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PROCESSING AND QUALITY STUDIES OF SHRIMP HELD IN REFRIGERATED SEA WATER AND ICE

Part 1 - Preliminary Observations on Machine-Peeling Characteristics and Product Quality

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ABSTRACT

Preliminary information is given on (1) the peeling characteristics of shrimp held in refrigerated sea water, (2) the leaching effect on shrimp of the washing action of the machine peeler, and (3) the effect of certain holding and processing variables on the quality of the canned product.

BACKGROUND

Two processors at Wrangell, Alaska, installed mechanical peelers in the winter of 1957-58, thus introducing to Alaska a mechanized process for shrimp canning. Along with these developments, industry expressed interest in the refrigerated-sea water system as a method for holding the shrimp prior to processing.

Considerable literature is available detailing the characteristics of the refrigerated-sea water system for holding fish. This generally indicates that there are considerable advantages inherent in the system for certain fish. However, only limited information (Higman and Idyll 1952; Higman, Idyll, and Thompson 1953; Roach and Harrison 1954) has been published on the holding of shrimp.

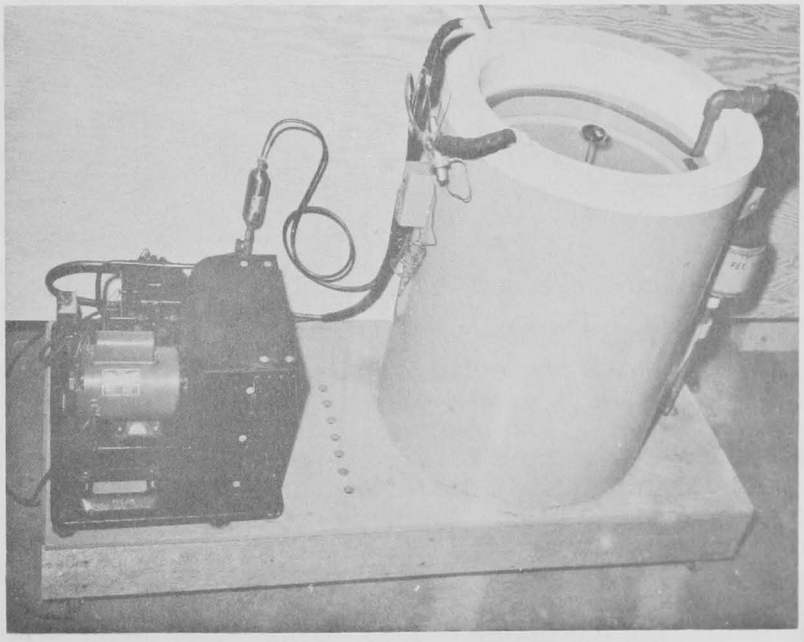

Fig. 1 - Portable laboratory refrigerated-sea water unit.

The literature indicates that the advantages of the system for holding shrimp may include (1) a greater freedom at sea to fish more distant grounds, (2) less crushing and breakage, (3)

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reduced labor costs, both on the vessel and at the plant, and (4) a safety factor to the plant operation in that a more consistent and economical processing schedule can be maintained. Before the potential advantages of the system could be evaluated, it was first necessary to determine whether shrimp held in refrigerated sea water would mechanically peel satisfactorily, since no large-scale production of the small shrimp is feasible in Alaska without the aid of the mechanical peeler.

The primary objective of the work reported here was to investigate the peeling characteristics of pink shrimp held in refrigerated sea water. Secondary objectives were to make a preliminary study of (1) the changes in the composition of the shrimp due to the leaching action of the water used in machine peeling and (2) the effect of refrigerated sea water on black discoloration of the canned shrimp.

PEELING CHARACTERISTICS

In the investigation of peeling characteristics, tests were carried out using a portable laboratory refrigerated-sea water unit in a commercial processing plant in Wrangell.

