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Some Observations of the Textural Properties of Marine Myosystem Foods

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Abstract

The susceptibility of myosystem foods to low homogenizing stress were examined by means of the microscopic observation of the fragments separated from the muscle homogenates and of the determination of ratio of protein extractability. 1) Appreciable difference in the fragility of raw muscle was observed between fish and live-stock on the market and within the respective group as well. 2) Photomicrographs of the fragments from thawed fish muscle showed the less disintegratability of its muscular structure, which was supported by a increase of the volume of settled fragments and by a decrease of the ratio of protein extractability. 3) The fish muscle was made less disintegratable by means of cooking or salting, but the characteristic difference was observed in the separated fragments of each muscle differently processed. The relation of textural alteration in those foods and their sensory palatability, and the mechanism of the alteration were discussed.

The texture of foods has been well known to be one of important characteristics affecting their sensory quality. But the studies of the textural properties of marine foods, particularly of raw and thawed fish, are comparatively scarce. It has been considered to be due greatly to the difficulty in observing objectively the textural properties of fish muscle[1-3]. And also the difficulty above has been regarded ascribed to the characteristic properties of fish muscle fibers themselves[4].

A considerable number of studies made on the quality-change of frozen fish, have shown the increased toughness of fish muscle during its storage[5-7]. However, an adequate understanding of the mechanisms involved in the toughness change has not yet been reached.

The present report describes the results of preliminary investigation made on the susceptibility of myosystem foods, particularly of thawed fish, to low homogenizing stress.

Materials and Methods

Preparation of sample muscle cubes Eight species of fresh fish on the market were used as materials (Mackerel, *Scomber japonicus*; Tuna, yellowfin *Thunnus albacares*, blue fin *Thunnus thunnus*, big eye *Thunnus obesus*; Skipjack, *Katsuwonus*

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pelamis; "Hamadai", *Etelis carbunculus*; "Himedai", *Pristipomoides sieboldi*; "Takabe", *Labracoglossa argentiventris*). The dorsal portion of each fish was cut into small cubes (ca. 10 mm^3) and subjected to the test. One portion of sample cubes was freeze-stored at $-10°C$ and thawed at 0°C.

Other two portions were wrapped in a coarse cloth respectively, and the former was cooked in waters of different temperatures and the latter immersed in salt solutions of different concentrations. The susceptibility of treated samples to homogenizing was examined and compared with the untreated ones. Three species of live-stock muscle (lean) on the market were submitted to a part of reference test.

Examination of the susceptibility to homogenizing On refferring to the reports of Love et al.[4,8] and Cowie et al.[9], the following procedures were used. Five grams of the sample cubes were homogenized in 100 ml of the cold water at 3,000 or 6,000 rpm for 30 sec. The homogenates were taken in a large test tube and 500 ml of water was allowed to flow into the bottom of the tube at the rate of about 70 ml/min. Then, the muscle fragments that remained in the tube were transferred into a small measuring tube, and the volume of the fragments settled under gravity in the measuring tube under a given condition was measured. And also the appearance of settled fragments was observed under a microscope.

In a part of the test, the extractable protein under the low strength homogenization was determined to be compared with that under the full strength homogenization. The determination was done by a modification of Dyer's method[5].

Results

Raw fish and live-stock muscle Fig. 1 is photomicrographs of the fragments obtained from the muscle homogenates of 3 species of fish on the market. The muscle fragments from mackerel and "takabe" were of single and complex pieces of muscle fiber respectively, in which the characteristic patterns of cross-striation were seen. However, the fragments of "hamadai" could not be identified as of fiber pieces structure because those were fluffy and had no cross-banding. On the other hand, the fragments from live-stock muscle were in appearance of single fiber structure or their clusters (Fig. 2). The foregoing facts show that there were appreciable difference in the susceptibility of myosystems to disruption between fish and live-stock, and even within the respective group.

