FISHERIES OF THE WEST COAST OF INDIA

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FISH PRESERVATION

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Compared with other food materials fish is highly perishable. At the temperatures prevailing in India fish can remain in fresh condition up to eight hours at the most after being taken out of the water. Most fishing in India is carried out within a distance of about seven miles from land; the boats remain at sea for a few hours and return to port on the same day. No preservation methods are employed on board the boats to ensure that the catch remains in good condition when brought ashore. Fishing is carried out in mid-waters further away from land by mechanised craft at Bombay and a few other centers. These vessels remain at sea for some days and the catch is iced on board for preservation. The proportion of iced fish thus landed, to the total sea fish landings is however small at present. In view of the increasing emphasis on the exploitation of both the inland and marine fisheries of our country, and the gradual increase in the purchasing power of the common man resulting from progress in industrialisation, the use of modern methods of fish preservation and processing as well as improvement in the quality of the product obtained by indigenous methods of preservation are necessary. Progress in fish preservation is essential for the proper utilisation of the fish landings and raising the nutritional status of the dietary of our people by increasing the consumption of fish.

Before discussing the problems of fish preservation with special reference to Indian conditions it is necessary to explain briefly the biochemical and other changes which constitute fish spoilage, and the principles underlying the various methods of preservation. The external surfaces of the freshly caught fish and the gut, if full of food, carry large numbers of bacteria which attack the flesh after the death of the fish. The various enzymes produced by the rapidly multiplying bacteria convert the flesh-proteins into simple components, the amino acids, and finally into ammonia and carbon dioxide. The sea fish also contain trimethylamineoxide which is reduced through bacterial action to *trimethylamine*, a basic compound having the sharp, characteristic odour of spoiled sea fish. This reduction occurs

during the early stages of the spoilage and the estimation of the trimethylamine provides a very useful test for assessing the freshness of fish. Hydrogen sulphide, indole, etc., are produced in the later stages of fish spoilage; these substances produce the odour characteristic of putrefaction. Other changes which are not due to bacterial action also occur during spoilage. The enzymes of the tissues and viscera of fish continue to function after the death of the fish. This process, termed autolysis, results in the flesh becoming soft and more susceptible to bacterial invasion. The fat of the fish undergoes oxidation causing rancidity. A third type of spoilage occurs when fish are frozen and kept in storage. The proteins of the fish muscle undergo changes in their physical structure; these changes called 'denaturation' cause the flesh to become tough and fibrous, reducing its flavour.

The autolytic and oxidative changes proceed very slowly compared with the changes brought about through bacterial activity. Lowering the temperature reduces the rate of reproduction of the bacteria. Initially the bacteria multiply very slowly; this period is called the 'lag phase'. At ordinary air temperature, *i.e.*, 27° to 31° C., the lag phase lasts for a few hours only; at the temperature of melting ice, 0° C., the lag lasts for a few days. When the temperature is lowered still further below 0° C. some bacteria are slowly destroyed but many remain alive in a dormant condition. This phase lasts for several months.

Autolytic changes are reduced to the minimum at low temperatures; oxidative changes continue to take place. Denaturation of the proteins is maximum when the rate of freezing is slow as might happen if the freezing temperature is not sufficiently lowered; hence quick-freezing or 'deep-freezing' in which the fish are frozen within about six hours by employing temperatures as low as — 40° C., is carried out.

As seen from the above discussion the period of storage of fish in ice can extend only over a few days. The incorporation of chemical preservatives such as sodium nitrite, or antibiotic such as chlorotetracycline (popularly known as aureomycin) in small concentrations extends the preservation period by about one week.

Frozen storage at about — 20° C. can preserve the fish in excellent condition for several months. During the long period of storage dessication, *i.e.*, loss of moisture, is minimised by glazing the frozen fish with a film of water at intervals during the storage. Modern methods of wrapping the fish in moisture-proof material have yielded good results. A recent development in this line is the freezing of fish in alginate jelly; this is particularly

useful in the case of fatty fishes. This prevents the contact with oxygen thus minimising rancidity development, besides retaining moisture. Denaturation of the protein is also minimised under these conditions. Alginic acid is a carbohydrate substance extracted from certain seaweeds and is commonly used in food preparations, *e.g.*, as stabiliser for ice-cream.

Bacteria are susceptible to increases in temperatures. Moist heat is particularly lethal to bacteria and the application of temperatures of about 121° C. and a steam pressure of about 15 lb. per square inch for short durations suffices to destroy all forms of bacterial life. Even the resistant forms, spores, produced by certain types of bacteria, are destroyed under these conditions. The canned product obtained by the application of these methods is essentially sterile. Thermophilic sporeforming types might occasionally survive the canning process.