EQUIPMENT AND METHOD OF PROCESSING: In this subsection, refrigerated sea water is defined, and the tank that was used for holding the refrigerated sea water, the machine for peeling the shrimp, and the method of processing them are described. The normal plant procedure for holding the shrimp in ice is also given.

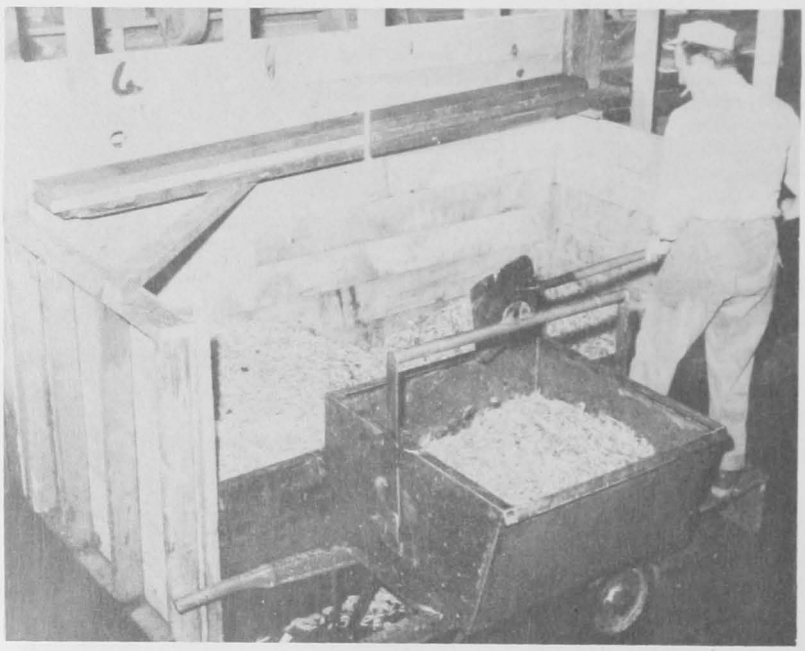

Fig. 2 - Shrimp being removed from an aging bin prior to machine-peeling.

Refrigerated Sea Water: Refrigerated sea water is a watery solution for holding fish or shellfish at about 30° F. It consists of a water-cooling medium, a tank to hold it, and a source of refrigeration. Since "refrigerated sea water" has been applied to several variations, the standard system and holding conditions described in this and subsequent papers is defined as follows: Refrigerated sea water (RSW) is the system in which an artifically-prepared solution of 3-percent (by weight) sodium chloride (canner's grade) dissolved in potable water is held in a tank constructed of an inert material and maintained at 30° ± 1° F. by means of mechanical refrigeration, suitable circulation of brine, and suitable insulation. Shrimp is held at a 1 to 1 ratio of shrimp to brine unless otherwise indicated. This ratio is optimum for shrimp in that it allows the brine to submerge the shrimp and only enough excess for proper circulation.

Holding Tank: The portable laboratory holding tank used (fig. 1) was constructed by coating the inside of a 55-gallon steel drum with white Fiberglass-Fiberlay. Copper tubing (100 feet in length and $\frac{1}{2}$ inch in diameter) was tightly wrapped on the outside of the drum and sealed to it with a thermomastic. The drum was then insulated with 3 inches of glass wool and covered with sheet metal. The refrigeration was supplied by a $\frac{3}{4}$-horsepower compressor with Freon 12 passing through an

expansion valve. The brine was circulated from the bottom center of the drum (false bottom with screened outlet) in polyvinylchloride pipe ($\frac{3}{4}$ inch in diameter) through a 1/8-horsepower magnetic circulator and back into the top of the drum through a perforated peripheral spreader pipe located just under the surface of the brine. The unit had a working capacity of 200 pounds of refrigerated sea water and 200 pounds of shrimp.

Fig. 3 - Shrimp in the process of being machine-peeled.

