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STORAGE LIFE OF PINK SHRIMP HELD IN COMMERCIAL AND JACKETED COLD-STORAGE ROOMS

By John A. Peters* and Daniel T. McLane**

ABSTRACT

Tests were conducted to determine the frozen storage life of pink shrimp held at 0° F to -5° F. in a commercial-type cold-storage room and in a jacketed cold-storage room. Use of the jacketed storage room resulted in a significant extension of the storage life.

INTRODUCTION

Information on the keeping quality of frozen shrimp is needed by industry for the establishment of inventory and marketing practices that will enable it to supply the consumer with products of uniformly high quality. This information is also required in developing standards and specifications for government purchases of this product.

One problem in the storage of frozen foods, including frozen pink shrimp (Penaeus duorarum), is that of dehydration. During frozen storage, moisture tends to sublime from the food and to condense on the surface of the evaporator coils in the cold-storage room. Over a period of time, the product may lose so much moisture in this manner as to become unpalatable.

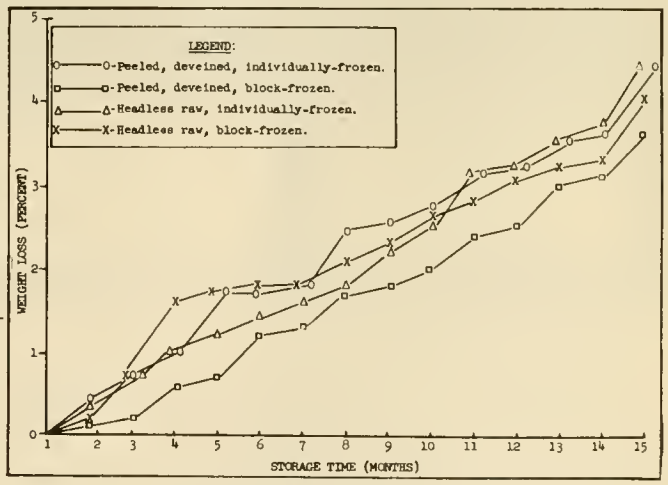

Fig. 1 - Average percentage weight loss in commercial packages of shrimp stored at 0° to -5° F. in a commercial-type cold-storage room.

Several approaches have been proposed for the solution of this problem. Among these are (1) to use glazes on unpackaged products, (2) to use packaging materials having very low moisture vapor transmission rates, or (3) to increase the relative humidity of the air in the storage room. The relative humidity can be most easily increased by enlarging the area of the surfaces used to cool the room. In a jacketed type of cold-storage room maximum cooling surface area is provided by cold air circulating through an enclosed jacket which completely surrounds the product storage space (Young 1952; Lentz 1955; Butler, Slavin, Patashnik, and Sanford 1956; Slavin, Peters, and Pottinger 1958). This provides a high relative humidity, and sublimation of moisture from the food thus is minimized.

The practice of industry now is to hold shrimp at 0° F. to -5° F. The objective of the present study therefore was to determine the keeping quality, at these tem-

* Chemist
** Fishery Aid
Fishery Technological Laboratory, Division of Industrial Research and Services, U. S. Bureau of Commercial Fisheries, East Boston 28, Mass.

peratures, of commercial packages of pink shrimp held in a commercial-type frozen-storage room and of those held in a jacketed one.

SAMPLES STORED IN A COMMERCIAL-TYPE STORAGE ROOM

Frozen pink shrimp are marketed in a number of different styles of packs, the principal ones being (1) headless raw shrimp (shells on) and (2) peeled and deveined