Thawed fish muscle As seen in Fig. 3, the fragments from thawed muscle of any species of fish, are distinctly larger in appearance than those of the respective control (unfrozen) muscle. Especially the fragments of skipjack and bream group were much longer and wider, and also those of tuna fine and markedly longer. In addition to this, photomicrographs of the fragments from thawed muscle showed that the fibers of muscle and their bundles considerably survived homogenization (Fig. 4). Such less susceptibility of thawed muscle to disruption was also found in Figs. 5 and 6, which show that when the muscle cubes were freeze-stored at relatively

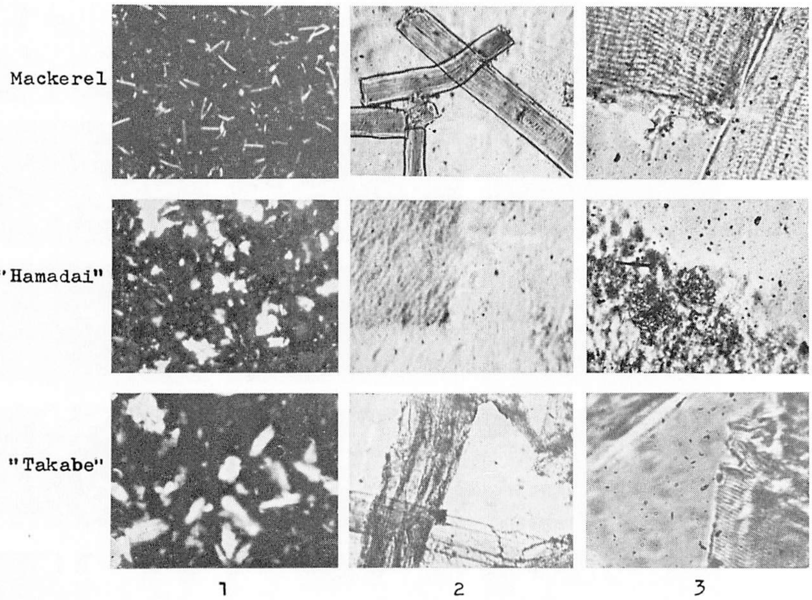

Fig. 1. Photomicrographs of residual fragments from the homogenates of raw fish muscle on the market. (Magnification: 1, ×1; 2, ×50; 3, ×600)

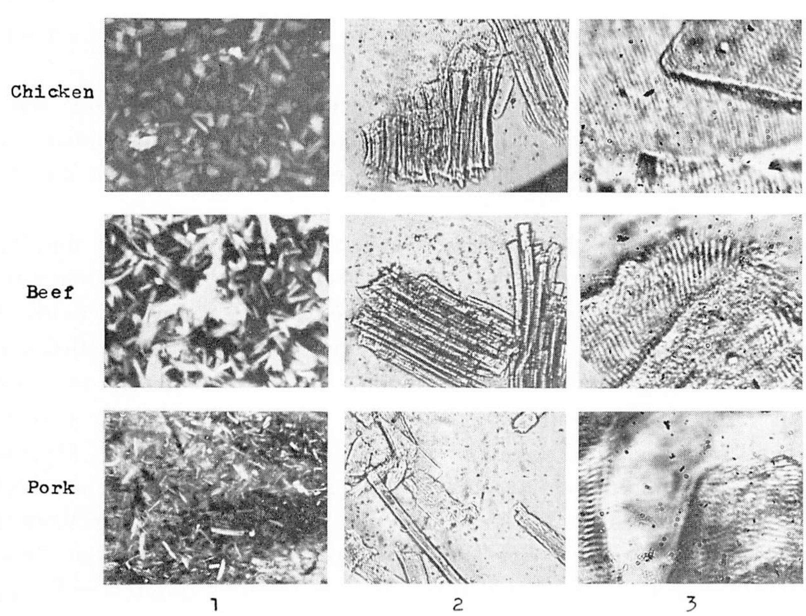

Fig. 2. Photomicrographs of residual fragments from the homogenates of raw livestock muscle. (Magnification: 1, ×1; 2, ×50; 3, ×600)