Icing Procedure: The shrimp are normally unloaded at the plant on the same day that they are caught. For optimum machine-peeling, such shrimp require a controlled aging period to release the meats from the shells prior to peeling. Aging is accomplished by layering the shrimp with flake ice in 4 by 8 foot wooden bins to a depth of about 3 feet. After 40 to 48 hours, the shrimp are transferred from the bins to the machine peeler.

Peeling Machine: The particular peeling machine used was a Model A peeler manufactured by the Peelers Company.

Processing: After the shrimp were machine-peeled, the meats dropped onto a continuous stainless-steel woven belt and passed through a covered steam box for 90 seconds. The meats, after being given this precook, passed through a rotating tunnel blower, where loose shell was removed, and onto a table for final inspection prior to seaming and retorting.

EXPERIMENTAL PROCEDURE AND RESULTS: Pink shrimp (Pandalus sp.) were used, since they are the species that make up the bulk of the shrimp that are machine-peeled in Alaska. In this study on machine peeling, three experiments were performed.

Experiment 1: Three hours after being caught 200 pounds of pink shrimp were placed in refrigerated sea water and held for 18 hours. These shrimp, although of excellent quality and easily peeled by hand, did not peel properly by machine, since the shells had not released from the meats sufficiently.

Experiment 2: The shrimp were held in refrigerated sea water for 40 hours. After this length of time, the shrimp were still of excellent quality, were easily peeled by hand, and were peeled satisfactorily by machine.

Experiment 3: The shrimp were held for 40 hours in 6-percent brine (Roach and Harrison 1954). Although these shrimp did not appear to be markedly different from those in the previous run, the operator of the machine found that the shrimp peeled slightly better. It was his opinion that shrimp held for 40 hours in either refrigerated sea water (as defined here) or in 6-percent brine would peel satisfactorily in the machine given enough shrimp to adjust the machine properly.

LEACHING ON PEELER

Since the shrimp were sprayed with a large volume of water during the peeling operation (fig. 3), it was of interest to determine the extent of leaching of certain soluble constituents under these conditions. For this study, (1) fresh hand-peeled shrimp, (2) shrimp held in refrigerated sea water for 40 hours and then hand-peeled, and (3) shrimp held in refrigerated sea water for 40 hours and then machine-peeled were frozen for later analysis. These analyses were for total chloride, total nitrogen (Association of Official Agricultural Chemists 1955), and total volatile base (Stansby, Harrison, Dassow, and Sater 1944).

Table 1 - Change in Certain Shrimp Constituents as a Result of Holding Shrimp in Refrigerated Sea Water (RSW) and Peeling Them by Machine

Treatment of Sample	Total Chloride Content	Total Volatile Base	Total Nitrogen Content
	As % NaCl	Mg.N/100 g.	Percent
Fresh, hand-peeled shrimp . . .	0.5	-	-
Shrimp held 40 hrs. in RSW then hand-peeled	1.4	7.2	3.0
Shrimp held 40 hrs. in RSW then machine-peeled	0.7	6.3	2.6

The data are shown in table 1. They indicate that leaching did occur when shrimp were machine-peeled. As can be noted from the table, for example, most of the salt that was absorbed when the shrimp were held in refrigerated sea water for 40 hours was leached out during the subsequent peeling operation. Both the total volatile base and the total nitrogen content also decreased as a result of machine-peeling.1/

BLACK DISCOLORATION

The black discoloration of canned shrimp has been a problem of long standing. It is generally accepted that the use of poor-quality shrimp will result in a discolored product. From the published literature on the use of refrigerated sea water for the holding of fish, it was expected that shrimp so held would be of better raw quality than when held in ice (time of holding being the same). It also seemed possible that discoloration might be less for shrimp held in refrigerated sea water. Therefore, preliminary tests were carried out during the peeling experiments, previously described, in order to determine the relative effect that aging in ice or aging in refrigerated sea water would have on black discoloration.