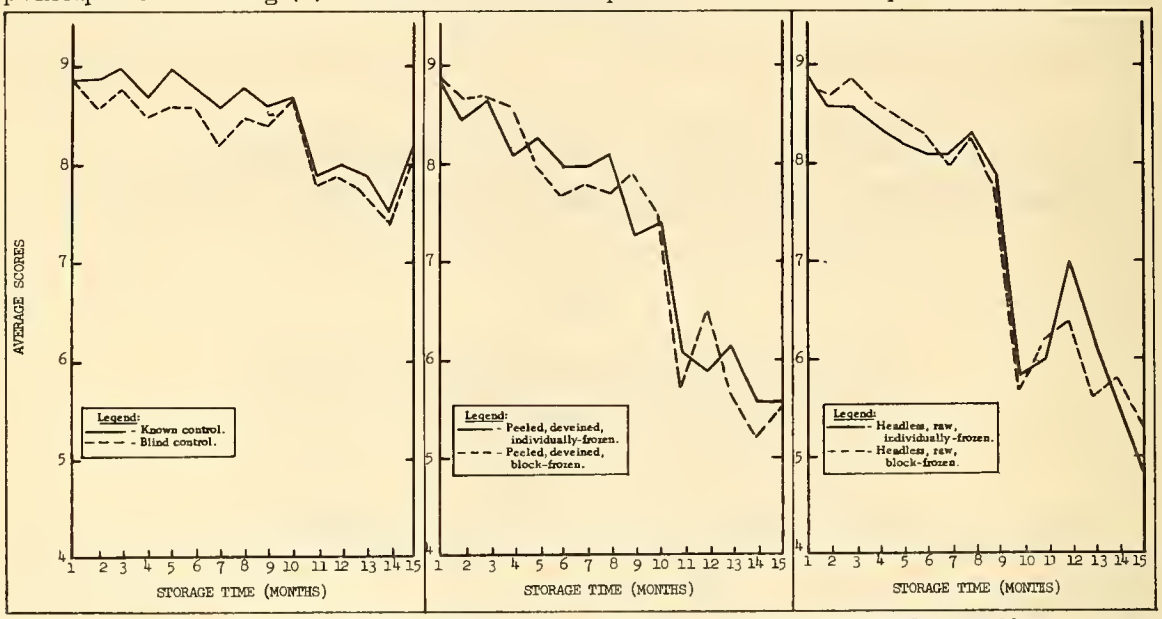

Fig. 2 - Average taste-panel scores for commercial packages of shrimp stored in a commercial-type cold-storage room.

raw shrimp. These shrimp may be frozen and glazed individually or in block form. The individually-frozen shrimp appeal to a large portion of the buyers because any amount of the shrimp thus frozen can be removed from the package without the necessity of thawing the entire contents. In our study of the samples held in the commercial-type storage room, the effect of these variations in pack were investigated.

Two measurements were made. One was a determination of the loss in weight of the packages in storage, and the other was a determination of the change in palatability of the shrimp.

A problem encountered in determining changes in palatability of a food which occur during frozen storage is that of providing a reference sample so that the taste tester can keep in mind how the product tasted originally. Stansby (1955) has suggested the packaging of fishery products in hermetically-sealed tins as a method of preserving the original palatability. In the preparation and storage of control samples for use in the present experiment, advantage was taken of this and of the fact that frozen foods change least when held at very low temperatures.

The details of the experiments and the results are given in the following subsections.

PREPARATION OF SAMPLES: The shrimp used in this study were packed using typical commercial packaging materials and were frozen in a modern shrimp plant in Tampa, Fla., under the supervision of a member of the Laboratory.

The individually-frozen samples consisted of peeled and deveined or headless raw shrimp that were frozen on trays in a blast freezer, glazed by dipping in fresh water, and packed in $2\frac{1}{2}$-pound-size one-piece waxed paperboard cartons. These

cartons were overwrapped with waxed, opaque, bleached sulfite paper. The block-frozen samples consisted of peeled and deveined or headless raw shrimp that were packed in 2½-pound-size one-piece waxed paperboard cartons. Water was then added; the cartons were overwrapped with waxed, opaque, bleached sulfite paper; and the packaged shrimp were frozen in a blast freezer. The packages of individually-frozen and block-frozen shrimp were stored for several days at 0° F. in the processing plant. They were then packed with dry ice in insulated shipping containers and sent to the laboratory at East Boston by air freight. The samples were still solidly frozen when received at the Laboratory, where they were removed from the shipping containers and put in storage at 0° F. to -5° F.