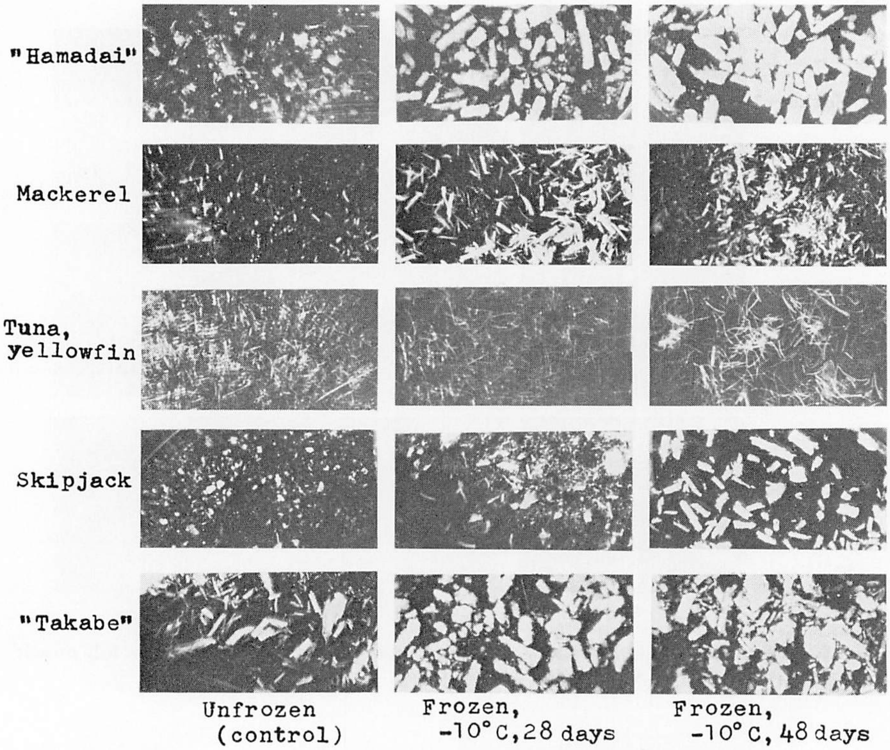

Fig. 3. Appearance of residual fragments from the homogenates of thawed fish muscle.

high temperatures, the settled volume of fragments from thawed muscle was greater and the ratio of protein extractability was smaller. Those findings indicate that the changes in textural property of the muscle have occurred during the freeze-storage of tested fish.

Cooked and salted fish muscle Fig. 7 shows comparison of the fragments from raw and cooked fish muscle cubes. The fragments of cooked muscle was fibrous or slender in appearance nearly in any case of the tested fish, differing markedly from those of uncooked muscle. And also both the proximate size and settled volume of the fragments were greater than those of raw muscle. The tendencies as stated above were found in the case of salted muscle, too, (Fig. 8), though its fragments were smaller in size and more fleshy in colour than in the case of cooked one. Especially the fragments of salted tuna muscle was characteristically more fine and flexible compared with those of cooked tuna. The facts show not only that the muscle tissue became less susceptible to disruption owing to cooking and salting, but also that the effect of those treatments on the muscle structure have considerably differed in its mode according to the difference of treating methods and of muscle species.

