New Cooked Fish Paste from Frozen Alaska Pollack Surimi

Eiji NIWA, Kazuhaya NISHIMURA and Satoshi KANOH

Faculty of Fisheries, Mie University, Tsu 514, Japan

Received July 21, 1989

A viscous fish-flesh sol, *shio-surimi*, prepared from frozen Alaska pollack surimi, water, sodium chloride and starch was cooked at 80°C for 30 min. The cooked product remained viscous if the starch had been pregelatinized. The most viscous type of paste with a consistency of mayonnaise or tomato ketchup was obtained from the *shio-surimi* containing 4.5–9% of pregelatinized tapioca starch or potato starch and 150 or 300% of water. The viscosity of the paste was increased when salad oil or butter was further added to the *shio-surimi*. Furthermore, a type of paste with the consistency of French dressing was obtained by grinding the resulting paste with rice vinegar and salad oil or butter. Cooked fish pastes prepared in this way may be utilized as a new form of marine food.

Viscous salted fish-flesh paste, *shio-surimi*, is changed to an elastic gel, *Kamaboko*, on heating. In this case, the elasticity of the *kamaboko* is strengthened by the addition of raw starch, but is scarcely strengthened if the starch has been pregelatinized.¹⁾ In this paper, we deal with a new cooked fish paste with a consistency of mayonnaise or tomato ketchup that is obtainable from frozen Alaska pollack surimi, if an adequate amount of pregelatinized potato or tapioca starch and water have been added, the resulting paste being miscible with rice vinegar and salad oil or butter. These pastes may be utilized as a new form of marine food.

Materials and Methods

Materials. Non-salted frozen surimi of Alaska pollack, *Theragra charcogramma* (Taiyo Gyogyo Co., SA-grade) was used as the main starting material for the cooked fish paste. Raw and pregelatinized starches from corn, potato and tapioca were donated by San-ei Tohka Co. There were two types of the respective pregelatinized starches, one being dehydrated by a drum drier after pregelatinization, while the other was immediately pregelatinized by passing through an extruder.

Preparation of the cooked fish paste. The frozen surimi was thawed by leaving overnight in a refrigerator at 4°C minced and then ground in an automatic mortar (Nitto Kagaku Co., ANM-200) with sodium chloride, water and

starch at 4°C for 15 min to form the *shio-surimi*. The final concentration of sodium chloride was held at 3% of the water contained within the *shio-surimi* (the water content of the frozen surimi was 78%). In the case of salad oil (Nisshin Seiyu Co., Nisshin Salad Oil) or butter (Yukijirushi Nyugyo Co., Snow Brand Hokkaido Butter) being added to the *shio-surimi*, the mixture was repeatedly homogenized for 30–60 sec five times in a homoblender (Sakuma Seisakusho Co., No. 500C) instead of grinding in the mortar. The viscous *shio-surimi* was packed into casings (Kureha Kagaku Kogyo Co., Krehalon casing, 2 cm diameter) and cooked at 80°C for 30 min in a water bath after closing both the ends of the casing. The resulting cooked fish paste was stored overnight in a refrigerator.

Visco-elasticity measurements. The dynamic visco-elasticity measurement of the cooked fish paste was carried out by using a dynamic rheometer (Toyoseiki Co., Rheograph Sol, No. 653) on a sample prepared within the measuring cell. The *shio-surimi* was packed into the cell ($4 \times 1.5 \times 0.2 \text{ cm}^3$) and fixed to the rheometer together with a blade ($2.5 \times 1 \times 0.05 \text{ cm}^3$), and then heated by a thermo-module at 80°C for 30 min. After lowering the temperature to 20°C, the storage modulus (G') and loss modulus (G'') were recorded while vibrating the cell at a frequency of 3 Hz under a strain of 1%.

The viscosity measurement was carried out by using a rotational viscometer (Tokyo Keiki Co., BM type; cylindrical rotor: length, 3 cm; diameter, 3.2 mm; rotational speed, 6 rpm). Thirty milliliters of the cooked fish paste was poured into a beaker (diameter, 3 cm), covered with small amount of liquid paraffin to prevent the evaporation of water during heating, and immersed for 30 min in a water bath previously adjusted to the prescribed temperature. The viscosity was read when the indication of the viscom-

eter became constant after revolving the rotor (about 3 min).

