# FREEZING AND COLD STORAGE OF PACIFIC NORTHWEST FISH AND SHELLFISH

## PART II - KING CRAB

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ABSTRACT

VARIOUS METHODS OF PACKAGING ALASKAN KING-CRAB MEAT WERE STUDIED TO DETERMINE PROCEDURES THAT WOULD YIELD MAXIMUM FROZEN-STORAGE LIFE OF THE MEAT. THE RESULTS INDICATE THAT FROZEN KING-CRAB MEAT CAN BE STORED SATISFACTORILY AT 0° F. FOR AS LONG AS ONE YEAR IF PACKAGED IN HERMETICALLY SEALED TIN CONTAINERS OR NINE MONTHS IF PACKAGED IN (MSAT) CELLOPHANE.

## BACKGROUND

King crab (Paralithodes camtschatica) were caught and processed by the Japanese and the Russians as long ago as the early nineteen hundreds, but were not handled in commercial quantities by United States fishermen until the past few years. In 1941 the U. S. Fish and Wildlife Service conducted exploratory fishing to determine where in Alaskan waters the king crab could be caught in commercial quantities. Application of these findings by the American fishing industry was delayed by World War II, but since 1945 a number of concerns have entered actively into the field. Nearly all the American-caught and processed king crab has been frozen rather than canned, which is the reverse of the practice of the Japanese and the Russian packers. Production of canned crab meat requires a larger crew of workers and more equipment aboard the crab-processing ship than does the processing of frozen crab.

Until recently (Dassow 1950), no technical information has been available on the most suitable methods of freezing and storing king crab. However, several possible methods of processing were available for consideration. The raw or the cooked crab legs could be frozen in the shell and ice-glazed to prevent dehydration, or the raw crab legs could be cooked and the meat removed from the shell and packaged in a number of different ways. As another alternative, the cooked crab legs could be frozen in the shell and ice-glazed, then thawed later, the meat removed from the shell and packaged for refreezing. Packaging materials could include flexible films, such as cellophane and either friction-top or hermetically-sealed tin containers. If packed in tin containers, the crab meat could be covered with a weak brine solution. This report presents data on the cold-storage keeping quality of crab meat processed and packaged by some of the foregoing methods.

## EXPERIMENTAL

Background information for the present work was obtained from preliminary storage tests of samples prepared aboard the trawler Alaska, which fished for king crab in the Bering Sea during August 1947. Practical aspects of this fishing venture are described in Fishery Leaflet 330 (King 1949). The samples for the present study were prepared by U. S. Fish and Wildlife Service personnel in May and June of 1948 aboard the factoryship Pacific Explorer. A report on the operations of the Pacific Explorer in the Bering Sea is presented in Fishery Leaflet 361 (Wigutoff and Carlson 1950).

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King crab for the storage studies were obtained by chartered vessels during commercial crab-trawling operations in 30 to 40 fathoms of water in the area north and somewhat east of Amak Island on the Bering Sea side of the Alaska Peninsula during May and June of 1948. Only select live crabs were used. These were processed entirely by the laboratory personnel on the same day that they were caught. Butchering or "backing" (removal of the carapace) was accomplished by impaling the animal on the jointed hook of the butchering tool and pulling it down sharply on the horizontal blade (fig. 1). This served also to divide the crab into two halves, each consisting of a claw and three legs. Gills and viscera were then cut or pulled away and the halves were washed in clean, cold, running sea water.

FIG. 1 - THE BUTCHERING OPERATION. THE FIXED BUTCHERING TOOLS ARE TO THE LEFT OF THE CONVEYOR.

At this stage, a number of raw legs with attached body segments were selected at random for freezing, glazing, packing, and storing. The remaining crab sections were cooked in a 30-gallon vat of boiling water for approximately 15 to 18 minutes and then cooled immediately by dipping into cold sea water.

A number of cooked legs with attached body segments were also taken at random for freezing, glazing, and storing. The meat in the remaining cooked sections was removed by breaking and tearing the legs apart at the joint and shaking the meat from the shell (fig. 2). The leg meat was placed in separate shallow trays (experience indicated that baskets would have been better) and washed in clean, running sea water with sufficiently rapid agitation to remove adhering coagulated proteinaceous material and blood, bits of shell, pieces of gills, tendon, and visceral material (fig. 3). After being washed and inspected, the meat was allowed to drain completely before packing (fig. 4). The methods used in preparing test samples are described in table 1.

FIG. 2 - THE SHAKING TABLE. THE CRAB MEAT IS REMOVED FROM A LEG SEGMENT BY A QUICK, SHARP RAP OF THE HAND ON A BRACKET COVERED WITH SPONGE RUBBER.