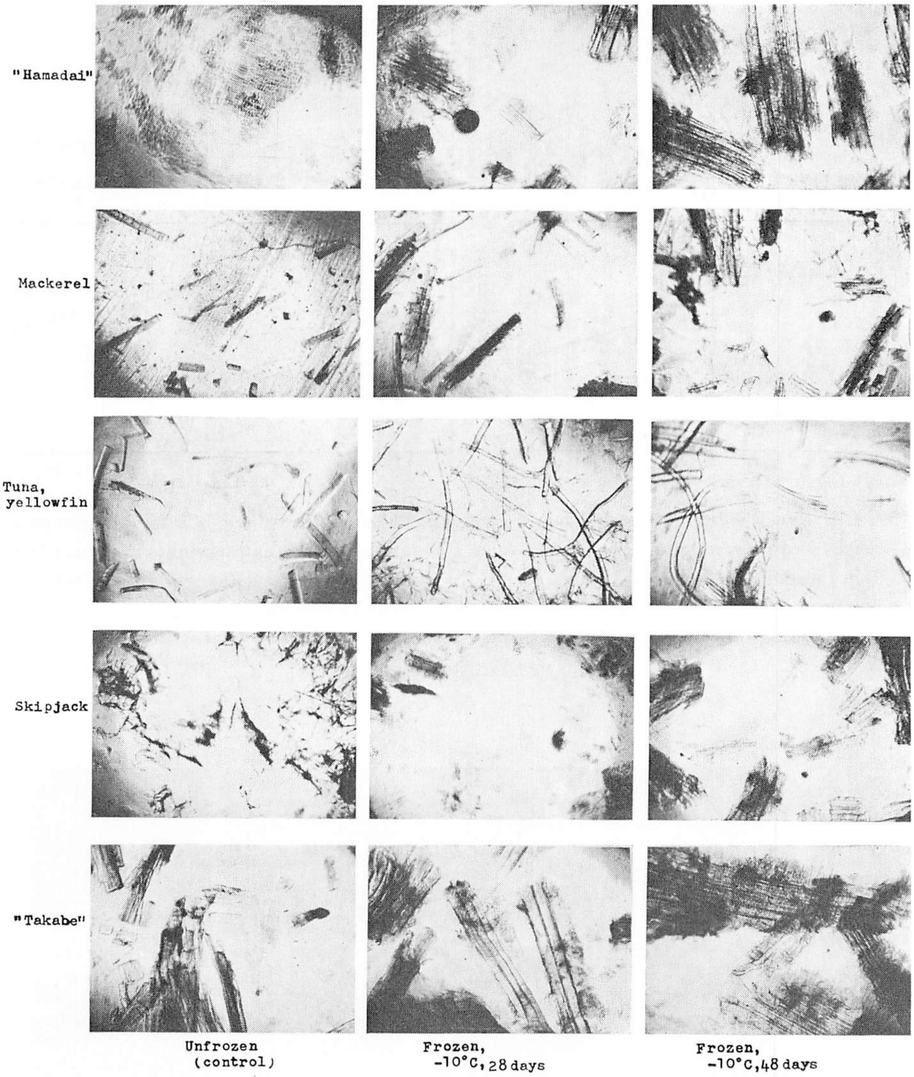

Fig. 4. Photomicrographs of residual fragments from the homogenates of thawed fish muscle. (Magnification: ×20)

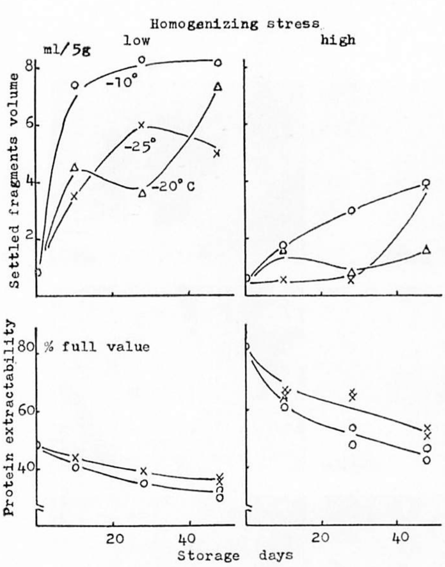

Fig. 5. Changes in volume of settled fragments and ratio of protein extractability in thawed "hamadai" muscle. (Homogenizing: low, 3,000 rpm; high, 6,000 rpm)

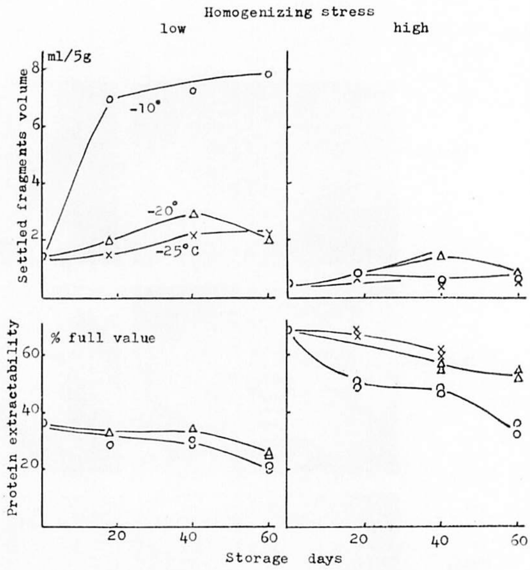

Fig. 6. Changes in volume of settled fragments and ratio of protein extractability in thawed bigeye tuna muscle. (Homogenizing: low, 3,000 rpm; high, 6,000 rpm)

