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PACKAGING FROZEN FISHERY PRODUCTS

By S. R. Pottinger, Chemist,
Branch of Commercial Fisheries

The problems of freezing and frozen storage of fish and shellfish are, on the whole, very much like those for other frozen foods. The packaging requirements are similar and the requirements for storage, with some exceptions, are much alike. Changes in flavor will occur in seafoods during periods of frozen storage much the same as in other frozen foods. Some varieties of fishery products have a tendency to toughen after being held for varying periods of storage.

There is, however, an additional important problem with certain varieties of fish which is encountered with only a few other frozen products. The fat or oil that is present in the body tissues of these fish will undergo oxidation, with subsequent undesirable changes in flavor and, in extreme cases, changes in the appearance of the fish.

Fish and shellfish may be classified arbitrarily into two broad groups, depending upon the fat content of the muscle tissue. The non-fatty fish comprise one group which includes those fish the flesh of which contains less than 3% fat. The fat or oil of these fish is generally stored in the liver; haddock and cod are examples. The other group, which is made up of fatty fish, includes those which store their fat in the muscle tissues of the body. The flesh of these fish contains more than 3% fat and in some species as much as 20%. Salmon and mackerel are examples of fish included in this group. Shellfish are classified as non-fatty, since their flesh contains very little fat.

During storage, fishery products undergo changes of two general types, namely, chemical and physical. Chemical changes include those brought about by the action of bacteria, those due to the action of naturally occurring enzymes, denaturation of the protein and oxidative changes in the fat or oil. The principal physical changes are desiccation or drying out of the flesh and ice-crystal formation.

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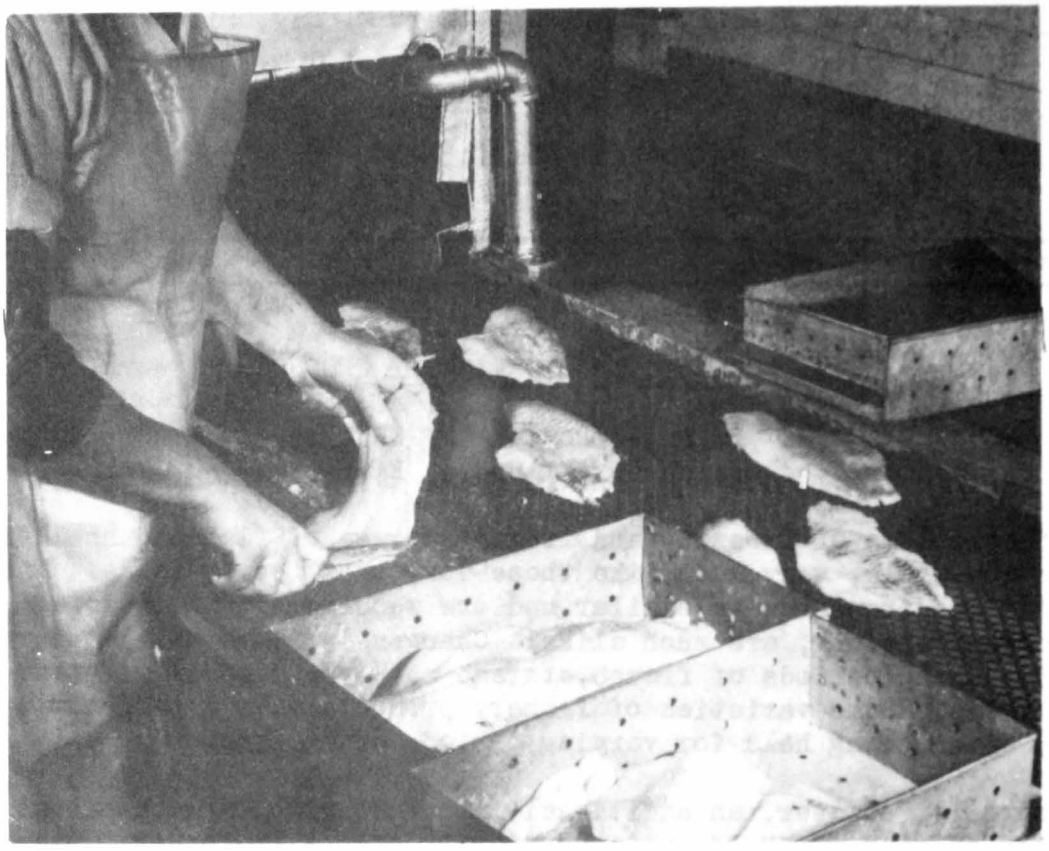


