CHEMICAL STUDIES ON THE MEAT OF "SUKETODARA" (*THERAGRA CHALCOGRAMMA*)-Ⅱ

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Ⅲ. CHEMICAL PROPERTIES OF "SUKETODARA" MEAT PROTEIN

4. The change in the amount of proteins dissolved out during bleaching of the "Suketodara" meat in water or 0.6 Mol NaCl solution

When the "Suketodara" meat is soaked in water or NaCl solution, the kind of protein dissolved out from the meat is different as described in the previous experiment[1]. The amount of the protein dissolved in soaking water during the processing of fish paste is considered to influence the quality of the fish paste products.

Here, the authors have examined the change of the dissolved amounts of proteins from the "Suketodara" meat soaked in water or 0.6 Mol NaCl solution for various length of time by estimating the amount of nitrogen dissolved out.

(1) Experimental method

Fresh "Suketodara" was filleted, the meat was removed from the skin and homogenized. Each 5 g of the homogenized meat was put into bottles containing each 50 cc of distilled water or 0.6 Mol NaCl solution and each bottle was shaken and stored. The storing time was 10, 30, 60, 120 minutes and 19, 24 hours at room temperature (at 15°C). After each definite storing time, each bottle was shaken and each content was centrifuged. The total amount of nitrogen in the upper transparent liquor of each content was determined.

The ratio of the dissolved amount of nitrogen to the total amount of nitrogen in the raw meat was calculated as the solubility (%). Also, the intensity of flow birefringence of the upper clear liquor of each content was examined.

Table 15. Changes in the solubility of "Suketodara" (*Theragra chalcogramma*) meat with water and flow birefringence, during the soaking in water for various times

Soaking time	Solubility (% in Total-N)	S.B.
10 mins.	28.13	—
30 〃	28.36	—
60 〃	28.37	—
120 〃	29.29	—
19 hrs.	30.44	—
24 〃	30.53	—

(2) Results

Results are shown in Tables 15 and 16.

As seen in Table 15, the solubility with water increased with the increase of the soaking time; after 19 hours the solubility reached constancy about 30 %. Each extracted solution did not show flow birefringence.

As seen in Table 16, the solu-

Table 16. Changes in the solubility of "Suketodara" (*Theragra chalcogramma*) meat with 0.6 Mol NaCl solution and flow birefringence, during soaking in NaCl solution for various times

Soaking time	Solubility (% in Total-N)	S.B.
10 mins.	—	—
30 〃	44.28	—
60 〃	47.73	—
120 〃	47.27	—
19 hrs.	48.11	—
24 〃	48.20	—

bility with 0.6 Mol NaCl solution increased becoming larger than that with water at initial storing time.

The solubility reached constancy after 19 hours' storage, about 48 %.

No extraction showed flow birefringence as was also true in the previous experiment.

From the results obtained, it was clear that solubility with water or 0.6 Mol NaCl solution increases with the prolongation of the soaking time. But the increase of solubility became almost constant after soaking of 30 minutes. If the time of soaking is longer than 30 minutes, the yield amount of fish paste becomes less. Therefore, when the raw material of fish paste is soaked in water or NaCl solution as a bleaching (soaking) procedure, the soaking of "Suketodara" meat should be less than about 30 minutes.

5. Swelling of the "Suketodara" meat

Inasmuch as the swelling of protein is considered to be one of the phenomena of lyotropic hydration, the authors have examined the phenomenon of swelling of the "Suketodara" meat immersed in various salt solutions and the relation among the degree of swelling, the kind of salts and the pH. value of the immersion solution, similarly as was done in the case of the meat of sea-cucumber (*Stichopus japonicus*)[2].

(1) The relation between the degrees of swelling and the concentrations of various kinds of salt solutions

In the presence of salts, according to Migita[3], swelling of meat has an intimate relation to the hydration of the structural protein, in low concentration (0.05 ~ 0.1 Mol) electro-chemical adsorption of salt ions on protein molecules is carried on, and in medium concentration (0.2 ~1.0 Mol) the salt will be adsorbed surface-chemically by protein molecules. At any rate, hydration is accelerated in the range of concentrations as above stated.

The present authors have observed swelling of the "Suketodara" meat soaked in various concentrations of several kinds of salt solutions.

1) Experimental method

Fresh "Suketodara" was filleted ; blocks of the meat (2~3 g) were taken, and accurately weighed.

Each block was immersed in 50 cc of the following various salt solutions at room temperature for about 24 hours. After taking up from immersion liquid, moistened water on the surface of the blocks was wiped off with a filter paper, and the weight of each block was measured. The ratio of the weight of the block meat after immersion (W) to the weight of the block meat before immersion (W_o) was calculated as the degree of swelling (S) of the sample meat ($S=W/W_o$).

