

QUALITY AND SAFETY ISSUES IN FISH AND FISH PRODUCTS

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Introduction

Fish and other seafood are highly important as they cover a part of protein demand for humans. The nutrient composition of fish is rich in health beneficial polyunsaturated fatty acids, vitamins and minerals. Fresh fish spoilage can be very rapid after it is caught. Freshness makes a major contribution to the quality of fish and fishery products. Nutritional values, color, texture, and edibility of foods are susceptible to spoilage. Improper pre and post-harvest handling conditions can enhance exacerbation of indigenous bacteria that could cause spoilage of fish.

Freshness is the most important attribute when assessing the quality of seafood and is of great concern. The quality of seafood degrades after death due to the chemical reactions [changes in protein and lipid fractions, the formation of biogenic amines and hypoxanthine (Hx)] and microbiological spoilage. This leads to the deterioration of sensory quality of seafood during inadequate storage. The factors contributing to spoilage of fish are

- High fat content
- High protein content
- High moisture content
- Weak muscle tissue
- Extent of bacterial contamination
- Unhygienic handling etc.

Quality of fish

Quality is “The degree of excellence to which a product meets all of the attributes, characteristics and features that the buyer or consumer of the product, and the regulatory agencies expect”. In case of fish, quality refers to the aesthetic appearance and freshness or degree of spoilage that the fish has undergone. Freshness makes a major contribution to the quality of fish and fishery products. Quality of harvested fish depends upon both extrinsic and intrinsic factors . Intrinsic factors are species, size, sex, composition, spawning, and cultivation practice. Extrinsic factors are location of catch, season, methods of catch (gill net, handline,

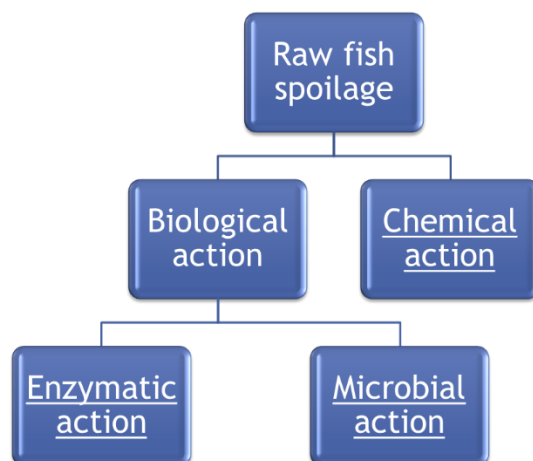
longline, or trap, etc), on-board handling, hygienic conditions of vessel, processing and storage conditions. ‘There is no control over intrinsic qualities, which are part of the fish, however extrinsic qualities, can be controlled by handling fish properly and by cleaning and chilling them as soon as possible. Today food safety remains a major concern facing the seafood industry, and it is a critical component in ensuring food and nutrition security worldwide.

Fish quality is lost because of

- Bacterial spoilage
- Enzyme activity
- Chemical changes
- Physical damage
- Dehydration
- Contamination

Spoilage of fish

Seafood is highly perishable food commodity and spoilage of fish involves three separate processes such as enzymatic spoilage, bacterial spoilage and chemical decomposition. "Spoilage refers to any change in the condition of food in which the food becomes less palatable, or even toxic; these changes may be accompanied by alterations in taste, smell, appearance or texture."



Spoilage of fish is also called “Putrefaction”. It refers to the contamination of fish, resulting in an undesirable change in the colour, texture, flavour, odour, appearance, etc.

Enzymatic spoilage

Shortly after capture of fish chemical and biological changes take place in dead fish due to enzymatic breakdown of major fish molecules. The changes textural quality during early stages of deterioration but did not produce the characteristic spoilage off-odors and off-flavors. The digestive enzymes cause extensive autolysis which results in meat softening, rupture of the belly wall and drain out of the blood water which contains both protein and oil. During improper storage of whole fish, proteolysis is responsible for degradation of proteins and is followed by a process of solubilization. Belly bursting is caused by leakage of proteolytic enzymes from pyloric caeca and intestine to the ventral muscle.

Table 1. Enzymes involved in spoilage of fish

Enzyme(s)	Substrate	Effect	Prevention
Glycolytic enzymes	Glycogen	Lactic acid production resulting in pH drop.	Avoid pre-rigor stress
Autolytic enzymes involved in nucleotide breakdown	ATO, ADP, AMP, IMP	Gradual production of Hypoxanthine	Avoid pre-rigor stress and improved handling.
Cathepsins	Proteins, peptides	Softening of tissue	Avoid rough handling during storage
Chymotrypsin, trypsin, carboxy-peptidases	Proteins, peptides	Belly-bursting	Problem increased with freezing/thawing or long-term chill storage
Calpain	Myofibrillar proteins	Softening	Removal of calcium
Collagenases	Connective tissue	Softening and gaping of tissue	Time and temperature of chilled storage
Trimethylamine Oxide (TMAO) demethylase	TMAO	Formaldehyde	Storage temperature less than -30°C, physical abuse, freeze/thawing

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Oxidative spoilage

Lipid oxidation is a major cause of deterioration and spoilage for the pelagic fish species such as mackerel and herring with high oil/fat content stored fat in their flesh. Fish lipids which consist of polyunsaturated fatty acids are highly susceptible to oxidation. Lipid oxidation involves a three-stage free radical mechanism: initiation, propagation and termination. Initiation involves the formation of lipid free radicals through catalysts such as heat, metal ions and irradiation. This free radical which reacts with oxygen to form peroxy radical. During propagation, the peroxy radicals reacting with other lipid molecules to form hydroperoxides and a new free radical. Termination occurs when a buildup of these free radicals interacts to form non radical products. In fish, lipid oxidation can occur enzymatically or non-enzymatically. Enzymatic hydrolysis by lipases is called as lipolysis (fat deterioration) in which lipases split the glycerides forming free fatty acids resulting off flavor. Non-enzymatic oxidation is caused by heme compounds (hemoglobin, myoglobin and cytochrome).

