococcus faecalis* and *E. faecium* are commonly associated with feces. These are fastidious in their nutritional requirements and grow over a wide pH range than other food borne bacteria. These being microaerophilic grow in reduced Eh condition. Generally do not multiply in water especially when organic matter load is low. Compared to *E. coli* these are less numerous in human faces. Ratio of 4 or higher between *E. coli* and streptococci is considered as indicative of faecal contamination.

Enterococci die off at slower rate than coliforms in water. Live longer in water than coliforms thus outlive the pathogen in water. These are found to be better indicators of food sanitary quality in frozen foods as they are more resistant to freezing condition. Also exhibit resistances to adverse environmental conditions, and have better survival in dried foods than coliforms. These show poor relation with the incidence of food borne intestinal pathogen. Though they possess qualities suitable to be considered as indicator organisms they have not gained importance, as coliforms.

7.2.2. Metabolic products as indicators of quality

Metabolic products of microorganisms may be used to assess and predict microbial quality in some products. In fishes, the production of nitrogenous compounds by spoilage organisms has been used as indicators of product quality. These include;

- Trimethyl amine (TMA)
- Total volatile bases (TVB) such as ammonia and dimethyl amine,
- Total volatile nitrogen (TVN).

Increase in their value indicates the spoilage, and their concentration increases as the spoilage progresses.

7.2.3. Total viable counts as indicators of sanitary quality

The natural counts of microorganisms vary depending on the environment from which the fish is caught. Besides, microorganisms are added during processing and handling of food.

Number of microorganisms present in fish starts increasing once the fish dies unless steps are taken to halt their multiplication. As the quality deteriorates with increase in microbial count, the total viable counts are used as indicators of product quality. Thus, to ensure quality, limits or standards are set for total viable load for fresh and processed foods. Further, Increase in microbial build up in processed foods during storage is attributed to likely changes in storage/

preservation conditions. Total viable counts are of greater value as indicators of existing condition of given product than as predictors of shelflife, because the portion of counts responsible for ultimate spoilage are difficult to ascertain.

7.3. Microbiological standards and criteria

Control on the microbiological quality of food is ensured by the regulatory agencies and food industry. This is done to ensure the safe of food to consumers, extend shelflife and to ensure product consistency from one batch to another in terms of safety and shelflife. Distinguishing the food of acceptable quality from food of non - acceptable quality is made possible with the application of microbiological criteria.

The purpose of microbiological criteria

The purposes of microbiological criteria for foods are to give assurance that;

- The foods will be acceptable from the public health stand point. That is, the food will not be responsible for the spread of infectious diseases or for food poisoning.
- The foods will be of satisfactory quality. That is, the food will consist of good original materials that have not deteriorated or become contaminated during processing, packaging, storage, handling etc.
- The foods will be acceptable from aesthetic view point. That is, it is free from extraneous material such as hair, scales, plastics etc.
- The foods will have keeping quality that should be expected of product.

Establishing microbiological criteria for a food product is based on factors such as total number of organisms, number of indicator organisms and number or absence of pathogens.

Types of microbiological criteria

Three types of microbiological criteria have been defined by the International Commission on Microbiological Specifications for Food (ICMSF). They are;

- Microbiological standard
- Microbiological specification
- Microbiological guideline

Microbiological standard

Microbiological standard is a criteria specified in a law or regulation for a specific food. It is a legal requirement that foods must meet and is enforceable by the appropriate regulatory agency.

Microbiological standard is that part of the law or administrative regulation designating maximum acceptable number of microorganisms or specific types of microorganisms as determined by prescribed methods in a food produced, packed or stored or imported into the area of jurisdiction of an enforcement agency.

Microbiological specifications

Microbiological specification is the maximum acceptable number of microorganisms or of specific types of microorganisms as determined by prescribed methods in a foods being purchased by a firm or agency for its own use.

Microbiological specification is the criteria applied in commerce. It is a contractual condition of acceptance that is applied by a purchaser. Failure to meet the condition by supplier will result in rejection of the batch or a lower price.

Microbiological guideline

A microbiological guideline is that level of bacteria in a final product that requires identity and correction of causative factors in current and future production or handling after production. It is used to monitor microbiological acceptability of a product or process. It differs from standard and specification in that it is advisory in nature rather than mandatory.

Factors to be included in suggesting a microbiological criteria (ICMSF)

- A statement of the food to which the criteria applies. As foods of different origins, composition and processing provide different microbial habitats; different foods pose different spoilage and public health problems.
- A statement of the microorganisms or toxin of concern. These include spoilage and health aspects. A realistic decision has to be made based on microbial ecology of food in question.
- Details of the analytical methods to be used to detect and quantify microorganisms/toxins. Methods elaborated by international agencies, and scientific methods that confirm the compliance with guidelines to be used.
- The number and size of the samples to be taken from a batch of food or from source of concern such as a point in a processing line.
- The microbiological limits appropriate to the product and the number of sample results which must conform with these limits for the product to be acceptable.

