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Original article

Effect of the processing/freezing method on properties of frozen surimi gels

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Introduction

Nowadays, the requirement for the freezing of commercial kamaboko is increasing for the reason of extending shelf-life and exporting. However, the quality sometimes may be damaged by freezing and frozen storage. In our research conducted to elucidate the factors that affect the quality deterioration of frozen surimi-based products, it has been shown that various factors affected the quality of heat-induced surimi gels upon freezing. On the other hand, Hiraoka et al. [1] had reported that the quality of Jakotempura, which is a traditional fish paste product in Ehime prefecture, prepared by Method A (freezing the samples after 2-step heating) was damaged by freezing, but the quality of the product prepared by Method B (freezing the samples after setting, and followed by heating at 90°C) was improved, in terms of showing low thawing drip loss. However, the mechanism underlying the differences is still unclear. Therefore, this study aimed to elucidate this phenomenon by using heat-induced surimi gels from Alaska Pollock as a model.

Materials and methods

Materials
Alaska Pollock (*Theragra chalcogramma*) frozen surimi (AA grade, Glacier fish company) was obtained, cut and stored at -30°C until use. Potato starch was obtained from Wako pure chemical industries (Osaka, Japan).

Surimi gel preparation
Alaska Pollock surimi was thawed at -3°C overnight before being cut into small cubes with side length 10 mm, ground at 1,500 rpm by refrigerated vacuum mixer (UMC-5, Stephan Machinery Corp, U.S.A.) for 1.5 minute, and then ground with 30% water, 3% sodium chlorine and with/without 5% potato starch at 1,500 rpm for 8 minutes. The surimi paste was shaped and processed into heat-induced surimi gels with different preparation methods.

Setting and heating method
In method A, the surimi gels were heated by 30°C for 60 min, and then heated by 90°C for 30 min before being frozen. A part of the surimi gel prepared by this method was heated again at 90°C for 30 min after thawing (A +).

In method B, the surimi gels were heated by 30°C for 60 min, and frozen. After thawing, the thawed gels were heated at 90°C for 30 min.

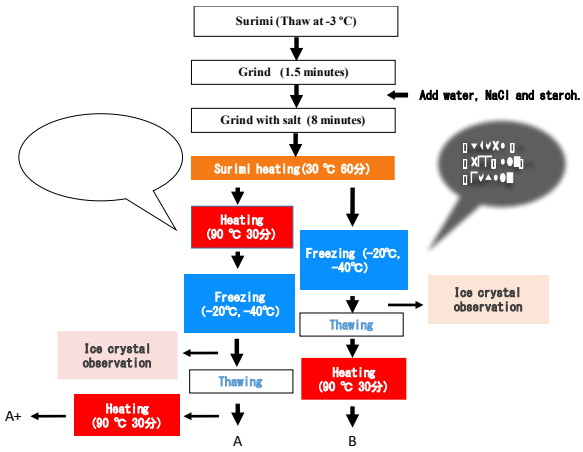

Fig. 2. Preparation of surimi gels.

Freezing and thawing
Heated surimi gels were removed from tubes and molded into cylindrical pieces (23 mm in diameter and 25 mm in height), and then vacuum-packed in plastic bags and frozen under two different conditions as following: 1) freezing by immersing in the -40°C ethanol solution, i. e quick freezing: 2) freezing in the

atmosphere of freezer, i.e. slow freezing. Freezing curve was measured using thermometer (5020A, Eto Denki Corp, Japan) from the beginning of freezing. The frozen samples were stored at -20°C or -40°C for 1 or 4 weeks.

The frozen samples were thawed in refrigerators at 4°C overnight before using.

These methods for the surimi gel preparation including heating and freezing were shown in Fig. 1.

Water holding capacity

Water holding capacity (WHC) was measured by thawing drip and expressible drip. Thawing drip was determined by the drip loss which was released from the gels when sample was thawed. Expressible drip was determined by the drip loss which was released from the gels when 1g of sample was compressed for 20 s.

Physical properties

Both breaking strength (gw) and breaking deformation (mm) of gels were performed upon puncture test using rheometer (RE-3305B, Yamaden Corp, Japan). Plunger was spherical with diameter 5 mm, load cell was 20 N. Thawing samples were kept at 0°C and measured in the central portion with depression speed of 1 mm/s, every measurement was repeated 4 times.

Microscopic observation and statistical analysis

Surimi gels after freezing or thawing were cut to 2-3 mm thickness and fixed with a 10% formalin solution. The samples were embedded in paraffin using a rotary machine (RH-12DM, Sakura finetek Japan Co., Ltd., Tokyo, Japan) and cut to 5 μm slice. The paraffin sections were stained using Periodic Acid-Schiff (PAS) method and observed by optical microscope (BZ-9000, Leica Microsystems Corp, GER) amplifying surimi four times.

Results

For heat-induced surimi gels without starch, Method B was not more effective than Method A. The gel by B method was found to have much more drip amount, larger ice crystal size, and greater damage after thawing than the gel by A method, even when changing the freezing rate, storage temperature and storage period.

On the other hand, in the case of heat-induced surimi gels with starch, the surimi gels processed by method B showed the lower thawing drip than that of method A significantly. For physical properties, the surimi gels processed by method B showed lower breaking strength and lower breaking deformation than method A significantly.

The result of microscopic observation of the gels by method A showed that the starch granules absorbed water and swelled after 2-step heating, and the starch granules were thought to be damaged by freezing, especially slow freezing.

On the other hand, the result of microscopic observation of the gel by method B showed that the starch granules weren't affected by heating at 30°C for 60 minutes, and so the starch granules weren't damaged by freezing and frozen storage. The starch granules absorbed water and swelled after 2-step heating.

Discussion

In the case of heat-induced surimi gels without starch, Method B was not more effective than Method A. On the other hand, in the case of heat-induced surimi gels with starch, the surimi gels processed by method B showed the lower thawing drip than that of method A significantly. It was suggested that water holding capacity obtained by Method B was higher because starch granules were still intact after setting and freezing, which provided tolerance to freezing.

Therefore, the method B has been proved that it has beneficial effects on the water holding capacity compared to the method A in the case of surimi gel containing starch.

References

1. Hiraoka Y et al. (2011) Studies on frozen storage of Jakotempura: Freezing test on casing boiled fish paste of *Acropoma japonicum*, JSRAE Annual Conference, pp. 365–366