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Review Article

Whey you want to Avoid Drawback of Fish Preservation?

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Abstract

Fish is one of the healthiest foods available to man and there is an ever-increasing demand for fish and fishery products. Being a highly perishable commodity, fish require immediate processing and various options are available for the value addition of fish. Fish processing, particularly seafood processing and marketing have become highly complex and competitive and exporters are trying to process more value-added products to increase their profitability. Value can be added to fish and fishery products according to the requirements of different markets. These products range from live fish and shellfish to ready to serve convenience products. In general, value-added food products are raw or pre-processed commodities whose value has been increased through the addition of ingredients or processes that make them more attractive to the buyer and/or more readily usable by the consumer. It is a production/marketing strategy driven by customer needs and perceptions. Technology developments in fish processing offer scope for innovation, increase in productivity, increase in shelf life, improve food safety and reduce waste during processing operations. A large number of values added and diversified products both for export and internal market based on fish, shrimp, lobster, squid, cuttlefish, bivalves etc. have been identified. This paper gives an overview of the processing techniques, emerging technologies and the value-added products from fish and shell fish.

Key words: fish processing; seafood; techniques; emerging technologies; marketing, fish spoilage

Introduction

After fish are caught, spoilage starts rapidly, and rigor mortis is responsible for changes in the fish after its death. A breakdown of various components and the formation of new compounds are responsible for the alterations in odor, flavor, and texture that happen throughout the spoilage process, and deterioration occurs very quickly due to various mechanisms triggered by the metabolic activity of microorganisms, endogenous enzymatic activity (autolysis), and by the chemical oxidation of lipids (1,2,3,4, 5, 6 and 7).

Autolytic Enzymatic Spoilage

Initially, the main autolytic changes happening are the enzymatic degradation of adenosine 5′-triphosphate (ATP) and its related products, followed by the action of proteolytic enzymes, as reported in. The concentrations of ATP and its breakdown products (adenosine 5′-diphosphate (ADP), adenosine 5′-monophosphate (AMP), inosine 5′-monophosphate (IMP), inosine (INO), and hypoxanthine (Hx)) are one of the most effective and reliable indicators of fish freshness (K-value), varying according to the fish species, muscle types, and storage conditions. High autolytic activity of the major muscle endogenous proteases causes the hydrolysis of key myofibrillar proteins, contributing to the weakening of the myofibril structure during post-mortem storage. The main proteolytic systems in place are the cytoplasmic calpains (at neutral pH) and the lysosomal cathepsins (at acid pH), such as cathepsins B, L, H, and D.Trimethylamine (TMA) and its N-oxide compounds are usually used as indices for freshness in fishery products (8,9,10,11, 12, 13 and 14). The pathway of the production of formaldehyde and ammonia from TMA and its N-oxide is shown in, which are associated with the formation of undesirable odors, and occur in fish by the action of several enzymes, such as trimethylamine N-oxide reductase (TMAO reductase), trimethylamine dehydrogenase (TMA dehydrogenase), dimethylamine dehydrogenase (DMA dehydrogenase), and amine dehydrogenase. Total volatile base nitrogen (TVB-N) and trimethylamine-nitrogen (TMA-N) are quality indicators traditionally used for fish products. TVB-N includes the measurement of volatile basic nitrogenous compounds associated with seafood spoilage, like TMA produced by bacteria, DMA derived from autolytic enzymes action, ammonia produced by the deamination of amino acids, and others. A value of 35 mg N/100 g is proposed as the upper limit for the spoilage initiation. However, some studies present lower limits, depending on the results obtained and the studied fish species. TMA-N typically has a fishy odor, and it is produced by the decomposition of TMA N-oxide (major constituent of non-protein nitrogen fraction) caused by bacterial spoilage and enzymatic activity. The upper limit of acceptability is typically around 10–15 mg TMA-N/100 g, however, like TVB-N, lower limits are suggested by other authors (15,16,17,18, 19, 20 and 21).

