Studies on the "Browning" of Canned Crab Meat—IV. Soaking of the Raw Material in Water and Heating

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In the previous paper¹⁾, it was demonstrated that the "browning" of canned crab meat is intimately related with the freshness of the raw crab material. The present paper deals with an experiment carried out to clarify how previous soaking of raw crab in water and the conditions in which the raw material is subjected to heating (pH of the bath, time, and temperature) effect the "browning" of the content such as seen in that already canned.

Experimental

1. Relation between soaking and "browning"

a. Method

Raw white meat of crab was divided into two groups. The white meat of the crab of one group was soaked in running water and leached for 1 hour, the other was not soaked. Samples of the two groups were respectively put into ERLÉNMEYER'S bottles, plugged with cotton and heated at 115.2°C. (a pressure of 10 pound) for 90 minutes.

Then juice was separated from the meat. To the juice was added trichloroacetic acid to precipitate the protein. The amounts of amino-nitrogen and sugars in this juice were estimated, and the degree of "browning" was measured by the method already described elsewhere²⁾³⁾.

b. Result

The amounts of amino-nitrogen and sugars in the juice were estimated, and the degree of "browning" was measured. Results obtained are shown in Table 1.

Table 1. The effect of soaking in water on the degree of "browning".

Sample	Items	Free amino-N (mg%)	Free reducing sugar (mg%)	Degree of browning (as shown in transparency %)
Crab meat not soaked		274	132	30
Crab meat subjected to soaking		23	20	50

As seen in the table, the amounts of amino-nitrogen and sugars in the juice separated from the meat which was not soaked were much more than that which was

soaked. Browning occurred completely. But in the juice separated from the meat which was soaked, "browning" did not occur.

The discrepancy was considered to be caused by flowing out of some elements (amino-nitrogen and sugars) during the soaking.

2. Relation between the temperature and duration of heating the raw crab and the "browning" of the canned meat

a. Method

(1) Experiment A

Fractions of a mixture made from 0.01 M glucose solution and 0.01 M arginine solution were put separately in test tubes and heated respectively at various temperatures for 85 minutes. After allowing the mixtures to cool, the degree of the "browning" and the amount of reducing sugar were estimated as in the previous paper²⁾³⁾.

(2) Experiment B

Samples of the raw white meat were heated at 115.2°C. (a pressure of 10 pounds) for various times from 60~120 minutes or at 108°~114°C. (a pressure of 5~9 pound) for 60~90 minutes respectively. After being cooled the state of meat, degree of "browning" and amounts of amino-nitrogen and sugars in the juice were estimated.

b. Result

Results of experiment A are shown in Table 2, those of B in Tables 3 and 4.

Table 2. The relation between the heating temperature and the "browning" of the mixed solution of glucose and arginine.

Items \ Heating temp. (°C)	100	105 (3 lbs)	110 (6 lbs)	115 (10 lbs)	120 (15 lbs)	Blank
Degree of browning in the mixed solution (% of transparency)	99.0	98.5	96.5	95.0	94.0	100
Amounts of reducing sugar before heating (mg%)	180	180	180	180	180	180
Amounts of reducing sugar after heating (mg%)	89.7	59.0	57.5	46.1	11.1	—
Relative decrease of reducing sugar on heating (%)	50.0	62.3	68.1	74.4	93.8	0

Table 3. The browning of crab meat caused by heating at 115.2°C. (a pressure of 10 pounds) for various heating times.

Items \ Heating time (min.)	0	60	90	120
Free amino-N (mg%)	274	—	133	113
Free reducing sugar (mg%)	132	—	80	71
Degree of browning of crab meat (% of transparency)	70	66	63.6	45.9

Table 4. The relation between the "browning" and the heating temperature-time.

Heating time (min.) Heat- ing temp. (°C.)	60			90			120		
	Juice	Meat	Smell	Juice	Meat	Smell	Juice	Meat	Smell
108.4 (5 lbs.-press.)	Good	Good	Good	Good	Good	Good	Muddy	Spoiled	Bad
109.9 (6 lbs.-press.)	Good	Good	Good	Muddy	Spoiled slightly	Good	Muddy	Spoiled	Bad
111.3 (7 lbs.-press.)	Muddy. Brown- ed sli- ghtly	Spoiled	Bad	Muddy. Brown	Spoiled	Bad	Muddy	Spoiled	Caramel- ized
112.7 (8 lbs.-press.)	Brown	Spoiled. Brown	Bad	Brown	Brown	Caramel- ized	Brown	Very brown	Strong- ly cara- melized
113.3 (9 lbs.-press.)	Very brown	Very brown	Caramel- ized	Very brown	Brown	Caramel- ized	Very brown	Very brown	Strong- ly cara- melized

As seen in Table 2, the degree of the "browning" in the mixed solution of glucose and arginine increased and the amount of glucose decreased with ascending temperature.