INSPECTING AND TRIMMING OF FILLETS PRIOR TO PACKAGING.

From the standpoint of packaging, there is little that can be done to stop the action of the autolytic enzymes in fish. In the preparation of certain other products, such as vegetables for freezing, blanching is an important step in order to inactivate or markedly reduce the action of the enzymes. Such treatment is not practicable for animal tissues, however, and although the temperature of frozen storage will greatly retard the rate of enzyme action, spoilage from this source will eventually occur.

A second important factor is decomposition by bacterial action. The growth of bacteria is reduced proportionately as the temperature is lowered. As long as the products are maintained at temperatures generally recommended for storage of frozen products, the package has little direct influence on spoilage caused by bacterial action. At a temperature of about 15 deg. F. most bacterial action is stopped. Freezing will cause a marked reduction in the number, but will not necessarily kill all bacteria present. If the temperature becomes too high, bacteria will again multiply.

The package, then, does have an important function in helping to control the degree of spoilage caused by bacterial action by preventing further contamination of the product during handling. This is especially important for foods both in the unfrozen condition and particularly during and after thawing, when bacterial action may be quite rapid. During storage in the

PACKAGING LINE FOR PREPARING FRESH FISH FILLETS FOR FREEZING.

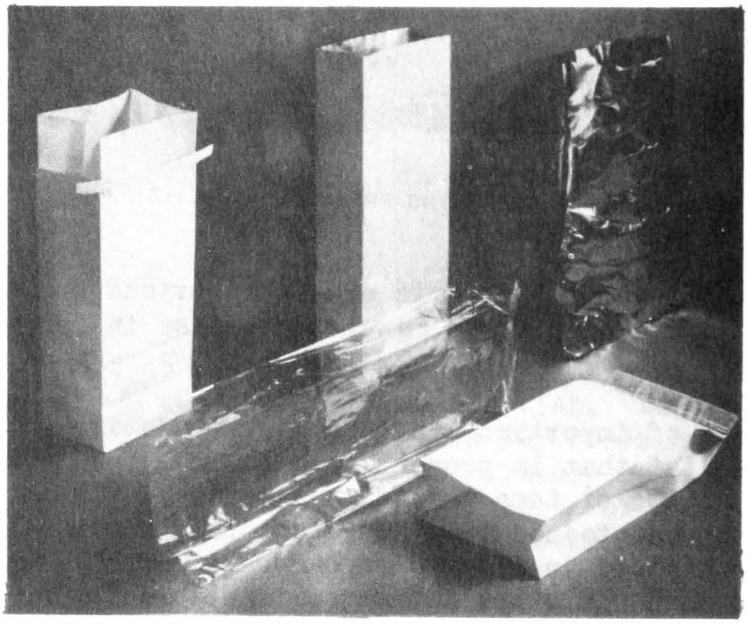
frozen state, the inactive bacteria are less obvious but, nevertheless, are potential sources of trouble, awaiting a rise in temperature to become active.

