TECHNICAL NOTE NO. 51 - USE OF CORN-SIRUP SOLIDS IN PACKAGING AND FREEZING FISH

The quality of frozen fish and shellfish is dependent to a large degree on the use of freezing, packaging, and storage methods that minimize the chemical and physical changes in the product. Much of the research on the use of additives, dips, and coatings results from the desirability of delaying or inhibiting oxidative changes that gradually destroy natural color and fresh flavor.

During the past two years, we have made a number of tests and observations on the potential usefulness of corn-sirup solids in packaging and freezing fish (Anonymous 1957). These tests were not comprehensive, but were limited to cooperative industry trials on small lots of fish and to short-term laboratory tests that we were conducting along with other studies of packaging and storage variables in frozen fishery products. Three uses or applications of corn-sirup solids were investigated. These studies indicated: (1) that a solution of corn-sirup solids may be used as a protective dip or coating in packaging and freezing fish, (2) that the use of smaller concentrations of either corn-sirup solids or dextrose in ice-glazing solutions produces a glaze of desirable properties for frozen whole or dressed fish, and (3) that either corn-sirup solids or dextrose may be used in salt brines to produce immersion-freezing media of desirable properties.

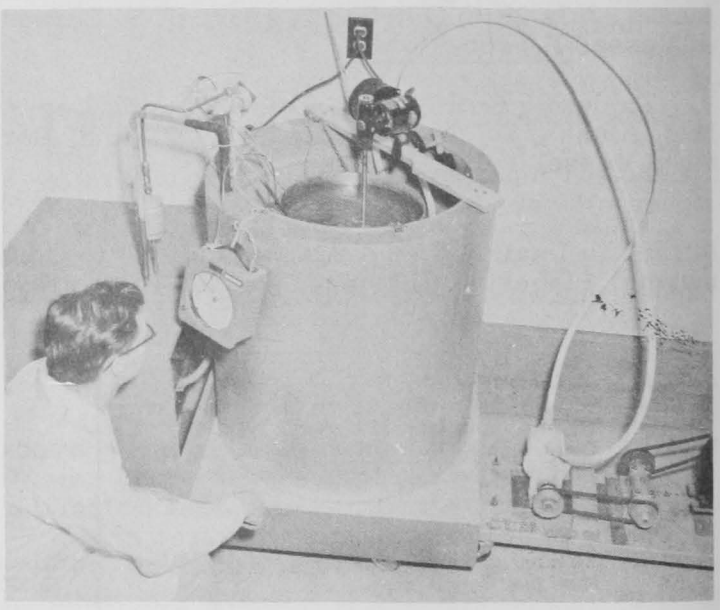

Fig. 1 - Laboratory refrigeration unit used for experimental immersion-freezing of fishery products in modified salt brine.

The purpose of this technical note is to describe the characteristics of corn-sirup solids and then to report, from the viewpoint of a processor interested in new techniques, our observations on the three applications of corn-sirup solids to fishery products.

CHARACTERISTICS OF CORN-SIRUP SOLIDS

Corn-sirup solids meet to a high degree several basic requirements of a desirable food additive. They are accepted widely as a food component; are easily soluble in water; are colorless, almost tasteless, and odorless; are stable in storage at room temperature; and are economical. In our tests, a regular-conversion

corn-starch hydrolysate of 42 dextrose equivalent (42 D.E.) was used. Pure dextrose is 100 D.E. The dextrose equivalent is based on the content of total reducing sugars as a percentage of the total dry substance. The average carbohydrate composition of corn-sirup solids of 42 D.E. is shown in table 1, which illustrates the high content of polysaccharides in the product. Other conversion products of the hydrolysis of corn starch may be used for the applications indicated in this report including corn sugar (also called dextrose)--the product derived from complete hydrolysis.

Table 1 - Carbohydrate Composition of Commercial 42 Dextrose Equivalent Corn-Sirup Solids 1/

Type of Conversion	Relative Amounts of the Various Saccharides							
	Mono-	Di-	Tri-	Tetra-	Penta-	Hexa-	Hepta-	Higher
	(Percent)							
Acid	18.5	13.9	11.6	9.9	8.4	6.6	5.7	25.2

1/ Data from Corn Sirups and Sugars, American Maize-Products Company, New York, 1956.

It appears probably that in the use of corn-sirup solids as a coating for fish prior to packaging and freezing, the preservative effect is due not only to its action as a physical barrier to absorption of oxygen by the fish meat but also to an antioxidant or inhibiting effect of the polyhydroxyl compounds in the product. For this reason, corn-sirup solids of different dextrose equivalents may give different results. It should be emphasized that in considering the possible application to a particular product, the processor should make his own tests on a small scale under the conditions existing in his plant.