Microbial spoilage

Composition of the micro flora on newly caught fish depends on the microbial contents of the water in which the fish live. Fish micro flora includes bacterial species such as *Pseudomonas*, *Alcaligenes*, *Vibrio*, *Serratia* and *Micrococcus*. Microbial growth and metabolism are a major cause of fish spoilage which produce amines, biogenic amines such as putrescine, histamine and cadaverine, organic acids, sulphides, alcohols, aldehydes and ketones with unpleasant and unacceptable off-flavors. For unpreserved fish, spoilage is a result of Gramnegative, fermentative bacteria (such as *Vibrionaceae*), whereas psychrotolerant Gram-negative bacteria (such as *Pseudomonas* spp. And *Shewanella* spp.) tend to spoil chilled fish.

Safety of fish

Food safety can be termed as the assurance that the food will not cause an adverse health effect for the consumer when it is prepared and/or consumed in accordance with its intended use. Safety of fish is a major concern and critical factor for ensuring food and nutritional security globally. It is a measure of the acceptability in terms of its ability to support both nutrition and health of consumer. In the manufacturing process it is vital to ensure that the products delivered to consumers do not interfere with the consumers' health adversely. The assurance that the food will not cause an adverse health effect for the consumer when it is prepared and/or consumed in accordance with its intended use.

The objective of handling, processing and preservations is to control or reduce the spoilage process so that the final product is wholesome and safe for the consumer.

Quality and safety issues in fish products

Quality and safety issues in Live/fresh/chilled/frozen fishes, Dried fish, Fish mince and surimi, Smoked fish, Canned fish, convenient, coated products and fermented fish products are listed below.

Quality issues	Safety issues
<i>Live/fresh/chilled/frozen fishes</i>	
Belly bursting	Pesticide residues and Other
Discoloration	Persistent organic pollutants
Blackening/ melanosis in crustaceans	Residues of veterinary drugs and
Pink discoloration in squid and cuttlefish	extra label chemicals

Freezer burn/ dehydration Off flavors	Unapproved additives Presence of adulterants Growth of pathogenic bacteria Allergens
<i>Dried fish</i>	
Shrinkage Casehardening Protein denaturation and rehydration Maillard reaction Rancidity Dun, Pink/Red Insect infestation Fragmentation	Growth of pathogenic bacteria <i>Clostridium botulinum</i> toxin production (for uneviscerated products) <i>Staphylococcus aureus</i> toxin Pesticide residues Unapproved additives Allergens
<i>Fish mince and surimi</i>	
Dehydration Presence of foreign matter Denaturation of protein	Parasites Growth of pathogenic bacteria Pathogenic bacteria survival Heavy metals Natural toxins Allergens and Food intolerance substances Metal inclusion
<i>Smoked fish</i>	
Presence of pathogens Decomposition Parasites	Growth of pathogenic bacteria <i>Clostridium botulinum</i> toxin production Pathogenic bacteria survival Allergens and Food intolerance substances Metal inclusion Natural toxin Polyaromatic hydrocarbons
<i>Canned fish</i>	

<p>Struvite formation</p> <p>Sulphide blackening</p> <p>Blue discoloration</p> <p>Curd and adhesion</p> <p>Honey combing</p> <p>Retort burn</p> <p>Case hardening</p> <p>Softening and mush</p>	<p>Growth of pathogenic bacteria</p> <p><i>Clostridium botulinum</i> toxin production</p> <p>Pathogenic bacteria survival</p> <p>Allergens and Food intolerance substances</p> <p>Metal inclusion</p>
<i>Convenient products</i>	
<p>Discoloration</p> <p>Rancidity</p> <p>Protein denaturation</p> <p>Loss of nutrients</p>	<p>Growth of pathogenic bacteria</p> <p><i>Clostridium botulinum</i> toxin production</p> <p>Pathogenic bacteria survival</p> <p>Allergens and Food intolerance substances</p> <p>Metal inclusion</p>
<i>Coated products</i>	
<p>Shelling</p> <p>Blow off</p> <p>Poor adhesion</p> <p>Gummy interface</p>	<p><i>Clostridium botulinum</i> toxin production (Reduced Oxygen Packaging -ROP)</p> <p><i>Staphylococcus aureus</i> toxin (ROP & other than ROP)</p> <p>Allergens and Food intolerance substances</p> <p>Metal inclusion</p>
<i>Fish pickles</i>	
<p>Soft, slippery slimy/dark appearance</p> <p>Shriveled/bitter tasty pickle</p> <p>Yeast and mold growth</p> <p>Presence of pathogenic bacteria</p>	<p>Growth of pathogenic bacteria</p> <p><i>Clostridium botulinum</i> toxin production</p> <p>Allergens and Food intolerance substances</p> <p>Metal inclusion</p> <p>Glass inclusion</p>

Fermented fishery products

Parasites	Growth of pathogenic bacteria
Natural toxins	<i>Clostridium botulinum</i> toxin
Histamine	production
Presence of pathogenic bacteria	Allergens and Food intolerance
Rancidity	substances
Dehydration/ dryness and discoloration	Metal inclusion
Presence of extraneous matter	Glass inclusion