Due to the limitations at sea, all samples were prepared by vessel personnel and were not prepared at the same time but rather were prepared during an interval of several weeks during the voyage. All the samples had been frozen at least six weeks when the vessel returned to port. On arrival at Seattle, the samples were transferred to the Fish and Wildlife Service cold-storage room and stored at 0° F. Since laboratory personnel

were not aboard the vessel while at sea, the initial examinations were delayed for a number of weeks. This accounts for the lack of data during the early period of storage.

FIG. 3 - WASHING STATIONS. THE PANS OF MEAT ARE WASHED IN RUNNING SEA WATER IN STAINLESS STEEL SINKS.

FIG. 4 - PACKING TABLE.

Table 1 - Preparation of test samples. (All samples were frozen at -20° F. to -30° F. in a blast freezer, then stored at 0° F.)

| Sample | Sample Material | Packaging Method |
|---|---|---|
| a | Cooked, dressed, half crab portions, in the shell. | Half crabs, water-ice glazed, and packed into untreated fiberboard cartons, holding about 25 pounds. |
| b | Crab meat, picked from body and leg sections after cooking. | One pound quantities of meat wrapped in (MSAT)1/ cellophane and five of these packages placed in a waxed carton. |
| c | Crab meat, picked from body and leg sections after cooking. | Meat packed in No. 2 (307x409) inside "C" enameled cans and hermetically sealed.2/ |
| d | Crab meat, picked from the first or large leg section (the leg section nearest the carapace) after cooking. | Meat packed in No. 2 (307x409) inside "C" enameled cans and hermetically sealed. |
| e | Crab meat, picked from the second and third leg sections after cooking. | Meat packed in No. 2 (307x409) inside "C" enameled cans and hermetically sealed. |
| f | Crab meat derived from body and leg sections that had been cooked, frozen in the shell, and stored at 5° F. for a period of one month prior to thawing and picking. | Meat packed in No. 2 (307x409) inside "C" enameled cans and hermetically sealed. |
| g | Crab meat, picked from body and leg sections after cooking. | Meat packed in No. 2 (307x409) inside "C" enameled cans, covered with 50 ml. of one-percent salt solution and hermetically sealed. |
| h | Crab meat, picked from body and leg sections after cooking. | Meat packed in No. 2 (307x409) inside "C" enameled cans covered with 50 ml. of 3-percent salt solution and hermetically sealed. |

1/ (MSAT), MOISTURE-VAPOR-RESISTANT, HEAT SEALING, ANCHORED COATING, TRANSPARENT CELLOPHANE.
2/ ALL CANS WERE DOUBLE SEAMED AT ATMOSPHERIC PRESSURE.

For evaluation of quality, samples were removed from cold storage at various intervals and thawed in circulating air at room temperature before being opened. All samples were judged for appearance (color) and flavor on the basis of the following terminology and numerical ratings:

| Appearance | |
|---|---|
| Color Value | Rating |
| No discoloration ..... | 5 |
| Slight discoloration ..... | 4 |
| Moderate discoloration ..... | 3 |
| Considerable discoloration . | 2 |
| Extreme discoloration ..... | 1 |

| Flavor | |
|---|---|
| Flavor Value | Rating |
| Normal - no off-flavor ..... | 5 |
| Slight off-flavor ..... | 4 |
| Moderate off-flavor ..... | 3 |
| Definite off-flavor ..... | 2 |
| Inedible ..... | 1 |

Fractional values were used to indicate quality ratings falling between the whole numbers. The data as reported are an average of at least six tenderometer readings and six taste-panel observations. Samples receiving an average color or flavor rating of less than 3.0 were not considered salable. Not more than three samples were evaluated at any one time in order to eliminate the fatigue factor in organoleptic testing.

Tenderness is one of the qualities of frozen crab meat most subject to change. Relative values of tenderness were obtained by means of a tenderometer (Shockey, McKee, and Hamm 1944). Any sample of crab meat having an average tenderometer value of 36 or above was not considered salable.

