

central portions of the fishery to the southern portion of the fishery during the fall and early winter, and a northward movement from the southern portion of the fishery during the late winter and early spring was described. Migrations of shrimp in the northern Gulf of Mexico were discussed by sections: east of Mississippi River, in Louisiana west of the Mississippi River, and the lower Texas Coast. This presentation was in general terms; details will be presented in a paper to be published shortly and entitled "Growth, Migrations, Spawning and Size Distribution of the Shrimp, *Penaeus setiferus* (Linn.)," by Milton J. Lindner and William W. Anderson.

Evaluation of Five Pound Packages of Glazed and Unglazed Shrimp

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Because of the rapid growth of the shrimp industry during the last few years the need for additional information on the packaging requirements of frozen shrimp was found necessary. An investigation of the correct packaging conditions for several types of shrimp was started in December, 1951, by a review of the published literature and by discussions with several experts in the field. It was determined that the bulk of all frozen shrimp is sold as headless raw shrimp, which are packed in five pound packages and glazed with water. The glaze in this size package amounts to twelve to twenty ounces of water per package and serves to protect the shrimp during subsequent storage at 0°F. There has been considerable production of small "consumer" size packages of headless raw shrimp packaged without glazing, using a printed overwrap, and some five pound packages have also been made with overwrap. The experience of these packers and investigators has been that protection from the overwrap was apparently sufficient, and that there were no adverse effects on the quality of the shrimp (Anon. 1950; Fieger, 1950; Fieger, Green, Lewis, Holmes — DuBois, 1950; Divers, 1953). As a result of the recommendations of several authorities on shrimp processing and marketing the present tests were outlined, incorporating all of the suggestions which were obtained.

Shrimp are almost the only packaged frozen food now being glazed. Other frozen foods, including fish fillets, poultry, meat and vegetables, can be held for periods of at least one year when packaged without a glaze, but with a suitable water vapor barrier, such as an overwrap (Anon. 1951). Extensive packaging tests in this laboratory on all of these foods have shown that adequate protection is provided by a suitably waxed carton with a special overwrap which features a hard wax coating, designed for use at the low temperatures encountered in storage of frozen foods.

The glazing operation involves extra costs and problems, including the following:

1. Sharp freezing prior to glazing sometimes causes undesirable desiccation.
2. Shrimp packages must be opened after the initial freezing period and passed through the glazing line, involving extra labor.

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3. Additional refrigeration capacity and 35°F. glazing water are required.
4. The ice glaze increases the package weight 15 to 20 per cent, with simultaneous increase in storage and shipping charges.
5. Undesirable effects are encountered, such as water leakage on inverting cartons, individual packages freezing together, water damage to corrugated shipping containers, and prolonged defrosting periods.

In view of these many disadvantages, it appeared desirable to eliminate the glazing operation. Therefore, a test program was initiated to determine whether unglazed shrimp could be held satisfactorily for long term storage at 0°F., when protection was provided by a heavy waxed carton with a suitable outer overwrap.

Texas brown shrimp (*Penaeus aztecus*) averaging 31 to 35 to the pound, were used in the experiments. These had been four days old in ice storage on a fishing boat. They were landed at the Pan Am Frozen Foods plant, Brownsville, Texas. Thirty packages were frozen; one lot was glazed a day later and the shipment was sent in dry ice to the Marathon Corporation Laboratories at Menasha, Wisconsin.

A duplicate test was set up at New Orleans, with white shrimp (*P. setiferus*), averaging 31 to 42 to the pound. These had been six days on ice when packed. The packages were handled under commercial conditions at both plants, with the exception that the top shrimp were arranged in a "layer pack", for better observation of desiccation and for photographs. A net drained weight of five pounds three ounces was used. The glaze on the brown shrimp averaged 18.2 ounces, and on the white shrimp 23.2 ounces.

The packages made up at both Brownsville and New Orleans had the following variations in glazing and wrapping:

A. Glazed Shrimp

1. Marathon high gloss wax, solid bleached carton with glued construction.
 - a) No overwrap
 - b) Moistureproof cellophane overwrap
 - c) "Tyton" waxed paper overwrap (thirty pound opaque paper waxed to 44 pounds with a special blend of waxes).
2. Present commercial carton fabricated of high gloss waxed board with stapled construction.
 - a) No overwrap

B. Unglazed Shrimp

1. Marathon high gloss waxed, solid bleached carton with glued construction.
 - a) No overwrap
 - b) Moistureproof cellophane overwrap
 - c) "Tyton" waxed paper overwrap

All cartons were one piece telescope style.