Common salt (sodium chloride) acts as a preservative in two ways: it helps to draw the water away from the flesh by osmosis and it also directly kills many of the bacteria. Loss of moisture is detrimental to bacterial life. There are however a special group of bacteria which not only can tolerate high concentrations of salt but depend on high salt concentrations for optimum growth. These bacteria produce a red pigment which causes the discolouration often present on the surface of dried salt fish. The elimination of these bacteria presents a problem in the fish curing industry. These bacteria have their origin in the curing salt.

In smoking fish the preservative action is due to two factors: the preliminary brining which is always done removes large numbers of bacteria and subsequently the phenolic constituents of the smoke kill most of the remaining bacteria. Some dehydration also occurs during the smoking process. Dehydration of fish by mechanical means is also carried out as a method of preservation. The dehydrated fish flesh is reconstituted by soaking in water before cooking.

Present Status of Fish Preservation in India.—Nearly one-half of the total marine fish landed in India is marketed after curing by one or other of the several indigenous methods. Sea fishing is mostly in the inshore waters and the small size of the boats and the inshore fishing conditions do not lend themselves to easy adaptation of preservative methods on board. The supply of really fresh marine fish is therefore limited in proportion to the total sea fish landings. Preservation methods which yield a fermented or semi-fermented product such as the *nam-pla*, or *patis* popular in the south-east Asian countries are not used in India. Smoked fish is

not liked by the people and very little smoking is carried out for preserving fish.

In large cities such as Bombay and Calcutta cold storage facilities and ice are available. Fish is often packed in ice and kept overnight in the cold storages for marketing the next day. Ice is becoming available more and more in fishing centres and considerable quantities of fish are transported in ice by rail and by motor trucks into the interior. Fish are thus sent inland up to distances of three hundred miles. Insulated vans are not usually available at most places, but the fish are packed in ice in baskets or boxes for transportation. Large quantities of fish are transported from the Chilka Lake area to Calcutta as well as from west coast places such as Calicut to Madras City or to Bangalore. Carrier motor launches also transport iced fish from Karwar in the south and from various fishing centres in the north to the City of Bombay where there is a very large demand for fresh fish.

There are a number of fish freezing plants on the west coast at Bombay, Mangalore, Calicut, Cochin, Trivandrum, etc. These plants, with the exception of the plant at Bombay, are engaged exclusively in freezing prawns, lobsters and frog-legs for export. At Bombay choice varieties such as pomfrets, Jew fishes (*Sciaenids*), *Dara* (*Polynemus* spp.) are frozen when the catches are abundant and stored for several months. The frozen fish are taken out, thawed and marketed according to the demand during the rest of the year. The frozen fish is consumed in Bombay city and practically no frozen fish is sent into the interior.

There are a few fish canning factories, but these work for a few months only and often are engaged in canning other products during the rest of the year. Present canned fish production is almost negligible. The demand for canned fish as a variety is mainly met by imported products.

Freshwater fish are mainly consumed in the fresh condition, and are often transported alive. Large quantities of freshwater fish are brought in ice from distant places to consumer centres such as Calcutta. In some areas curing is done to a limited extent.

After this brief review of the existing status of fish preservation it is possible to appraise the present trends and outlook for the future of fish marketing and the role that fish preservation has to play in the developing Indian fishing industry.

While the consumption of fresh fish is bound to increase due to increasing transport facilities, increasing availability of ice, etc., the importance of the fish curing industry is not likely to diminish. Being cheap the cured

product will be necessary for supplying the needs of the poorer classes. The emphasis therefore has to be on an improvement in the quality of the cured fish so that the product is acceptable to a wider sector of the public.

During the years subsequent to World War II the most important development in the marketing of fish has been the production on a large-scale of deep-frozen fish in several countries. The deep-freezing process makes it possible to keep fish in a condition almost the same as absolutely fresh fish over a period of several months, without any change occurring in its flavour or consistency unlike as in other preservation methods. The usefulness of the freezing method in evening out the fluctuations in the supply of fish due to the seasonal abundance in the catch is obvious. This long-term preservation method can be of great use in maintaining an adequate supply throughout the year and thus help in maintaining more balanced prices. However transport and distribution facilities are of prime importance in the development of a frozen fish trade. The frozen product must reach the kitchen in the frozen state. For making this possible the maintenance of a cold chain at all stages from the freezing plant to the retailer's counter is a prerequisite.

