STUDIES ON THE MANUFACTURE OF CANNED MACKEREL.

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The making of canned mackerel (*Scomber Japonicus HOUTTUYN*) has recently increased greatly and has taken precedence of production of canned fish meat in Hokkaido. Its production has a bright future. However, at the process of the manufacturing of canned mackerel there are many questions, and unless those questions are clarified, the wholesome development of the mackerel canning business cannot proceed with success.

The wrtiers have studied some of those problems in the manufacturing of canned mackerel, and have obtained some satisfactory conclusions, which will be reported in this Bulletin under several headings.

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PART I. COMRARISON OF CHEMICAL COMPONENTS OF MEAT OF MACKEREL CAUGHT RESPECTIVELY IN THE JAPAN SEA AND IN THE PACIFIC OCEAN OFF THE HOKKAIDO COAST.

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Mackerel, (*Scomber japonicus HOUTTUYN*), which comes to the shores of Hokkaido is classifiable into two groups. One of them is called the Japan Sea Group which comes by spawning migration to Japan Sea coasts of Hokkaido near Otaru and Yoichi in June to July. They are large in size and have ripened eggs and milt. The other, called the Pacific Ocean Group, comes to the coasts of Hokkaido off Kushiro in July to September. They are somewhat smaller in size and have unripened eggs and milt. These two groups are thought to be different schools. The chemical components of the mackerel meat of these two groups are different according to the type of migration and various environmental effects. The most remarkable difference of chemical components of the mackerel meat of these two groups is in the fat-content[1]. The fat-content of mackerel meat generally decreases in spawning season of April to May; it reaches the minimum value after the spawning season, and

thereafter increases and attains the maximum value in January to February of the next year.

Mackerel of the Japan Sea Group consists of 3, 4 and 5 year old fish, of which the 4 year old are the majority. Mackerel of the Pacifie Ocean Group consists of 2, 3 and 4 year old, of which the 3 year old are the majority. Therefore the former are large in size and the fat-content of the meat is 10—13% dependent upon relationship to the spawning season; the latter are younger and smaller in size and the fat-content of the meat is 20—30% on acconnt of their seeking food migration. The fat-content of the former is generally 10% less than that of the latter.

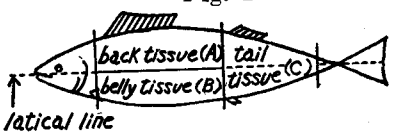
The writers have clarified the differences of general chemical components between the two Groups besides the fat-content of the meat according to the samples which were caught in the Japan Sea (Yoichi) and in the Pacific Ocean (Kushiro) in the respective fishing seasons.

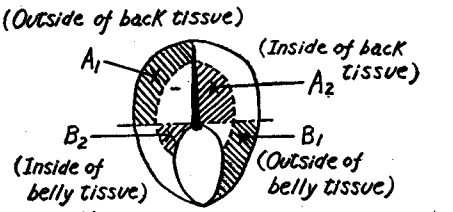
EXPERIMENTS

1. Preparation of the sample.

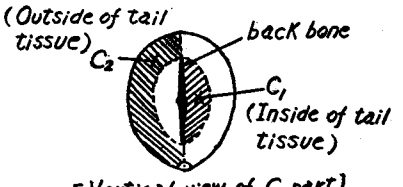
The writers have analyzed the samples which were brought in ice from fishing grounds to their laboratory. The samples of mackerel of the Japan Sea Group were male and averaged 1,015 gm in weight, 45 cm in length; the milt was ripe. The samples of mackerel of the Pacific Ocean Group were male and 970 gm in weight, 41 cm in length; the milt was unripe.

Fig. 1





[Vertical view of A and B parts]



[Vertical view of C part]

The samples were cut into the following three parts: The back tissue (A-part), the belly tissue (B-part) and the tail tissue (C-part). These parts were separated into both outside part and inner part. From those tissue parts respectively, the meat was taken and crushed in a glass-mortar, homogenized in a homogenizer, and then used for chemical analysis.

2. Experimental procedure.

(1) Moisture: 1 gm of samples were taken and the moisture content detrermined by the usual method.

(2) Ash: 5 gm of samples were taken and the ash-content determined by usual method.