7.4. Fish plant sanitation

Consumers expect the foods to be pure, safe and processed, handled and served in a sanitary manner. Sanitary food is defined as one that is free of agents that cause disease or illness and free from objectionable extraneous material like insect fragments. Therefore, sanitation is concerned with the food and also the environment and conditions under which the food is handled.

Fish plant sanitation is defined as the controlling of all conditions or practices within the plant so that the fish processed is free from disease-producing microorganisms and foreign matter.

Requirements for an effective sanitation programme

Implementation of effective sanitation programme becomes necessary in any food processing industry. For a workable sanitation programme the following requirements have to be met.

- Management must be aware of the need for good sanitation.
- The processing unit should be suitably located and constructed.
- The processing unit must have required quantity of good quality water supply.
- The processing unit must have adequate washing facility for whole fish.
- The processing unit must have smooth working surfaces.
- The processing unit must have a sound clean-up policy.
- The processing unit must have adequate sanitary facilities.
- The processing unit must ensure good personal hygiene habits of employees.
- The processing unit must have effective rodent and insect control programme.

Need for hygienic practices

Practicing of proper hygienic practices by food handlers is of critical importance as they serve as fundamental sources of many microorganisms responsible for foodborne illnesses. Pathogens such as *Staphylococcus aureus* is naturally associated with humans, and will contaminate the food unless proper care is taken. Production of toxin by this organism in any food is responsible

for staphylococcal food poisoning.

The food handlers could also serve as carriers for many of the pathogenic microorganisms responsible for typhoid fever, dysenteries, salmonellosis, hepatitis etc. So, there is a need for acceptable hygienic practices by food handlers to prevent microbial contamination to food. Compliance to proper hygienic practices by the food handlers can be achieved only by educating them on the importance and need for personal hygiene practices.

7.4.1. Hygienic practices for seafood plant employees

The following personal hygiene practices are to be adhered by the food handlers in seafood industry.

- **Employee health:** Employees suffering from any communicable disease, carriers of any diseases, infected wound or open lesion on an exposed part of their body should be prevented from working in the processing areas.
- **Employee appearance:** All employees should have clean and tidy appearance.
- **Fingernail polish:** Employees wearing fingernail polish are not to be engaged in handling of the product
- **Jewellery:** Employees engaged in the handling of the product should avoid wearing rings, earrings, or any other jewellery.
- **Smoking/spitting/ gum or tobacco chewing:** No person is allowed to smoke, spit or chew gum or tobacco in the processing areas.
- **Hand washing:** Employees should thoroughly wash hands with warm water and soap following each absence from duty.
- **Headgear:** Employees have to wear suitable headgear covering the hair completely.
- **Bearded employees:** Male employees with beards or mustaches will have to secure them with headgear.
- **Outer garments:** Employees should wear clean uniform (coats, aprons etc) in processing area. These garments should not be worn outside the processing unit or inside toilet areas, not be placed on processing tables or equipment during break. Employees must keep their shirt, blouse and sweater sleeves rolled up past the elbow.
- **Protective hand coverings:** Gloves need to be washed and disinfected at each break and at the end of each shift.
- **Toilet area:** Employees should avoid loitering in toilet areas.
- **Personnel permitted in processing areas:** Only authorized personnel are permitted in the processing areas.
- **Foot dips:** Employees should make use of foot dips wherever required.

7.4.2. Clean- up procedure

The absolute cleanliness of personnel, equipment and premises is very important at all stages of food production. The main objective of cleaning is to minimize the risk of cross contamination between foods and also from waste food material left on equipment and food contact surfaces. The clean-up procedure in food processing industry assures;

- Protection of food from contamination by pathogenic microorganisms that can cause disease in consumers.
- Protection of food from spoilage organisms that can cause deterioration in the quality of food.
- Maintenance of good standards of cleanliness which helps minimizing the risk of rodent and insect infestation.

A good clean-up procedure generally consists of initial cleaning procedure followed sanitation phase.

Cleaning phase

Cleaning can be defined as the removal of all dirt, slime, blood, curry, oil, grease and any food soil from all food contact surfaces. This operation is accomplished with the aid of a detergent which when added to water helps to remove all kinds of dirt effectively. The basic steps involved in cleaning phase are initial rinsing with cold water followed by scrubbing with warm water and detergent, and final rinsing with cold water.

Sanitizing phase

Sanitizing or disinfecting phase is the parts of the cleaning operation wherein surfaces and equipment are rendered microbiologically clean by using sanitizers. Sanitizing is done after cleaning phase and it involves cleaning using sanitizers followed by final rinse with cold water.

The cleaning operation involves separation of dirt/soil from the object to be cleaned, carrying the dirt away and its suitable disposal using detergent, leaving the surface being cleaned in the desired condition and disinfection when desirable.

Selection of a suitable cleaning solution or detergent is necessary to achieve effective cleaning as it depends on various factors such as neutralization, pH, alkalinity, buffering capacity, surface tension, wetting ability, mechanical action, emulsification, deflocculation, etc. Several types of mechanical aids are available for use in food industry for cleaning and sanitation purpose.

Guidelines for the use of sanitizers

The following guidelines should be followed in attaining effective sanitation in a food industry.