A control sample was prepared by repacking some of the headless raw individually-frozen and glazed shrimp from the original cartons into No. 10 C-enamel cans. The cans of shrimp were filled with fresh water (cooled to 35° F.), sealed under 27 inches of vacuum, and frozen to -25° F. in the Laboratory's blast freezer.

STORAGE OF THE SAMPLES: The control sample was stored at -25° F. The commercial packages of individually-frozen and block-frozen shrimp were stored at 0° F. to -5° F. in a commercial-type cold-storage room with overhead evaporator plates. The relative humidity of this storage area, as measured with an electric hygrometer, varied from 70 to 80 percent. Sufficient samples were put in storage to permit monthly tests for a period of 15 months.

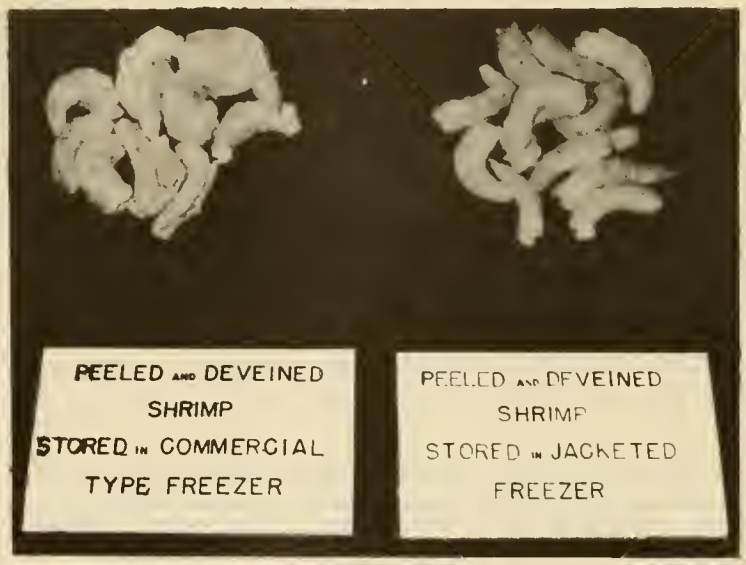

Fig. 3 - Appearance of frozen shrimp stored for 9 months at 0° to -5° F. in a commercial-type freezer and in a jacketed freezer.

WEIGHT-LOSS TESTS: The loss in weight of the package gives a quantitative indication of the amount of dehydration that has taken place. The test can be made with considerable precision.

PROCEDURE: At the beginning of the storage period and each month during the test, the commercial packages of block-frozen and individually-frozen shrimp were weighed in the storage room using a beam balance accurate to 1.0 gram.

RESULTS: The average percentage weight loss of the various samples during 15 months storage is shown in figure 1. Both of the individually-frozen samples showed a weight loss of 4.4-percent; the block-frozen samples showed a 4.0-percent weight loss for the headless raw shrimp and 3.5 percent for the peeled and deveined shrimp. The slightly greater weight loss of the individually-frozen and glazed samples may be due to the larger amount of product surface area that is exposed and the larger amount of air space within the package as compared with the block-frozen samples.

PALATABILITY TESTS: Although palatability tests cannot be made with precision, owing to the human factor, they nevertheless are needed to give a practical interpretation of the weight loss tests. Palatability tests indicate the point where dehydration results in a noticeable change in palatability.

PROCEDURE: Two packages of shrimp from each sample were removed from storage at monthly intervals, examined in the frozen state for dehydration, and then cooked for evaluation by a taste panel comprised of eight members of the laboratory staff. Preliminary taste tests were conducted to acquaint the panel with this product.