USE OF CORN-SIRUP SOLIDS AS A PROTECTIVE COATING

Several tests in which salmon steaks and fillets were dipped in dense solutions of corn-sirup solids before being wrapped and frozen indicated that the coating was effective in minimizing oxidation of surface meat during storage at 0° F. Cooperative tests with a local fish processor and separate laboratory studies were conducted in which both fresh salmon and frozen dressed salmon were used for preparation of steaks and fillets. These steaks and fillets were dipped in solutions of 30-, 45-, and 65-percent corn-sirup solids (by weight), drained briefly, wrapped with MSAT cellophane, and packaged in waxed cartons. These samples along with untreated ones were frozen and stored in either commercial or laboratory storage at 0° F. The samples were examined at intervals, in the thawed and cooked state, by an experienced panel at the Laboratory.

In those series in which the fresh salmon were used, the coating was noticeably effective in minimizing the fading and discoloration of the astacin pigments in the surface meat. The coating had the additional effect of enhancing the red or pink meat color because of the glossy surface. At later periods during storage when the surface fatty layer of the untreated salmon became both yellowed and definitely rancid, it was found that the fat of the treated salmon had little or no yellowing and rancidity. In one series in which silver salmon steaks were examined periodically, for example, after 8 months, the treated steaks were given definitely superior ratings for color and flavor, as contrasted to the untreated steaks. After 12 months, the treated steaks were still palatable, whereas the untreated steaks were unmarketable because of rancidity in the fatty layer and discoloration. The panel preferences were usually in the order of steaks treated with solutions of the highest percentage to the lowest percentage of corn-sirup solids, followed by the untreated steaks. In another series of tests conducted during a second year in which king salmon steaks and pink salmon fillets were used, the results confirmed the findings in the first year.

In contrast to these favorable results with fresh salmon, the use of the coating was not effective uniformly for packaged salmon prepared from previously frozen

dressed fish, which in some cases had been frozen 5 or 6 months. Two factors enter into this observation: (1) any protective coating that delays or inhibits oxidation can function best if it is added before any oxidation has taken place and (2) in the application of the dip to steaks sawed from frozen salmon, the coating does not appear to be absorbed and distributed effectively in the frozen fish meat. Evidently, the moist resilient meat of the fresh fish permits a much more intimate absorption and distribution of the coating in the surface meat, an effect that is probably increased by the subsequent pressure applied during wrapping and freezing.

In a study of the percentage of corn-sirup solids to use in commercial application, it appeared that 65-percent was too high--even though an excellent preservative effect was found. The coating, with this percentage, detracted from the appearance when the fish were unwrapped and prepared for cooking. Another somewhat objectionable feature of the coating with 65-percent corn-sirup solids was the charring of the solids around the edges of the fish when they were baked for evaluation of flavor. Although the normal flavor of the subsurface meat was not affected by the coating, tasters noted a slight semisweet taste in the surface meat of the cooked, unseasoned fish. This taste was not objectionable.

These factors were present to a lesser degree in steaks treated with the 45- and 30-percent coating. From a commercial viewpoint, the 30-percent coating would be more desirable to minimize these slightly adverse features, would be more economical because of lower pickup, and yet would provide a reasonably effective coating with fresh salmon or other fish in which surface oxidation is a problem.

Limited data were obtained on the weight pickup of the coatings by the fish, using a dip time of approximately 10 seconds. One test showed approximately 0.5 ounce of coating pickup from the 30-percent corn-sirup solids solution per pound of fish dipped, when samples of fish were used in which there were 2 to 4 portions per pound. Based on the current local price of $9.37 for 100 pounds of corn-sirup solids (42 D.E.), the actual coat of material would be about 0.1 cent per pound of fish. A slight additional labor cost also would have to be included.

USE OF CORN-SIRUP SOLIDS IN GLAZING FROZEN FISH

Frozen whole or dressed fish are dipped usually in cold fresh water to produce a surface ice glaze that protects the fish from drying during cold storage. Similarly, packaged fish and shellfish, such as steaks cut from frozen dressed salmon, often are glazed before being packaged. In the improvement of the glaze by the addition of modifiers to the glazing water, the most important need is to produce a more resilient and lasting glaze that will not crack, break off, and evaporate (sublime) as readily as does a pure ice glaze.

In our tests, a 2- to 3-percent solution of corn-sirup solids was found to produce an excellent glaze with the resilient properties desired for glazing dressed fish directly from the freezer. The glaze is transparent and resists cracking caused by changes in temperature. The modified glaze does not evaporate as readily as does a pure ice glaze during long cold storage, and the reduced rate of evaporation will result in better keeping quality of the product. Either corn-sirup solids or dextrose may be used. They are not necessarily superior to other glazing additives but they have the virtues of being convenient, economical, and definitely harmless.