- Sanitizer should never be used as a substitute for thorough cleaning.
- Sanitizers should be used as an additional safeguard to thorough cleaning.
- Should not be used where sterilization need to be achieved. Because, sterilization aims at destroying or removing all microbial life, whereas sanitization does not kill all microorganisms, but help to reduce microbial load.

The detergents used for cleaning purpose should be inexpensive, approximately neutral (pH 6-8), biologically degradable, easy to wash away, non-toxic and approved by the appropriate regulatory body for food use.

The sanitizer used in the food industry should possess good bactericidal activity and active against a wide variety of organisms, be non-toxic or low in toxicity, not affect the colour, odour and flavour of the food, be fairly cheap, be easy to dispense and wash away, should not adversely affect the operators and food handlers and should not cause damage to surfaces being sanitized (Ex. equipments).

Common sanitizing agents

The most commonly used sanitizing agents in food industry are chlorine, iodine and phenolic compounds. Chlorine is more commonly used than the other two in food processing plants. It is the least expensive and readily available in several forms. Iodine is more expensive and is not easily available, but is more effective than chlorine even in low concentrations. Phenolic compounds are not used in fish processing plant as their use even in very small quantities leaves a long lasting odour and bad taste.

Degree of cleanliness

Equipment, object or any food contact surface is considered clean only when it is clean

physically, chemically and microbiologically. The object or the surface is considered physically clean when it appears clean by sight and feel. This is easy to achieve as this can be easily tested by close observation. Chemical cleanliness of an object or surface refers when the object or surface is free from traces of undesirable chemicals (too small to be seen or felt, but sufficient to influence the quality of the product). Even traces of some chemicals can affect the taste, odour, colour or keeping quality of the food product. - The object or surface is considered microbiologically clean when it is free from undesirable microorganisms. This kind of cleanliness can be tested by determining the kind and number of microorganisms left on the object cleaned, decrease or increase of bacterial load of the product at the end of the processing line, and keeping quality of the product.

7.5. Process water quality

7.5.1. Water requirement

Water is an important requirement for any food processing industry and is required in large quantity. Likewise, fish processing industries too have a requirement for large volume of good quality water for various activities. All fish processing industries should have uninterrupted water supply of potable quality which is free from diseases causing organisms, toxic substances, and objectionable odour and taste. However, depending on the availability, the quality of water used for different purposes could vary. Since the sanitary quality of food is affected by the quality of the water, there is a need to use good quality water.

In a fish processing industry water is required for activities such as unloading and storage of small sized fishes, bulk storage of fish (Ex. Refrigerated seawater, brine, ice flakes), and cleaning purpose (cleaning of processing facility, equipments, containers etc), washing of raw material and processed material, product preparation, ice making, cooling, generating steam for cooking, blanching, retorting etc.

7.5.2. Sources of water

Waters of all sources can be utilized for use in processing industry. These may include surface waters, seawater, ground water and rain water.

Surface waters

Any surface water from sources such as rivers, streams, lakes and ponds can be used in fish processing industries. However, the availability and quality varies greatly depending on the source and season. Generally, stagnant waters such as lakes and reservoirs have less sedimentable debris than flowing waters (rivers). However, pollution of surface waters due to decaying plant and animal matter, industrial wastes, sewage, fertilizer and agriculture waste could affect water quality. These waters often require treatment before using.

Seawater

Most seafood processing units situated near sea often use seawater for cleaning purpose especially when freshwater is scarce. Use of seawater could cause problems such as corrosion of equipments, water pipes, fixtures etc., difficulty in treating and threats due to waves, tides, small sea animals and weeds in intake water. However, seawater could be an effective unlimited source only if used after desalination.

Ground water

Underground sources such as well water and spring water form an important source because of their better quality than surface waters. Contamination of ground waters from sewage and presence of high dissolved salts may require treatment before use. The availability of this source of water depends on the season and geographical location.

Rain water

Rainwater may be used in processing industries when available surface waters become scarce or unfit for use due to pollution. Rainwater is collected during times of heavy precipitation, stored and used with or without mixing with other sources of water supply. The collected water needs to be protected from contamination from birds, animals etc., and may often require treatment

before use.

7.5.3. Water quality requirements

The water used in processing industry should be of potable quality. As large quantity of water is required for various purposes, it should not affect the quality of food and contaminate with harmful organisms. The water used should meet physical, chemical and microbiological quality requirements.

The physical quality requirement for process water used in processing industries is that it should be free from any noticeable colour, odour, taste and undissolved material. The type and concentration of chemical substances dissolved in water contribute for chemical quality of water. Presence of higher concentration of calcium and magnesium salts contributes for extent of hardness of water. The use of soft water is recommended in processing industries as it does not affect product quality.

Microbiologically the process water contains natural water microflora and may or may not with human pathogenic microorganisms. The natural flora of water contaminates the product and may involve in spoilage under suitable conditions. The presence of pathogenic microorganisms in water is mainly due to contamination with domestic sewage. Thus, water should be treated effectively using standard water treatment procedures to make it free from pathogenic organisms.

The standards for water quality used in fish processing industries should ensure that the water is free from harmful microorganisms, deleterious and toxic chemicals and objectionable colour, odour and taste.