Prior to each taste test, the frozen shrimp were thawed in running cold water. The headless raw samples were peeled. Each lot of shrimp then was cooked for 5 minutes in slightly salted boiling water and was cooled in the chill room (35° F.) for serving to the taste panel. At each taste test, four samples were served to the panel. The panel was instructed to compare the quality of three unknown samples with a known -25° F. control sample (known control). As a check on the accuracy of the panel, another of the -25° F. control samples was included as one of the three unknown. This sample was referred to as the blind control. Each sample was scored by the eight taste panel members for appearance, odor, flavor, texture, and over-all quality. The samples were rated by the panel on a scale of excellent, very good, good, fair, borderline, slightly poor, poor, very poor and inedible. In calculating the results, numerical values from 9 = excellent to 1 = inedible were assigned and the gross average score of the five quality factors for each sample was calculated.

Table 1 - Average Taste-Panel Scores on Commercially-Packaged Samples of Shrimp Stored at 0° to -5° F. in a Commercial-Type Cold-Storage Room

Storage Time	Average Taste-Panel Scores 1/					
	Known Control 2/	Blind Control 3/	Peeled, Deveined, Individually Frozen, and Glazed	Peeled, Deveined, Block-Frozen, and Glazed	Headless Raw Individually-Frozen and Glazed	Headless Raw Block-Frozen and Glazed
Months						
1	8.9	8.9	8.9	8.9	8.9	8.9
2	8.9	8.6	8.5	8.7	8.6	8.7
3	4/ 9.0	8.8	8.7	8.7	8.6	8.9
4	8.7	8.5	8.1	8.6	8.4	8.7
5	5/ 9.0	8.6	8.3	8.0	8.2	8.5
6	8.8	8.6	8.0	7.7	8.1	8.3
7	8.6	4/ 8.2	8.0	7.8	8.1	8.0
8	8.8	5/ 8.5	8.1	7.7	8.3	8.3
9	8.6	8.4	7.3	7.9	7.9	7.6
10	8.7	8.7	7.4	7.5	5.8	5.7
11	7.9	7.8	6.1	5.7	6.0	6.2
12	8.0	7.9	5.9	6.5	7.0	6.4
13	7.9	7.7	6.2	5.7	6.2	5.6
14	7.5	7.4	5.6	5.2	5.5	5.8
15	8.2	8.1	5.6	5.5	4.9	5.3

1/ Scores of 9 = excellent, 8.0 - 8.9 = very good, 7.0 - 7.9 = good, 6.0 - 6.9 = fair, 5.0 - 5.9 = borderline (should not be marketed), and 4.0 - 4.9 = slightly poor (unmarketable).
2/ Stored in hermetically-sealed cans at -25° F. Taste panel was informed of the identity of this sample.
3/ Same as known control but identity was not revealed to taste panel.
4/ Preference became significant at 5-percent level of probability.
5/ Preference became significant at 1-percent level of probability.

RESULTS: The average taste-panel scores for the various samples are given in table 1. In figure 2 these data are plotted to show the trend of the loss in quality of the shrimp during frozen storage. The curves show a gradual decrease in quality of the commercial samples of shrimp during the first 9 months of frozen storage followed by a much faster rate of quality loss after this point.

Application of the rank test for significance of differences (Kramer 1956) to the average scores given by the taste panel to the various samples shows that (1) the preference for the known-control samples over the commercial samples became significant at the 5-percent level of probability after 3 months of frozen storage and at the 1-percent level of probability after 5 months and that (2) the preference for the blind control sample over the commercial samples became significant at the 5-percent level of probability after 7 months of frozen storage and at the 1-percent level of probability after 8 months. These results indicate that no appreciable difference existed between the control samples stored at -25° F. and the commercial samples stored at 0° F. to -5° F. until after the seventh or eighth month of frozen storage because the taste panel was unable to distinguish, with statistical significance, the quality difference between the blind control and the commercial samples until after that period of storage had elapsed.

The marked change in taste-panel scores after the ninth month of frozen storage corresponds to the development of excessive dehydration of the shrimp in the commercial packages. At this time, the commercial samples of block-frozen and individually-frozen shrimp were considered to be of unmarketable quality because of their very poor appearance. It was found, however, that the dehydrated shrimp rehydrated to such an extent during water thawing and cooking that they were acceptable to the taste panel.