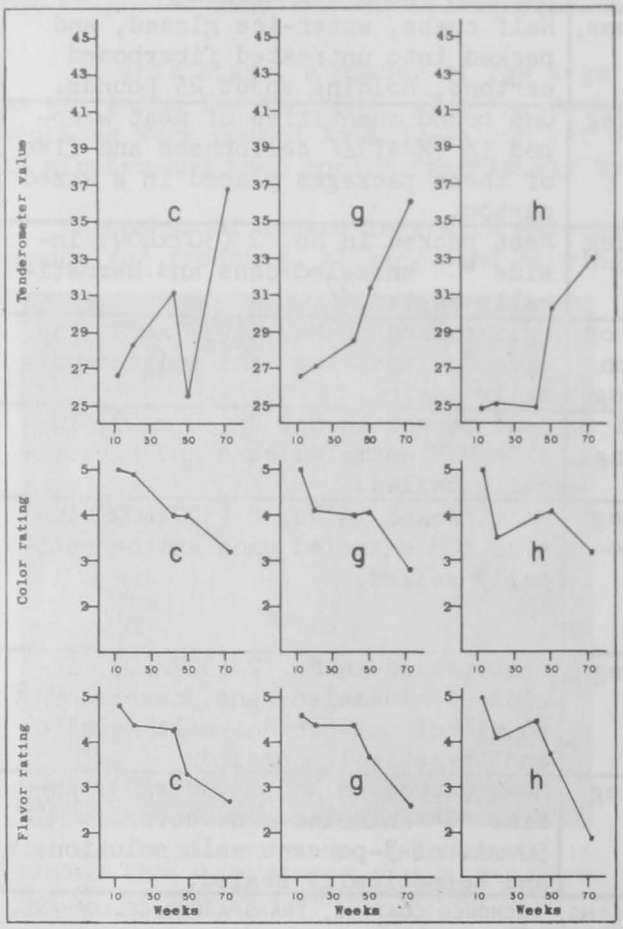


FIG. 5 - EFFECT OF STORING FROZEN KING-CRAB MEAT PACKED IN TIN: DRY (C); IN 1-PERCENT BRINE (G); AND IN 3-PERCENT BRINE (H).

## DISCUSSION

Examination of the crab meat frozen in tin containers--dry (c), with added one-percent salt solution (g), and with added three-percent salt solution (h)--revealed that the samples were not always as uniform as might be desired (fig. 5). Specifically, the low color and flavor values recorded at 20 weeks for crab meat in a three-percent salt solution (h) and the low tenderometer value recorded at 50 weeks for dry crab meat (c) are indicative of a fair amount of variation within identical samples. Judging from the data that was obtained, however, the three-percent salt-solution pack remained somewhat more tender throughout the entire storage period than either the one-percent salt-solution pack or the dry pack. Otherwise, the addition of salt solutions did not appear to have any appreciable effect upon either color or flavor. The storage life of all three packs was approximately 60 weeks at 0° F. These acceptability limits resulted from alterations in flavor before texture or color changes had reached a critical stage.

Cellophane packs (b) were equal to tinned packs (c) in retention of color, according to data in figure 6. Tinned packs were somewhat better in flavor retention than cellophane packs during the early examinations, but there was no flavor difference between the packs at the final (72 weeks) examination. Frozen king-crab meat packed in tin was definitely superior in texture to the cellophane packs. In fact, the tinned pack stored at 0° F. remained commercially acceptable until about the 58th week when it failed on the basis of both color and flavor. The cellophane pack, in contrast reached the limit of acceptability at about 44 weeks because of high tenderometer values and poor flavor. (Frozen Dungeness-crab meat when packed in cellophane bags reached its limit of commercial acceptability due to toughening in less than 13 weeks, Heerdt 1947). King-crab meat has frozen-storage characteristics definitely superior to Dungeness-crab meat.