Package construction A-1-b and A-1-c above, in which shrimp were glazed and then overwrapped, are probably not commercially practical, but were included to indicate the degree of protection possible by both glazing and overwrapping, and to provide a standard of quality of shrimp against which other packages could be measured. Another package, B-1-a, in which the shrimp were not glazed and not overwrapped, is also not a commercial pack-

age because of its poor keeping qualities, but it was included to determine the extent of quality degradation which might occur with very poor packaging.

Upon arrival at the laboratory the master shipping containers were weighed, the individual packages were removed and examined, and damaged overwraps were replaced. The latter was necessary only in the case of the cellophane overwraps, as these were the only ones which arrived in a damaged condition. All packages were then transferred to storage at 0°F. (± 1 °F.) after removal of surface ice from the outside of the packages. The freezer used was a Wilson 8' x 12' commercial unit, with refrigeration provided by a Bush blower using Freon 12, at a design temperature of -10°F. Daily temperature records indicated that the temperature of the air from the blower was 0°F. ± 1 °F. (the same temperature as that in the entire room). The refrigerator coils were automatically defrosted once a day for thirty minutes, with a maximum air temperature in the room of approximately 5°F. The packages were arranged on racks out of the direct air blast, with free air circulation on all sides of each package.

After three days holding period at zero, four packages for each type shrimp and package construction were weighed to 0.1 gram to determine the initial package weight. All weighings were made inside the zero room. One set of packages was then reweighed and removed from test after three, six, nine, and twelve months storage. After determining the package weight loss, the cartons were opened, and the shrimp were examined visually for amount and location of the desiccation.

The five pound packages of shrimp, after observation of desiccation, were defrosted as rapidly as possible under running tap water at about 50°F. The surface shrimp, which suffered the most extreme damage according to visual observation, were isolated for the taste tests. These shrimp were peeled, veined and washed. The shrimp for taste tests were cooked under controlled conditions. One pound of cleaned shrimp was placed in one gallon of boiling water. When the water came to the second boil, the shrimp were removed from the water, drained, and chilled in cold water. The total time in hot or boiling water was about three minutes. The boiled shrimp, identified only by code number, were tasted by a trained panel of five persons. Observations of color, taste, texture, and off-flavor were recorded.

The taste panel consisted of a group of typical mid-westerners who were not particularly familiar with shrimp at the start of the test. They were familiar with panel testing of many other foods, particularly frozen meats, poultry, and fish. The taste panel was trained during the initial period of storage (zero time in months) using shrimp from extra five pound test packages. The cooking procedure was decided upon only after a series of trial cooks were made in which the ratio of shrimp to water, salt in water, and cooking time were varied. The final procedure, without salt, was believed to give fairly reproducible results, without interference to shrimp taste or texture.

The condition of the master shipping containers and individual cartons upon arrival at the laboratory was as follows:

1. The ten glazed packages within the master carton were frozen together as a result of leakage of water from inversion of the cartons after glazing. These cartons had to be forced apart prior to testing.
2. All of the glazed shrimp packages had a heavy layer of ice on the outer surface of the carton. This was removed before the storage tests.

3. The cellophane overwraps were generally severely damaged in shipment, and many had to be replaced prior to testing. The Tyton overwrapped packages arrived intact.
4. The master shippers, each containing ten five pound shrimp packages, were weighed upon arrival to determine the difference in the weight of shippers with unglazed and glazed shrimp. Two cartons of Louisiana shrimp with a glaze weighed 70 pounds 15 ounces and 71 pounds 5 ounces, while a carton of unglazed shrimp weighed 56 pounds 5 ounces.