The technical maintenance of such a cold chain is difficult in a relatively undeveloped country like ours. It may even appear useless to attempt an expansion until adequate transport and even retail cold storage facilities are developed in the first place. A general application of the freezing method to fish preservation in India will depend on the industrial progress of the country and an increase in the standard of living. The frozen product is essentially suited to the taste of consumers who are anxious to simplify their daily routine and save time as demanded by an industrialised economy.

However, while any large-scale expansion may not be feasible immediately the need for providing for the development of the frozen fish industry is real even now. With the increased exploitation of offshore fisheries and mechanised fishing operations envisaged in the near future resulting in the availability of excellent raw material (fish catches brought in ice storage) in great abundance the freezing of fish is inevitable as a routine method for preservation. It is conceivable that frozen fish fillets and processed products such as ready to eat fish-sticks which are popular in the U.S.A. and other countries would be in demand in our urban areas in particular.

Not only for the production of fish for direct consumption but also for the development of other processing industries such as the fish canning industry, freezing is a very valuable aid.

While the development of an export trade in frozen fish is not conceivable in the near future there are immense possibilities of increasing the export of frozen prawns, lobsters, etc., immediately. The freezing plants now engaged in processing prawns have no adequate supplies of the raw material. The supply of prawns, etc., could be increased through planned exploitation of the fishing grounds. The prawns have to be iced immediately upon being taken and transported to the freezing plants. The quality of the raw material is of the utmost importance in maintaining the high quality of the frozen product and thus stabilise the demand from overseas countries.

The relatively short season when suitable fish is available for canning is one of the difficulties in the development of canning on a large-scale. But with increased exploitation of the fishing grounds in middle and even distant waters and availability of cold storage and freezing facilities this problem could be solved to some extent. There is an immediate need to produce canned fish for meeting the demand from our Defence Services. An industry on a modest scale could be supported at present on the demands from the Services. Fish such as mackerel and sardines which are abundantly available on the west coast have been canned by some local firms and the product is good and wholesome.

While evaluating the possibilities of the development of fish processing industries such as canned fish, fish freezing, frozen fillets, etc., it is pertinent to visualise the other beneficial results of these developments. The fish residues from the processing plants, such as the heads, entrails, fins and scales provide considerable quantities of raw material for the production of fish meal, poultry feeds, fish manure, pearl essence, enzymes for use as leather bates, etc. The existence of processing industries provide centralised supplies of the raw materials.

Researches carried out in recent years have revealed the possibilities of the employment of antibiotics in fish preservation. Chlorotetracycline, a product of the mould *Str. aureofasciens*, was found effective in concentrations as low as one part per million. Trials made in Canada and some other countries showed that when incorporated in ice it enhanced the preservation period by about one week. Other methods of using this antibiotic include dipping the fish in solutions containing fifty parts per million of the antibiotic which reduces the bacterial load on the surfaces of the fish and helps to keep the fish fresh for a few hours longer even at ordinary air temperatures. Tests have shown that the antibiotic is destroyed to the extent of over 50% during normal cooking processes and there is no hazard to health in the concentrations in which it is likely to be injested in food. In Canada and

in the U.S.A. the use of chlorotetracycline in seven parts per million concentration in uncooked poultry and fish has been permitted. Experiments carried out at the Central Marine Fisheries Research Station have shown that several varieties of fish remain fresh for longer periods in ice treated with five parts per million of aureomycin compared with fish kept in ordinary ice. In fact in our tropical conditions the problem of preserving fish is difficult and the aid of chemicals and antibiotics may prove very advantageous. There are certain drawbacks in the use of medicinally important antibiotics in food preservation industries. The development of pathogenic strains resistant to the antibiotic, and sensitisation of persons handling the antibiotic are to be anticipated. This necessitates a search for new antibiotics for use in fish preservation.

Quality control measures are essential in all methods of fish processing, at all the stages of the 'cold chain', and at different stages in the canning and curing procedures. Suitable objective tests chemical, bacteriological or physical are needed for facilitating the establishment of quality standards. So far no test which is satisfactory from all aspects or which can be generally applied has been perfected. Research from the basic as well as technological aspects is necessary before any of the known tests could be put into use particularly from the enforcement standpoint. These and other problems are expected to be dealt with in detail at the Central Fisheries Technological Research Station of the Government of India which is to be established soon to carry out investigations on fish processing as well as on fishing gear and craft.