

Role and significance of microorganisms in food

Introduction to fish microbiology

Fish /aquatic foods contain a variety of microorganisms from different sources. These contaminants in food cause problems of spoilage and health risk to consumers. Fish are not sterile and the microflora includes natural flora of the waters from which fish are harvested and acquired transient flora from environment especially during handling, processing, storage etc.

Inner tissue of healthy fish is sterile and microorganisms are mainly associated with outer slime, gills and intestine. Microbial load is higher in intestine followed by gills and skin. Natural microflora of fish varies depending on the habitat of fish (freshwater / marine / river/ water/ lake/ etc.), its feeding habit and life history stages. Generally, fresh warm water fish have more mesophilic bacteria than cold water fish. Transient flora include microorganisms entering the food from fish contact surface (crafts/gears/ baskets/ fish holds etc), the air, soil, water/ice used for washing, food handlers, packaging material and storage environment.

Fish harvested from polluted water contain variety of microorganisms depending on nature of pollutant, and also human pathogens such as bacteria, fungi, viruses, protozoans, parasites etc. Once the fish dies the associated microorganisms affect quality due to spoilage. Thus, it is necessary to maintain the quality by destroying associated microorganisms and preventing growth of surviving microorganisms. The different preservation methods mainly aim at maintaining fish quality by reducing, killing or inactivating associated spoilage microorganisms.

History of microorganisms in food

The role of microorganisms in spoilage and food poisoning was realised only after the establishment of bacteriology or microbiology as a science during the early 18th century. However, adoption of several approaches to avoid/ reduce spoilage was known since early civilization. The use of salted meat, fish, fat, dried animal skin and cereals was practiced by the Sumarians at about 3000 B.C. Romans were known for adopting preservation techniques for meat and also use of snow for perishables including prawns at around 1000 B.C. Smoking of meats and making of cheese and wines emerged during the same time. But the people at that time were not fully aware of nature of the preservation techniques and also the role of foods in the transmission of diseases and the danger of eating infected animal meat.

A Kircher, a monk, was first person in 1658 to observe the decaying bodies, meat, milk and other substances and believed it to be due to invisible worms, thus suggesting the role of microorganisms in food spoilage. During that time the theory of spontaneous generation of life was gaining importance and L. Spallanzani in 1765 was first to oppose it with his experiment using beef broth which remained sterile after boiling and sealing. But he was not able to convince the proponents of spontaneous generation who felt that air was necessary for life to begin. Later in 1837, Schwann's experiment of passing heated air in to the boiling broth caused it to remain sterile

thus disproving spontaneous generation of life. But it was not until Pasteur's well planned swan neck flask experiment that the theory of spontaneous generation of life was put to rest.

The development of canning of meat in glass bottles by Nicholas Appert in 1809 had practical application in food preservation. Pasteur was the first person to appreciate and understand the presence and role of microorganisms in food. He demonstrated the role of microorganisms in souring of milk in 1837, and applied heat to destroy undesirable microorganisms in wine and beer, in about 1860. Involvement of microorganisms in food spoilage and food poisoning has led to the development of preservation methods to arrest and kill microorganisms. The science of food microbiology has application in all kinds of food meant for human consumption and aims at ensuring the wellbeing of consumers.

Role of microorganisms in nature and in foods

The food of humans which is of plant and animal origin are naturally associated with microorganisms of several kinds. Microorganisms in their natural habitat play an important role in cycling of nutrients in the ecosystem. In the process of performing their primary role in nature, the microflora associated with food cause spoilage of foods meant for human consumption. Thus, the knowledge on types of microorganisms naturally associated with plant and animal foods helps to predict the microbial types that could be present at later stages of handling, storage and preservation of food.

Depending on the nature of food and its habitat a variety of microorganisms are expected in the food and these may often affect the safety of food. Therefore, information on factors such as total number and types of microorganisms' naturally present, types of microorganisms present in specific food, and ones which are not natural to the food becomes necessary. This information becomes valuable in ascertaining the safety of food during different stages of processing, handling and storage.

Microorganisms in aquatic environment

All surface waters such as ponds, lakes, rivers and oceans differ in their physical, chemical and biological characters. Depending on the nutrient status of water body, the microbial load varies with higher numbers encountering in eutrophic waters. Ground waters or subterranean waters generally have very low microbial load because of filtration effect of soil layers.

Categories of microorganisms in natural waters

The natural waters contain a variety of microorganisms. These include,

- **Natural flora** : Microorganisms natural to the water body and

- **Transient flora:** Microorganisms entering the water body from outside environment like from soil, air and through pollutants.

Microorganisms in natural aquatic environment play an important role in nutrient recycling, and as primary producers and decomposers of organic matter. All the microorganisms present in a water body can be seen as surface flora of inhabiting organisms. These not only include spoilage organisms but also human pathogenic microorganisms especially in sewage contaminated waters.

Primary source of microorganisms found in food

The foods of plants and animal origin carry several microorganisms associated with their natural habitat. Plants carry typical micro-flora on their surface and also get contaminated from outside sources. Animals carry microorganisms on their surface and intestine, and also contain contaminants from surrounding environment. Through their excretions and secretions animals release microorganisms in to surrounding environment. Besides, both plants and animals carry pathogenic microorganisms capable of causing human illness. The food associated microorganisms are influenced by the availability of specific nutritional requirements and the environmental parameters. The primary sources of entry of microorganisms in to foods are from the soil, water, air, during handling, processing transportation and storage of foods.