Salt solutions employed were NaCl, KCl, $MgCl_2$, K_2SO_4, KCNS, $NaNo_3$, $CH_3COONa \cdot 3H_2O$, $C_3H_4OH(COONa)_3$, NH_4Cl, Na_2CO_3 solutions of 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 and 2.0 Mol and $Na_2B_4O_7 \cdot 10H_2O$ or $Na_3PO_4 \cdot 12H_2O$ solutions of 0.05, 0.1, 0.2, 0.3, 0.4 and 0.5 Mol. As contrast, distilled water was also employed.

(2) **Results**

Results obtained are shown in Figs. 12~14.

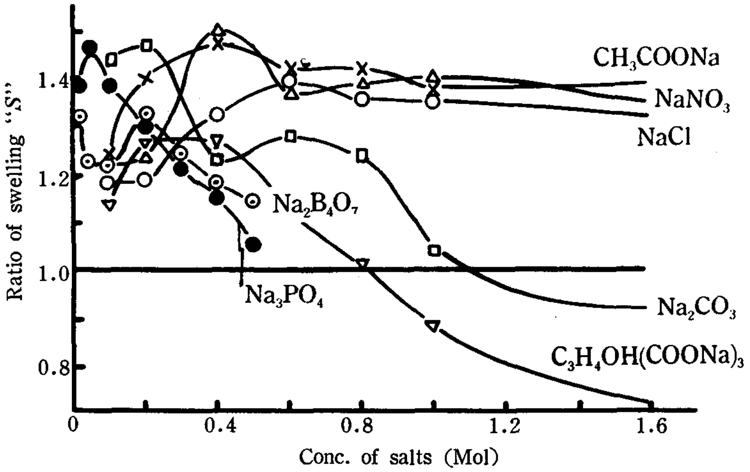

Fig. 12. Degree of swelling of "Suketodara" (*Theragra chalcogramma*) meat in the case of varying anions upon Na^+

As seen in Fig. 12, concerning the influence of varying anions upon Na^+, in monovalent salts, such as NaCl, $NaNO_3$ and CH_3COONa, the degree of swelling of the block meat shows maximum at near 0.4 ~ 0.6 Mol concentrations. In bivalent salts solutions, such as Na_2CO_3, the maximum was shown at near 0.2 Mol. Therefore, the degree of swelling in the lower concentrations was influenced by the ionic valency of Na^+. Comparing organic acid solutions with inorganic acid solutions, in the same ionic valency, for example in $C_3H_4OH(COONa)_3$ and Na_3PO_4, the degree of swelling in the former solution was larger than that in the latter. This is perhaps due to the difference of the dissociating ability between the two solutions. In the concentration of the solutions at above 0.8~1.0 Mol, when the block meat was immersed in the monovalent salt solution, the degree of swelling was almost constant. On the contrary, in the same range of concentrations above stated, the degree of swelling of the block meat immersed in the bivalent salt solution

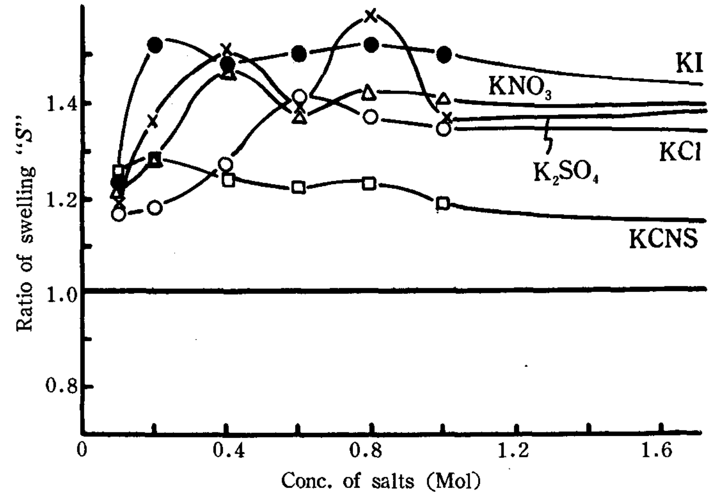

Fig. 13. Degree of swelling of "Suketodara" (*Theragra chalcogramma*) meat in the case of varying anions upon K^+

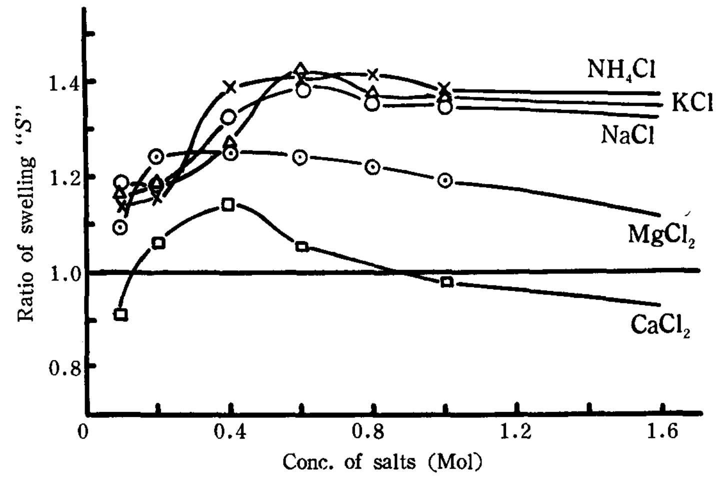

Fig. 14. Degree of swelling of "Suketodara" (*Theragra chalcogramma*) meat in the case of varying cations upon Cl^-

decreased. When the block meat was immersed in Na_3PO_4 or $Na_2B_4O_7$ solutions the degree of swelling showed the maximum at 0.05 Mol or 0.2 Mol respectively.