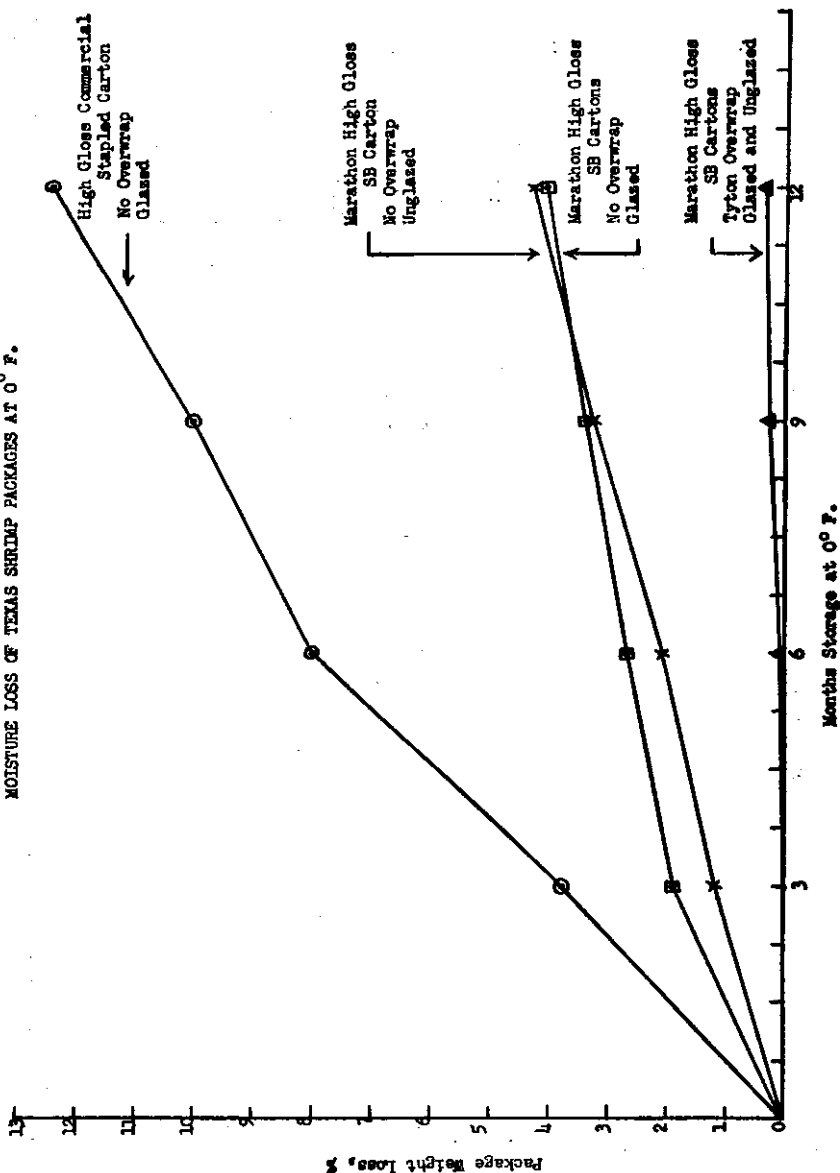
The weight loss of the various types of packages after storage at 0°F. for three, six, nine and twelve months is shown in Table 1.

Table 1
Weight Loss of Five Pound Shrimp Packages After Storage at 0°F.

Type of Pack	Packing Materials	Texas Shrimp			
		3 Mo.	6 Mo.	9 Mo.	12 Mo.
Glazed	1a) Marathon High Gloss SB Carton No Overwrap.	1.9%	2.7%	3.4%	4.1%
	1b) Marathon High Gloss SB Carton Cellophane Overwrap.	0.1	0.1	0.2	0.1
	1c) Marathon High Gloss SB Carton Tyton Overwrap.	0.0	0.1	0.1	0.3
	2a) Commercial Stapled High Gloss Carton No Overwrap.	3.8	8.0	10.0	12.4
Unglazed	1a) Marathon High Gloss SB Carton No Overwrap.	1.2	2.1	3.3	4.3
	1b) Marathon High Gloss SB Carton Cellophane Overwrap.	0.2	0.2	0.2	0.2
	1c) Marathon High Gloss SB Carton Tyton Overwrap.	0.0	0.1	0.3	0.4
Type of Pack	Packing Materials	Louisiana Shrimp			
		3 Mo.	6 Mo.	9 Mo.	12 Mo.
Glazed	1a) Marathon High Gloss SB Carton No Overwrap.	1.9%	4.0%	5.9%	6.4%
	1b) Marathon High Gloss SB Carton Cellophane Overwrap.	0.0	0.0	0.4	0.3
	1c) Marathon High Gloss SB Carton Tyton Overwrap.	0.1	0.2	0.4	0.6
	2a) Commercial Stapled High Gloss Carton No Overwrap.	2.1	6.0	6.5	12.2
Unglazed	1a) Marathon High Gloss SB Carton No Overwrap.	2.0	5.2	4.3	7.0
	1b) Marathon High Gloss SB Carton Cellophane Overwrap.	0.1	0.0	0.1	0.2
	1c) Marathon High Gloss SB Carton Tyton Overwrap.	0.0	0.3	0.3	0.2