Photographs were taken of the particularly characteristic cooked fish paste.

Results and Discussion

The texture of the cooked fish paste was varied not only by the amount of water added but also by the kind of starch added. When raw starch was added, the paste felt elastic like kamaboko, but when the pregelatinized starch was added, the elasticity was weakened in most cases by increasing its amount, and the product remained viscous when an adequate amount of water was added. If no pregelatinized starch was added to the shio-surimi containing a large amount of water, the resulting cooked fish paste was very unstable, and a large amount of water was separated during cooking.

Figure 1 shows the effect of the pregelatinized starch treated with the drum drier on the storage modulus (G') and loss modulus (G'') of the cooked fish paste at 20°C. By increasing the amount of water added, G' and G'' were remarkably decreased. (The percentage of wa-

ter, starch, salad oil, butter and rice vinegar added is expressed by the weight ratio to the frozen Alaska pollack surimi used as the main starting material according to the usual custom of the surimi-product industry). Irrespective of the amount of water added, both the moduli were remarkably increased by increasing the amount of corn starch added. For the cooked fish paste supplemented with 300% of water, the moduli were scarcely affected by the addition of the potato or tapioca starch, but for the paste supplemented with 100 or 150% of water, the moduli were decreased by increasing the amount of starch added. All the cooked fish pastes supplemented with 100% of water were in an unstable gel form while those supplemented with 150 or 300% of water were sols.

Figure 2 shows the effect of the pregelatinized starch treated by the extruder on G' and G'' of the cooked fish paste at 20°C. Differing from the results in Fig. 1, for the cooked fish pastes supplemented with 300% of water, both the moduli were slightly increased by the addition of each starch, and for the pastes supplemented with 100 or 150% of water, they

Fig. 1. Effect of the Pregelatinized Starch Treated by the Drum Drier on the Storage Modulus (G') and Loss Modulus (G'') of the Cooked Fish Paste at 20°C.

—●—, G' ; ---●---, G'' .

Amount of water added to the frozen surimi: 300% (top row); 150% (middle row); 100% (bottom row).

Fig. 2. Effect of the Pregelatinized Starch Treated by the Extruder on the Storage Modulus (G') and Loss Modulus (G'') of the Cooked Fish Paste at 20°C.

—●—, G' ; ---●---, G'' .

Amount of water added to the frozen surimi: 300% (top row); 150% (middle row); 100% (bottom row).

Fig. 3. Effect of Temperature on the Viscosity of the Cooked Fish Paste Supplemented with Various Amounts of Pregelatinized Starch Treated by Drum Drier.

Amount of water added to the surimi: 300% (upper row); 150% (lower row).

Amount of pregelatinized starch added: —●—, 2.25%; ---●---, 4.5%; —○—, 6.75%; ---○---, 9%.

were decreased by increasing the amount of corn starch added. Nearly the same results were obtained as those in Fig. 1 for the pastes supplemented with 100 or 150% of water and the potato or tapioca starch. The cooked pastes supplemented with 100% of water were unstable gels, but those supplemented with 150 or 300% of water were sols. Velvety smoothness was sensed for the cooked fish pastes supplemented with the potato or tapioca starch, but rough to the tongue was sensed for the paste supplemented with the corn starch.

Figure 3 shows the effect of temperature on the viscosity of the cooked fish paste supplemented with various amounts of pregelatinized starch treated with the drum drier. For all the cooked fish pastes, the viscosity was decreased by raising the temperature, but increased by increasing the amount of starch added. This increment was the most marked when the corn starch was added.

Figure 4 shows the same effect on the viscosity of the cooked fish paste supplemented with the pregelatinized starch treated by the extruder. A decrease in the viscosity with temperature, and its increase upon the addition of the starch showed nearly the same tendencies as those in Fig. 3, although the increase in viscosity was not as high as that from the addition of starch treated by the drum

Fig. 4. Effect of Temperature on the Viscosity of the Cooked Fish Paste Supplemented with Various Amounts of Pregelatinized Starch Treated by the Extruder.

Amount of water added to the frozen surimi: 300% (upper row); 150% (lower row).