As seen in Fig. 13, concerning the influence of varying anions upon K^+, the degree of swelling in the salt solutions differs slightly with the kinds of salts, the large degrees of swelling were shown at 0.4 ~ 0.8 Mol. KCNS is different remarkably from other salts, showing the maximum at 0.2 Mol, and its degree of swelling is considered to be non-dependent on the concentration of that salt solution. In the medium concentration of 1~2 Mol, the solutions of KI, KNO_3, KCl and K_2SO_4 showed the similar degrees of swelling.

As seen in Fig. 14, concerning the influence of varying cations upon Cl^-, in monovalent salt solutions, the degree of swelling shows the maximum at near 0.6 Mol and in bivalent salt solutions the swelling shows the maximum at near 0.4 Mol. In this case, in the lower concentration the degree of swelling depends only slightly on the concentration of the solution. In bivalent salts solutions, such as $MgCl_2$, $CaCl_2$, the degree of swelling shows maximum at near 0.4 Mol, with decrease accompanying increase of the concentration. There is a remarkable difference between the degrees of swelling in monovalent and bivalent salts solution.

From the results described above, the degree of swelling of the "Suketodara" meat varies with differences in the concentrations of the various salt solutions into which it is immersed.

The results obtained from experimental observations on this point are summarized as follows: Below 0.6 Mol of the concentration of salt solutions, the degree of swelling is proportionate to the ion concentration of salts. Above the concentration which shows the maximum degree of swelling, almost all the kinds of salt solutions show decrease of the swelling, especially the degree of swelling in a bivalent salt solution decreased more remarkably than that in a monovalent salt solution. The reason why the degree of swelling decreases above the maximum degree may be due to the fact that until the maximum the meat protein shows swelling because of adsorption of ions, but above the maximum degree, the absorbed water and also a part of bound water in the meat will decrease according to the osmotic dehydrating phenomenon.

That is to say, the equivalent point between the absorption of water by salts and the dehydration is shown as the maximum point of degree of swelling.

(2) The influence of the hydrogen ion concentration upon the degree of swelling of the "Suketodara" meat

As one of the factors influencing the degree of swelling of fish meat, the pH of the solution in which it is soaked has been frequently studied by many investigators[4)5)6)7)8)9)].

The present authors have also studied the influence of pH upon the swelling of the meat of "Suketodara" (*Theragra chalcogramma*).

1) Experimental method

The experimental method and the detection of the degree of swelling were carried on in the same manner as that described in the previous Article.

pH of the immersing solution was adjusted by varying the proportion of the mixture of N/25 HCl and N/25 NaOH covering the range of pH 1 to 13.

2) Experimental result

Results obtained are shown in Fig. 15.

As seen in Fig. 15, the degree of the swelling of the meat is small in the solutions

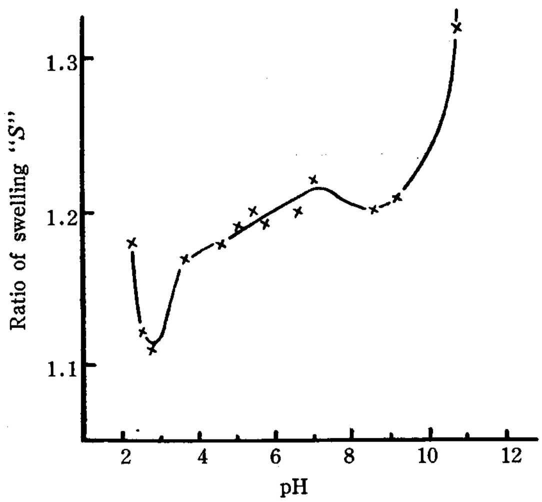

Fig. 15. Degree of swelling of the "Suketodara" (*Theragra chalcogramma*) meat in various pH solutions

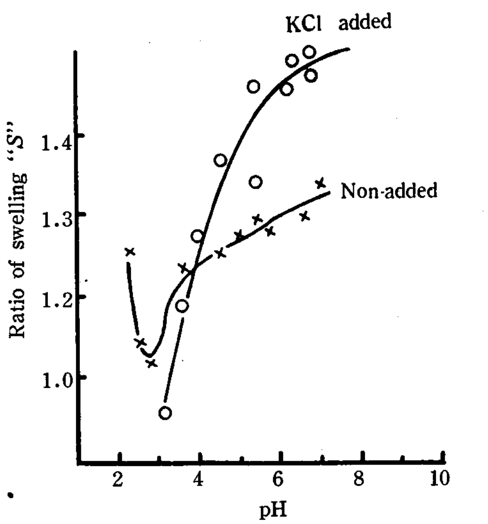

Fig. 16. Degree of swelling of the "Suketodara" (*Theragra chalcogramma*) meat in 0.6 Mol KCl solution having various pH values

on acidic side, but becomes larger from pH 5.0 to the alkaline side.