In these experiments, shrimp held either in ice (the normal plant procedure) or refrigerated sea water were processed both with the addition of citric acid prior to retorting, which was the normal plant procedure, and without the addition of citric acid but with the addition of brine. The acid, if used, was added by flooding the cans, prior to seaming, with 4.8-percent sodium chloride brine containing 0.36-percent citric acid. All cans were then stored at room temperature and subsequently examined at various intervals up to 7 months.

The darkening characteristics for the cans processed without citric acid are arranged in order of increasing tendency to darken as follows:

1/ It might be argued that the data are artifacts caused by moisture uptake rather than a true leaching. Moisture, of course, is absorbed by the meats, but if the "loss of constituents" is caused only by moisture uptake, then the ratios of the initial to the final values of the three analyses would be constant and equal to each other. Since this was not the case, leaching must also have occurred.

Holding Conditions	Relative Darkening
Iced shrimp, 40 hours aging, good quality	very slightly dark
RSW shrimp, 18 hours aging, 3-percent brine, good quality	slightly dark
RSW shrimp, 40 hours aging, 3-percent brine, good quality	moderately dark
RSW shrimp, 40 hours aging, 6-percent brine, good quality	moderately dark
Iced shrimp, 40 hours aging poor quality	very dark

In the samples processed with the addition of citric acid, the acid prevented darkening except for one ice-held sample that was of borderline freshness.

QUALITY

Although observations in the course of the present work indicated that holding shrimp in refrigerated sea water yielded a product of satisfactory quality, the work was carried out under favorable conditions that may not always be obtainable. Quantitative data are therefore needed regarding the effect of holding and processing variables before the relative usefulness of refrigerated sea water can be evaluated for Alaska shrimp. Accordingly, data on such factors will be presented in subsequent reports in this series of articles.

CONCLUSIONS

1. Pink shrimp machine-peeled satisfactorily after being held 40 hours in refrigerated sea water containing either 3-percent or 6-percent brine.

2. Salt, total volatile base, and total nitrogen contents of the shrimp were reduced by the leaching action of water during machine-peeling.

3. When shrimp were canned without the addition of citric acid, black discoloration increased with (1) loss in quality of ice-held shrimp, (2) time of holding in refrigerated sea water, and (3) increased brine concentration. Adding citric acid prevented darkening except for one ice-held sample of borderline freshness.

4. Before the relative usefulness of the refrigerated-sea water system can be evaluated for Alaska shrimp, quantitative data are needed regarding the quality of the product as affected by holding and processing variables.

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LITERATURE CITED

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS
1955. Official Methods of Analysis. Eighth Edition, 1955, Association of Official Agricultural Chemists, P. O. Box 540, Benjamin Franklin Station, Washington 4, D. C., Analyses numbers: 2.22, 2.23; and 18.7 respectively.

HIGMAN, J. B.; and IDYLL, C. P.
1952. Holding Shrimp in Refrigerated Sea Water. Proceedings, Gulf and Caribbean Fisheries Institute, 5th Annual Session, pp. 41-53.

_____; _____; and THOMPSON, J.
1953. Further Experiments in Holding of Fresh Shrimp in Refrigerated Sea Water and Ice. Proceedings Gulf and Caribbean Fisheries Institute, 6th Annual Session, pp. 114-121.

ROACH, S. W.; and HARRISON, J. S. M.
1954. Use of Chilled Sea Water and Dilute Brines in Place of Ice for Holding Shrimp Aboard a Fishing Vessel. Fisheries Research Board of Canada, Progress Reports of the Pacific Coast Stations, no. 98, pp. 23-24.

STANSBY, M. E.; HARRISON, R. W.; DASSOW, J.; and SATER, M.
1944. Determining Volatile Bases in Fish. Industrial and Engineering Chemistry, Analytical Edition, vol. 16, no. 9 (September), pp. 593-596.

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