Packaging is of importance in retarding oxidative changes in fish. Oxidation of the fat that is present in fish is a factor which has much to do with the period of time that fish - particularly those designated as fatty - can be maintained in a satisfactory condition in frozen storage. The fat contained in fish is much more susceptible to oxidation than is the fat found in other animal or vegetable foods. Oxygen is rapidly absorbed by this fat and will soon cause the loss of fresh flavor and the development of rancidity. Bleaching and fading of the natural color of the fish may also occur and in extreme cases the fat will darken, causing the fish to assume a brown color. These changes can be retarded by packaging tightly with essentially air-tight wrappings to prevent ready passage of air to the fish.

The low temperatures which are required for proper storage of frozen fishery products and frozen foods in general will cause extreme desiccation or drying out unless special preventive precautions are taken. The humidity of the air in a frozen-storage room is quite low. On the other hand, the air immediately surrounding the frozen food is practically saturated with moisture. The dry air in circulating through the room will pick up any moisture that is available. Any exposed or improperly packaged food products in the room will thus lose moisture, in the form of water vapor, and will rapidly develop a dry, spongy and discolored surface. The tissues

become tough due to denaturation or irreversible changes in the protein. This condition is known as "freezer burn." The package is of prime importance in order to prevent this drying. Care is needed to package the food properly in containers which have a very low or - ideally - a zero rate of water-vapor transfer, so as to keep the moisture where it belongs - within the package.

For bulk storage of frozen fish, the "package" which has been generally in use for many years is the ice glaze formed by coating the frozen fish with cold water. Such a "package" falls far short of meeting the requirements of a satisfactory package as we know it today, since the glaze is quite brittle and will crack or chip very easily. In addition, it does not last long at best, since it will soon sublime or evaporate in the dry atmosphere of the cold-storage room and must be renewed at frequent intervals. This difficulty is overcome to some extent by freezing some varieties of fish in blocks which, after being glazed, are placed in cartons or boxes to retard the loss of the glaze.



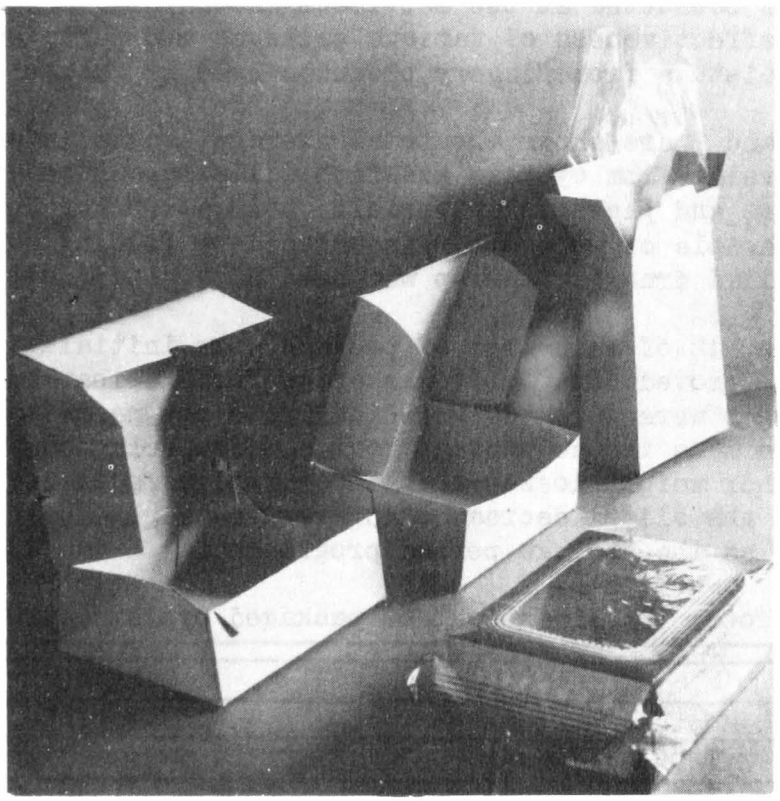
ASSORTED FROZEN FOODS CONTAINERS

The glaze, which has found wide usage in the frozen-fish industry, serves as a protective coating for retarding the loss of water vapor from products during storage. It also prevents ready access of air to the fish and retards the onset of rancidity. Through its use, the dry air of the storage room picks up moisture largely at the expense of the glaze and removes very little moisture from the fish itself. For this very reason, however, the glaze must be renewed rather frequently, requiring special attention and increased handling.