Generally the swelling or the hydration of protein is minimum in degree at the isoelectric point (pH 5.2~5.4).

Tarr[4], Noguchi[5], Okada[6], and Takahashi[8] have studied the same subject using fish meat or fish skin.

They have observed that the degree of the swelling of fish meat shows minimum value at the isoelectric point (pH 4 ~ 5) and maximum value on alkaline side (pH 10 ~ 12) or acidic side (pH 2 ~ 3).

(3) The swelling of the "Suketodara" meat soaked in various pH solutions in the case of definite concentration of KCl

1) Experimental method

Next, to the immersing solutions having various pH values, KCl was added to make concentration of 0.6 Mol. The swelling of meat blocks soaked in those solutions was estimated similarly to procedure described in the previous Article.

2) Experimental result

Results obtained are shown in Fig. 16.

As seen in Fig. 16, the existence of a neutral salt such as KCl increases the degree of swelling in the various pH solutions. The increase was remarkable until pH 5.2. Above pH 5.2, the swelling became apparently constant. In the acidic side the swelling was inhibited by the presence of KCl. Those results agree with those of Tarr[4] on halibut meat and those of Fujii[7] on Atka mackerel meat.

General speaking, the swelling of the "Suketodara" meat was remarkably large in the alkaline side above pH 5.2 and small in the acidic side below pH 5.2.

6. Dehydration and coagulation of the "Suketodara" meat dy heating

It is important to understand the phenomena of coagulation and ratio of dehydration by heating in order to determine the heating conditions during the processing of fish paste ("Kamaboko").

Here, the authors discuss their attempt to estimate the ratios of absorption of water or of dehydration of the "Suketodara" meat heated in water at various temperatures, and heat coagulation of proteins which were extracted by water or NaCl solution.

(1) Absorption of water or dehydration

When fish meat is soaked in water at comparatively lower temperatures, the meat absorbs water, but when the meat is heated in hot water dehydration occurs.

1) Experimental method

Fresh "Suketodara" was filleted. The skin was removed from the meat. Blocks of the meat, $1\times1\times1$ cm ($2\sim3$ g), were prepared, and weighed. Some blocks were put into a beaker containing 50 cc of water. The temperature of the water was brought up slowly to each pre-determined definite temperature from 20° to 90°C by heating. After the blocks were heated at each definite temperature for 10 minutes, they were taken out from the beaker, and cooled. The water attached to the surface of the blocks was wiped off with filter paper. The blocks were then weighed. The difference between the weight of the block before and after the immersing in heated water was obtained and the ratio of the difference to the original weight was calculated.

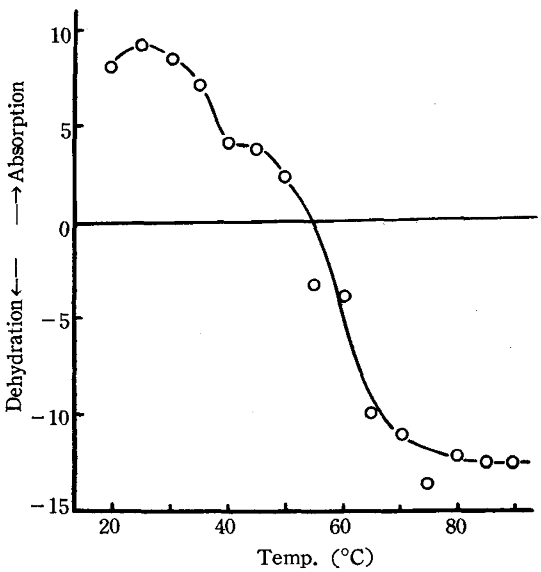

Fig. 17. Curves of temperature-ratios of absorption of water or dehydration

If the original weight (A) is less than the weight (B) of a block after the soaking, the ratio shows minus; this is the ratio of absorption of water. But if the original weight (A) is larger than the weight (B) of block after the soaking, the ratio shows plus ; this is ratio of dehydration.

At each temperature, each ratio was plotted on a graph and curves were drawn of temperature-ratios of absorption of water or dehydration.

2) Experimental results

Results obtained are graphed in Fig. 17.

As seen in Fig. 17, with the boundary at 55°C, the meat absorbs water below 55°C, and it dehydrates above 55°C. In the part of the curve showing absorption of water, there were two stages. The first step of the absorption ended at 40°C; the second step began at 50°C and ended at 65°C. In the part of curve showing dehydration, above 70°C the ratios of dehydration showed almost constant. At this point, all the proteins in the meat seemed to be completely coagulated, and the ratio of dehydration attained to the maximum. On the basis of those observations, there seem to be two kinds of proteins in the "Suketodara" meat. One of them corresponds to myosin and the other corresponds to myogen.

