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Short Paper

Changes in the Strengths of Heat-induced Gels from Myofibrils in Combination with Sarcoplasmic Proteins from Lizardfish and Pacific Mackerel

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In western Japan, raw fish are sometimes used as raw materials for making kamaboko, a kind of fish jelly product in Japan, together with frozen surimi. In the process of making kamaboko, the meat must usually be washed repeatedly to improve the texture, color, and flavor of the product when the freshness of the fish is low, and/or the gel forming ability of the fish is low.[1] But the washing process is wasteful in terms of recovery of materials, because the water soluble components, i.e. sarcoplasmic proteins (Sp-P), free amino acids, ATP-related compounds, etc. are lost from the meat.

Okada[2] reported that the kamaboko gel improving effect of washing is attributable to (1) an increase in the concentration of myofibrillar protein, the essential constituent of the gel, and (2) removal of Sp-P, which is supposed to inhibit the gel formation. In his experiment, he used the frozen arrow tooth flounder, which is supposed to have a low gel forming ability. Washing should be required to improve the strength of the gel when the gel forming ability of the fish used is low. However, it still remains unclear whether washing the meat repeatedly is necessary in terms of the strength of the kamaboko gel and recovery of the protein when the gel forming ability of the fish used is high.

In a previous paper[3], we reported that the strength of unwashed meat gel (heated at 80°C) was higher than that of washed meat gel for the same recovery. We also reported that the strength of Sp-P added myofibril (Mf) gel became higher than those of heat-denatured Sp-P added Mf gel and water (instead of Sp-P solution) added Mf gel (control gel). From these results, we concluded that Sp-P significantly contributes to the strength of heat-induced (80°C) Mf gel. In this case, however, Sp-P was added to Mf in the ratio of 1 (Sp-P) to 3 (Mf). As Sp-P interacted with Mf during heating at 80°C[4,5], the Sp-P content (the ratio of Sp-P to Mf) might affect the gel strength of Mf gel.

The purpose of this paper was to clarify the dependence of the gel strength on Sp-P content.

Fresh Lizardfish *Saurida undosquamis* and Pacific mackerel *Scomber japonicus* were used.

Sp-P was extracted from the ordinary muscle of each fish with 4 volumes of NaCl solution (I=0.05, pH 7.0). To add Sp-P to Mf quantitatively, each Sp-P solution was submitted to lyophilization. The obtained powders were found to comprise 73.6% (lizardfish) and 70.8% (Pacific mackerel) of water soluble proteins. Mf was prepared from the ordinary muscle of each fish by washing with 4 volumes of NaCl solution (I=0.05, pH 7.0) three times, and dehydrating to 88%.

Sp-P powders were mixed with the respective Mf for 5 min, and then the mixture was ground with NaCl (3% in final concentration) for 10 min. The paste obtained was stuffed into a stainless ring (inner diameter, 3.1 cm; height, 3.0 cm), wrapped with a polyvinylidene chloride film, and then heated in a water bath at 80°C for 20 min. Immediately after heating, gels produced were cooled in ice water and brought to room temperature for testing (tensile test). The tensile test was performed by Shimizu's method[6] using a ring-shaped test piece to measure the tensile strength (g/cm^2) and breaking elongation ($\Delta l/l_0$). The product of the tensile strength and elongation was expressed as gel strength (g/cm^2).

As shown in Fig. 1, the gel strength of lizardfish Mf gel heated at 80°C (715 g/cm^2) was 8 times higher than that of Pacific mackerel Mf gel (91 g/cm^2) for the same water content (88%). This result was consistent with that reported by Shimizu.[7] This low gel strength of Pacific mackerel might be due to the denaturation of Mf proteins by the rapid decline in pH value of muscle.[8] In the following experiment, lizardfish and Pacific mackerel were used as fish with a high and low gel forming abilities, respectively.

In the case of Pacific mackerel, the tensile strength and the gel strength increased on increasing the Sp-P content, but the elongation remained almost constant regardless of the Sp-P content. On the other hand, in the case of lizardfish, the tensile strength of Mf gel increased on increasing the Sp-P content up to 2.3% (Mf:Sp-P=5:1), but decreased at the Sp-P content of 3.8% (Mf:Sp-P=3:1) to 5.7% the (Mf:Sp-P=2:1). The elongation was almost constant at Sp-P content of 0 to 2.3% and decreased when the Sp-P content increased from 3.8 to 10.7% (Mf:Sp-P=1:1). The gel strength increased with an increase of Sp-P content from 0 to 2.3%, but decreased at the Sp-P content of more than 3.8%. These differences of the gel strength dependency on the Sp-P content between lizardfish and Pacific mackerel might be partly due to the difference in the strength of Mf gel itself and partly due to the difference in the composition of Sp-P.