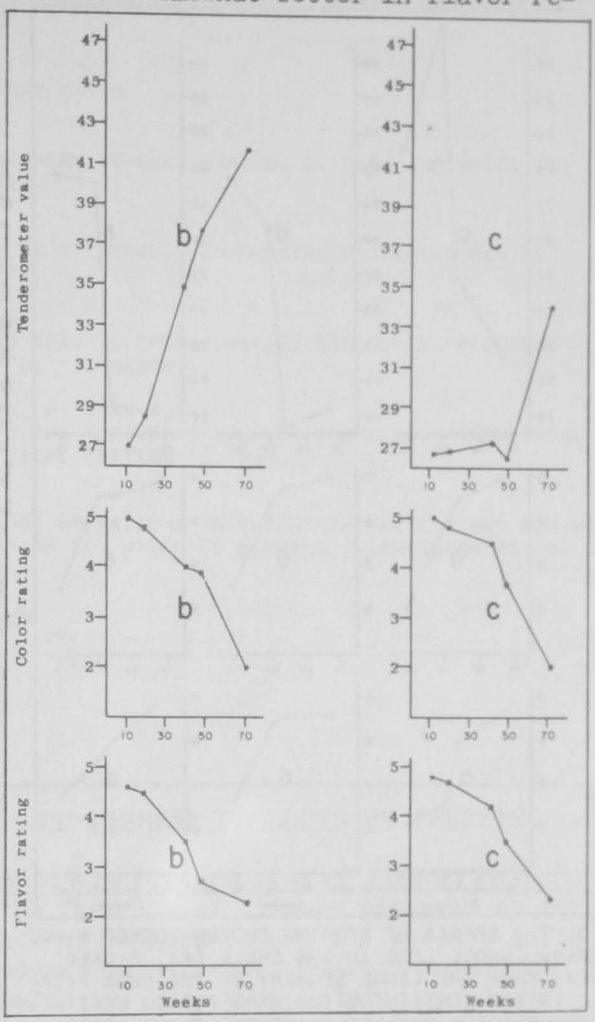


FIG. 6 - EFFECT OF STORING FROZEN KING-CRAB MEAT: PACKAGED IN (MSAT) CELLOPHANE (B), AND PACKED IN TIN (C).

Figure 7 shows the effect of storing frozen cooked whole king-crab legs in the shell (a), picked meat from the large segment of the legs packed in tin containers (d), and picked meat from the two smaller segments of the legs packed in tin containers (e). On the basis of tenderometer values, the large-leg segment pack was somewhat superior to the small-leg segment pack in keeping quality. Both the large- and small-segment packs in tin were definitely superior on the basis of color, flavor, and tenderometer values, to cooked whole legs frozen and stored in the shell. The whole legs (a) reached the limit of commercial acceptability at about 46 weeks because of high tenderometer values and poor flavor, whereas the picked meat (d) and (e) from both the large and small segments remained acceptable up to about 66 weeks at 0° F. Picked-meat packs (d) and (e) fell below the limits of acceptability at 66 weeks because of both poor color and poor flavor.

The effect of storage at 0° F. on king-crab meat prepared from cooked crab legs that were held frozen in the shell for one month, then thawed, picked, packed in tin containers, and refrozen (f) is given in figure 8. The effect of storage at 0° F. on king-crab meat prepared from cooked crab legs from which the meat was picked immediately, packed into tin containers, and frozen (c) is also given in figure 8. The purpose of pack (c) was to serve as control for pack (f).

Pack (c) was only slightly superior in color and flavor, yet definitely superior in tenderness. In fact, the refrozen pack fell below commercial acceptability after only 21 weeks of storage because of high tenderometer values. Pack (c), however, remained commercially acceptable until sometime between the 50th and 72nd week when it declined below the acceptable limit because of changes in flavor. By this time both the flavor and color of the refrozen pack also scored less than

3.0. Variation in quality within identical samples was of minor importance. Thus, refreezing king-crab meat that has been cooked and stored frozen in the shell is of limited practicability.

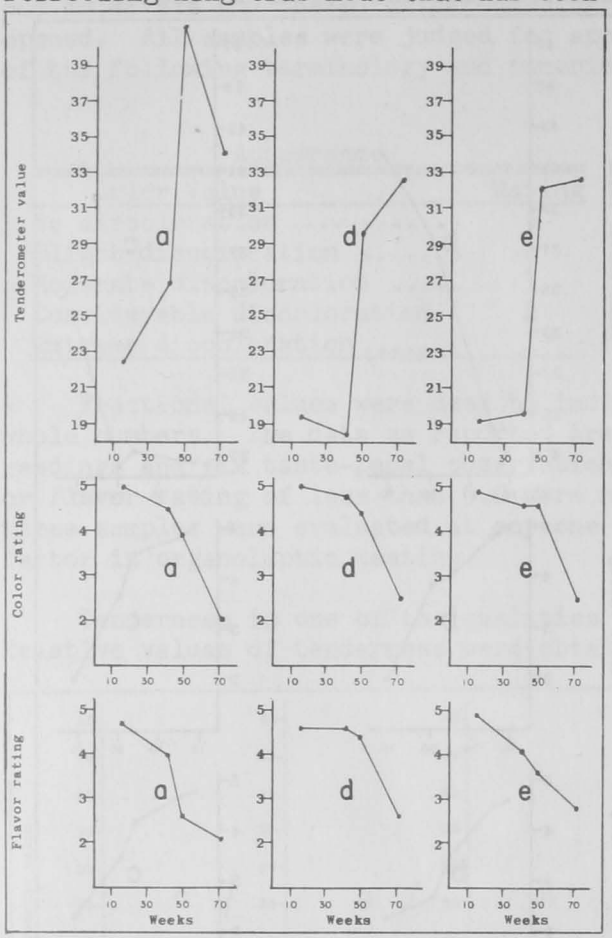


FIG. 7 - EFFECT OF STORING FROZEN COOKED KING CRAB: WHOLE LEGS IN THE SHELL (A), PICKED MEAT FROM THE LARGE SEGMENT OF THE LEGS PACKED IN TIN CONTAINERS (D), AND PICKED MEAT FROM THE TWO SMALLER SEGMENTS OF THE LEGS PACKED IN TIN CONTAINERS (E).