Amount of pregelatinized starch added: —●—, 2.25%; ---●---, 4.5%; —○—, 6.75%; ---○---, 9%.

drier. For a commercial mayonnaise (Kewpie Co., Kewpie Mayonnaise), G' and G'' were 1.0×10^3 and 8.8×10^2 dyn/cm² at 20°C, respectively, and its viscosity was 5.4×10^4 cP at this temperature. Judging from the value of G' , G'' and viscosity, the cooked fish pastes supplemented with 150% of water and more than 4.5% of the potato or tapioca starch treated with the drum drier or extruder somewhat resembled the mayonnaise in consistency. Furthermore, for a commercial tomato ketchup (Kagome Co., Kagome Tomato Ketchup), G' and G'' were 2.6×10^2 and 4.8×10^2 dyn/cm² at 20°C, respectively, and its viscosity was 2.8×10^4 cP at this temperature. Therefore, the cooked fish pastes supplemented with 300% of water and more than 4.5% of the potato or tapioca starch treated with the drum drier somewhat resembled the tomato ketchup in consistency. In fact, these pastes also closely resembled the mayonnaise and tomato ketchup, respectively, from an organoleptic judgement. It was hard, however, to discriminate between the pastes supplemented with the potato starch and those with the tapioca starch, or to detect a textural difference between the pastes with the same species of added starches pregelatinized by different methods.

Figure 5 shows the effect of temperature on

Fig. 5. Effect of Temperature on the Viscosity of the Cooked Fish Paste Supplemented with Salad Oil or Butter, Except for the 4.5% Pregelatinized Potato or Tapioca Starch Treated by the Drug Drier.

Amount of water added to the surimi: 300% (upper row); 150% (lower row).

Amount of salad oil or butter added: —●—, 0%; --●--, 10%; ···▲···, 20%.

Fig. 6. Photographs of the Cooked Fish Paste.

a: Cooked fish paste supplemented with 150% of water and 4.5% of the pregelatinized corn starch treated by the extruder.

b: Cooked fish paste supplemented with 150% of water and 4.5% of the pregelatinized tapioca starch treated by the drum drier.

c: The same cooked fish paste as in b.

d: Cooked fish paste supplemented with 150% of water, 4.5% of the pregelatinized tapioca starch treated by the drum drier, and 20% of butter.

the viscosity of the cooked fish paste with 10 and 20% of the salad oil or butter added apart from the 4.5% of pregelatinized potato or tapioca starch treated with the drum drier. The viscosity was remarkably decreased by raising the temperature, but conversely increased by increasing the amount of salad oil or butter added. Furthermore, the faintly remaining fishy odour of the cooked fish paste was nearly masked, and good body was given to the taste by their addition.

Figure 6 shows the photographs of the especially characteristic cooked fish paste prepared in the present study. Figures 6a and 6b show the cooked fish paste squeezed out from a tube. A somewhat coarse texture could be felt for the cooked fish paste supplemented with 150% of water and 4.5% of corn starch treated with the extruder (Fig. 6a). On the contrary, a particularly fine texture was felt for the paste supplemented with 150% of water and 4.5% of the tapioca starch treated with the drum drier (Fig. 6b). The marked viscosity of the latter paste can be understood from Fig. 6c. Figure 6d shows the fish paste supplemented with 150% of water, 4.5% of the tapioca starch treated with the extruder, and 20% of butter. The very sticky features are apparent.

The viscous cooked fish pastes obtained in this way are quite new marine foods, although

they are fundamentally classified into the usual cooked surimi product. The cooked fish pastes supplemented with 150 or 300% of water and 4.5–6.75% of the potato or tapioca starch were felt to the most agreeable in taste.

The other marked feature of these cooked fish pastes was that little protein coagulation due to acid-denaturation was induced even if rice vinegar was added, and that the mixture of the paste and vinegar was well miscible with salad oil or butter. Presumably, the cooked fish flesh would act as an emulsifier in the presence of the pregelatinized starch. For example, a dressing type of paste was obtained by grinding the paste supplemented with 150% of water, 4.5% of tapioca starch treated with the drum drier and 26% of rice vinegar (Nakano Vinegar Co., Ltd., Rice Vinegar) in a mortar for 5 min, which was followed by grinding with 160% of salad oil for a further 5 min. A tasty French dressing type of product would be given if adequate seasonings and condiments are added. In order to preserve such a product, however, the preventive measures for retrogradation of the starch should be studied.

Reference

- 1) M. Okada, *Bull. Tokai Reg. Res. Lab.*, No. 36, 21 (1963).