Lipid Hydrolysis and Oxidative Spoilage

Fish quality can also be affected during storage at different temperatures by lipid oxidation through odors and lipid peroxide formation or by taste, texture, consistency, and nutritional value losses. Transition metals are primary activators of molecular oxygen, leading to oxidation, which consists of oxygen reacting with the double bonds of fatty acids, mostly of

polyunsaturated fatty acids (PUFAs), that are highly susceptible to oxidation. Lipid oxidation can occur either enzymatically or non-enzymatically in fish. In the enzymatic hydrolysis (lipolysis) process, glycerides are split by lipases, forming free fatty acids that are responsible for the common off-flavor (rancidity) and from the denaturation of sarcoplasmic and myofibrillar proteins. Main lipolytic enzymes include triacyl lipase, phospholipase A2, and phospholipase B, and they can either be endogenous or derived from psychrotrophic microorganisms, Furthermore, the presence of pro-oxidant enzymes, like lipoxygenases and peroxidases, facilitates lipid oxidation (22,23,24,25, 26, 27 and 28).

Non-enzymatic oxidation is triggered by the catalysis of hematin compounds, such as hemoglobin, myoglobin, and cytochrome, generating hydroperoxides. The peroxides are unstable and susceptible to hydrolysis, forming volatile compounds (like aldehydes, ketones, and alcohols), which causes off-flavors (29,30,31,32, 33, 34 and 35).

Lipid oxidation is relevant for fish quality due to the development of off-odors, especially in fatty fishes. Normally, the degree of lipid oxidation is given by a thiobarbituric acid (TBA) value that measures the malondialdehyde (MDA) content that is formed by the reaction with hydroperoxides (initial products of lipid oxidation). TBA values of 2–4 mg MDA/kg are within quality limits. Nevertheless, this value might not reflect the real rate of lipid oxidation, because MDA can interact with other components of the fish body and produce secondary metabolites that include reactions with carbohydrates, furfural, alkenals, alkadienals, and other aldehydes and ketones (36,37,38,39, 40, 41 and 42).

So, in fish, lipid oxidation consists of a complex chain of reactions, with three distinct phases: primary (formation of hydroperoxides), secondary (e.g., hexanal and malondialdehyde formation), and tertiary/interaction compounds (new compounds are formed by the breakdown of secondary oxidation products or through the reaction with other molecules, mostly nucleophilic type) (43,44,45,46, 47, 48 and 49).

Microbial Spoilage

Microbial growth is the first mechanism deteriorating fish, being the spoilage factor that most affects the quality of fresh or lightly preserved fish. Initially, the fish muscles are sterile, but after death, they are contaminated by the microbial population present at the fish skin.

The high-water activity, low acidity (pH > 6), and high amount of non-protein nitrogenous compounds typical of fish results in the fast growth of microorganisms, leading to undesirable changes in appearance, texture, flavor, and odor, reducing its quality. Spoilage created by microorganisms generates volatile amines, biogenic amines, organic acids, sulfides, alcohols, aldehydes, and ketones, which have unpleasant and unacceptable off-flavors (50,51,52,53, 54, 55 and 56).

Causes of fish spoilage:

High moisture content, High fat content. High protein content. Weak muscle tissue. Ambient temperature. Unhygienic handling (57,58,59,60, 61, 62 and 63).

Methods of fish preservation:

Preservation can be done, both for short and long duration:

Preservation for short duration

Chilling

The first and simplest method to both preserves and process fish is to keep it cool. Cool fish keeps longer than uncooled fish, although both will spoil in a matter of hours. This is obtained by covering the fish with layers of ice. However, ice alone is not effective for long preservation, because melting water brings about a sort of leaching of valuable flesh contents which are responsible for the flavor. But ice is effective for short term preservation such as is needed to transport landed fish to nearby markets or to canning factories, etc. Here autolytic enzymatic activities are checked by lowering the temperature (64,65,66,67, 68, 69 and 70). Most fish caught are preserved with ice at some stage in their processing. Trained taste panels are usually unable to distinguish well-iced fish kept less than six or seven days from fresh fish, and storage life can be extended somewhat if antibiotics are added to the ice. Ice works in two ways, It reduces the growth rate of bacteria by reducing the temperature of the fish; and It also washes the bacteria and slime away as it melts. Because of this, it is important to keep melt water drained away from the fish (71,72,73,74, 75, 76 and 77).

