15. GENERAL QUALITY ISSUES IN FISH AND FISHERY PRODUCTS

Laly S. J.,A. Jeyakumari, Abhay kumar, L. Narasimha Murthy

Mumbai Research Centre of ICAR-Central Institute of Fisheries Technology, Navi Mumbai

* lalyjawahar@gmail.com

Introduction

Fish is a nutrient rich food commodity with high perishable nature. It is highly susceptible to post harvest losses both physical (material) and quality.According to ISO, Quality is defined as the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs. Quality loss of fish refers to the undergone changes due to spoilage or physical damage and finally resulted quality deterioration.Quality and safety are important parameters for perishable foods like fish and fish products. Directly after death of the fish, a series of biochemical reactions starts, which is of paramount importance for the quality and shelf life of products.

Spoilage of fish

Spoilage is defined as the sensory changes resulting in a fish product being unacceptable for human consumption. Fresh product is defined as the one whose original characters remain unchanged. Spoilage therefore is the indicative of post-harvest change. This change may be graded as the change from absolute freshness to limits of acceptability to unacceptability. Spoilage of fish begins immediately after the death of the fish. Fresh fish spoilage can be very rapid after it is caught. The spoilage process will start within 12 h of their catch in the high ambient temperatures of the tropics. It depends upon several different factors such as the type of fish species, the physiological condition of the fish, as well asenvironmental influences (for example water temperature, salinity). In addition, catching and harvesting methods, killing procedures and the performance of slaughtering have a great effect on the biochemical reactions.The spoilage of fish is a complicated process brought about by actions of enzymes, bacteria and chemical constituents.The process involves three stages namely enzymatic autolysis, oxidation and microbial spoilage.

1. Enzymatic spoilage - A number of proteolytic enzymes are found in muscle and viscera of the fish after catch. These enzymes contribute to post mortem degradation in fish muscle and fish products during storage and processing. There is a product associated alteration that can be contributed by proteolytic enzymes. Lactic acid produced by the anaerobic glycolytic pathway in post mortem fish decrease the pH from 7 – 7.2 to 6.2 – 6.5 resulting post mortem stiffening called rigor mortis. Autolytic enzymes activate nucleotide degradation process and result bitter tasting hypoxanthine which is an indicator of loss of freshness. Proteolytic enzymes cause extensive autolysis which results in meat softening and rupture of the belly wall.
2. Microbial spoilage - Directly after the catch, the muscle tissue of healthy marine fish is free from bacteria, but not the gills, skin and intestines. The bacteria penetrate into the fillet mainly through the gills and body cavity during storage and processing, accompanied by changes in the composition of the bacterial flora. Gram-negative psychrotrophic rods (*Shewanella* spp., *Pseudomonas* spp., *Vibrio* spp. and *Aeromonas* spp.) are important spoilage bacteria. Microbial growth and metabolism is 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.
3. Chemical 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. Lipid oxidation involves a three stage free radical mechanism: initiation, propagation and termination. Oxidation typically involves the reaction of oxygen with the double bonds of fatty acids. Therefore, fish lipids which consist of polyunsaturated fatty acids are highly susceptible to oxidation. In fish, lipid oxidation can occur enzymatically or nonenzymatically. The enzymatic hydrolysis of fats by lipases is termed lipolysis (fat deterioration).

Quality issues in chilled fish and shellfish

- **Belly bursting –**Belly bursting of fish is due to enzymic spoilage in well fed fish. It can occur in only a few hours after catch in sardines, herring etc, is caused simply by a weakening of the belly wall due to self-digestion. The rate of self-digestion is much dependent on temperature. Chilling of the fish to just above the freezing point does not stop, but retards self-digestion. In the dissolved gut components, bacteria proliferate and produce gases such as CO_2& H_2. This gas production leads to belly bursting after short storage period.
- **Blackening or melanosis –**Black spot or mealnosis is objectionable black discolouration appearing in crustaceans especially shrimps, lobsters etc during storage. Dark pigments mainly appear in the cephalothorax and joints region, which is due to the enzymatic oxidation of phenolic compounds by poly phenoloxidase (PPO) enzyme. Even though it is harmless, it reduces marketability of shrimp. Sulphite containing compounds namely sodium metabisulphateat 0.2 to 0.5 % (w/v) for one minute dip treatment is used in industries to prevent blackening of shrimp.
- **Discoloration -** Darkening of dark-fleshed fish such as sardine and mackerel during iced storage is mainly caused by the formation of metmyoglobin by the autooxidation of myoglobin.The discoloration increase with the increase of storage period.
- **Pink discoloration in squid and cuttle fish –** Pink discoloration in squid during handling and chilled storage reduce the quality and acceptability. Pigment released from the disrupted chromatophores localized in the skin most likely stains the mantle during the handling or storage. Large squids are more prone to develop colour in comparison to small. Pink colouration is commonly observed in squid stored in insufficient ice as well as stacking condition for extended period. Bleaching agents are commonly used to prevent pink discolouration.