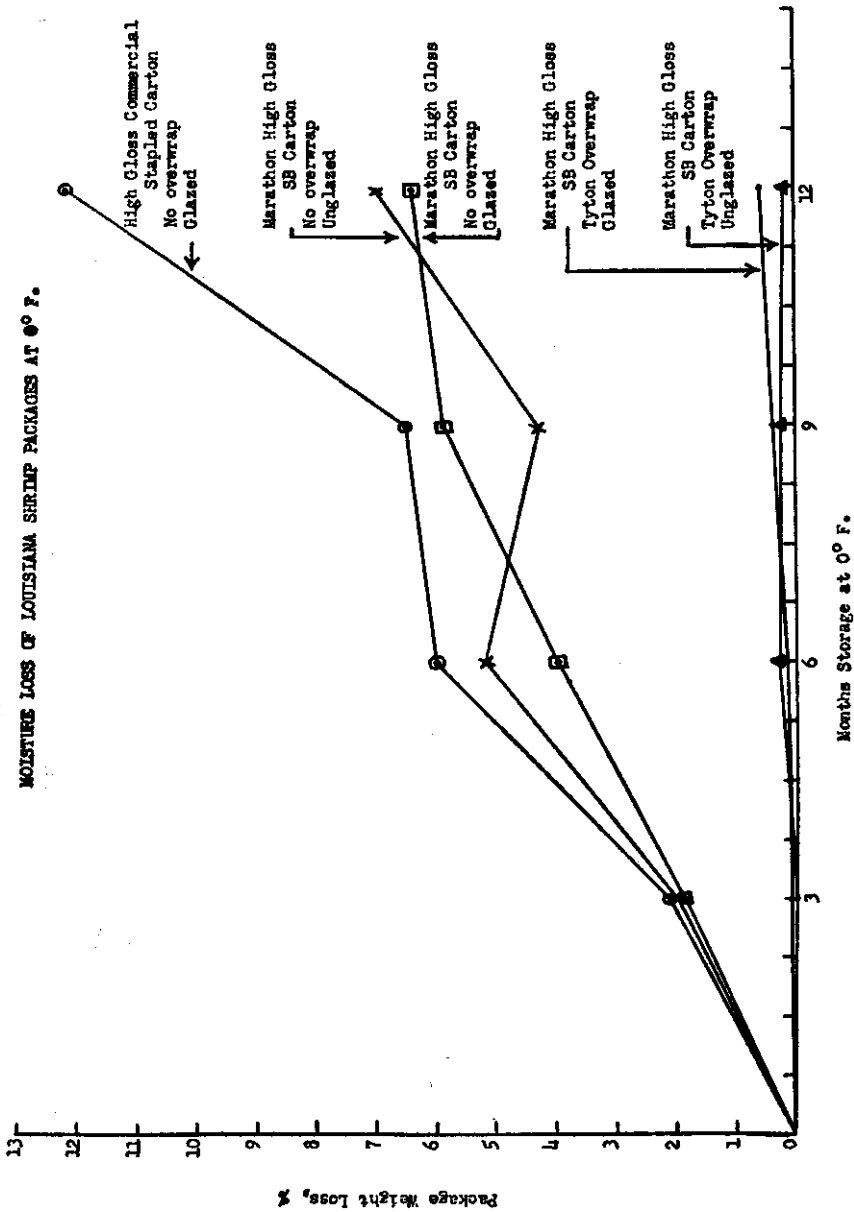
Figure No. 1

MOISTURE LOSS OF TEXAS SHRIMP PACKAGES AT 0° F.



The weight losses were on the basis of the total package weight, which included shrimp, glazing water (if any), carton and overwrap, if any. It was impractical to determine moisture loss on the shrimp alone because of the glazing water. The moisture loss data are plotted in Figures 1 and 2. The difference in protection obtained on the two sets of samples was probably due to differences in carton construction and in the amount of glazing (Louisiana glazing was heavier.)