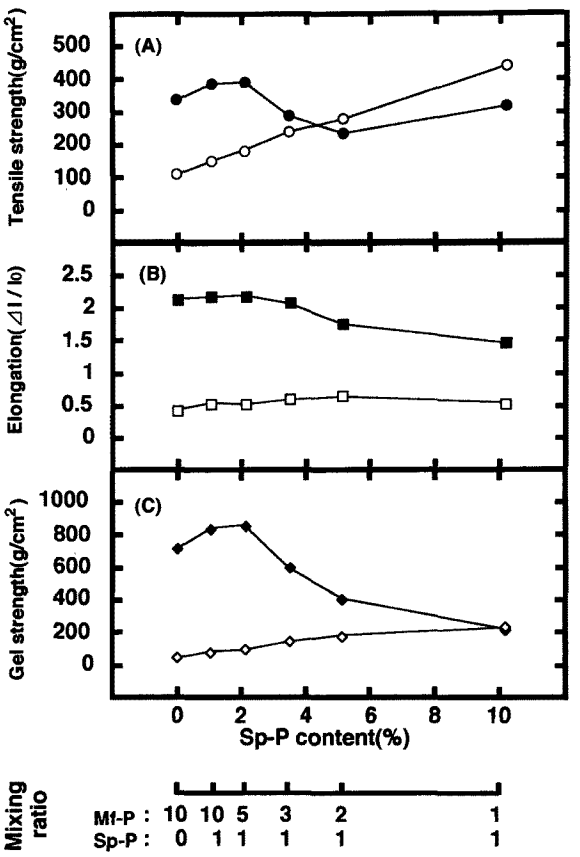

Fig. 1. Relationships between the tensile strength (A), elongation (B), gel strength (C), and sarcoplasmic protein contents.
The open symbols show the values for Pacific mackerel and the closed symbols show the values for lizardfish.

In both fish, the gel strength of the Mf gel decreased with an increase in the content of Sp-P when the water content of the gel was adjusted to 88% (data not shown). From these results, it was suggested that Sp-P from Pacific mackerel may not directly contribute to the network structure of the heat-induced gel, but may serve as fillers, just as egg white.[9] In lizardfish, it was also suggested that Sp-P may serve as fillers for Sp-P content up to 2.3% and may inhibit the gel formation of Mf for Sp-P content over 3.8%.

In this study, it was shown that 2.3% (Mf:Sp-P=5:1) addition of Sp-P to Mf increased the gel strength in lizardfish with a high gel forming ability. Shimizu and Nishioka[10] reported that the ratio of Sp-P to actomyosin in the dorsal muscle of lizardfish was 1 to 2. Our result suggests that it is advisable to reduce the number of times of washing and leave Sp-P to some extent in terms of the gel strength for the same recovery when fish with a high gel forming ability is used for making kamaboko. In Pacific mackerel, the addition of Sp-P also increased the gel strength of Mf, but the gel strengths of all gels were too low for use as a commercial product. Therefore, Mf concentration should be increased by washing the meat repeatedly in order to increase the strength of the gel to some extent, just as Okada reported[2] when fish with a low gel forming ability is used for making kamaboko.

From all the results, it was concluded that not only the gel forming ability of Mf, but also the ratio of Sp-P to Mf affected the strength of heat-induced gel of fish meat paste and that washing the meat should be performed by considering these properties of each fish.

References

1) Y. Shimizu, T. Ikeuti, and W. Shimidu: *Nippon Suisan Gakkaishi*, **20**, 811–813 (1955).
2) M. Okada: *Nippon Suisan Gakkaishi*, **30**, 255–261 (1962).
3) K. Morioka and Y. Shimizu: *Nippon Suisan Gakkaishi*, **56**, 929–933 (1990).
4) Y. Shimizu and F. Nishioka: *Nippon Suisan Gakkaishi*, **40**, 231–234 (1974).
5) K. Morioka and Y. Shimizu: *Nippon Suisan Gakkaishi*, **58**, 1529–1533 (1992).
6) Y. Shimizu, R. Machida, and S. Takenami: *Nippon Suisan Gakkaishi*, **47**, 95–104 (1981).
7) Y. Shimizu: *Nippon Suisan Gakkaishi*, **40**, 175–179 (1974).
8) A. Hashimoto, N. Katoh, H. Nozaki, and K. Arai: *Nippon Suisan Gakkaishi*, **51**, 425–432 (1985).
9) N. Iso, H. Mizuno, T. Saito, C.Y.Lin, T, Fujita, and E. Nagashima: *Nippon Suisan Gakkaishi*, **51**, 485–488 (1985).
10) Y. Shimizu and F. Nishioka: *Nippon Suisan Gakkaishi*, **40**, 267–270 (1974).