On the Manufacture of Canned Crab from *Paralithodes camtschaticus* (TILESIIUS)—III.

The Relation between Volatile Basic Nitrogen Produced in Crab Meat during Heating and the Freshness of the Meat

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ŌTA and NAKAMURA¹⁾ have previously studied the variation of the amount of volatile basic nitrogen (V.B-N) present in fish meat heated in a pressure cooker. They observed that V.B-N increased proportionally to the falling of the freshness of the meat within the range of treatment generally employed.

MATSUIKE²⁾, SHIMO³⁾ and UMEMIYA¹⁾ have studied the relation between the grade of the quality of canned pink salmon or tomato sardine and V.B-N produced in the canned meat. They have observed that with the falling of the quality of the canned fish meat, V.B-N increased. From these various observations, the freshness of the raw fish meat is considered to be detectable by measuring V.B-N present in the canned fish meat.

The authors have measured V.B-N present in crab meat of various grades of freshness during heat processing, and discussed the relation between V.B-N before and after the heating. Here, the authors present a report on experiments in which raw crab meat was heated at various temperatures.

Experimental

1. Experimental method

One part of raw shoulder meat was mixed with two parts of leg meat which were adjusted to various grades of freshness by leaving the meat in a room at ordinary temperature. The mixture of the meat was homogenized by a Waring Blendor.

Each 10 grams of the homogenized meat were put in each ERLNMEYER's bottle of 100 cc. with 20 cc. of 2 % NaCl. The bottles were plugged with cotton and covered with parchment paper, and were heated separately in boiling water, in autoclaves of 6 lbs./cm². (110°C.), 8 lbs./cm². (112,7°C.) and 10 lbs./cm². (115.2°C.) for a definite period. After the heating, the bottles were cooled in water. V.B-N present in the sample meat were respectively measured by WEBER-WILSON's method. The grades of the freshness of crab meat were determined by measuring V.B-N, and that of the raw crab meat was about 6, 14, 20, 32 and 44 mg.% respectively.

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Fig. 1~4. Relation between the amounts of volatile basic nitrogen in the meat samples before and after heat treatment.

2. Experimental result and discussion

Results obtained are shown in Figs. 1~4.

As seen in these Figs., with the increasing of V.B-N in raw crab meat before heating (B) and with longer time of the heating, V.B-N produced by the heating increased. Up to the point of heating at 111.3°C ., with the rising of the temperature V.B-N produced in the meat was increased by the heating. V.B-N produced by the heating at 115.2°C . is less than that by the heating at 112.7°C .

The relation between the heating time " t ", and V.B-N produced by heating shows a similar curve which is manifested by an equation of mono-molecular reaction. Therefore, the relation between $\log A_0/A_0 - A$ and " t " was examined from the equation :

$$\log A_0/A_0 - A = kt \quad \dots\dots\dots (1)$$

Here, " A " is the amount of V.B-N after " t " minutes heating, and " A_0 " is the maximum amount of V.B-N produced by heating at corresponding temperatures.

Fig. 5. Relations between logarithms of the value of A and B (110°C .)

As consequence, the curve showing the relation between $\log A_0/A_0 - A$ and " t " was broken down at the point of 30 minutes heating and no linear relation was obtained. That is to say, the relation can not be strictly manifested by the equation of mono-molecular reaction. In actual practice it is convenient to know the relation between the amount of V.B-N before heating (B) and that after heating (A).

