



Fishery Leaflet 415

Washington 25, D. C.

February 1954

PASTEURIZATION OF CRAB MEAT

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PART I

Experiments in pasteurizing the fresh-cooked meat of the blue crab Callinectes sapidus were conducted to determine whether this process would prolong the keeping quality--thus increasing the shipping radius--and to ascertain if the heat applied during pasteurization would affect the aroma of the fresh-cooked product, impair its taste, kill E. coli, reduce the total number of bacteria, and change the pH value. The pasteurizing temperatures and times most suitable for use in commercial practice also were studied.

Pasteurization has been used to preserve food since Scheele in 1782 used the process in preparing vinegar. It was not popular until Pasteur in 1860-64 demonstrated that a temperature below the boiling point of water would kill pathogenic organisms.

Puncochar and Pottinger (1) tried to preserve the quality of fresh-cooked crab meat in the original one-pound containers by applying heat above the boiling point of water. They found that some white crab meat was discolored, and loss of weight was observed as well as shrinking of the meat. Tobin and McCloskey (2) used the same process but were not successful in maintaining the color of white crab meat the same as when fresh. In the experiments to be described temperatures below the boiling point of water were used.

Pasteurization, as used in this paper, is understood to be a process of heating the fresh-cooked crab meat at a temperature below the boiling point of water. The exposure to heat involves both temperature and time, one being as important as the other.

Experimental Procedure

The fresh-cooked crab meat used in the experiments was bought in one-pound cans from a wholesale dealer in Washington, D. C., and brought to the

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NOTE: This leaflet is a reproduction of articles that appeared in Fishery Market News as follows: Part I: Vol. 4, No. 1, pp. 3-6 (January 1942)  
Part II: Vol. 4, No. 2, pp. 9-10 (February 1942).

College Park laboratory where it was divided into three portions. Two portions were pasteurized and the third was used as a nonpasteurized control sample. Total count of bacteria and the presence of E. coli were determined. Organoleptic tests were conducted and pH values measured.

The samples to be pasteurized were packed in #2 flat enameled cans, closed with a double seam in a hand sealer and pasteurized in a water bath. The water temperature was maintained five degrees above the desired temperature of the crab meat. The temperature of the pasteurized samples was determined by inserting a thermometer in one of the cans so that the bulb would be in the center of the meat. As soon as the crab meat reached the proper temperature the heat was regulated and the samples held at that temperature for the period of time selected.

The temperatures and times used during these experiments were as follows:

145° F. for 30 minutes.  
150° F. for 20 minutes.  
155° F. for 15 minutes.  
160° F. for 10 minutes.  
170° F. for 1 minute.

The temperatures and times selected represent the combinations below the boiling point of water which kill the majority of organisms that cause spoilage of fresh-cooked crab meat.

The bacteriological and pH determinations were made from 1 to 10 dilutions which were prepared by placing 20 grams of the crab meat from the center of the cans into sterile mason jars containing 180 cc. of water and 2 heaping teaspoons of glass beads. The jars were shaken thoroughly and the supernatant liquid used for making further dilutions to determine the total number of bacteria per gram in the samples. The medium used was nutrient agar which was incubated at 37° C. for 48 hours. Other portions of the liquid were used to test for E. coli by the Rapid MacConkey Agar method (3). The pH value was determined by using a Beckman pH meter.

Organoleptic tests were performed by several members of the laboratory staff who were requested to judge the crab meat according to color, aroma, and quality - the latter a combination of color, aroma, and taste. The purpose of these tests was to determine whether they would be able to separate the pasteurized from the nonpasteurized crab meat samples.

A total of ninety-nine pounds of fresh crab meat was used in these experiments, representing samples from nine different plants from three States along the Atlantic and Gulf coasts. The 57 pounds of white crab meat and 42 pounds of darker claw meat were judged separately.

#### Nonpasteurized samples.

The fresh-cooked meat was examined when the one-pound cans were first opened and test data recorded for comparison with the same meat after pasteurization. The color and aroma of the meat were graded as "very good", "good",

and "fair". Fifty-two cans of white meat, or 91 percent, were "very good" in color while 9 percent was rated as "fair". The aroma of forty-eight cans, or 84 percent, was "very good" and 16 percent was classified as "good". Of the darker claw meat 40 cans, or 95 percent, were "very good" in color and 5 percent "fair". The aroma of the claw meat was "very good" for 36 cans, or 86 percent; "good" for 4 percent; and "fair" for 10 percent.

TABLE 1.--Comparison of Color in Pasteurized and Nonpasteurized Crab Meat

Item	Treatment	C o l o r			Total cans judged Number
		Very good	Good	Fair	
		Percent	Percent	Percent	
White meat	Pasteurized	92	0	8	101
	Nonpasteurized	91	0	9	57
Claw meat	Pasteurized	93	3	4	74
	Nonpasteurized	95	0	5	42

In judging the quality of the nonpasteurized samples the members of the technological staff also placed them in three classes--"very good", "good", and "fair". Of the 27 nonpasteurized samples of claw meat, 30 percent was classed as "very good"; 30 percent as "good" and 40 percent "fair". Of the 47 nonpasteurized samples of white meat, 21 percent was "very good"; 45 percent was "good"; and 34 percent was "fair".