The control samples stored at -25° F. in hermetically-sealed containers showed an increase in rate of quality loss after 10 months of frozen storage but were still of good-to-very-good quality at the fifteenth month of frozen storage (the end of the test). Packaging shrimp in a hermetically-sealed container and storing them at a temperature of -25° F. therefore resulted in at least a 6 months increase in keeping quality over that of commercially-packaged shrimp stored at 0° to -5° F.

Table 2 - Average Taste-Panel Scores on Commercially-Packaged Samples of Shrimp Stored at 0° to -5° F. in a Jacketed Storage Room or Commercial-Type Still-Air Storage Room

Storage Time	Known Control[2]	Blind Control[3]	Average Taste-Panel Scores[1] on Samples of Peeled, Deveined, Individually-Frozen and Glazed Shrimp Stored at 0° to 5° F. in	
			Jacketed Storage Room	Commercial-Type Storage Room
Months				
9	8.6	8.4	[4]8.1	7.3
12	8.0	7.9	[5]7.6	5.9

1/Scores of 9 = excellent, 8.0 - 8.9 = very good, 7.0 - 7.9 = good, 6.0 - 6.9 = fair, 5.0 - 5.9 = borderline (should not be marketed), and 4.0 - 4.9 = slightly poor (unmarketable).
2/Stored in hermetically-sealed cans at -25° F. Taste panel was informed of the identity of this sample.
3/Same as known control but identity was not revealed to taste panel.
4/Preference over sample stored in commercial-type storage room is not significant.
5/Preference over sample stored in commercial-type storage room is significant at 1-percent level of probability.

CONCLUSIONS: (1) The average weight loss of commercial packages of pink shrimp stored in a commercial-type cold-storage room at 0° to -5° F. was from 1.8 to 2.5 percent after 9 months and from 3.6 to 4.4 percent after 15 months. Slightly higher losses occurred in the individually-frozen and glazed samples.

(2) Commercial samples of peeled and deveined or headless raw pink shrimp, frozen individually or in block form, were of unacceptable quality after 9 months of 0° to -5° F. storage in a commercial-type cold-storage room because of excessive dehydration.

(3) No significant differences in storage life were attributed to the style of pack employed in the commercial samples of peeled and deveined or headless raw pink shrimp that were frozen individually or in block form.

(4) Pink shrimp packed in hermetically-sealed containers and stored at -25° F. were of good quality for at least 6 months longer than were pink shrimp that were packed in commercial packages and stored at 0° to -5° F. in a commercial-type cold-storage room.

SAMPLES STORED IN A JACKETED STORAGE ROOM

Owing to the tendency of taste testers to become fatigued quickly, the number of samples in the over-all experiment had to be kept small. It therefore was decided to limit the studies concerning the jacketed storage room to the use of peeled, deveined, individually-frozen pink shrimp--this being the product likely to show the greatest change.

The samples used in this phase of the study were part of the lot of commercial packages of peeled and deveined, individually-frozen pink shrimp described previously in the section on samples stored in a commercial-type cold-storage room. The control sample was also the same as the one described in that phase of the test.

STORAGE OF THE SAMPLES: The packages of frozen shrimp were put in storage at 0° to -5° F. in a jacketed cold-storage room. The design of this type of

room provides high humidity in the storage area, which in this instance was found to be between 90 and 95 percent (Slavin, Peters, and Pottinger 1958).

PALATABILITY TEST: Procedures: After 9 and 12 months of frozen storage in the jacketed room, samples of the peeled and deveined, individually-frozen shrimp were removed from storage, examined for dehydration, and then prepared in the manner described in phase 1 of this study for serving to the taste panel. At the same time, samples of the known control, blind control, and peeled and deveined, individually-frozen shrimp from the commercial-type storage room were served for comparison.