(2) Heat coagulation

When fish meat is heated in water, the proteins in the meat are coagulated at a certain temperature according to the kind.

1) Experimental method

Fresh "Suketodara" was filleted. The skin was removed from the meat, and the meat was homogenized to make a sample. To 100 g of the homogenized meat 300 cc of dist. water was added. The mixture was left for one hour with occasional agitation. After having been left, the mixture was filtered. Ten cc portions of the filtrate (water-soluble protein) were poured separately into test tubes. Those test tubes were heated separately at each definite pre-determined temperature from 35°C to 85°C for 10 minutes. After the heating, the test tubes were cooled rapidly, and the solution was filtered. The total amount of nitrogen in 5 cc of the filtrate was estimated by Kjeldahl's method. The difference in the amount between that in a definite volume (5 cc) of the filtrate (non-coagulable protein) and in that of the original water-soluble protein solution was considered to be the coagulable protein. Similarly the amounts of coagulable protein in the meat heated in 0.5 Mol NaCl solution at various temperatures was estimated.

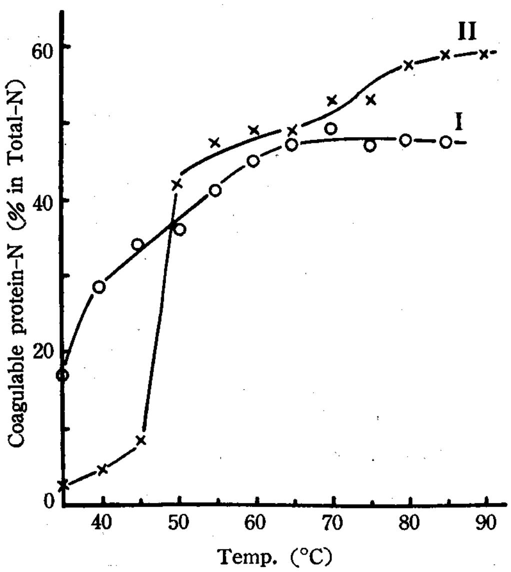

Fig. 18. Curves showing the changes of the amounts of heat coagulable protein of "Suketodara" (*Theragra chalcogramma*) meat

I …Water soluble protein

II …NaCl solution soluble protein

2) Experimental results

Results obtained are shown in Fig. 18.

As seen in Fig. 18, the heat coagulation of water-soluble protein was completed at 60° ~ 65°C. At the coagulating point, the amounts of the protein were constant showing as 45 ~ 47 % of the total water-soluble protein.

The curve showing the water-soluble protein ascended gradually from about at 35°C, and became constant at 60° ~ 65°C. The main component of the coagulable protein in this case is considered to be myogen.

On the other hand, the heat coagulation of NaCl solution-soluble protein is continued gradually from 35° to 45°C, but it is continued rapidly from 45°C to 55°C and it becomes slow from 60°C. The coagulation is again caused to occur pretty rapidly from 70°C to 75°C. That is to say, there are observed in this curve two steps indicating the presence of two kinds of proteins. One of the proteins which is coagulated at the lower temperature is actually myosin, while the other at higher temperature is considered to be myogen. The presence of two kinds of proteins was also observed in the absorption curve obtained as described in the previous article.

7. Hydration of the "Suketodara" meat

In order to find out about the hydration of "Suketodara" meat, the water-content (g) — relative vapour pressure (p/p_0) curve in the fresh raw meat was determined, and compared with that of other kinds of fish meat.

Similarly the curves in frozen "Suketodara" meat prepared by rapid or slow freezing methods which was stored during various periods at low temperature were determined, and the relation between hydration and freezing or storing was ascertained.

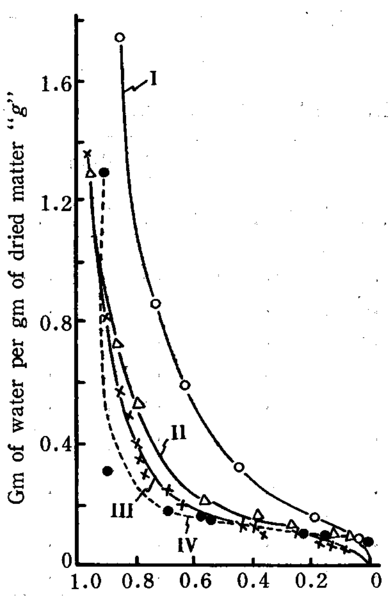

Fig. 19. Comparison of "g—p/p_0" curve of the "Suketodara" meat with that of other kinds of fish meat

I ···Suketodara
II ···Atka mackerel
III ···Squid
IV ···Sea-cucumber

(1) Fresh raw "Suketodara" meat

1) Experimental method

The relation between water-content (gram of water per 1 g of the dried matter), "g" and relative vapour pressure (p/p_0) in fresh "Suketodara" meat (water-content 81.18 %, volatile basic nitrogen 5.34 mg%) was determined at 20°C by vapour tension method[10].

