PRESERVATION OF FISH IN WARM CLIMATES.*

The principal methods of preserving fish, other than canning, are refrigeration, salting, smoking and drying. The details of the methods used vary in different countries according to local conditions and requirements.

Refrigeration.

To produce frozen fish which after several months of storage is equal in flavour and food value to freshly caught fish, it is essential that they should be placed in the freezing room as soon as possible after leaving the water. Bruising or damage hastens their deterioration, and they should, therefore, be handled as little as possible. A difficulty in freezing fish in tropical countries is that any very slight increase in temperature causes changes in the flesh which cannot be remedied by freezing. Freezing only keeps the fish in the same condition as that in which it entered the refrigeration chamber, and it is therefore essential that it should be in prime condition. Unless fish can be delivered to the chamber within three or four hours after landing they should be kept in ice or under refrigeration in the boats.

Before freezing, all fish should be thoroughly freed from dirt and slime in clean, cold, running water. Either fresh water or sea water may be used, but care should be taken that it is pure. Larger fish are usually "gutted" before being frozen, although practice in this respect depends on the market for which they are intended. Gutting of smaller fish is normally impracticable. Fish containing much oil are apt to deteriorate more quickly than other varieties.

For freezing, the fish are commonly placed in pans which are set on the refrigerating pipes until the fish are frozen. They are removed by pouring a little cold water on the outside of the pan, which causes sufficient melting to allow the frozen fish to be removed from the pan. Where it is desired to freeze each fish separately, they may be placed on trays or shelves over the pipes.

In most modern up-to-date plants the fish are quick-frozen in brine, and this method is stated to give a product superior to that obtained by freezing in air.

After freezing the fish are "glazed". Glazing is designed to encase each fish in a protective coating of thin clear ice which prevents the evaporation of water from the flesh of the fish with consequent shrivelling, helps to prevent the fish turning white, and prevents the entrance of air which tends to make the fish oils deteriorate. Glazing also provides an ice surface on which moulds and fungi cannot grow.

For glazing the fish are immersed quickly in a trough of clean fresh water at a temperature just above freezing point, in a room in which the temperature is maintained at 20° F. to 25° F. The water covers the fish with a thin film, which freezes instantly into a thin coating of ice as soon as the fish is withdrawn from the water. The fish are immersed three or four times until the coating of ice is considered sufficient, and every part of the fish is covered.

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Another method of glazing is by means of a hose with a special spray nozzle with which a fine stream of water may be sprayed on the frozen fish.

After glazing the fish are taken to the cold-storage rooms, which are kept at temperatures ranging from — 5° to + 10° F., and kept until required for market.

Salting.

Difficulties in salting fish in warm climates are due chiefly to the slow penetration of salt and the rapid decomposition of the fish. In this connexion, in experiments carried out in the Fishery Products Laboratory, United States Bureau of Fisheries, it was found that calcium and magnesium salts, common impurities found in commercial salt, greatly retard the penetration of the salt into the fish. It was also found that the salt penetrates the fish far more quickly if it is applied as dry salt than if in the form of brine. Of great importance also in the salting of fish in warm climates, is the thorough cleaning of the fish before salting, since it was found that while thoroughly cleaned fish could be salted successfully at temperatures of 90° F. to 100° F., fish containing blood, roe and milt spoiled at about 65° F.

Before salt is applied, therefore, the fish should be beheaded, and the entrails, kidneys and roe removed, and the fish thoroughly washed, preferably in cold brine about the strength of sea water, or in fresh water. The fish should be rolled in the salt, which should be as fine grained as possible, the belly cavities filled, and the fish packed with their backs down, in tubs. A weight should be placed on the fish, sufficient to keep them immersed in the brine formed by the absorption of the water from the fish by the salt without crushing them. After the fish have become thoroughly saturated with salt, or "struck through," the tubs may be packed full.

Another method of salting which is also used is that of brine salting. In this method the cleaned fish are placed in large vats partially filled with concentrated salt solution. A small amount of salt is put on top of the fish floating in the brine, and the fish are stirred regularly to prevent the brine becoming too dilute at any one point.

The proportion of salt used varies from 10 per cent. to 35 per cent. of the weight of the fish, according to the kind of fish, climatic conditions and local customs. The time required for salting depends on the temperature and the size of the fish. Small fish can often be salted in about two days.

For immediate marketing the fish should be taken from the brine and the brine drained off. More dry salt is then applied, and the fish are packed in containers ready for the market. If the fish are to be held for some time, however, it is necessary to keep them under the brine continually to exclude air, which causes the fat in the fish to "rust". For this purpose the barrels should be filled with fish, headed, and nearly filled with brine through the bunghole. In warm climates, however, where possible, salted fish which is not to be consumed for any considerable time should preferably be kept in cold storage.