The increase of "browning" and the decrease of the amount of glucose became more and more noticeable as the temperature of heating was raised to exceed 110°C (a pressure of 6 pounds).

As seen in Table 3, when the crab meat was heated at 115.2°C., the degree of "browning" increased and the amounts of free amino acid and reducing sugar decreased with elongation of heating time.

As seen in Table 4, a condition of heating suitable to prevent "browning" in the processing of crab meat is a temperature of 108.4°C. and a period of 90 minutes, or a temperature of 110°C. and a period of 60 minutes. The higher the temperature and longer the heating duration, the stronger the "browning" of the product.

3. Relation between pH and "browning"

a. Method

(1) Experiment A

Mixtures composed of M/10 glucose solution and M/10 arginine solution were adjusted in regard to pH respectively to different values falling in the range of 5~8 respectively by adding N/10 HCl or N/10 NaOH solution and were heated at 110°C. (a pressure of 6 pounds) for 85 minutes. The degree of "browning" and the amount of reducing sugar were estimated as described in the previous paper²⁾³⁾.

(2) Experiment B

To the white meat were added the buffering solutions having pH values of 6.5~9.8, and the meat was heated at 115.2°C. (a pressure of 10 pounds) for 90 minutes. Then the degree of the "browning" was estimated.

b. Result

Results obtained are shown in Tables 5 and 6.

Table 5. Relation between the "browning" and pH of the mixed solution of glucose and arginine.

Items \ pH	5.0	6.2	7.2	8.0
Degree of browning (% of transparency)	83.0	24.5	1.0	0.5
Amounts of reducing sugar before heating (mg%)	90.1	90.1	90.1	90.1
Amounts of reducing sugar after heating (mg%)	20.8	5.95	2.65	2.30
Decreasing ratio of reducing sugar as effected by heat- ing (%)	77.0	93.6	97.3	97.6

Table 6. Relation between the "browning and pH of the crab meat.

pH of the crab meat	Degree of browning of the crab meat (% of transparency)
6.5	68.8
7.5	63.8
8.1	56.7
8.7	36.8
9.3	10.2
9.8	1.5

As seen in Table 5, in the case of the solutions composed of glucose and arginine at pH's above 6, the "browning" increased remarkably and the amount of reducing sugar decreased. Also as seen in Table 6, in the meat of pH's above 6.5, especially in the alkali region, the "browning" increased remarkably.

From these results, the "browning" may be said to be promoted noticeably with increasing pH value.

Discussion

When the crab meat was soaked in water, the amino acids and reducing sugar components contained in the larger portion as the extractive of the meat flowed out, so that the "browning" of the meat after the heating was less. TARR⁴⁾ has obtained same result for the meat of *Sebastodes sp.* From these results, the washing of the meat in the processing of canned crab may be judged to be effective for the

decreasing the "browning". Preservation in ice water of the meat boiled with crust is also effective. It is true from the results in Experiment 2 that the "browning" is caused by heating, so even if a small amount of chemical components causing amino-carbonyl reaction is present in the crab meat before the heating, the "browning" finally is made visible by heating.

The relation between the mechanism of the amino-carbonyl reaction and the conditions of heating must be studied in the future. At the same time, the changes of chemical components concerning amino-carbonyl reaction contained in the raw material of crab meat before heating must be considered. As to those subjects, the author will discuss them in a separate paper.

It was shown that the heating at 110°C. (a pressure of 6 pounds) for more than 60 minutes increased the "browning". In this case, if the freshness of the raw material falls, and the pH value of the meat shifts to the alkali side, it may easily be assumed that the "browning" is accelerated as seen in the results reported above in Experiment 3.

In the practical processing of canned crab, if the heating at 110°C. (a pressure of 6 pounds) is carried out for over a period of 85 minutes, the "browning" may occur. Therefore, if the unfresh material is used, the conditions of soaking and heating should be considered.

References

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- 3) ————— : *ibid.*, **24** (10), 816 (1959).
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