Spoilage of fresh and processed fish and fishery products

Spoilage of semi-processed and processed fishery products

The native microbial floras as well as the microorganisms entering in to the food through various stages of handling and processing play an important role in spoilage of fresh as well as processed fish and fishery products. Though the post- harvest handling and treatment of fish is expected to reduce microbial proliferation, some of the process-tolerant and surviving microorganisms grow and cause spoilage of the product.

Microbiology and spoilage of fresh fish

The microbial laod and and types of microorganisms associated with the freshly harvested fish directly reflects on the microflora of the immediate environment from which fish is harvested. Further, several microorganisms are added to the fish from harvesting gear and net, from the boat deck, fish contact surface, fish holds and fishermen. Once the fish dies, microorganisms present on the body surface, gills and the intestine start multiplying and increase in numbers causing deteriorative changes in fish. As the time lapses the spoilage proceeds faster making the fish unfit for human consumption. The spoiling fish is generally characterized by the loss of bright body coloration, fading of gill colour, sunken eyes and development of off odour metabolites of spoilage bacteria. The spoilage flora of fresh fish is generally dominated by the Gram negative bacteria.

The effective way to prevent or delay spoilage of fresh fish is by reducing the activity of spoilage microorganisms which can be achieved by lowering the temperature of holding the harvested fish.

Microbiology and spoilage of chilled fish

Holding the fish in low temperature close to freezing point of water affects the microflora of fish. The low temperature reduces microbial and enzymatic activity resulting in extension of shelf life of fish. Factors such as quality of fish, method and duration of chilling and efficiency of storage method influence the quality of chilled fish. Many microorganisms associated with fish survive low temperature and spoilage is mainly caused by psychrotrophs. Among the bacterial flora dominance of Gram negatives is observed over Gram positive bacteria. Chill storage brings about changes in composition of microflora, and mesophiles are gradually dominated by psychrophiles. The low temperature, however, helps to maintain fish in good condition only for a short time. The prolonged storage under chill condition leads to growth of psychrophilic microorganisms resulting in spoilage of fish.

Microbiology and spoilage of frozen fish

The bacteriological quality of frozen products depends on the bacterial load of the raw material, contamination during handling and processing and extent of removal of these contaminants during processing. The freezing and storage under frozen condition has detrimental effect on surviving microorganisms and reduction in count is highly variable.

Growth and survival of microorganisms associated with frozen foods

The psychrotrophic bacteria in fish are sensitive to freezing stress, and the sensitivity is strain dependent. Spoilage microorganisms generally grow and cause spoilage when the raw fish product is held long time before freezing, frozen at a very slow rate (slow freezing conditions), thawed too slowly or held under thawed condition for a long time. However, the ultimate activity of microorganisms depends on the time duration and temperature of holding the product. As most microorganisms are unable to grow below -10 ºC or -12 ºC, increase in temperature above this limit results in dramatic increase in growth rate. The changes in microflora and biochemical alterations observed in frozen fish products are similar to that of raw chilled fish.

Seafood held at elevated frozen storage temperatures (-10 ºC to -5 ºC) are likely to support mold growth though at very slow rate. Some molds and yeasts can grow in that range. Though bacteria do not grow in frozen foods, they are able to survive freezing and frozen storage to a certain extent, so that thawed fish spoils about as fast as fish that has never been frozen. Gram negative bacteria are more readily killed by the freezing conditions than Gram positive bacteria while, spores are least sensitive and thus show better survival.

Microbial analysis of frozen product gives some information about the quality of the fish before it was frozen. However, all strains of microorganisms are to some extent killed by freezing and frozen storage. Hence, the bacterial load in frozen fish is always lower than that observed before the product was frozen. For frozen foods use of E. coli as indicator of sanitary quality during processing is not suitable, and instead fecal streptococci are preferred owing to their greater ability to survive freezing.

Pathogenic microorganisms and frozen foods

Among human pathogenic microorganisms, *Vibrio parahaemolyticus* is encountered in small numbers in frozen foods since it is quite sensitive to conditions of freezing and thawing. However, these potentially dangerous bacteria get destroyed on cooking, but pose threat only under the conditions of recontamination of the cooked food and abuse of holding time and temperature. The potentially toxigenic *Clostridium botulinum* is not affected by freezing conditions and presents no hazard unless conditions for its outgrowth and toxin production are provided. However, toxins that might be present in the raw product or produced as a result of bacterial growth in seafood prior to freezing would not be inactivated by the freezing process. Generally, conditions permitting the development of large populations of spoilage bacteria also favour toxigenesis of *C. botulinum*. The poor temperature control which is commonly encountered during the distribution of frozen seafood favours bacterial growth leading to spoilage. Staphylococci are reasonably resistant to the effects of freezing hence their load in frozen food gives an indication on the extent of handling/human contact that the food had received prioer to freezing.

Prevention of spoilage

Foods frozen and held at appropriate temperature conditions are free from microbial spoilage unless the conditions of freezing and thawing had permitted growth of associated microorganisms as in slow freezing and slow thawing. Therefore, temperature control is the principal means to stop microbial activity in frozen seafood involving rapid freezing, holding at or below -18 ºC and rapid thawing.

Microbiology and spoilage of canned fishery products

Canned seafoods are expected to be commercially sterile and free from spoilage and potentially pathogenic microorganisms. The bacteriological hazards of canned food mainly results from improper or inadequate processing or leakage of cans. The inadequate heat processing causes survival and growth of heat resistant clostridial spores responsible for botulism. The mesophilic spoilage organisms entering the cans through leakage caused due to improper seaming of cans grow during storage eventually resulting in spoilage of canned product.

The semi-processed canned seafood products are often subjected to bacteriological problems. The stability and safety of these products depend on the factors such as combination of preservatives used and pasteurization process applied. In most pickled products that depend on salt (eg. anchovies) or a low pH (eg. mussel) for stability, the heat process given destroys both hazardous and spoilage microorganisms. Yeast like *Pichia fermentans* often cause illness after growing in semi-processed canned seafood.
In some smoked products which are canned using minimal heat treatment, the storage stability is attributed to presence of salt, smoke constituents and a low water activity. Thus, production of safe final product can be achieved only by having good control over processing parameters.

Microbiology and spoilage of cured fishery products

Salting and drying are the most common methods used for curing of fish. The preservative effect of salted and or dried fishery products is due to lowering of water activity. Bacterial counts of fully dried seafood are generally low, unless there has been extensive surface contamination. Spoilage of such products is mainly caused by halophilic bacteria which can persist on the surfaces of contaminated cured seafood. However, the microbiological hazards due to pathogenic microorganisms are negligible in cured or salted seafood products.

Smoked seafood products vary widely in microbial stability depending on the nature and degree of severity of processing. Heavily salted, hot smoked products are microbiologically similar to the fully dried products since their water content is too low to support bacterial growth and hence pose little or no hazard. Lightly smoked products that are brined only enough to improve a flavour carry a mixed microbial population and are only slightly more stable than unprocessed fish. Generally, Gram positive bacteria dominate the microflora of such products soon after preparation but Gram negative bacteria gradually become more numerous during refrigerated storage and are ultimately responsible for their spoilage. The hot smoked fishery products that have not been adequately dryed are of high risk due to selective outgrowth of *C. botulinum* resulting from favourable Eh and elimination of competing bacteria.