(3) Ether-extracted matter: 10 gm of samples were taken, 10 gm of dehydrated sodium sulphate was added to each, extracted with ether as usual, and the amount

of ether-extracted matter was estimated.

(4) Total nitrogen: 0.5—1 gm of samples were taken and the amount of total nitrogen was estimated by micro Kjeldahl's method.

(5) Volatile basic nitrogen: 20 gm of samples were tanken and the amount of volatile basic nitrogen was determined by Weber-Willson's method at 45°, 140 mm Hg for 40 minutes.

(6) Cold-water soluble nitrogen and 0.3% NaCl-solution soluble nitrogen: 2 gm of samples were taken, 5 c.c. of distilled water or 0.3% NaCl solution respectively were added and infused about 40 minutes. Then the infused solution was added with distilled water to 100 c.c. Desired quantities of the filtrates were estimated respectively by the method noted above in (4).

(7) Hot-water soluble nitrogen and non-protein nitrogen: 5 gm of samples were taken, 300 c.c. of distilled water added to them and the whole slowly heated to boiling in 20 minutes. After the extraction of soluble protein, the total volume was brought up to 500 c.c. by adding distilled water. After filtration, 20 c.c. of the filtrate was added with 20 c.c. of 10% Trichloracetic acid solution, and after heating, the volume was made up to 250 c.c. by addition of water. Then the amount of the nitrogen of 20 c.c. of the filtrate was determined.

(8) Mercuric chloride reaction (Amano's method[2]): 1% $HgCl_2$ solution (A solution) and $HgCl_2$ solution acidified with 0.5% acetic acid (B solution) were used according to Amano's method (The detecting of freshness of fish meat).

(9) Acid value, saponification value, iodine value of the extracted oil: Other fish bodies from both the Japan Sea and the Pacific Ocean Groups were crushed respectively; 30 gm of dehydrated sodium sulphate was added to them and extracted with ether. The acid value and saponification value of the extracted oil were estimated in the usual manner. The iodine value of the extracted oil was estimated by Wijis' method.

3. Results of experiments.

The experimental results obtained by the methods described above were shown in Table 1.

As to mackerel of the Japan Sea Group, the following conclusions may be drawn. (1) The water-content was 70—73% in all parts of the fish body; it seemed that the water content in the outside belly tissue and tail tissue parts were rather less. This may happen because those parts have larger quantities of fat-content than other parts of tissue. (2) In the outside belly tissue and tail tissue parts the fat-content amounted to 7—12%; the fat content of those parts was larger than that of other parts. The amounts of water content, ash and crude protein in those parts were contrariwise less than in other parts. The fat content in the various parts of the fish body amounted to only about 10%. (3) The amount of crude protein came to about 23% in each inside part of the fish body, and about 20% in each outside part. The fat content of the outside belly tissue which is rich in fat indicated

Table 1. Proximate components of mackerel meat (in the comparison between Groups from Japan Sea and those from the Pacific Ocean).