2) Experimental result

The result obtained from the fresh raw "Suketodara" meat is shown as curve I in Fig. 19. In the same Fig., curve II is for Atka mackerel (20°C)[7], curve III is for squid (20°C)[10]; curve IV is for sea-cucumber meat (18°C)[2].

As seen in Fig. 19, when water in each sample shows the same relative vapour pressure (that is water-activity "a"), the hydrating affinity decreases in the order "Suketodara", Atka mackerel, squid and sea-cucumber. That is to say, the hydrating affinity is the strongest in the raw meat of "Suketodara".

(2) **Frozen "Suketodara" meat**

1) Experimental method

Several filleted meat samples of fresh raw "Suketodara" were divided into two groups. One group was rapidly frozen at -29°C in a contact freezer, and the other was slowly frozen at -17°C in an air-freezer.

After freezing of each sample, they were enveloped in polyethylene paper and placed in cold storage at -17°C for definite periods (22, 50 and 90 days).

After the storing, the amounts of water, nitrogen and drip were estimated. At the same time, the relation between water-content and relative vapour pressure was estimated by the same method as that described above.

2) Experimetal result

The results of chemical analysis are shown in Table 17. The curves showing water-content—relative vapour pressure ("g-p/p_o") are shown in Figs. 20~22.

Table 17. Chemical results of analysis of frozen and stored "Suketodara" meat

Storage / Freezing method / Items	0	· 22 days		50 days		90 days	
	Raw meat	Quick Freezing	Slow Freezing	Q.F.	S.F.	Q.F.	S.F.
Total-N (%)	2.35	2.67	2.63	2.56	2.54	2.58	2.48
Water content (%)	81.18	79.87	80.23	80.44	81.59	79.98	83.75
Protein-N (%)	2.26	2.36	2.33	2.36	2.23	2.29	2.15
V.B.-N (mg%)	5.34	8.41	8.67	10.01	10.41	15.35	16.02
pH of the meat	6.2	6.0	6.2	6.2	6.3	6.4	6.4
H_2O-soluble-N (% in Total-N)	37.2	34.7	28.4	28.9	26.2	29.8	26.2
0.5M.NaCl-soluble-N (% in Total-N)	46.0	45.2	36.9	26.37	30.98	33.64	28.00
Free drip (%)	0	10.3	6.7	9.4	8.9	10.8	12.8
Expressible drip (%)	—	6.4	15.5	10.8	21.9	20.8	22.5

As seen in Table 17, during the cold strage, the solubilities of "Suketcdara" meat by water or 0.5 Mol NaCl solution decreased, while the amount of drip increased.

The decreasing of the solubilities of the meat by various solutions and increasing of drip are larger in the slow frozen meat than in the rapid frozen meat. This suggests that the denaturation of meat protein and destruction of the tissue are larger in the meat frozen by slow freezing.

As seen in Figs. 19 and 20, the hydrating affinity of water in the frozen meat

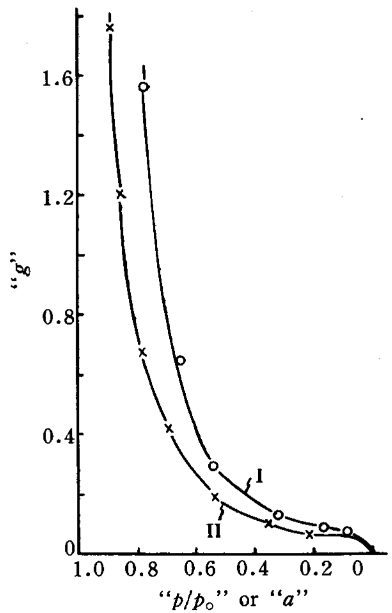

Fig. 22. Comparison of curves of "g—p/p_0" of "Suketodara" samples prepared by rapid and slow freezings

Ⅰ …… Rapid frozen meat (55 days storing)

Ⅱ …… Slow frozen meat (55 days storing)

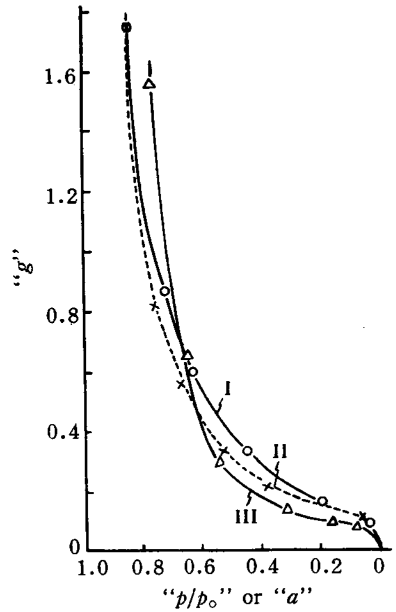

Fig. 21. Curves showing "g—p/p_0" of rapid -frozen "Suketodara" meat

Ⅰ …… Fresh raw meat

Ⅱ …… Frozen meat (22 days storing)