Soil

Soil being the rich source of several kinds of microorganisms immediately contaminates the plants and edible plant parts, and the surface of animals with the soil associated microorganisms. As the soil particles are carried in to aquatic environment through wind, rain and other means contamination of water takes place with several soil micro-flora. Therefore, it is not uncommon to find several microorganisms both in soil and water environment. These soil derived microorganisms form part of the the microbial flora involved in spoilage of foods of plant and animal source. Thus, there is a need to reduce the load of soil microorganisms in foods which can be achieved by removing the soil by washing the surface of foods with good quality water, and by avoiding contact with soil/ dust.

Water

Natural waters not only contain several microorganisms native to the aquatic environment but also from soil, raw/treated sewage and pollutants entering the water body. The microbial numbers and types vary in different water bodies depending on the nutrient status. Thus, all kinds of microorganisms found in water are likely to be associated with the aquatic organisms as surface flora. Use of such water for food processing will add microorganisms from water to food.

Sewage waters containing human pathogenic microorganisms contaminate foods when such waters are used without proper treatment. The water used in food processing should meet agreeable chemical and bacteriological characteristics.

Air

Air contains several microorganisms which may get deposited on the food being processed and handled. Though the air does not contain natural flora of microorganisms, whatever microorganisms encountered are those associated with the suspended solid material and water droplets. The sources of microorganisms to air are from dust, dry soil, and water spray from natural surface waters, droplets of moisture from coughing, sneezing and talking by food handlers, from sporulating moulds growing on walls, ceilings, floor, foods and food ingredients. Thus, it is likely that the microorganisms persisting in air get deposited on the food being processed and contribute for microbial load and subsequent spoilage of food.

The number of microorganisms present in air depends on factors such as extent of movement of air, sunshine, humidity, location and amount of suspended dust in air. Quiet air allows settling of microorganisms but the moving air brings in microorganisms and keeps them suspended. Thus, the number of microorganisms in air is increased by air currents caused by movement of people, by ventilation and by breeze. The rain or snow removes microorganisms from the air.

Micro-flora of food processing facility

The nature of micro-flora in a food processing facility varies depending on the nature of food being processed. Hence characteristic microbial populations are encountered in different processing units. Also variations may be observed in microbial numbers from one area of processing plant to another. The microbial types present inside the processing plant are related to quality of air outside the plant and the microbial population levels are related to the level of activity of workers.

Reducing microbial load in processing area

There is a need to reduce microbial load in the processing area. This can be achieved by installing filtration, chemical treatment and heat or electrostatic precipitation units, and taking measures in preventing the build up after reducing the microorganisms. The build up of microorganisms in the processing area can be prevented by maintaining the positive pressure in food process area, installing filters in ventilating systems that prevent spread of microorganisms from one part of a plant to another and installing UV- irradiated air locks at doors to reduce the number of organisms carried by workers.

Handling and processing

Foods grown/cultured in natural environment containing specific groups of microorganisms are further contaminated by several microorganisms during harvesting, handling and processing. Further, addition of microorganisms to food may take place from;

- All food contact surfaces including equipments coming in contact with foods, packaging material, and from food handlers. Foods are also prone for microbial contamination during transportation and storage.

- Use of sewage contaminated water for washing foods being processed contaminates it with human pathogenic microorganisms
- All the microorganisms associated with food handlers enter the food during handling of food from hands, garments, body surface, hair etc under poor personnel hygiene practices.

Significance of microorganisms in foods

Microorganisms associated with food derive energy from food for those cell growth, maintenance and reproduction. Based on their function microorganisms associated with foods may be divided in to three general groups;

- Those causing spoilage or undesirable changes in the food
- Those producing desirable changes
- Those producing disease

Based on the extent of stability to microbial invasion foods may be classified as;

- Perishable foods Ex. Fish and meat
- Semi-perishable foods Ex. Potatoes. Tomato
- Stable foods Ex. Cereals, Flour and Sugar

The stable or semi-stable foods become unstable or perishable when the moisture content increases.

Factors affecting microorganisms in foods

The survival and activity of microorganisms in foods depends on several factors namely, numbers and types of microorganisms present, type of food, treatments to which the food has been exposed, processing or storage treatments that the food receives, whether the food is to be consumed as it is or heated.

The food associated microorganisms may have useful function, cause spoilage, cause health hazard and play no role or remain inert. The cases of spoilage, food-borne illnesses or useful activity results due to the growth and multiplication of the microorganisms. The inert microorganisms are those which do not find food environment favorable for their growth, and remain dormant without causing any changes in food.

Causes for spoilage of food

Spoilage of food usually occurs due to,

- Undesirable changes brought about by the microorganisms in the odour, colour, taste, texture and appearance of the food.

- Some microorganisms may not directly involve in spoilage but bring about changes in food that will facilitate growth of spoilage organisms. Ex. Bacteriophage attacking useful organisms and facilitating growth of undesirable organisms leading to spoilage.

Microorganisms associated with food

The presence of small numbers of microorganisms associated with foods may not cause any problem, but their unrestricted growth can result in spoilage or deterioration of the food making it unfit for consumption. The wide variety of microorganisms associated with foods is mainly saprophytic. They can not be avoided in food as these are derived from the environment in which the food is prepared or processed, and also difficult to eliminate completely. However, it is possible to reduce the number or decrease their activities by altering the environmental conditions.

A variety of bacteria, molds and yeasts are important as food spoilage organisms. Important microorganisms involved in spoilage of fish are:

Bacteria

Gram Negative Bacteria

Acinetobacter, Aeromonas, Alkaligenes, Enterobacter, Flavobacterium, Moraxella, Photobacterium, Pseudomonas Vibrio etc

Gram Positive Bacteria

Bacillus, Corynebacterium, Enterococcus, Listeria, Microbacterium, Clostridium, Staphalococcus, etc