Figure No. 2



C. One of the increasingly important factors in packaging of frozen foods is the visual appearance of the product to the housewife. As the use of frozen foods, and particularly of household freezers, becomes widespread, more and more people are learning the significance of "freezer burn", or loss of moisture (desiccation) of frozen foods. Therefore, close observations were

made of the visual appearance of the shrimp in the various packaging combinations.

At three months the glazed packages were still in good condition with only slight desiccation. Shrimp in the overwrapped packages were in excellent condition. After six, nine, and twelve months the shrimp in the stapled commercial carton were badly desiccated, with the glaze partially evaporated. The packages of Louisiana shrimp were less affected than the Texas shrimp, presumably because of the heavier glaze on the former. The overwrapped packages were all in excellent condition, with slight desiccation only on a few surface shrimp and at the corners. The visual observations of desiccation and loss of glaze correlated exactly with the weight losses (Table 1, and Figures 1 and 2).

The top surface of the shrimp in the present commercial package showed a noticeable loss of glaze and desiccation after twelve months of storage. By comparison, the unglazed shrimp packaged in a Tyton overwrapped carton showed only slight surface desiccation after a similar period of time.

The length of time required to defrost five pounds of frozen shrimp under running water (50°F.) is shown in Table 2 for glazed and unglazed samples. The data show that elimination of the ice glaze considerably reduced the

Table No. 2
Defrosting Time of Five Pound Packages of Frozen Shrimp
Using Running Water At 50°F.

Type Pack	Defrosting Time (minutes)
Texas brown shrimp, glazed	45
Texas brown shrimp, not glazed	20
Louisiana white shrimp, glazed	70
Louisiana white shrimp, not glazed	45

defrosting time. The difference between the thawing times of Texas and Louisiana shrimp was probably due to the variation in the amount of ice glaze on the two sets of packages, since the Louisiana shrimp had a heavier glaze.

E. The taste tests on shrimp newly shipped from the Gulf indicated that both Texas and Louisiana shrimp were tender, sweet, juicy, and of mild flavor. There was a definite difference in both flavor and texture of the brown and white shrimp, which was attributed to the difference in species and size.

At three months there was little change in any of the shrimp, by taste and texture comparison. At six, nine, and twelve months the shrimp in cartons which had suffered high moisture loss were slightly tough and less juicy than the freshly frozen shrimp, but there was no off-flavor development, either from oxidation or other cause.

At twelve months both glazed and unglazed shrimp from overwrapped packages were tender and juicy with good flavor, however, there was a slight loss of sweetness in all shrimp. Using blindfold tests, the panel was unable to distinguish between glazed and unglazed shrimp packaged with an over-wrap.

The following conclusions have been reached in this study:

1. Unglazed shrimp can be packed successfully for twelve months storage at 0°F., in a high gloss waxed carton with a satisfactory overwrap. Glazing is not necessary for protection.
2. "Tyton" waxed paper overwrap was as good as the cellophane overwrap from a protective standpoint. The cellophane overwraps were badly damaged during shipment of finished packages whereas the Tyton overwraps withstood shipment without damage.
3. Taste testers could not distinguish between glazed and unglazed shrimp from overwrapped packages. These shrimp were tender and juicy with good flavor, although there was a slight loss of sweetness at 12 months. Glazed and unglazed shrimp from packages without overwrap were slightly tough, with no off-flavor. The texture change appeared to be the main adverse factor resulting from loss of moisture.
4. Elimination of glazing reduced the defrosting time of a five pound frozen shrimp block approximately 36 to 55 per cent.
5. The shipping weight of a corrugated fiber board box, containing ten five-pound packages of frozen shrimp, was reduced fifteen pounds (approximately 21 per cent) by elimination of the glazing process.
6. Glazed shrimp, packaged without an overwrap, showed high weight losses, disappearance of ice glaze, and desiccation of surface shrimp.
7. When tested without overwraps, Marathon shrimp cartons provided considerably more protection for glazed shrimp than the present commercial, stapled cartons.

The laboratory test results have been confirmed by the experience of a number of shrimp packers who have completely converted their packaging line to handle unglazed shrimp in a carton-overwrap combination.

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Comparison of Objective Tests for Quality of Fresh and Frozen Gulf Shrimp

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The goal of the food technologist has been the development of simple rapid objective tests for evaluating the quality of both fresh and frozen foods. In