TABLE 2.--Comparison of Aroma in Pasteurized and Nonpasteurized Crab Meat

Item	Treatment	A r o m a			Total cans judged Number
		Very good	Good	Fair	
		Percent	Percent	Percent	
White meat	Pasteurized	87	12	1	101
	Nonpasteurized	84	16	0	57
Claw meat	Pasteurized	85	10	5	74
	Nonpasteurized	86	4	10	42

The total count of bacteria found in the nonpasteurized samples ranged from 100,000 to 220,000,000 per gram. Of the 75 samples tested, only 4 were found to contain 146,600,000 or more. Six samples contained from 73,300,000 to 146,600,000 while 65 samples had 100,000 to 73,300,000. Ninety-one non-pasteurized samples were tested for E. coli and 15 percent was found to be positive. The pH value of seventy-nine nonpasteurized samples was determined. The lowest value was 7.35 and the highest 8.5.

#### Pasteurized samples.

One hundred and seventy-five #2 flat cans of crab meat were pasteurized. Of these, 101 contained white crab meat and 74 darker claw meat. The 101 cans of white meat were rated as follows with respect to color: "Very good" 92 percent; "fair" 8 percent. The 74 cans of claw meat were judged, "very good" 93 percent; "good" 3 percent; and "fair" 4 percent. According to aroma, the cans of pasteurized white meat were judged as "very good", 87 percent; "good", 12 percent; and "fair", 1 percent. Pasteurized claw meat was classified as "very good", 85 percent; "good", 10 percent; and "fair", 5 percent.

When they were judged for quality with nonpasteurized crab meat, the white pasteurized samples were placed as follows: "Very good" 37 percent, "good" 33 percent, and "fair" 30 percent. The total number of white meat samples judged for quality was 87. The claw meat was placed as follows with respect to quality: "Very good" 32 percent; "good" 32 percent; and "fair" 36 percent. The total number of claw meat samples judged for quality were 69.

TABLE 3.--Comparison of Quality in Pasteurized and Nonpasteurized Crab Meat

Item	Treatment	Quality			Total cans judged
		Very good Percent	Good Percent	Fair Percent	
White meat	Pasteurized	37	33	30	87
	Nonpasteurized	21	45	34	47
Claw meat	Pasteurized	32	32	36	69
	Nonpasteurized	30	30	40	27

All of the pasteurized samples were found to be free from E. coli.

The greatest change in pH value was .4 in one sample when compared with the original nonpasteurized crab meat. The pH values of the other pasteurized samples were within .2 of the original pH readings.

The total count of bacteria in pasteurized samples ranged from zero to 23 million per gram. A few samples had a number of pin-point colonies. The samples with a large number of organisms were those pasteurized at 145° F. for one-half hour. The samples pasteurized above 160° F. had no more than 2,000 colonies per gram of crab meat.

#### Discussion of Data

The experimental results presented indicate that the pasteurization of crab meat eliminated E. coli; therefore, it could be assumed that there were no pathogenic organisms present. The total number of organisms in the pasteurized samples was small when compared with the nonpasteurized samples even after 6 weeks' storage at ordinary refrigerator temperature (41° - 43° F.).

The change in the pH value cannot be used as an indicator to determine whether or not fresh-cooked crab meat is pasteurized because the difference is too small to be significant.

As the various grades of crab meat usually are sold according to color, aroma, and taste, there is no objection to pasteurization because there were no noticeable changes which took place during the process. This is further confirmed by the critical placement of the samples by the technological staff. They were unable to distinguish between the nonpasteurized and pasteurized crab meat as evidenced by the close agreement of the percentage classifications of the two types before and after pasteurization.

Pasteurization can be accomplished with the usual equipment found in the average crab meat packing plant with the addition of a can sealer. After the cans are sealed they should be placed in the racks which are used to steam the live crabs, and then placed in a retort containing water five degrees

higher than the desired pasteurizing temperature. Any other container will do in which the temperature of water can be controlled. When the crab meat reaches the desired temperature it is held for the proper time. At the end of that period the cans should be removed and immediately cooled, either by immersion in cold water, or by a stream of cold water played on them until most of the heat is removed. The cans of crab meat then should be placed in a refrigerator or thoroughly iced for shipment. Further work is in progress on methods of procedure, information concerning which may be obtained by addressing the Service.

It should be distinctly understood that the pasteurizing process does not sterilize the crab meat. It is still a perishable product. However, pasteurizing does prolong the keeping quality for a considerable time.

The experiments demonstrate that when good quality fresh crab meat was used the final product also was good. It must be realized that pasteurization cannot replace absolute cleanliness in the care and handling of crab meat in the packing plants.

### Conclusions

From the experiments the following conclusions are warranted:

1. Pasteurization does not in any way impair the color, aroma, or taste of crab meat.
2. Pasteurization kills a large number of organisms including E. coli.
3. The pasteurizing temperatures and times recommended for use in crab meat plants are 160° F. for ten minutes or 170° F. for one minute.
4. The average crab meat plant can use its present equipment with the addition of a can sealer.