In every curve shown in Figs. 1~4, the relations between logarithms of the value of A and B are ascertained to be linear as shown in Fig.5 (in the case at 110°C .). Therefore following equation

Fig. 6. Relation between the values of "m" and "t" relations as seen in Fig. 6 and 7. These relations are manifested by equation (3) and (4)

Fig. 7. Relation between the values of "log n" and "t" both "m" and "n" show linear

(2) is derived.

$$A = mB^n \quad \dots\dots (2)$$

Here, in equation (2) "m" and "n" are constants which are functional values of heating time, "t", and heating temperature, "θ", (or heating pressure, "P"). Among the

$$m = a^t + b \quad \dots\dots\dots (3)$$

$$n = e^{-ct+d} \quad \dots\dots\dots (4)$$

Here, in equation (3) and (4), "a", "b", "c" and "d" are constants. From equations (2), (3) and (4), following equations (5) and (6) are obtained.

$$A = (ai + b)B^{e^{-ct+d}} \quad \dots\dots\dots (5)$$

$$B = \left(\frac{A}{ai + b} \right)^{\left(\frac{1}{e^{-ct+d}} \right)} \quad \dots\dots\dots (6)$$

If the amount of V.B-N in crab meat after the heating, A, was measured, the amount of V.B-N in the raw crab meat before heating, B, may be calculated from

Table 1. Values of the constants, "a", "b", "c" and "d" under various conditions of heat treatment.

	a	b	c	d
Boiling	0.230	0	0.0071	0.100
6 lbs heating	0.072	5.11	0.0016	0.670
8 "	0.204	7.56	0.0055	0.575
10 "	0.145	6.40	0.0032	0.577

Fig. 8. Relation between the pressure and volatile base nitrogen value in heat-treated crab meat.

equation (6), when the heating conditions (heating temperatures, time, etc.) are known.

The values of the constants, "a", "b", "c" and "d" are shown in Table 1.

As to the mutual relations among the heating temperatures (pressures), each value of constants, "a", "b", "c" and "d", is considered to have some functional relation with heating temperature (pressure), but it is difficult to discuss the relation in detail from the experimental results obtained, because the arrangement of each curve is somewhat irregular, e.g. the curve showing the heating of 115.2°C. (10 lbs./cm².) situated between the curves showing 110°C. (6 lbs./cm².) and 112.7°C. (8 lbs./cm².). In Fig. 8, up to the heating of 112.7°C. V.B-N increased with the rising of temperature (pressure),

but above that temperature the amount decreased.

As to the amount of V.B-N, when V.B-N in the raw meat (*B*) is below 32 mg. %, the value of (*A*) increased with the rising of temperature, but when V.B-N attains 42 mg. %, in the heating of 30 minutes above 110°C., the value (*A*) decreased, and in the heating of 120 minutes, the functional relation between the constants and temperature is linear. That is to say, when the raw meat which does not reach to incipient putrefaction, below 30 mg. %, is heated at 112.7°C., V.B-N increased with certain proportional value and when the raw meat is heated above that temperature, V.B-N is observed to decrease. This fact is perhaps due to the secondary decomposition of volatile basic materials. But the exact cause is not yet known.

The relations which are manifested in equations (5) and (6) are applicable for the case when the raw crab meat is heated.

It is beyond the range of these experimental results to discuss whether the same fact happens in the canned food or not. Further experiments will be carried out in detail.

Summary

(1) The amount of volatile basic nitrogen (V.B-N) present in crab meat of various degree of freshness was estimated when the meat is heated under various conditions. When the heating temperature (pressure) is definite below 112.7°C. (8 lbs./cm².), the relation between V.B-N and the heating time was considered to be manifested equations (5) and (6).

(2) The constants in equations (5) and (6) were determined in the heating.

(3) The relations which are manifested in equations (5) and (6) are applicable for the case when the raw crab meat is heated below 112.7°C. As for application in practical canning, further detailed experiments seem to be necessary.

References

- 1) ŌTA, H. and NAKAMURA, T. (1952) : *Bull. Jap. Soc. Sci. Fish.* **18**(1), 15—20.
- 2) MATSUIKE, Y., et al. (1936) : "Suisan Kenkyu Shi". **31**(12), 681.
- 3) SHIMOI, M., et al. (1939) : "Suisan Kenkyu Shi". **34**(5), 143.
- 4) UMEMIYA, T., et al. (1930) : *The Cannery Jour.* (Kanzume Jiho). **17**(3), 52.