Crab meat wrapped in (MSAT) cellophane and stored at 0° F. remained palatable for nine months before becoming undesirably tough. Cooked crab legs that had been frozen, ice-glazed, packed in untreated fiberboard cartons, and stored at 0° F. also remained palatable for nine months. Flavor and color were not limiting factors for either of these two methods of packaging.

Crab meat packaged in hermetically-sealed tin containers and stored at 0° F. was palatable for twelve months. Covering the crab meat with 1-percent or 3-percent salt solution prior to sealing the tin containers delayed the onset of toughening but did not extend storage life beyond the twelve-month period because off-flavors developed.

## SUMMARY

King crabs obtained by trawling near Amak Island in the Bering Sea were butchered, cooked, packaged by various methods, frozen, and stored temporarily aboard a mothership. At port, the pack was transferred to frozen storage ashore. Samples were then withdrawn at intervals and judged as to color, flavor, and texture. Color and flavor were determined organoleptically; texture was determined by means of a tenderometer. The studies indicate that king-crab meat has good storage characteristics when held at 0° F.

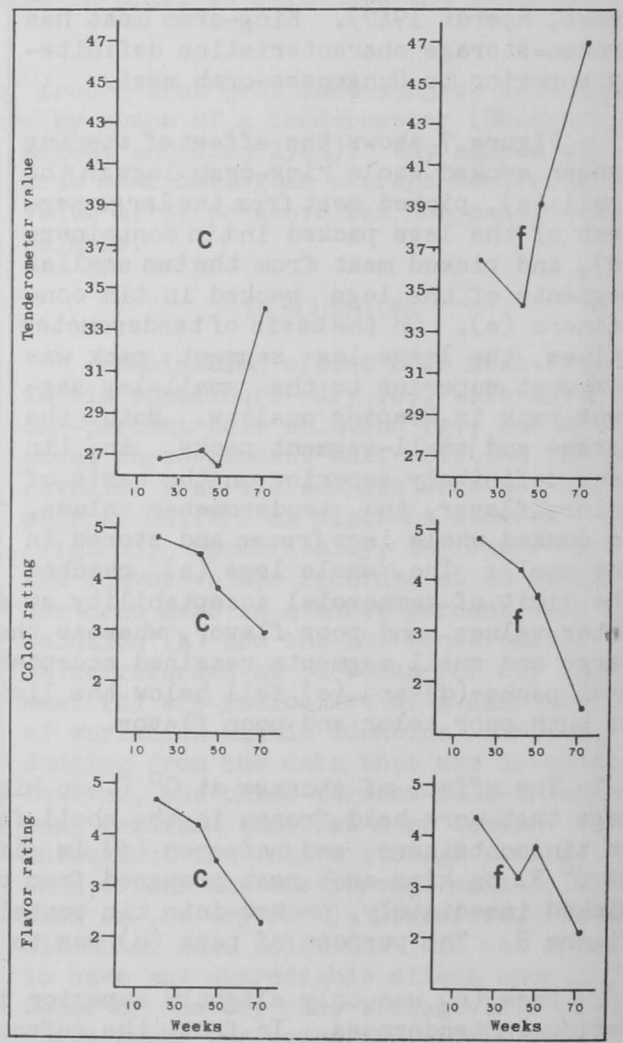


FIG. 8 - EFFECT OF STORING FROZEN KING-CRAB MEAT (C), AND REFROZEN KING-CRAB MEAT (F): BOTH PACKED IN TIN.

Refreezing meat removed from cooked crab that had been frozen and stored in the shell for one month at 0° F. gave an undesirably tough product after four-months' storage.

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Divided into two parts, Part I covers the period to January 1945 and is a reissue; and Part II covers the period of January 1945 to December 1947, inclusive, and has been issued as a supplement. Those who already have Part I, can obtain only Part II to complete the leaflet, while others can obtain both parts.

This is the final issue of this bibliography. More recent literature in the field of frozen fishery products is covered in the Service's publication, Commercial Fisheries Abstracts.