### References

- (1) Puncochar, J. F., and Pottinger, S. R. 1938. Commercial production of meat from the blue crab. (Callinectes sapidus). Unpublished report, 1938. Fish and Wildlife Service, Department of the Interior.
- (2) Tobin, L. C., and McCloskey, 1941. Bacteriological studies of fresh crab meat. Food Research 6 (2), p. 157.
- (3) Reedy, R. J., and Anzulovic, J. V. 1941. A paper #A13. The Society of American Bacteriologists Annual Meeting.

### PART II

The last issue of Fishery Market News contained a report setting forth the results of studies dealing with the pasteurization of crab meat. In this second article additional data for the specific methods of procedure are given.

Pasteurizing crab meat does not call for any changes in the present methods of steaming the crabs and picking out the crab meat. Instead of packing the crab meat in the usual friction-top cans with holes in the bottom, the cans used should be lined with C-enamel, contain no holes, and be provided with covers for sealing with a double seamer. The best size can is the 1/2-flat--307 x 201.25--which contains 1/2-pound or approximately enough crab meat for serving a small family. If the packer supplies a trade which prefers the meat in 1-pound cans, No. 2--307 x 409--cans are recommended.

The cans should be sealed as soon as they are filled and weighed, and placed in ice or a refrigerator until enough have accumulated to fill a retort. The cans then may be dumped into baskets which are used to cook the live crabs. They should not be stacked but should be placed in an irregular manner that will expose the largest possible surface of each can to hot water. The filled baskets are placed in the retort or any other container in which the temperature of the water can be controlled. The water in the retort should be at the proper temperature before the cans are actually placed in it. For example, if the operator decides to pasteurize the crab meat at 170° F. (this temperature is recommended), the water should be heated to 175° prior to placing the cans in it. When the water in the retort has reached this temperature, the baskets of cans should be added and a constant temperature of 175° maintained throughout the pasteurizing period. The 1/2-pound cans should be kept in water at this temperature for 70 minutes, and the 1-pound cans for 103 minutes. Time should be measured from the moment the temperature of the water in the retort returns to 175° after addition of the cans.

Pasteurizing in boiling water is not satisfactory because the crab meat sometimes has a dry appearance where it comes in contact with the inner surface of the can. The 1/2-pound cans should be processed only 25 minutes, and 1-pound cans 53 minutes, if boiling water at 212° F. is used.

When the cans have been processed for the proper length of time they should be transferred to or sprayed with cold water. As soon as the cans feel cool to the touch, they are ready to be iced or placed in a refrigerator with a temperature not higher than 43° F. The length of time the cans should be kept in cold water must be determined by the individual operator, because the temperature of the cold water varies in each plant with the season of the year and the source of the water. After the cans, whether 1-pound or 1/2-pound size, are thoroughly chilled, they are ready for shipment or storage in crushed ice or in a refrigerator.

A crab meat plant needs no additional equipment for pasteurization except a double seamer and a supply of C-enamel lined cans, such as the No. 2 for 1-pound net weight of contents or No. 2 flat for 1/2-pound. The packer should have at least one accurate Fahrenheit thermometer for use in determining the temperature of the water in the retort.

It is necessary to open the cans of the type mentioned above with a can opener. They should be opened only by the consumer and immediately prior to preparation for serving. Cans opened for inspection should not be repacked and resealed, and should not be sold as pasteurized crab meat.

The present cans with holes in the bottom or with friction tops are not suitable because water may enter and contaminate the meat. This would defeat the purpose of pasteurization. The pasteurized crab meat does not

become slimy in the cans without holes. There is no excess water present in the cans after they are pasteurized and cooled. Oyster cans, although the tops are sealed with a double-seam cannot be used because the side seams are not soldered and the tops are not fitted with a gasket. They are, therefore, not airtight.

The pasteurization of crab meat in the cans will not make it possible for packers to keep the meat indefinitely. It does not destroy all bacteria. Pasteurization does kill E. coli, pathogenic organisms, and about 99 percent of other micro-organisms. If the crab meat is properly pasteurized and held at a temperature not exceeding 43° F., it will remain in edible condition for at least six weeks.

Sanitary conditions must continue to be maintained throughout the plant. Although crabs are steamed before the meat is picked; it is necessary to pasteurize the meat afterwards, because both pathogenic and non-pathogenic organisms may be introduced from the hands of the pickers, the equipment, and the air, thus causing spoilage. Pasteurization does help the packers to keep their product in good condition by preserving the desirable taste, color, and aroma of the crab meat.

In the experiments reported, parchment or paper liners for the cans were not used because they are not necessary in enameled cans.

The pasteurization of crab meat should be handled as carefully as possible, particularly with regard to maintaining the proper temperature throughout the pasteurization process. A 2-degree variation in the pasteurization temperature and a 2-minute leeway in the pasteurizing time are permissible. Further deviation from the recommended minimum temperatures and times will not successfully pasteurize the crab meat and keep it in edible condition.