Samples	Parts		Water content (%)	Ash (%)	Ether extract (crude fat) (%)	Characteristics (Body oil)	Crude protein (%) (Total-N ×6.25)	Total nitrogen (%)	Soluble nitrogen: Water soluble (%)	Soluble nitrogen: Hot-water soluble (%)	Soluble nitrogen: 0.3% NaCl soluble (%)	Non-protein nitrogen (%)	Volatile basic nitrogen (mg %)	Amano's reaction ($HgCl_2$ reaction)
Mackerel caught in the Japan Sea coast near Yoichi (June.)	A_1	Outside of back tissue	72.99 (0.00)	1.33 (4.93)	5.05 (1.87)	Acid value 12.8	20.5 (75.9)	3.28 (12.1)	1.16 [35.4]	0.76 [23.2]	1.12 [34.2]	0.98 [29.9]	17 [0.52]	A ± B −
	A_2	Inside of back tissue	72.72 (0.00)	1.43 (5.24)	0.95 (3.48)		22.6 (82.8)	3.62 (13.2)	1.70 [47.0]	0.91 [25.1]	1.28 [35.4]	0.94 [26.0]	3.8 [0.105]	〃
	B_1	Outside of belly tissue	69.74 (0.00)	1.03 (3.41)	11.88 (39.3)	Saponification value 190.4	16.3 (53.9)	2.61 (8.63)	0.83 [31.8]	0.81 [31.0]	0.97 [37.2]	0.71 [27.2]	16 [0.61]	〃
	B_2	Inside of belly tissue	74.06 (0.00)	1.30 (5.01)	1.41 (5.44)		23.1 (89.1)	3.70 (14.2)	1.13 [30.6]	0.92 [24.9]	1.70 [46.0]	0.89 [24.1]	3.2 [0.087]	〃
	C_1	Outside of tail tissue	69.92 (0.00)	1.12 (3.74)	7.6 (25.35)		21.0 (70.1)	3.37 (11.23)	0.90 [26.7]	0.80 [25.8]	1.04 [30.9]	0.71 [21.1]	3.8 [0.11]	〃
	C_2	Inside of tail tissue	72.92 (0.00)	1.40 (5.17)	0.80 (2.95)	Iodine value 170.3	23.7 (87.5)	3.80 (14.0)	1.00 [26.3]	0.65 [17.1]	1.23 [32.4]	0.72 [18.9]	1.5 [0.04]	〃
	Average		72.06 (0.00)	1.27 (4.55)	4.62 (16.5)		21.2 (75.8)	3.4 (12.2)	1.12 [33.0]	0.75 [19.6]	1.22 [32.1]	0.83 [24.4]	7.55	
Mackerel caught in the Pacific Ocean coast near Kushiro (October)	A_1'	Outside of back tissue	64.86 (0.00)	1.08 (3.08)	9.95 (28.3)		23.94 (68.2)	3.83 (10.9)	1.90 [49.6]	0.75 [19.6]	1.65 [43.1]	0.99 [25.8]	6.2 [0.16]	A ± B −
	A_2'	Inside of back tissue	70.33 (0.00)	1.30 (4.38)	2.10 (7.09)	Acid value 7.5	25.75 (86.8)	4.12 (13.9)	1.59 [38.6]	0.40 [9.72]	1.27 [30.9]	0.48 [11.6]	5.4 [0.13]	〃
	B_1'	Outside of belly tissue	54.54 (0.00)	0.82 (1.81)	26.84 (59.1)		17.31 (38.1)	2.77 (61.0)	1.12 [40.5]	0.56 [20.2]	1.63 [58.9]	0.94 [34.0]	23.0 [0.83]	〃
	B_2'	Inside of belly tissue	60.17 (0.00)	1.44 (3.62)	8.84 (22.2)	Saponification value 172.6	29.0 (72.8)	4.64 (11.6)	1.39 [30.0]	0.41 [8.84]	1.52 [32.7]	0.49 [10.5]	3.63 [0.088]	〃
	C_1'	Outside of tail tissue	57.47 (0.00)	0.99 (2.32)	18.38 (43.1)		22.56 (53.0)	3.61 (8.48)	0.4 [11.1]	0.26 [7.20]	0.89 [2.46]	0.39 [10.8]	7.40 [0.205]	〃
	C_2'	Inside of tail tissue	69.32 (0.00)	1.27 (1.15)	1.82 (5.93)	Iodine value 196.7	27.12 (88.3)	4.34 (14.1)	1.20 [27.7]	0.34 [7.85]	0.78 [18.0]	0.62 [14.3]	8.48 [0.195]	〃
	Average		62.78 (0.00)	1.15 (3.09)	11.32 (30.4)		24.28 (65.3)	3.89 (10.44)	1.27 [32.7]	0.45 [11.6]	1.29 [33.2]	0.65 [16.7]	9.02	〃

Note: The numbers in ( ) show the percentage to dried matter, in [ ] show the percentage to total nitrogen.