USE OF CORN-SIRUP SOLIDS OR DEXTROSE IN IMMERSION FREEZING

Corn-sirup solids or technical-grade "dextrose" (often called glucose but usually called "crude corn sugar" in the trade) may be used in high concentration in salt brines to produce an immersion-freezing solution of desirable characteristics. The salt and corn-sirup solids lower the freezing point of the solution, and the corn-sirup solids or glucose minimize the absorption of salt into the product being frozen.

Work at the Boston Fishery Technological Laboratory (Peters and Slavin 1956, Slavin and Peters 1958) demonstrated that a solution of 34-percent glucose and 12-percent salt (by weight) could be chilled to 0° F. and used satisfactorily to freeze lobsters. In other tests, a solution of 20-percent glucose and 20-percent salt was used for immersion freezing of scallop meats with good results. In the tests with scallops, Slavin (1958)1/ reports that scallop meats frozen in the 20 percent glucose-20 percent salt solution had a salt content before thawing of 1.1 percent. The meats frozen in 22-percent salt brine had a salt content before thawing of 3.5 percent. Previously, modified brines have been used to freeze other foods by immersion. In the Gulf of Mexico area, for example, glucose-salt brines have been used successfully to freeze shrimp aboard fishing vessels (Anonymous 1955).

Recommendations apply to freezing in modified brines that are similar to those applying to freezing in straight salt brine. The product should be chilled thoroughly before being frozen. Either agitation of the brine or movement of the product through the brine is necessary for efficient freezing. The brine should be chilled to 0° to 5° F. and maintained at 10° F. or less during the freezing process in order to minimize the absorption of salt.

If the product to be immersion frozen is wet and thoroughly chilled prior to being immersed, an ice glaze quickly forms on the product. This glaze is formed essentially by the wet surface of the product but does contain a small amount of salt and any other additive in the brine. During long storage, it is important to protect the product from loss of this glaze by packaging or by renewal of the glaze. Otherwise, the salt absorbed in the surface meat tends to accelerate discoloration, drying, and oxidative changes in flavor.

Tests at the Seattle Fishery Technological Laboratory have demonstrated that certain products may not be immersion-frozen with good results even in the modified brine. Pacific oyster meats were frozen in solution (1) of 20-percent corn-sirup solids and 20-percent salt, (2) of 34-percent corn-sirup solids and 14-percent salt, and (3) of 20-percent corn-sirup solids and 10-percent salt, at temperatures of 0°, 10°, and 15° F., respectively. The oyster meats absorbed salt too readily even during the short period required for freezing. In addition, the exterior surface of the immersion-frozen oysters became very soft when the oysters were thawed. Discoloration and oxidation of the oysters occurred during frozen-storage periods of only 4 months at 0° F. These results suggest that experimental trials with each type of product should be made to determine the effect both of the immersion-freezing and of the subsequent cold storage.

SUMMARY

Corn-sirup solids and commercial-grade dextrose (crude corn sugar) were found to have desirable properties for the following three applications as food additives or modifiers in packaging and freezing of fish: (1) as a protective coating in dense solution for treatment of fresh steaks and fillets before they are packaged and frozen, (2) as a glaze modifier in dilute solution for producing a resilient glaze on frozen fish, and (3) as a modifier in dense brine solutions for minimizing absorption of salt during immersion freezing of fish and shellfish. It was suggested that the protective effect in minimizing oxidation in frozen packaged salmon is due not only to the physical barrier to absorption of oxygen at the surface of the fish but also to an antioxidant or inhibiting effect of the polyhydroxyl compounds in corn sirup solids. Tests in the use of both corn-sirup solids and dextrose in salt brines used for immersion-freezing demonstrated that actual trials are necessary to determine the feasibility of use with each particular fishery product under the specific conditions met in each plant.

1/ Personal communication from Joseph W. Slavin, Fishery Technological Laboratory, Boston, Mass.

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HANDLING FROZEN FOODS AT RETAIL

A recent study by the University of Massachusetts Extension Service at Amherst, Mass., includes excellent suggestions for the maintenance of quality.

The food retailer that consistently sells quality frozen foods will have a higher sales volume, more rapid turnover, add higher profits. However, quality can be assured only if the merchandise is properly handled at the retail level.

In order to assure handling efficiency in the frozen foods department, it is important that one person be assigned the responsibility of ordering, stocking, rotating, and the care and cleaning of the frozen food displays and storage.

Here are some pointers which will help personnel handling frozen foods:

Receiving Deliveries: Always be ready for the delivery and have space available for the merchandise to be placed under refrigeration. Exposure to high temperature means a loss of quality and product.

Handling in Zero Storage: Segregate merchandise as it is put into cold storage. Keep carton labels visible or mark visible ends of carton. This saves a lot of employee time when it comes to stocking frozen food cases.

Care of Display Cases: Do not stock the merchandise too tightly into display case, because it is difficult for customers to get at the merchandise, and often results in torn packages, bent cans, and disarrangement.