Seafood Spoilage

Subjects: Zoology

Contributor: Michael Kontominas , Anastasia Badeka , Ioanna Kosma

The term “seafood” includes (i) free-swimming, pelagic and freshwater fish, (ii) crustaceans, (iii) mollusks and (iv) the respective aquacultured species.

seafood spoilage | microbial spoilage | enzymic autolysis | lipid oxidation | food safety

1. Seafood Spoilage

As with the flesh of terrestrial animals and birds, the muscular tissue of fresh caught fish is normally sterile at harvest. On the contrary, skin, gills and intestines carry a large number of bacteria (10^2–10^7 cfu/cm^2 on skin and 10^3–10^9 cfu/g in gills and gut). The spoilage microflora of fresh ice-stored fish consist mainly of Gram-negative Pseudomonas spp. and H_2S-producing bacteria including *Shewanella putrefaciens*. Acinobacter and Moraxella spp. may comprise a portion of the spoilage microflora [1]. Olafsdottir et al. [2] reported on the spoilage microflora of haddock fillets stored at refrigeration and abuse temperatures and reported *Photobacterium phosphoreum* to be the dominant spoilage microorganism. Pseudomonas spp. and *Shewanella putrefaciens* were also present, being responsible for spoilage off-odors. The early stages of spoilage involve utilization of non-protein nitrogen, resulting in the formation and accumulation of amino acids, ammonia and volatile amines. As proteolysis proceeds, spoilage becomes more evident. Hydrogen sulfide and other sulfur compounds, such as mercaptans and dimethyl sulfide, produced by *S. putrefacians* and some pseudomonads usually contribute to spoilage [3].

After harvesting from the fish farm or capture at sea, fish may either be stored in ice or fresh-frozen. The flesh of mollusks differs from that of crustaceans and free-swimming fish in that it contains an appreciable amount of carbohydrates in the form of glycogen. Even though microorganisms involved in mollusks’ spoilage are the same as those encountered in fish and crustaceans (Pseudomonas and Acinetobacter-Moraxella spp.), spoilage of the former is primarily glycolytic (it contains 1–5% glycogen) rather than proteolytic, leading to a pH decrease from around 6.5 to 5.8. Under such conditions of acidity, enterococci, lactobacilli and yeasts dominate the later stages of spoilage.

On the other hand, crustaceans such as shrimp and prawns, in addition to their endogenous microflora, are subject to a more rapid microbiological spoilage due to usual contamination with bacteria from the mud trawled up along with these species following capture [1]. Microbial spoilage of crustaceans occurs in a similar manner to fish flesh; however, the higher amount of free amino acids and other soluble nitrogenous compounds present leads to rapid spoilage and elevated levels of volatile basic nitrogen spoilage compounds [3]. More specifically, fish spoilage can be attributed to (i) post-mortem enzymic autolysis, (ii) microbial growth and (iii) oxidation of lipids.

The flesh of fish is composed of macroconstituents: moisture, proteins and fats, and microconstituents: minerals, vitamins and enzymes. In addition, crustaceans and mollusks contain carbohydrates in the form of glycogen. Due to their specific composition, seafood products are considered a very perishable commodity. The fact that fishing vessels gear seafood usually at large distances from the sites of consumption necessitates proper preservation to avoid product spoilage. This need is further driven by consumer demand for high-quality, lightly processed products with minimal changes in nutritional and sensory properties. This also applies to aquacultured seafood species which need to be properly preserved in order to be safely shipped to far away destinations. Besides traditional seafood preservation methods including chilling (at 0–1 °C), freezing (<1 °C), drying, smoking, salting, fermentation and canning, more recent methods of seafood preservation include (1) the use of natural preservatives, (2) high hydrostatic pressure treatment, (3) ozonation, (4) irradiation, (5) pulse light technology, (6) retort pouch processing and (7) packaging in combination with refrigeration or freezing [4][5][6][7][8][9].

2. Innovative Seafood Preservation Methods

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