about 16%. (4) The amount of non-protein nitrogen was about 1% of the maximum value in the back tissue of the fish body and about 0.7% of the minimum value in the tail tissue. (5) The amount of cold-water soluble nitrogen measured 0.8~1.7% in the mackerel meat of the Japan Sea Group, the amount of this component is small in the outside part of the tissue which is rich in fat content, and the amount of this component in the back tissue is rather larger than in other parts of the tissue. (6) The amount of hot-water soluble nitrogen measured 0.7~1%, no difference was indicated by parts of tissue; the amount is pretty small in the tail tissue. (7) The amount of 0.3% NaCl-solution soluble nitrogen ranged 1~1.3%, no difference was notable by parts of tissue. (8) The amount of volatile basic nitrogen indicated 1.5~17 mg%. The amount of volatile basic nitrogen in outside as tested tissue is larger than in inside tissue. (9) The freshness of the mackerel meat by mercuric chloride reaction was pretty unfresh. This is because the mackerel was brought in ice.

Next, as to mackerel of the Pacific Ocean Group, the following conclusions were reached. (1) The amount of water content, ash and crude protein became less in order from the back tissue to the tail and belly tissue in both outside and innerside parts. In the same tissue part, the amounts of those chemical components of the innerside parts were larger than those of outside parts. (2) The fat content was the reverse of these chemical components. That is to say, the amount of fat was the richest in the belly tissue, followed by the tail tissue and the back tissue. The amount of fat of the outside part tissue was generally larger than that of the innerside part tissue. Here it is remarkable that the fat layer attached whitishly along the visceral and digestive organs. From this fact we know that mackerel of the Pacific Ocean Group has a larger quantity of fat. (3) The amount of non-protein nitrogen measured generally 0.4~1.0%, the amount of those components being especially rich in the outside part tissue. (4) The amount of the cold-water soluble nitrogen indicated 1~2% except in the outside tail tissue. The amount of the components of the innerside tissue was considerably greater than those of the outside tissue. (5) The amount of hot-water soluble nitrogen indicated 0.2~0.8%. This amount of such components of the tail tissue was less than in the other tissue parts. (6) The amount of 0.3% NaCl solution soluble nitrogen indicated 0.8~1.7%. The amount found in the tail tissue and innerside part tissues were comparatively small. (7) The amount of volatile basic nitrogen ranged 3.6~23 mg%; there are differences of the amounts of this component in various parts of tissue. We cannot state absolutely the tendency of the difference of the amount of this component. (8) The freshness of the sample of mackerel of the Pacific Ocean Group was also detected by the Amano's reaction to be pretty unfresh. This is also because of the transportation in ice.

At last, the comparison of the amounts of chemical components between

mackerel of the Japan Sea Group and the Pacific Ocean Group are as follows: (1) The amount of water- and ash- content of mackerel tissue of the latter Group was less than that of the former Group through all the parts. (2) The amount of fat content of the latter Group was especially larger than that of the former Group. This fact agrees with the practical knowledge of canners. (3) The acid value and the saponification value of the oil which was extracted from the mackerel body of the former Group were considerably larger than the oil extracted from mackerel body of the latter Group, but the iodine value of the extracted oil measured reversely. (4) The amount of the crude protein of mackerel of the latter Group was more than that of the former Group. (5) The amount of non-protein nitrogen of mackerel of the former Group was more than that of the other. (6) The cold-water soluble nitrogen of mackerel of the latter Group was larger in amount than that of the former Group. (7) The amount of hot-water soluble nitrogen of mackerel of the former Group was larger than that of the latter Group. (8) There was little difference in the amount of 0.3% NaCl solution soluble nitrogen between both the groups.

4. Conclusion

There are some differences in the chemical components of mackerel tissue between the fish of the Japan Sea Group and those of the Pacific Ocean Group according to the stage of their migration. The greatest difference between the two groups is found in the fat content of mackerel tissue; there is especially a remarkable difference of fat content in the belly tissue and the tail tissue. The water-contents of those parts of mackerel tissue differ reversely to the amount of fat contents of mackerel meat are supposed to have some connection with the quality of canned mackerel meat. The writres wish to clear that connection in later experiments.

Literatures cited

(1) T. Uno and S. Nakamura (1950): J. of the Hokkaido Fish. Sci. Inst. (in Japanese), Vol. 7, No. 12, p. 36.

(2) K. Amano and H. Uchiyama (1948): Bull. Jap. Soc. Sci. Fish. (in Japanese), Vol. 14, No. 1, p. 48.

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