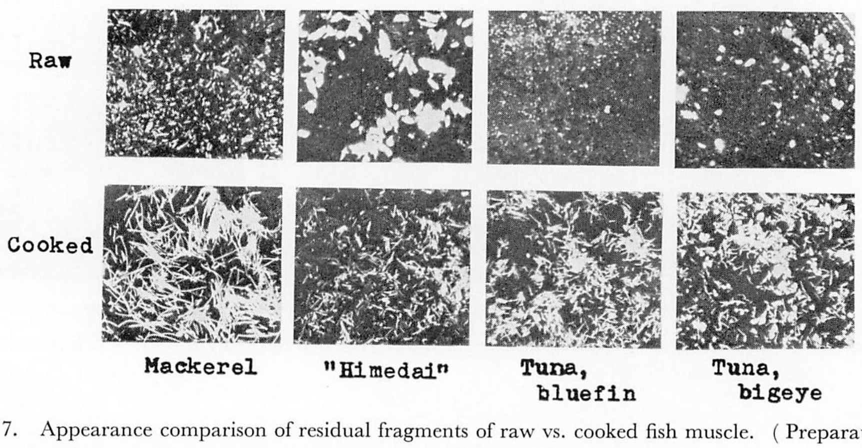

Fig. 7. Appearance comparison of residual fragments of raw vs. cooked fish muscle. (Preparation of cooked samples: muscle cubes, 5 g; cooking, in boiling water for 10 min)

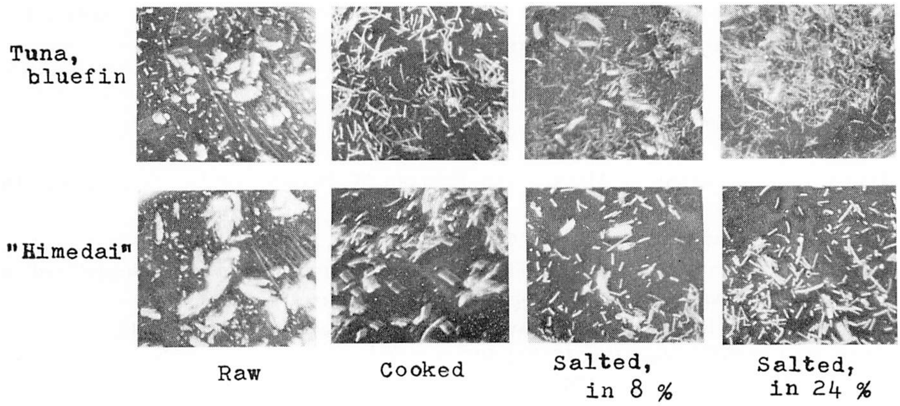

Fig. 8. Appearance comparison of residual fragments of cooked vs. salted fish muscle. (Cooking, in boiling water for 10 min; Salting, in salt solution overnight at 10°C)

Discussion

The extent and mode of disintegratability observed in the raw muscle cubes seemed to be related to the difference in the sensory texture, so-called firmness, empirically known of those muscle foods. On the other hand, it was noticeable that the difference of disintegratability of raw muscle was observed not only in its cooked and salted muscles but also in thawed muscle as the textural changes. Those findings are supported by the reports of SHIMIZU et al.[10] and TAKAHASHI et al.[11] They have indicated that the firmness of fish muscle may be one factor affecting the rate of its spoilage and that the different fragility of cooked muscle is resulted from the difference in the protein distribution in the fish muscle.

The alteration of muscle structure in the thawed fish, which might lead to "toughening" of cooked thawed muscle found in certain species of fish, such as cod, was observed in the fish used for the present experiment. Accordingly the alteration seems to have occurred through the mechanism similar to that of toughening already proposed by some studies[12-14]. According to them the alteration is considered to have been due mainly to the microstructural changes and/or myofibrillar protein denaturation. The present experimental results, too, suggest that the microstructure change has occurred in the thawed muscle, and has brought about its less susceptibility. The present subject is left for further study to be done in connection with the protein denaturation in fish muscle and the changes of its organoleptic quality.

The less disintegratability of cooked or salted muscles appears to show becoming tough due to the dehydration and/or protein denaturation, as well known already[15]. Concurrently, it seems to be worthy of remarkes from the qualitative view point of processed myosystem food that the effect of processing on the muscle structure have considerably differed in its extent and mode in accordance with a difference of processing condition and of material muscle to be processed. The fact could be enhanced by DUERR et al.'s paper[16], in which the relation of salt content in the salted fish to its protein denaturation has been explained.

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