STUDIES ON THE MANUFACTURE OF CANNED MACKEREL.

PART II. RELATION BETWEEN THE FRESHNESS OF MACKEREL MEAT AND THE QUALITY OF THE CANNED PRODUCT.

Eiichi TANIKAWA, Susumu AKIBA, Yasunosuke INOUE, Minoru AKIBA and Terushige MOTOHIRO.

Faculty of Fisheries (Hakodate), Hokkaido University.

It is well known that the quality of canned fish meat depends decidedly on the freshness of the raw material fish. Canned mackerel meat is no exception.

To make good quality canned mackerel, absolutely good fresh raw material fish is necessary. However, the active mackerel fishing seasons in the seas surrouding Hokkaido are from June to July on the Japan Sea Coast, and from July to August on the Pacific Ocean Coast. These seasons are high in temperature and have high percentage of humidity. It is well known that these conditions are unsuitable for keeping good freshness of raw material fish. It is difficult to keep freshness of fish even if the raw material is handled carefully in ice from the catching to the packing.

Mackerel meat is autodigestible, as the saying is "mackerel stinks alive". Sakai[1], Oya[2], Ogura and Fujikawa[3] have studied the autodigestion of mackerel meat. Oya[2] has found that the rate of autodigestion of fish meat of red flesh such as mackerel and tuna is larger than that of white flesh such as flat fish and common sea-bass, he found that optimum hydrogen ion concentration of mackerel meat is 4.5.

Kimata[4] has studied the decomposition of mackerel meat and found that when the meat begins to putrefy after autodigestion, the putrefying velocity constant of fish meat of red flesh is larger than that of fish meat of white flesh. He said that the optimum temperature of putrefaction of mackerel meat is 25°C, and the putrefying velocity constant depends on the size of the mackerel, e. g. mackerel in larger size is not subject to putrefaction. Nickerson, Goldblith and Procter[5] have studied the comparison of enzymatic with bacterial changes in mackerel tissues which were irradiated with supervoltage cathode rays [irradiation dosage of 1,500,000 roentgensequivalent-physical (rep) was used]. They have found that in the decomposition of mackerel meat, enzymatic action is considered to be of relatively greater importance than bacterial-action.

The writers have studied how the degree of freshness of mackerel meat which is autodigestible and whose good freshness is difficult to keep, is connected with the suitability for use as the raw material for canned macke-

rel. Here the writers will report the results obtained.

EXPERIMENTS

1. Samples.

Mackerel which were caught in the Japan Sea near Yoichi and in the Pacific Ocean near Kushiro in the active fishing season and transported to the laboratory in ice as described in Report I were used for the experiment.

2. Experimental procedure.

Samples as above described were left alone at room temperature (15°—16°C) and the degree of freshness of the mackerel meat was allowed to deteriorate. 20 gm of each of those samples left alone was taken at definite hour intervals for determining the freshness of meat by the estimation of the amount of volatile basic nitrogen, amino acids, number of bacteria, pH values and mercuric chloride reaction (Amano's reaction). Another part of each sample was respectively packed in one pound tall cans. In the processing of the cans, they were exhausted by steam exhausting box or vacuum seamer.

The samples of thus processed canned mackerel were left alone for a month, then the amounts of the volatile basic nitrogen, amino acid nitrogen and the hydrogen ion concentration were estimated. The condition of the contents of each can of mackerel was observed.

The amount of amino acid nitrogen was estimated by Pope-Stevens' method[6] after removing protein in 10 gm of the samples by adding 10% Cl_3COOH. The number of bacteria was estimated by plate culture from tenth dilution. Mercuric chloride reaction was determined as described in Report I.

3. Results of Experiments.

Experimental results obtained are shown in Tables 1 and 2. The experimental results which are described in Tables 1 and 2 are summarized as follows.