Quality issues in frozen fish

- **Freezerburn or dehydration –** Freezer burn or white patches develop on the surface of frozen stored fish due to vapour pressure gradient within the product and environment during temperature fluctuation. High temperature of material while loading, frequent

opening of the door, excess defrosting and high air velocity accelerate dehydration. Proper packaging without air pockets, sufficient glazing, constant storage temperature and relative humidity are important for controlling this defect. The critical limit of dehydration is $50g/m^2/day$.

- **Yellow discoloration -** Yellowish color in the flesh, occurs in some frozen fish as a result of chromatograph disruption with consequent release and migration to the subcutaneous layer. Yellow discolouration reported in frozen pomfrets is due t oxidation. Application of glaze water containing antioxidants can prevent yellowing of frozen pomfrets.
- **Green discoloration in frozen tuna –** It is a common defect in frozen tuna and sword fish. Hemoproteins react with hydrogen sulphide produced from deterioration of fish under aerobic condition to form sulfhaemoglobin and sulfmyoglobin. These are green pigments accompanied with sour smell and off flavor. It can be prevented by proper bleeding of fish and maintenance of iced condition until frozen.
- **Protein denaturation –** Fluctuation in the frozen storage temperature leads to protein denaturation. It results loss of functional property and textural damage.
- **Weight loss –** frozen fish loss weight upon thawing as thaw drip. Along with thaw drip many water soluble nutrients and flavor are lost. Increased amount of thaw drip affect the appearance of the product and result weight loss. Weight loss increase with pre freezing ice storage period.

Quality issues in dried fish

- **Pink formation -** The formation of pink or red discolouration on surface of the cured or salted product adversely affects the appearance. Halophilic bacteria species of the genus *Halobacterium* and *Halococcus*attack dried fish and a pink or red discolouration is formed. Spoilage appears on the surface as slimy pink patches. They are aerobic and proteolytic in nature, grows best at 36ºC by decomposing protein and giving out an ammoniacal odour. However, these bacteria are not harmful in nature. Usage of good quality salt is recommended to avoid this condition.
- **Dun formation -** Dun is a brown or chocolate coloured pepper like spot that grows in dried fish at 10 to 15% salt content. This is mainly caused by growth of halophilic mould called *Sporendonemaepizoum. Wallemiaspora*and*Wallamiasabi*appears chocolate in

colour. The most common species,*Aspergillus species* and*A. glaucusspecies* can cause an objectionable flavour and textural changes in fish. The moulds are harmless, do not damage the flesh and growth is very slow. It can be prevented by good hygienic method in and around the processing plant. The presence of mould on the surface of the fish makes the product unacceptable to the consumer. To avoid the mould growth it is necessary that the fish be dried, packed and stored properly to avoid uptake of moisture.

- **Salt Burn:** A mixture of large and small grain sizes is recommended for dry salting of fish. If fine grain is used directly on the fish, salt burn may occur due to the rapid removal of water from the surface with no penetration of salt to the interior of the fish.
- **Chemical impurities of commercial salt:** main chemical impurities in salt are calcium chlorides and sulphates, magnesium chlorides and sulphates, sodium sulphate and carbonate and traces of copper and iron. Calcium and magnesium chlorides slow down the penetration of salt into the fish, thus increasing the spoilage rate. Magnesium chloride is hygroscopic in nature and tends to absorb water thus making the more difficult to dry. Excessive quantities of calcium and magnesium compounds impart a bitter taste to the fish and make it brittle when dry. Traces of copper gives a brown appearance to the fish making it look spoiled.
- **Case hardening –** When the rate drying is very rapid due to high temperature and low relative humidity, the surface of the fish can become very hard or 'case hardened'. This prevents the movement of moisture from the deeper layers to the surface. The surface of fish will be dried, while the centre remains wet and hence spoils quickly.
- **Rancidity:** This is caused by the oxidation of fat, mostly in oil rich fishes like mackerel. Oxidation of fat imparts characteristics odour and colour of the fish change to brown. This is known as rust. Certain impurities in salt and traces of copper accelerate this.
- **Insect infestation:** Dried fish losses in many developing countries are caused by insect infestation. The flies which attack the fish during the initial drying stage are mainly blowflies belonging to the family Calliphoridae and Sarcophagidae. These flies are attracted by the smell of decaying matter and odours emitted from the deteriorating fishes. During the glut season when the fish is in plenty and some are left to rot, these flies come and lay their eggs. These eggs develop into maggots, which bury within the gill region and sand for protection from extreme heat and develop mainly when conditions are favourable.