RESULTS: Examination of the samples of shrimp from the jacketed storage room after 9 and 12 months of frozen storage showed no significant dehydration compared with excessive dehydration of similar samples stored at the same temperature in the commercial-type cold-storage room (fig. 3).

The results of taste-panel tests comparing the quality of the shrimp after 9 and 12 months of storage in the commercial-type storage room and after the same length of time in the jacketed storage room are shown in table 2. The scores for the shrimp stored in the jacketed storage room are significantly higher than those for the shrimp stored for the same period of time and at the same temperature in the commercial-type storage room. It is therefore apparent that the packaging materials used were inadequate to prevent dehydration and to maintain high quality for longer than 9 months under ordinary commercial storage conditions. Even with the use of this package, however, high quality was maintained for at least 12 months by storing the shrimp in a high-humidity storage room, where dehydration was at a minimum.

CONCLUSION: Commercial samples of pink shrimp stored at 0° to -5° F. in a high-humidity jacketed storage room were of good quality for at least 3 months longer than were similar samples stored at the same temperature in the commercial-type cold-storage room.

SUMMARY

One approach to the solution of the problem of dehydration in frozen foods is the use of a jacketed freezer which maintains a high relative humidity in the product storage area. In the present study, both a commercial cold-storage room, with a relative humidity of 70 to 80 percent, and a jacketed cold-storage room, with a relative humidity of 90 to 95 percent, were used. The effect of dehydration was determined by measurement of loss of weight and loss of palatability.

In the use of the commercial storage room, the keeping quality at temperatures of 0° to -5° F. of commercial packages of pink shrimp that had been prepared in the following manner was studied: (1) peeled and deveined and (a) frozen individually or (b) frozen in block form and (2) headless raw and (a) frozen individually or (b) frozen in block form. For control, samples hermetically sealed in tin cans and held at -25° F. were used. It was found that with the commercial pack, the loss in weight was 1.8 to 2.5 percent after 9 months and 3.6 to 4.4 percent after 15 months. Owing to dehydration, the shrimp stored for 9 months or longer were of unacceptable quality. No differences in storage life were attributed to the style of pack. The control samples packed in hermetically-sealed containers and held at -25° F., however, were of good quality for 6 months longer than were the commercial samples.

In the use of the jacketed storage room, the keeping quality at temperatures of 0° to -5° F. of commercial packages of the peeled and deveined, individually-frozen pink shrimp were studied. It was found that these shrimp were of good quality for at least 3 months longer than were similar samples stored at the same temperature in the commercial cold-storage room.

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ELECTRICAL FISH DIVERSION SCREEN IN ENGLAND

To reduce the annual kill of sea trout and salmon, an electric screen has been installed about 1 mile above the Low Wood Power Station on the River Leven.

Designed for use in a normal water depth of 2.5 feet and also when tidal influence raised the water level below the turbines to 7 feet, the screen is a steel bridge from which are hung sixty 2-inch steel tubes graded to the river banks and bottom and loaded with 3-phase alternating current at 25 volts per phase at 50 cycles. The current consumption of each phase is about 1.5 amperes at low water, 2.3 amperes at high water; thus the total consumption is from 4.5 to 6.9 amperes.

In tests of the installation, salmon kelts in wood boxes seemed comfortable 5 feet downstream from the screen but were uncomfortable when put within 3 feet of it.

Brown trout (0.75-inch), used in tests to study the effect on migrating smolts, were uncomfortable within 9 inches of the screen. A 15-second stay between electrodes immobilized the fish; they recovered in 15 seconds after removal from the field. Held between electrodes for 1 minute, they did not recover. When freed upstream of the screen to be taken through it by the flow, many were killed, sinking quickly beneath the electrodes.

This first 3-phase alternating-current screen of its type to be set on any river in the country was installed with the cooperation of Mr. Hartley of the Ministry of Agriculture, Fisheries and Food. (L. Steward, Fisheries Officer, Lancashire River Board (The Progressive Fish-Culturist, July 1959), Lancaster, England.)