United States Department of the Interior, J. A. Krug, Secretary
Fish and Wildlife Service, Albert M. Day, Director

Fishery Leaflet 103

Chicago 54, Ill. Re-issued March 1947

SUGGESTIONS FOR STORING FROZEN FISH 1/

By J. M. Lemon, Chief, Technological Section
Division of Commercial Fisheries

Within the past few years the variety and quantity of frozen foods available to the consuming public have increased to a considerable extent and this has led to an increase in problems of handling by those serving perishable foods to the public. While specific regulations or rules for handling frozen foods are not available, there are a few general principles which cannot be overlooked if it is desired to render the highest class service to the consumer.

In the conduct of studies or investigations dealing with frozen foods as a class, it is impossible entirely to separate one group of foods from another as there are certain interrelated factors which cannot be overlooked. While the investigations conducted by the technologists of the Division of Commercial Fisheries are primarily confined to fishery products, they bear a definite relation to all other groups falling within this broad classification. If one frozen food falls below another in high standard of quality, not only is the single group affected in consumer appeal, but all those in the class may be adversely affected.

Fish, not including shellfish, may be classed in two broad groups according to the composition of the flesh. The first contains those fish which store oil or fat in their livers, and for this reason are generally referred to as the non-oily variety. Example of this group are cod, halibut, and haddock. The other group contains those which have oil throughout the body and are termed the oily or fatty fish. Representative species of the latter group are salmon, mackerel, and herring. The percentage of oil in the flesh varies considerably; however, the flesh of the non-oily fish contains less than three percent fat, while those placed in the oily class contain considerably more than three percent. If the shellfish were classified according to the fat content, they would be placed in the non-oily group. The nature of spoilage is, within certain limits, dependent upon the type of fish.

In any discussion of methods of handling frozen fish, it is necessary to consider to some extent the changes that occur naturally and cause deterioration of both the fresh and the frozen fish. There are three primary types of spoilage which are responsible for the deterioration: First, the action of bacteria with which the seafood becomes contaminated from handling after removal from the water; second, the oxidation of the oil composing a portion of the flesh; third, the action of substances contained within the tissue, which are known as enzymes.

1/ This leaflet supersedes memorandum F.I. 2436-A, issued by the former Bureau of Fisheries.

When the fish are frozen and stored at a low temperature the action of bacteria is almost entirely arrested, and for all practical considerations, spoilage from that cause is eliminated. The second type of spoilage is the oxidation of the oil or fat contained in the flesh of the fish, which imparts a rancid odor and flavor. In instances where the fish are of an oily variety and are stored frozen over a considerable period of time, this spoilage is often of serious consequence. It is not possible to state with any degree of accuracy the length of time fish are held in cold storage before being marketed. Some of the oily species are stored over considerably longer periods than others, and only those which are held for periods exceeding six months are likely to deteriorate from the oxidation of oil. Where the fish are properly glazed with a coating of ice, or covered with moisture-proof wrappings, reaction between the oxygen of the air and the oil is reduced to a minimum and oxidation is not a factor of much concern.

The enzymes are substances contained in the flesh of the fish which build up and tear down the tissues during the life processes. These reactions are common to all forms of animal life and are automatically controlled so long as the animal is alive. Upon death the enzymes which build the tissue are inhibited but those which tear down the tissue may remain active. The temperature at which the tissue is stored has a definite effect upon the rate or speed of this reaction. In fish which are stored at a temperature of 30° F. the rate is much greater than in those which are frozen and stored at 0° F. or below. This accounts for the value of freezing as a method of preserving foods for future use. While the action of these enzymes will eventually cause complete spoilage of any animal tissue as a food, they cannot be considered entirely detrimental as the process of "ripening" is necessary for meats derived from warm-blooded animals. Such "ripening" is not necessary nor desirable for fishery products, however, as the texture and composition of the flesh are such that the flavor is available without ripening. There is no method known at present for the prevention of the enzyme action in frozen food products; but it can be greatly reduced by low temperatures. It is considered advisable to freeze and store fish at as low a temperature as is economically possible. This varies between 0° and 10° above zero F.