The most commonly found pests during storage are beetles belonging to the family Dermestidae. Beetles attack when the moisture content is low and especially when the storage is for a long time. The commonly found beetles are *Dermestesater, D frischii*, *D maculates*, *D carnivorous* and *Necrobiarufipes*. The larva does most of the damage by consuming dried flesh until the bones only remain. Mites are also an important pest, which are found infesting dried and smoked products. *Lardoglyphuskonoi* is the commonly found mite in fish products. Infestation can be reduced by proper hygiene and sanitation, disposal of wastes and decaying matter, use of physical barriers like screens, covers for curing tanks etc, and use of heat to physically drive away the insects and kill them at 45 º C.

- **Fragmentation:** Denaturation and excess drying of fish results in breaking down of the fish during handling. Fish can become brittle and liable to physical damage when handled roughly. Insect infestation is also a reason behind fragmentation in dried samples. It is necessary that fresh fish be used as raw material to ensure a good finished product.

Quality issues in canned fish products

- **Discoloration –** It is normally observed in canned shellfishes. It can be result of physical, chemical or microbiological activity.
- **Blackening** of the contents or inside of the can is most often encountered in packing crab, clams, shrimp and lobster, but may also be found in other canned products. It occurs most readily where the product has an alkaline reaction.Sulfur compounds in the flesh of these species break down in processing and unite with the ion base of the tin plate to form iron sulfide. Parchment paper linings, the use of organic acids and lacquer coatings can prevent this problem.
- **Copper sulfide discoloration** is associated with hemocyanin, a biochemical component in crustacean blood. This is often the result of protein sulphur compounds breaking up under high temperature during blanching or cooking, and their combining with iron forming black iron sulphide. The use of enamel lined cans for these products eliminates this problem.
- **Can corrosion -** Internal can corrosion can lead to the accumulation of hydrogen which relieves vacuum and swells the can making it unmarketable. Externally, corrosion often causes pinholes that allow micro-organisms to penetrate the can and spoil its contents.

- **Stack burning –** It is a type of discoloration due to over processing. A considerable amount of heat is retained over a long period when canned products are stacked or cased before they are sufficiently cooled. Cooking goes on over a much longer period than is intended, which affects both color and flavor unfavorably.
- **Microbial spoilage -** Bacterial spoilage in canned fish and shellfish is caused almost entirely by organisms of high heat resistance, and may be divided into two general types, gaseous and non-gaseous. Swelled or "bulging" can ends are a common indication of gaseous decomposition. Organisms found quite commonly are *Clostridium welchii*and *Clostridium sporogens.* Gas formation is accompanied by an extremely foul and offensive odor. Gas-forming heat-resistant organism is *Clostridium botulinum.*Spoilage may not always be accompanied by the excessively disagreeable odor. There is no external indication of non-gaseous spoilage. The ends of the containers are flat and the contents may be normal in appearance. An "off" odor mayor may not be noticeable, but the product is sour in taste. This type of spoilage is known as "flat souring." It is caused by aerobic spore formers *Bacillus cereus, B. mesentericus*and *B. vulgatus.*
- **Bulged (swollen) cans –**They are **Flipper**, **Springer**, **Soft swell** and **Hard swell.**Flipper is the initial stage of swell and in flipper, can which may be normal in appearance, but if one end is struck on a box or table, the other end becomes convex, though the convexity may be pressed down again. Reasons are under exhausting, 1st stage of H2 production, 1st stage of microbial activity or pre-processing spoilage of food. In springer, a can having convex or bulging ends, which may be pressed flat, again with the fingers, but will spring out again after pressure is released. Reasons are same as that of flipper. In soft swell, permanently convex can ends. But when pressed by finger it gets depressed but when the pressure is removed it regains original bulge. In hard swell permanently convex ends and do not get depressed due to pressure by fingers. Soft and hard swell are due to high pressure gases, more hydrogen production or advance bacterial reaction.
- **Flat sour -** A can whose contents may be spoil d by microbiological action without the formation of gas and no external indication of spoilage. The product has a sour taste and may or may not have sour odour.
- **Leaker spoilage -** The micro-organisms involved in leaker spoilage can be any type found on can-handling equipment, in cooling water or on the skin of cans handlers. These include

bacterial cocci, short and long rods, yeasts and moulds, aerobic sporeformers or, more likely, a mixture of many of these organisms. Postprocess contamination can also result in outbreaks of botulism or *Staphylococcus* enterotoxin poisoning. Leaker spoilage is often associated with the integrity of the can seams, the presence of bacterial contaminants in the cooling water or on wet can runways and abusive can-handling procedures after heat processing. Cooling water can be the primary source of organisms responsible for leaker spoilage.