For fish and shellfish which because of their shape and size are adaptable to being frozen in blocks and then packaged, a glaze is often

applied prior to packaging. This is particularly true with green shrimp, as the many air spaces between the individual shrimp favor ice-crystal formation and desiccation of the shellfish. A glaze, by coating or filling these voids, retards or even prevents this difficulty.

Because of the widespread practice in the early days of the industry of glazing frozen fish, very little attention was given to their packaging. With the introduction of filleted fish over 25 years ago, packaging of other food products was becoming commonplace and the consumer soon demanded that fillets be available in packaged form also. When quick-frozen foods were introduced, the use of wrappers or packages rapidly followed and the consumer became conscious of the advantages of receiving frozen fish in convenient packaged form. This, however, is only a part of the story in regard to the need for packaging these frozen products.



ASSORTED FROZEN FOODS CONTAINERS

The necessity for providing proper packaging protection to the frozen product was not at first realized by many of the producers of frozen fishery products. It was soon found that steps had to be taken to permit the products to withstand long periods of storage without drying out and to maintain the original appearance and flavor so far as possible. Some producers have only recently begun to use packages which will provide the necessary protection against loss of water vapor. In fact, an apparent lack of understanding is still being shown by some packers in their failure to use satisfactory packages.

Too often a makeshift container entirely inadequate for the requirements which it should meet is provided for these products.

The requirements for satisfactory containers for frozen fishery products are no less rigid than for other frozen products. The choice of the package is very important in protecting and merchandising the product. The problem of vital importance is that of preventing loss of moisture from the product. The use of packaging materials having low water-vapor transmission rates must be emphasized. A package made of suitable water-vaporproof materials which will satisfactorily withstand low storage temperatures without becoming brittle or otherwise unsatisfactory and which is tightly sealed, will provide adequate protection for a long period of frozen storage.

Considerable variation was found in the efficiency of the different materials in tests conducted at the Service's laboratory in College Park, Maryland, on the effectiveness of various packages and packaging materials against loss of moisture from fishery products held in frozen storage.

In tables 1 and 2 are shown the total average losses in weight, at three month intervals, from oysters and fish fillets packaged in various types of containers and packaging materials, held at 0° F. The bags were heat-sealed if possible or were otherwise closed by folding over several times. The so-called druggist's wrap was used for the fillets.

In most cases, 12 of each type of package were initially prepared, one of each being removed monthly from storage for examination and then discarded. Packages were weighed periodically to the nearest gram, and all weighings were made in the storage room. Some packages which were discarded had higher weight losses than those remaining in storage. This accounts for the slight decreases in average weight loss for some types of packages as the storage period progressed.

Table 1 - Total loss in weight of packaged oysters at 0° F.

	Weight loss in percent			
Months in Storage	3	6	9	12
Type of Package				
Laminated bags (no carton):				
No.300 MSAT cellophane and treated paper	.02	.00	.00	.00
No.450 " " " "	.00	.00	.05	.00
Aluminum foil and paper	.04	.05	.00*	.00
Aluminum foil and cellulose acetate film	.04	.05	.00*	.00
Aluminum foil and vinyl film	.04	.05	.00*	.00
Bags (in rectangular waxed fibreboard cartons):				
Single No.300 MSAT cellophane	.06	.03	.05	.00
Double No.300 MSAT cellophane	.00	.00	.00	.00
Single No.450 MSAT cellophane	.00	.00	.00	.00
Coated paper	.11	.12	.05	.21
Laminated No.300 MSAT cellophane and treated paper	.08	.05	.10	.00
Pliofilm	.00	.00	.00	.00
Polyethylene	.00	.00	.00	.00