Ⅲ …… Frozen meat (90 days storing)

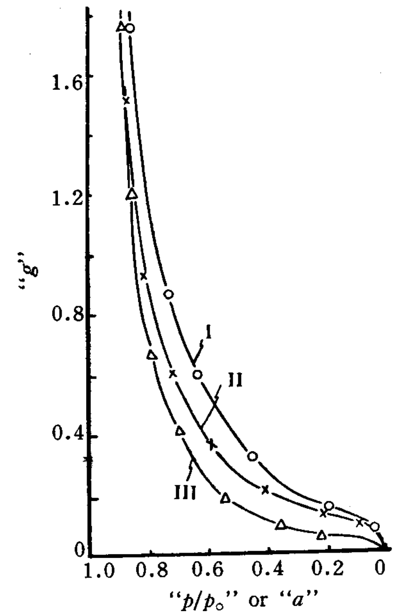

Fig. 20. Curves showing "g—p/p_0" of slow frozen "Suketodara" meat

Ⅰ …… Fresh raw meat

Ⅱ …… Frozen meat (22 days storing)

Ⅲ …… Frozen meat (90 days storing)

became smaller than that in the fresh raw meat when the comparison was made at the same water activity "*a*" (that is p/p_0). In meat frozen by the same freezing method, the hydrating affinity of water in the frozen meat which was stored for a longer period became smaller than in that stored for a shorter period. As seen in Fig. 21, the hydrating affinity of water in slow-frozen meat was smaller than in that frozen by rapid freezing at the same water activity "*a*".

The result obtained as above will suggest that the hydrating affinity of water in fish meat decreases with the denaturation of the meat protein during cold storage.

General Discussion

The Suketodara-fish which are abundantly caught in Hokkaido, Japan, are employed to process for dried goods (*e.g.* dried "Suketodara" after freezing, "Mintai"), or for salted and dried goods (*e.g.* filleted dried "Suketodara", "Sukimidara").

However, recently with the prosperity of the processing of fish sausage or fish ham the "Suketodara" meat has also attracted attension as a additive raw material for them.

Like Japanese fish paste, such as "Kamaboko" or "Chikuwa", fish sausage and fish ham are manufactured by homogenizing two or more kinds of fish meat with salt, and by heating to coagulate. The first physical necessity as the raw material for fish sausage and fish ham or Japanese fish pastes is strong elasticity of the meat pastes when the raw materials are processed.

Gengerally speaking, "Suketodara" meat as a raw material shows comparatively weak elasticity of the pastes[11]. Before estimating the value as the raw material for fish pastes, the authors undertook a fundamental investigation of the properties of the meat of "Suketodara".

In comparison with other fishes (*e.g.* Atka mackerel[7] etc.), "Suketodara" meat has scarce fat and protein (See above Chapter I, Articles 1 and 2[1]).

On the other hand, the kinds of proteins of the "Suketodara" meat and the nitrogen distribution in the meat extractive and the composition of amino acids in the protein are almost the same as corresponding characters of other fishes (See Chapter I, Article 3).

Therefore, the more plain taste of the "Suketodara" meat than that of other fish meat is not attributable to the composition of amino acids. Shimidu[11] has said that the taste rapidly becomes worse with falling of freshness. This will be explained somewhat by the more rapid velocity of fall in freshness of the "Suketodara" meat than that of other fishes (See Chapter II[1]). On the other hand, the more plain taste will also be explained by the scarce fat and low solubility of nitrogeneous components by 0.6 Mol NaCl solution (*e.g.* about 40% for "Suketodara" meat, and about 50% for Atka mackerel) (Chapter III, Articles 1, 3, 4), or by the facts of the histological properties in which the muscle tissue is comparatively fine and the amount of body fluid components between connective tissues seems to be small (Chapter II, Article 4[1]).

The fact that successively extracted solutions of "Suketodara" meat with Weber's solution or 0.6 Mol NaCl solution did not show the phenomenon of flow birefringence is peculiar, as compared with other fish meat[2][12]. This fact may perhaps be due to small quantity or different quality of myosin which is the cause of the phenomenon of flow birefringence considering from the fact that the presence of myosin was confirmed by the results from the experiments on the dehydration, hydration or heat coagulation (Chapter III, Article 6). As the elasticity of the fish pastes is said to be influenced remarkably by the quantitative difference of myosin (actomyosin) in fish meat protein[13], the weak elasticity of fish pastes which are processed from "Suketodara" meat will be due to the peculiarity of the meat protein. This point must be further investigated in the future.

As to the phenomenon of swelling of the "Suketodara" meat in various concentrations of various salt solutions, the maximum swelling was observed at 0.4 ~ 0.6 Mol in solutions of monovalent salts, and at 0.2 Mol in solutions of bivalent salts (Chapter III, Article 5). In solutions of bivalent salts, when concentration of the solutions is above 1 Mol, the swelling decreases in the following order, $NH_4^+ > K^+ > Mg^{++} > Ca^{++}$ as to cations, and $I^- > NO_2^- > SO_4^{--} > Cl^- > CNS^-$ as to anions.