Preservation for Long Duration

Salting, there are many different kinds of salt, some being better than others for fish curing. However, in islands or in outlying places there is often no choice, and whatever is available in the way of salt has to be used, whether it is bought in a shop, prepared on the spot, or extracted from earth containing salt. A distinction must be made between the two chief techniques of salting: wet salting and dry salting (78,79,80,81, 82, 83 and 84). Wet Salting, the principle is to keep the fish for a long time in brine. The equipment needed consists of a watertight container, which can be a tin, drum, canoe, barrel, etc. To make the brine, one takes four parts of clean water (sea or fresh water) and one part of salt. If the salt is coarse, it has to be ground or pounded first. It is then dissolved into the water by stirring with a piece of wood. To be good, the brine must float a fish. The next step depends on what kind of fish one wants to salt. It is best first to cut off the head, and gut and clean the fish, though small fish can also be salted whole. Large fish must be cut open, and it is preferable to take out the backbone. Fish with a heavy armour of scales must be scaled (85,86,87,88, 89, 90 and 91). In places where the flesh is thick, slashes must be made so that the salted brine can penetrate the flesh. Very large fish should be cut in thin fillets. After the fish has been prepared according to its size, it must be cleaned and put in the brine. A plank or matting is laid over it and weighted with rocks so that the fish is entirely covered with brine. This salted fish can be kept for a long time in a dark or at least a shady place. The remaining brine can be used three times, but water and salt must be added every time until a fish can again float on the liquid. In any case, fresh brine is always best (92,92,93,94, 95, 96 and 97). Dry Salting, In this method the fish is salted but the juices, slime and brine are allowed to flow away. Dry salting can be done in an old canoe, or on mats, leaves, boxes, etc. In any case, the brine formed by the fish juices and the salt must be allowed to run away. For two parts of fish, one needs one part of salt. Layers of fish must be separated by layers of salt. It is a valuable method when one has no containers. This method is used to salt down flying fish in open fishing boats while at sea, and the fish in this case are kept whole. Some people like the salty taste of fish prepared in this way, but it is always possible to wash the salt away by soaking it in fresh water before use (98,99,100,101, 102, 103 and 104). Drying, very small and thin fish can be dried straight away in the sun if they are brought in early enough in the morning (and if, of course, the sun is shining). If these conditions are not fulfilled the fish must be put for one night in brine, or dry salted. They can then be dried the next morning. If it happens to be raining the next day, it is necessary to wait until the weather has cleared up, which could take from a few hours to a couple of days. In this latter case it will be necessary to wash the salt away from the fish by soaking it in fresh or sea water for a couple of hours before drying it; this depends again on the tastes of the consumers and on the purpose for which the fish is cured. Small fish are mostly sun dried on mats, or suspended. When it rains the fish must be kept dry by covering or transferring them under shelter (105,106,107, 108, 109,110 and 111). If fish are laid on mats or other material to dry, it is best to turn them over every two hours so that they will dry quickly and not become maggotty. In the case of large fish, hanging is better if they are merely split. Dry salted fish can also be dried, but they should first be cleaned in water. Normally the fish will be dried after three days. If a great quantity of fish has been dried and is to be kept for some time, the best way is to pile it up in a dark place, off the ground and preferably on wooden boards. It should then be covered with a sack or mat. After a fortnight the fish should again be laid in the sun for one or two hours and then put away as before. These are only indications of the main principles of fish drying; variations are possible (112,113,114,115, 116, 117 and 118). Smoking, any kind of fish can be smoked. There are three main methods of smoking, Smoking and roasting; hot smoking; long smoking. Smoking and Roasting, this is a simple method of preservation, for consumption either directly after curing or within twelve hours. Re-smoking and roasting can keep the product in good condition for a further twelve