- **Honeycombing -** Honeycombing is found in canned tuna meat that is processed from stale raw material. The meat in such cases presents the appearance of honeycomb. During steaming the volume of the meat will contract due to removal of water because of the coagulation of muscle protein that begins at the surface. Production of gas in the flesh expands and makes little pockets in the flesh. On cooling, the pockets remain and the flesh seems to be filled with small holes or air paces. It also occurs in canned salmon and sardines.
- **Mush -** It is flabby condition met with some species of pilchards caught at the end of its spawning. This is caused by the invansion of prasitic protozoan *chloromyxum*whish decomposes the fish meat during storage such that it becomes entirely soft during canning.
- **Struvite formation -** Canned marine products such as brine packed shrimp,crab, tuna,salmonetc.are frequently seen to contain some glass like crystals,particulary when the temperature of storage is low. It occurs due to the formation of a chemical compound ,magnesium ammonium phosphate hexahydrate,MgNH4PO46H2O, called struvite. It can be prevented by adding chelating agent like hexametaphosphate.
- **Curd -** 'Curd' is precipitated protein often found in canned mackerel and salmon. This is more common with salmon, which is generally canned without pre-cooking. The meat coagulated by heat adheres to the inner side of the can ends and presents a poor appearance on opening the can. The lacquer may get peeled off while removing the curd from the can ends. Use of raw fish, which is not very fresh, and, inadequate brining and pre-cooking are some of the reasons responsible for formation of curd. It can be prevented if the raw fish is soaked in 10-15% brine for 20-30 minutes followed by thorough washing before filling.

Quality issues in minced fish products

- **Dehydration** - Deep Dehydration Greater than 10% of the surface area of the sample unit exhibits excessive loss of moisture clearly shown as white or yellow abnormality on the surface which masks the colour of the flesh and penetrates below the surface, and cannot be easily removed by scraping with a knife or other sharp instrument without unduly affecting the appearance of the block.
- **Foreign Matter -** The presence in the sample unit of any matter which has not been derived from fish (excluding packing material), does not pose a threat to human health, and is readily recognized without magnification or is present at a level determined by any method including magnification that indicates non-compliance with good manufacturing and sanitation practices.
- **Parasites -** The presence of two or more parasites per kg of the sample unit detected with a capsular diameter greater than 3 mm or a parasite not encapsulated and greater than 10 mm in length.
- **Bones (in packs designated boneless) -** More than one bone per kg of product greater or equal to 10 mm in length, or greater or equal to 1 mm in diameter; a bone less than or equal to 5 mm in length, is not considered a defect if its diameter is not more than 2 mm. The foot of a bone (where it has been attached to the vertebra) shall be disregarded if its width is less than or equal to 2 mm, or if it can easily be stripped off with a fingernail.
- **Odour and Flavour** - A sample unit affected by persistent and distinct objectionable odours or flavours indicative of decomposition or rancidity or of feed.
- **Flesh abnormalities** - A sample unit affected by excessive gelatinous condition of the flesh together with greater than 86% moisture found in any individual fillet or a sample unit with pasty texture resulting from parasitic infestation affecting more than 5% of the sample unit by weight.

Quality issues in battered and breaded products

- **Voids** – It is a common quality problem. Voids are bare areas that do not accept batter. It is due to excessive line speed, shape of fish portion, absence of pre dusting material, a no adhesive surface, ice glaze and air pockets. Once it is formed it is difficult to remove
- **Blow off** – This is seen when some or all of the batter is blown off or removed during frying. This is accelerated if it contains voids. It gives a dark unacceptable appearance.

- **Pillowing** – It is an elevated dome of batter on the product with a large air pocket beneath it. It is caused by the formation of steam pocket due to water vapourization which is trapped under the batter during the frying process.
- **Tailings** – Batter extends beyond the product like a tail or stringer. It is caused due to the excessive thick batter which results in inadequate blow off during the production.

****