The results for tests on the swelling of "Suketodara" meat almost agreed with Fujii's results for Atka mackerel meat[7].

Although as to the relation between pH and the swelling of fish meat, the minimum swelling is said to be shown in the range of the isoelectric point of the meat protein, the minimum swelling of the "Suketodara" meat was not clearly shown at pH 5.0 ~ 5.4 which is in the range of the isoelectric point (Chapter III, Article 2). This perhaps is due to the reason that on the acidic side of the isoelectric point, the acid coagulation of the meat is too strong to show the swelling and the swelling will be restricted.

Therefore, this fact suggests that care must be taken in acidic treatment during the processing of fish paste.

When the "Suketodara" meat is heated in water at various temperatures, it shows absorption of water below 55°C, and dehydration above 55°C (Chapter III, Article 6). On curves showing absorption or dehydration of water there are two steps ; this suggests that there are two kinds of proteins in the "Suketodara" meat; one is a group of proteins coagulated at low temperature (about at 40°C), and the other is that coagulated at comparative high temperature (about 65°C) ; the former agrees with the coagulating temperature of myosin while the latter agrees with the coagulating temperature of myogen.

The dehydrating ratio of "Suketodara" meat at high temperature (above 80°C) is smaller than that of other fish meat. (*e.g.* "Suketodara" meat was about 12%, Atka mackerel meat was about 20%). The point at which the absorption changes to dehydration in the Atka mackerel meat was about 37°C, on the other hand, that in "Suketodara" meat was about 55°C. This observation will show that the "Suketodara" meat is difficult to dehydrate at low temperature.

Those facts will show that the amount of myosin in meat protein of "Suketodara" is small, and the absorption or dehydration is remarkably influenced by the heat-coagulability of myogen in the meat. Considering that squid or sea-cucumber meat which have coarse muscle tissue and a large amount of connective tissue showed great dehydration (each about 35 and 60%), the "Suketodara" meat of which the muscle tissue is compact, seems to have a small amount of dehydration caused by heating.

Further peculiar properties are observed in hydration of the "Suketodara" meat besides the properties of the proteins or histological structure (Chapter III, Article 7). When the curve showing water-content (g) — relative vapour pressure (p/p_o) relation in "Suketodara" meat was compared with that of other fish, the amount of the hydrating affinity decreased in the order of "Suketodara", Atka mackerel, squid and sea-cucumber at the same relative vapour pressure (p/p_o) (*i.e.* at the same water activity, "a"). This observation was contrary to the supposition that the "Suketodara" meat having scarce fat and large amount of water-content would at first have a large amount of free water. The authors have considered that the difference or order of the bound water in meats of various kinds of fish may be due to qualititative or quantitative differences in tissue proteins. But this point must be further investigated in the future.

Summary

Before investigating the utilization of the meat of "Suketodara" which are caught abundantly in Hokkaido, Japan, the fundamental properties of the meat have been studied. Results obtained are summarized as follows:

(1) The "Suketodara" meat belongs to that type of fish meat having a large amount of water-content, but scarce fat and protein, although the chemical components of the meat vary somewhat by fishing season, six and size.

(2) The nitrogen distribution and the composition of amino acids in meat of the "Suketodara" are almost the same in comparison with other kinds of fish meat.

(3) The "Suketodara" meat falls more rapidly in freshness than other fish meat. Especially the incipient falling velocity of freshness of the "Suketodara" meat is more rapid than that of other fish meat.

(4) The "Suketodara" meat has muscle tissue with comparatively fine muscle fibre showing fine histological construction.

(5) With the falling of the freshness the amount of bound water in fish meat decreases.

(6) The amount of dissolving out of nitrogenous components in water or saline solution is smaller from "Suketodara" meat than that from the other fish meat.

(7) The isoelectric points of water soluble protein and salt solution-soluble protein are almost similar (both range in pH 5.0 ~ 5.4).

(8) In the solution extracted by salt solution (Weber's solution or 0.6 Mol NaCl solution), the phenomenon of flow birefringence was not observed. This is perhaps due to the comparatively smaller amount of myosin.

(9) The swelling of the "Suketodara" meat in various kinds of salt solutions little few difference from that of other kinds of fish meat.

(10) As to the relation between pH and the swelling of "Suketodara" meat, the swelling was restricted in the acidic side of the isoelectric point, differing from other kinds of fish meat.

(11) Dehydration of "Suketodara" meat by heating in water is difficult. From curves of absorption of water, dehydration or heat-coagulation, there seem to be present two kinds of proteins: myosin and myogen.

(12) Water in the "Suketodara" meat has good affinity to the meat proteins. The amount of water hydrated at the same water-activity "*a*", is larger than that of other kinds of fish meat.

(13) The hydration decreases with the denaturation of meat protein during freezing. The velocity of decrease is larger in slow frozen meat than in rapid frozen.

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