Table 1 - Total loss in weight of packaged oysters at 0° F. (Cont'd)

Type of Package	Weight loss in percent Months in Storage 3	6	9	12
Bags (in rectangular waxed fibreboard cartons with waxed paper overwrap):				
No.300 MSAT cellophane	.08	.05	.10	.00
Coated paper	.12	.12	.14	.20
Coated paper bag with tin tie closure	.43	.76	1.30	1.71
One piece telescopic rectangular waxed fibreboard cartons, with:				
No overwrap	.46	1.17	1.86	2.30
No.300 MSAT cellophane overwrap	.00	.00	.00	.00
Lightweight waxed paper overwrap	.04	.20	.72	1.24
Heavy " " " "	.00	.00	.29	.58
Laminated aluminum foil and paper overwrap	.00	.00	.00	.00
Rectangular waxed fibreboard carton with attached cellophane liner and no overwrap	.57	1.02	1.75*	2.26
Round waxed fibreboard carton:				
Slip-over top	.16	.86	1.08	1.44
Snap-in lid	.14	.40	.80	1.20
Waxed fibreboard carton with metal plug top	.06	.40	.62*	.68
Carton with waxed fibreboard body and crimped metal ends	.18	.25	.47	.69
Tin can:				
Plug top	.00	.03	.00	.00
Crimped ends	.00	.00	.00	.00
Glass jar	.09	.06	.00	.00

* Tenth month

The average loss in weight for most types of packages tested was quite small, amounting to only a few tenths of 1% during a storage period of one year. In some instances no loss occurred. In a number of instances considerable variations in weight losses, though slight, were found between individual packages made of the same material. This was particularly true with some of the packages containing heat-sealed cellophane bags and those with heat-sealed overwraps, whether they were coated paper, cellophane or metal foil. The heat seals appeared to be tight, but there was a possibility that a poor seal not readily detectable was obtained.

Table 2 - Total loss in weight of wrapped fillets at 0° F.

Months in Storage	Weight loss in percent			
	3	6	9	12
Type of Wrapper				
Aluminum foil (.001 inch)	.06	.21	.20	.45
Cellophane (No.300 MSAT)	.16	.18	.30	.33
Freezer paper*	3.23	6.64	8.47	10.77
Freezer paper*	- -	- -	- -	23.3
Pliofilm (120 FF)	.15	.17	.21	.18
Polyethylene (.001 inch)	.08	.11	.13	.13
Saran (.001 inch)	.06	.06	.06	.08
Vinylite (.001 inch)	.13	.30	.35	.50

*Products of different manufacturers

On the other hand, considerable variation in water-vapor permeability of coated films and papers is not at all uncommon due to irregularities in thickness of coating, small breaks, brittleness and cracking at low temperatures, and crevices caused by creasing of the sheet. One or more of these factors could very easily account for variations in weight losses between individual packages, particularly over an extended storage period.

From the standpoint of moisture retention afforded by the packages, little advantage was found in the use of an overwrap with a good quality bag-in-box type of container. Weight losses were about the same whether or not an overwrap was used. This is not to be taken as meaning, however, that an overwrap is of little value when used under these conditions. The extra protection which overwraps provide to certain types of containers is certainly of value in preventing possible leakage due to faulty materials or closures. With some other types of rectangular paperboard containers, which are often used without a sealed inner bag, an overwrap of good quality was found to be important in retaining water vapor within the package.

The tinplate can is often thought of as being an ideal container for certain varieties of frozen seafood. This may be true to the extent that there is no water-vapor loss and no leakage of the contents from a sealed can. For commercial use and distribution of frozen foods, however, particularly in consumer-sized containers, a very important factor must be considered. To the ultimate consumer of canned goods, the tin can is generally associated with processed foods which can be held on the shelf at room temperature. Because of this, the consumer who has always been in the habit of placing canned goods in the kitchen cabinet is very apt, through force of habit, to place the can of frozen food there also. The outcome is quite

obvious and, in fact could prove to be dangerous. For this and other reasons, the frozen-food industry has taken the stand that packages for frozen foods should be distinctive so that they will not be confused with products preserved by processing with heat.