In connexion with the salting of fatty fish, experiments carried out at the United States Bureau of Fisheries Laboratory in 1937 showed that the addition of 30 per cent. of pulverized whole oats, based on the weight of salt used, to the

brine in which mackerel were first dipped for salting, considerably reduced rancidity in the fish after storage. As far as the Imperial Institute is aware, however, this process if not being used at present on any commercial scale for the salting of fatty fish.

Another method of preserving fish, which is closely related to salting, is the preservation by means of sodium hypochlorite, which is a powerful preservative and sterilizer, and, in acting on organic matter, is converted into sodium chloride. The Madras Fisheries Department have been making preliminary experiments with this method, but it is not used to any commercial scale at present.

Smoking.

Small fish are usually smoked without evisceration: larger fish are beheaded, eviscerated and cut into strips or small pieces. In Europe and America fish are generally salted by immersion in brine or by adding dry salt before smoking, the degree of salting depending on the nature of the fish and the type of product desired. In the East, fish are often smoked without any preliminary salting. Before smoking and after immersion in brine the fish should be partially dried in the open air.

Smoking is of two kinds, hot-smoking and cold-smoking. In hot-smoking the fish are kept close to the fire and are wholly or partly cooked in the smoking process, which is completed in a few hours. In cold-smoking the fish are hung some distance from the fire and are smoked at a temperature not exceeding 80° F. The time taken for cold-smoking varies, according to the product required, from a few hours to several weeks, as in the case of hard herring.

The woods chiefly used for smoking are hard woods, the most important consideration in choosing the woods being to use one which burns slowly and produces a large amount of smoke. Soft woods which contain resin should not be used, since the resins are liable to give a disagreeable taste to the fish.

The method of building the fire and the erection of the smokeroom depend considerably on the capital available and the quantities of fish to be smoked. For smoking small quantities of fish, a barrel with the lower end of one or two staves removed, is placed on the ground over a small pit, in which the fire is made. The fish for smoking are hung from rods supported at the top of the barrel, and the barrel is then covered with sacking or coarsely woven cloth to keep the smoke in. Fuel may be placed on the fire through the holes made in the barrel by the removal of the staves. In China long narrow furnaces about 3 feet high and 3 feet wide are constructed of stone or concrete, with holes in the top. The smoke from the fire passes through the holes to the fish, which are contained in baskets.

Drying.

Drying preserves fish by destroying enzymes and removing water which is necessary for bacterial growth. Fish having a fat content of over 0.2 per cent., however, is not suitable for dehydration by ordinary processes since on storage of the fish the oil contained in it becomes rancid.

Methods of drying fish differ according to the locality. The main principles consist, however, of washing and eviscerating the fish and then drying them, usually in the sun, although where suitable plant is available, they may be dried in moving air currents or *in vacuo*. The more rapidly the fish are dried, the more rapidly they may be re-hydrated when required for use. In some districts the fish are salted or boiled for a short time before being dried. When unfavorable weather conditions are likely to make drying difficult and prolonged, preliminary salting is probably advisable. For drying, the fish may be hung on poles or placed on mats in the sun.

Although dehydration of fish helps to prevent autolytic changes and bacterial growth, it does not prevent oxidation of the fat in the fish. Dried fish should, therefore, be stored away from sunlight and warm air. Storage *in vacuo* or in inert gas such as carbon dioxide is preferable, where possible, although where the fish is for fairly immediate consumption such precautions need not be taken.

Dried fish normally weighs only about one-tenth of its weight when fresh, and in this form it can be economically stored and transported.

A NEW FLY SPRAY.*

Science News Letter, 16th December, 1939, p. 392, under title "New Family of Chemicals Parade at New York Show", states: "Any new use for castor oil to divert it from the use that you think of when you hear the name is news. Castor oil is being used to make paint, replacing tung oil largely imported from China and now difficult to get on account of the Japanese invasion."

To this important new use for castor oil may be added another valuable discovery involving the use of castor oil. Large quantities of pyrethrum obtained from a species of chrysanthemum plant are used in suitable hydrocarbon oil bases as fly sprays. The most important of the chief sources of pyrethrum is Japan, and, as in the case of tung oil, the supply is adversely influenced by the war. Castor oil again comes to the rescue.

Castor oil, when subjected to heat, is broken down into undecylenic acid, heptaldehyde and residues. The undecylenic acid is separated by distillation and treated with isobutylamine to form isobutyl undecylenamide. This, when used in combination with small amounts of pyrethrum in a suitable base oil, is an excellent spray for flies, better than either pyrethrum alone in the base oil, or isobutyl undecylenamide alone. Synergism appears to be demonstrated by the mixture. The isobutyl undecylenamide replaces about two-thirds of the pyrethrum formerly used and represents about ½ per cent. in the spray. In addition to the superior killing properties of the mixture, the castor oil derivative has the advantage of being a stable compound that can be manufactured according to specification. This is in contrast to pyrethrum, which is unstable and uncertain as to quality and supply. Extensive commercial use has proved the high efficiency of this fly spray, which was previously shown experimentally.

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