(1) In spite of leaving fish body (unviscerated) at room temperature (above 15°C), the amount of volatile basic nitrogen did not much increase in proportion to the lapse of time, unlike the case of carp meat[7] or squid meat[8]. For example, the amount of volatile basic nitrogen of mackerel meat left alone at room temperature for 30 hours was 29.17 mg%. On the contrary, the increasing of the amount of amino acid was remarkable. This fact shows that the autodigestion of mackerel meat lasts for a long time as was formerly stated by Nickerson, Goldblith and Procter[5].

Of course, mackerel meat in which 29 mg% of the amount of volatile basic nitrogen was accumulated smells stale. Bacterial counts increased rapidly in samples having between 20—30 mg % of the accumulation of volatile basic nitrogen.

(2) The pH value of raw mackerel meat decreased with the falling freshness of the meat, and then afterward increased gradually. From this tendency of change of pH value, it is known that the freshness of mackerel meat can be detected by mercuric chloride reaction (Amano's detecting method). The results

Table 1. Relation between the freshnees of raw mackerel meat caught in Japan Sea just before processing and the quality of canned mackerel.

Kinds	Items. \ Leaving time (hrs.)		0	12	18	25	27	30
Fish body left at room temperature	Volatile basic nitrogen (mg %)		2.03	16.22	21.24	20.67	27.18	29.17
	Amino acid nitrogen (mg %)		75.5	142.3	131.2	259.4	347.5	577.2
	Bacterial counts		13×10^2	41×10^3	88×10^3	94×10^3	105×10^3	130×10^3
	pH		5.8	5.6	6.0	6.0	6.2	6.2
	$HgCl_2$ reaction	A	−	−	±	±	±	+
		B	−	−	−	−	−	±
	Meat		good	〃	rather inferior	inferior inelastic	〃	putrefied odour
	Temperature of meat (℃)		15	19	22	23	23	24
Can contents packed after steam exhausting	Volatile basic nitrogen (mg %)		3.20	22.12	38.07	46.6	49.33	54.62
	Amino acid nitrogen (mg %)		80.75	130.2	141.5	249.6	381.5	562.5
	pH		6.4	6.4	6.5	6.6	6.6	6.8
	Vacuum (inch)		6	6	13	10	10	6
	Odour		good	〃	strange smell	rather strange smell	〃	〃
	Colour		good	〃	light pink	〃	〃	〃
	Curd		much	〃	〃	〃	〃	〃
	Liquid		clear	〃	turbid	〃	〃	〃
	Meat		good	〃	fragile	〃	〃	〃
	Crumbing of meat		none	〃	crumbled	〃	〃	〃
	Criticism		excellent	good	inferior	〃	〃	〃
Can contents packed with vacuum seamer.	Volatile basic nitrogen (mg %)		5.76	25.01	36.97	41.84	46.65	50.82
	Amino acid nitrogen (mg %)		92.44	141.5	147.8	311.5	375.4	624.2
	pH		7	7	7	7	8	8
	Vacuum (inch)		—	—	—	—	—	—
	Odour		good	〃	rather strange smell	strange smell	〃	〃
	Colour		good	〃	light pink	〃	〃	〃
	Curd		rather a deal	〃	little	〃	〃	〃
	Liquid		clear	〃	turbid	〃	〃	〃
	Crumbling of meat		none	〃	crumbled	〃	〃	〃
	Quality of meat		good	〃	fragile	〃	〃	〃
	Criticism		excellent	good	inferior	〃	〃	〃

Table 2. Relation between the freshness of raw mackerel meat caught in Pacific Ocean just before processing and the quality of canned mackerel.