hours. Fresh unsalted fish is put over a wood or coconut husk fire. This should be kept very small and the fish turned over every five minutes. In about half an hour the fish is ready for consumption or, if it is the intention to keep it for a while, it should be put in an aerated container. Fish can be preserved in this way even in open fishing boats, but the smoking has to be done in a tin or a half-drum. Salted fish can also be smoked by this method, but this is used mostly for immediate consumption or in order to bring the produce in smoked form to a nearby market (119,120,121,122, 123, 124 and 125). Hot Smoking, the hot smoking system can be used for immediate consumption or to keep the fish for a maximum of 48 hours. Small fish can be salted first for half an hour (see wet salting). After salting they are put on iron spits and dried in a windy place or in the sun for another half hour. It is necessary to have an oil drum to make the smoking stove. The top of the drum is cut out and holes are made 8 inches below the rim to place spits. Near the bottom a rectangular opening is made to control the fire. This opening should be closed with a small door or piece of steel plate. A fire of hardwood or coconut husks is made in the stove, and once it is well started it is regulated so as to give no flames. The fish are then placed over the spits (126,127,128,129, 130, 131 and 132). During the smoking operations the top of the drum must be covered with a sack or with palm fronds laid as close together as possible; the fire control opening should also be closed. The fire must be watched from time to time. The fish will be ready in about one hour. An indication that they are done will be found in the golden yellow colour of the skin. For big fish, l i to 2 feet long, the best method is to split them in halves, to the right and left of the backbone. Each half fish is fixed between two flat bamboo slats or sticks. These halves are then rested head down on racks built four feet above ground. A number of split fish can be lined up next to each other. A fire of hardwood or coconut husks, or several separate fires, are then lit under the rack. The number of fires depends on the quantity of fish one has to smoke. There should be a slow fire for about half an hour followed by a brisk one for one hour. A small fire is then kept going for six hours (just smoking) (133,134,135, 136, 137, 138 and 139). After this treatment the fish is ready for transport and will keep in good condition for two to three days under tropical conditions. This method is used in particular in the Celebes for skipjack and other tunas. Long Smoking: If fish must be kept in good condition for a long time, for instance, two or three months or even longer, it can be done by smoking, provided the fish is not oily. For this purpose, a small closed shed made of palm leaves or other local material can be used. The dimensions of the shed depend, of course, on the quantities of fish to be smoked, but the height should in no case be less than six feet. In this shed, racks are built to hang the fish from or to lay them upon. Hanging the fish on spits is the best method, but they can also be laid on loosely-woven matting. One can start hanging fish three feet from the bottom up to the roof (140,141,142,143, 144, 145 and 146). The preservation of fish is affected by smoke only in this method, and it is best to use coconut husks which should burn very slowly so that the fish is dry smoked after 48 hours. After such a treatment the flesh is dried throughout. If it is necessary to transport these fish to other islands, they should be packed in small packages wrapped in dry leaves and reinforced with bamboo or sticks. In Eastern Indonesia, packages of smoked fish are sent over great distances (147,148,149,150, 151, 152 and 153). Fish canning, this is a process involving heat treatment of fish in sealed containers made of tin plates, aluminum cans or glass, until the product has been fully sterilized. During caning, heat treatment should be sufficient to destroy all heat sensitive bacterial and spores, in activate, the enzymes and cook the fish so that the product remains acceptable to the consumer after prolonged storage commercialized sterilization this is used in thermal processing to describe the heat treatment designed to kill substantially all microorganisms and spores which is present and cable of growing in the product. The canned food fish is also prevented from contamination by pathogenic organisms by storing them in a virtually airtight package. If heat treatment is properly carried out canned fish may remain in storage for several years without refrigeration. Traditional canned fish are obtained from small pelagic fish species such as herrings (Clupea spp), Sardines (Sardinella sp), Mackerels (Scomberomerus sp), Anchovies (Engraulis sp), Tuna (Thunnus sp). Bonga (Ethmalosa sp) (Gopakumar, 2010). Fish intended for canning must be in first class condition and must be handle in hygienic manner to reduce microbial load on the fish. Poor quality fish will produce canned fish with offensive odour and flavour, poor texture (154,155,156,157, 158, 159 and 160).

Demerits of fish preservation

Although the preservation and processing constitute a very important aspect of the fish industry, it has certain draw backs. Chilling brings about denaturation of flesh. This is because of ice crystals formed during chilling and causing mechanical damage to the muscles. Cell walls burst, structure gets deformed and the flesh loses much of flavour and taste. The flesh also becomes dehydrated and losses texture. If proper hygienic measures are not taken during the processes like washing, guttation and evisceration, etc. more harm would be done to the preserved material, owing to increase in the bacteria population. (160,161,162,163,164,16 5 and 166).

Conclusion:

Incomplete or poor preservation leads to decarboxylation of histidine of fish flesh into histamine. The latter some other related substances, collectively called saurine, are common causes of food poisoning. Drying reduces weight, nutritive value and the digestibility of the flesh. Excess salting allows growth of salt tolerant bacteria, causing pink eye spoilage of fish flesh.

Conflicts of Interest

The author declares no conflicts of interest.

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