In the packaging of fishery products for freezing, particularly those which are classed as fatty, air should be excluded from the package so far as possible in order to delay oxidative changes and the onset of rancidity. Close-fitting packages made of high quality materials suitable for frozen-food packaging will be of particular value. Air spaces within the package should be kept at a minimum, not only to reduce the chances of oxidation occurring in the fish, but to prevent ice-crystal formation and localized freezer burn as well. For large fish and those products which cannot readily be packaged to exclude air and air spaces, a glaze should be used. If practical to do so, it will be found best to protect the glaze by use of a package.

In the selection of a package for fishery products, sight should not be lost of the fact that there are factors to be considered other than water-vapor retention and exclusion of air. Certainly the package has other functions to perform as well, particularly for those products which go out in consumer and institutional-sized packages. It must provide structural support during filling and freezing, as well as prevent physical damage to the contents in the normal course of handling during storage and distribution. The paperboard used in the fabrication of the container should be waxed or otherwise treated to prevent loss of rigidity and discoloration which might occur through contact with wet materials or through condensation of moisture on the surface of the package. The container should be made of materials that are tasteless, odorless and non-toxic.

In selecting a carton, certain characteristics of the product to be placed in it should be considered, together with the degree of handling which will be necessary during packaging and freezing. If oysters, for example, are to be packaged by hand a water-tight container such as a sealed bag within a carton, would probably prove more satisfactory, since the package can be turned at any angle before freezing without danger of spillage.

Much attention should be given to merchandising qualities of the package. This is quite important to insure consumer appeal and successful sale of the product. A properly designed and attractively printed package having a clean, sanitary appearance will go far in conveying merchandising appeal to invite purchase and encourage consumer acceptance.

An overwrap for most types of cartons provides added protection against leakage, against water-vapor loss and against wear and tear which normally are to be expected during distribution. In addition, it furnishes an excellent medium for attractive printing and labeling. Several types of materials for overwraps are now available.

There is hesitancy on the part of some operators of frozen-food storage plants to store fish with other products because it is believed that fish odors and flavors will be absorbed by the other foods. Because

of this uncertainty, a series of experiments was conducted by this Service to ascertain the extent to which such odors might be transferred. Packaged fish and butter were stored in close proximity to each other in a refrigerated locker for nearly a year. The fish were wrapped in water-vapor-proof material of the cellulose-derivative type, while the butter was wrapped in vegetable parchment, the customary wrap for butter. Butter was selected because of its susceptibility to the absorption of foreign odors or flavors and the ease with which they can be detected by tasting. Samples of butter were removed at intervals and judged for quality by a professional butter grader. After nearly a year of storage with fish, the butter maintained a high score and no absorption of odors by the butter was observed by the expert grader. These tests demonstrated that by proper wrapping in good quality frozen-food packaging material, fish can be stored with other frozen foods with little chance of odor transfer.

The quality of frozen fish and shellfish is determined to a large degree by the quality of the product at the time of freezing and the manner in which it is stored. The function of the package is to help maintain that quality from the time the product is prepared for freezing until it is opened by the consumer. Care in selection, processing and storing may be entirely wasted unless the product is adequately protected until it is consumed.

New packages and methods of packaging can help in merchandising frozen fishery products. Self service makes it easier for the consumer to decide for himself which product he will choose. Quality of product and the use of attractive packages and informative labeling can aid materially in furnishing the customer the required incentives for purchasing.

With the development of improved packaging and freezing techniques will come the expansion of markets for fishery products. These products can be frozen when supplies are plentiful and held until needed by the consumer. By packaging and quick freezing immediately, they are preserved at their peak of quality.