"Quick-freezing" has never been defined--there are a great variety of ideas as to just what constitutes a quick-frozen product. Each firm is apt to refer to its own method as quick-freezing regardless of the condition under which the results are accomplished. Much depends upon the rate at which freezing proceeds through the tissue, and it is generally conceded that fish frozen at the low temperatures are superior to those frozen at higher temperatures.

There is one universally recognized axiom in connection with handling frozen fish. The temperature of the storage room should be held constant, and not be allowed to fluctuate anymore than is unavoidable. Wide fluctuation permits an increase in the size of ice crystals within the tissues and thus damages the texture and hastens spoilage of the flesh. Another well-recognized rule which cannot be over emphasized is that fish which have been frozen should not be allowed to defrost until immediately before cooking. The increase in temperature speeds up the enzyme action and causes a gradual breakdown of the tissue.

It is almost impossible to state all of the points to be observed when selecting frozen fish for quality. The purchaser is dependent more upon the reputation of the firm packing the fish than he is upon his own judgment. In the light of present knowledge relative to all frozen products, it seems that the majority of the firms preparing frozen fish should exercise greater care in the selection of the stock, methods of processing, storage, and handling.

In selecting frozen stock, the purchaser should assure himself, so far as possible, that it has been kept in proper frozen condition. It should be examined carefully to see that all cut surfaces retain their waxy appearance, and that the surface coating, either wrapper or ice glaze, has not been broken. The skin surfaces should not show any great degree of discoloration which indicates drying, resulting from inferior cold storage. If the fish under examination is in the round, the eyes should not be sunken into the head. There should be no odor of ammonia from the gills or body cavity. After some experience it will be possible to judge the quality of the frozen stock quite accurately.

Summary.--Fish which are frozen for future markets should be carefully selected. Only those in prime condition should be handled by this process.

The fish should be frozen when received at the cold storage plant and held in that condition until finally delivered into the hands of the consumer.

The temperature of the cold storage room should be maintained at between 0° and 10° above zero F., using great care to limit the range as much as possible. It is advisable to control the temperature with a thermostat.

Boxes or cartons containing frozen fish should be piled in the storage room so that the air can circulate freely between them. Those in the center of a tight pile may defrost. Care should be exercised also to stack the piles well away from the walls, if the storage room has an outside wall or is near a room maintained at a higher temperature.

A heavy glaze of ice should coat the surface of all fish frozen in the round or which do not have a wrapping of some moisture and vapor-proof material. Frequent examination of the glaze should be made and reglazing done as is necessary The water used for reglazing should be near freezing temperature when sprayed upon the surface of the fish.

When refrigerator cars or trucks are to be loaded with fish taken from a cold storage room, it is advisable to precool them thoroughly before loading is begun. When the temperature of the cars has reached approximately that of the storage room, loading should be accomplished as rapidly as possible. When a car is received at the warehouse and opened, it should be completely unloaded with no delay.

If the fish become defrosted during transfer from one warehouse to another or enroute from producer to wholesaler, careful examination of the entire lot should be made. Those which have become entirely defrosted should be examined with particular care. If it is determined that they will remain in good condition until refrozen, allowing for approximately 24 hours additional time before they will refreeze after placing in the freezer, then refreezing is justified. If,

however, there is some doubt as to the quality of the defrosted fish, they should be disposed of immediately even if this entails a loss.

Those which have only partially defrosted can be refrozen with reasonable assurance that a first-class product will result. In any case, attempts to refreeze packaged fish in the original corrugated shipping carton should never be made. The individual packages of not larger than 10 pounds should be separated when placed in the freezer so that they will freeze as rapidly as possible. After the fish are entirely frozen they can be repacked in the original container.