Kinds	Items. \ Leaving time (hrs.)		0	5	10	20	25
Fish body left at room temperature	Volatile basic nitrogen (mg %)		6.24	11.21	26.24	43.42	54.76
	Amino acid nitrogen (mg %)		115.4	147.8	324.5	308.9	612.5
	pH		5.6	5.8	6.2	6.4	6.8
	$HgCl_2$ reaction	A	−	−	±	+	+
		B	−	−	−	±	+
	Quality of meat		rather inferior, crumbled	〃	〃	inferior, strange smell	putrefied odour
	Temp. of meat		22	25	26	27	28
Can contents packed after steam exhausting	Volatile basic nitrogen (mg %)		10.14	20.22	47.14	58.12	56.66
	Amino acid nitrogen (mg %)		119.1	155.2	375.4	365.8	598.7
	pH		6.4	6.4	66	6.8	6.8
	Vacuum (inch)		4.5	5	7	4.5	4.5
	Odour		good	〃	rather strange	stange smell	〃
	Colour		good	〃	〃	rather pink	light pink
	Liquid		clear	〃	rather turbid	turbid	〃
	Quality of meat		good	〃	rather fragile	fragile	〃
	Crumbling of meat		crumbled	〃	〃	〃	〃
	Curd		much	〃	〃	〃	〃
	Criticism		excellent	good	inferior	〃	〃
Can contents packed with vacuum seamer	Volatile basic nitrogen (mg %)		12.74	24.37	49.97	54.57	63.14
	Amino acid nitrogen (mg %)		120.3	161.4	341.1	375.4	520.4
	pH		6.4	6.4	6.6	6.8	6.8
	Vacuum (inch)		5	6.5	5	4	6
	Odour		good	〃	rather strange smell	strange smell	〃
	Colour		good	〃	〃	light pink	〃
	Quality of meat		good	〃	rather fragile	fragile	〃
	Crumbling of meat		crumbled	〃	〃	〃	〃
	Curd		rather a deal	〃	little	〃	〃
	Liquid		clear	rather turbid	〃	turbid	〃
	Criticism		good	rather good	inferior	〃	〃

obtained by the mercuric chloride reaction agreed with the rapid increasing point of bacterial counts and with the point of the amount of 30 mg% of volatile basic nitrogen accumulated in mackerel meat.

(3) The incipient putrefaction of mackerel meat corresponds to the accumulation of 30 mg% of volatile basic nitrogen. Until to the accumulation of 30 mg% of volatile basic nitrogen, no organoleptic change except decreasing of elasticity of meat was distinguishable.

(4) As mackerel of the Pacific Ocean Group was caught at high temperature in August, even if it was left as long as the mackerel of the Japan Sea Group, the amount of accumulated volatile basic nitrogen was larger than that of the mackerel of the Japan Sea Group. However, the stale odours corresponded to the accumulation of about 30 mg% of volatile basic nitrogen.

(5) In the case of packing with the raw material of mackerel which was left alone at room temperature (15°—28°C) and became unfresh in various degrees, when the raw material which had accumulated 20—26 mg% of volatile basic nitrogen, was packed in can, the amount of volatile basic nitrogen was accumulated to 30 mg% in the content. The increasing of the amount of volatile basic nitrogen was due to the method of processing.

(6) Therefore in order to make good quality canned mackerel, we must use the raw material meat which has accumulated less than about 16 mg% of volatile basic nitrogen.

(7) There was no difference of the quality of canned mackerel exhausted by steam exhaust box or vacuum seamer in the case of use of raw materials which had become unfresh to various degrees.

(8) The curd (a clot of coagulated protein at the top of the content in the can) is formed from more strictly fresh raw material of mackerel than from some unfresh material.

CONCLUSION

From the experimental results as above described, it is known that good quality canned mackerel cannot be produced when use is made of raw material which accumulated above 20 mg% of volatile basic nitrogen or indicated the score of A± and B− by the mercuric chloride reaction (the raw material is in the state of incipient putrefaction). As the mercuric chloride reaction is both the simplest and the most accurate method, the freshness of the raw material must be measured by the mercuric chloride reaction (Amano's reaction) in the case of manufacturing of canned mackerel.

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