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Original article

Application of emulsifying fish oil into commercial surimi-based product

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Introduction

Fish oil is an excellent source of long-chain polyunsaturated fatty acids, such as icosapentaenoic acid (20:5 n-3) and docosahexaenoic acid (22:6 n-3) [1]. To increase the value of food with high functionality, new products containing fish oil have been developed in recent years. Previously, we investigated the effects of the emulsification of surimi using fish oil on the properties of its heat-induced gel after frozen storage, and it was suggested that vigorous mixing of surimi with fish oil increased water-holding capacity through the formation of fine oil particles. We also confirmed the positive effects of emulsifying fish oil on the quality characteristics, such as color, gel-forming ability and on the prevention of quality deterioration by freezing [2-4]. To apply this technology in the surimi-based product industry, this study was aimed to clarify the effect of emulsifying fish oil on the quality of the commercial product "sasa-kamaboko".

Materials and methods

Preparation of emulsified kamaboko
Frozen surimi was thawed at -3°C overnight, ground with water, salt, and other seasonings to obtain surimi paste. Fish oil (0 (control), 2.5, and 5.0%) was emulsified by vigorous mixing under a vacuum and then with air. Emulsified surimi paste was shaped and heated by far infrared rays and baked to obtain sasa-kamaboko. The main procedures to produce the emulsified sasa-kamaboko were shown in Fig. 1.

Freezing and thawing
Samples were frozen by air-blast freezer at -40°C and frozen stored at -40°C. Frozen sample was thawed at 4°C overnight.

Measurement of water holding capacity
The WHC of the sasa-kamaboko was determined by the amount of thawing drip and expressible drip [4]. Thawing drip was determined by the drip loss which was released when sample was thawed. Expressible drip was determined by the drip loss which was released from the gels when 1 g of sample was compressed at 10 kg/cm^2 for 20 s.

Physical properties
Breaking strength (gw) and breaking deformation (mm) of gels were measured by puncture-test using a rheometer (RE-3305B, Yamaden Corp, Japan) [2].

Color measurement
The color of the samples was measured according to the CIE L*/ lightness, a*/ redness, b*/ yellowness system, using a color reader (Minolta Cr-13, Minolta Co., Ltd., Osaka, Japan) [3]. Whiteness was calculated as below,

$$\text{Whiteness} = 100 - \sqrt{(100 - L^*)^2 + a^{*2} + b^{*2}}$$

Microscopic observation
Microscopic observation of ice crystal and oil particle were also performed [4-5]. Surimi gels after freezing were cut into 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 4% formalin alcohol-free solution in a refrigerator for one night. Fix in 2% osmium tetroxide for 48 hours. Fixed sample were dehydrated in alcohol, embedded in the wax, sliced into 2 µm-thick sections and observed by optical microscope (BZ-9000, Leica Microsystems Corp, GER).

Sensory evaluation
For sensory evaluation, various prior training sessions

on the product were conducted to familiarize the panelists with the surimi-based product. Samples were stored at 5°C in cold room then cut into 2 portions, placed on white plates and served to the panelists. Questionnaires were listed from several parameters including appearance, odor, taste, and texture characteristics.

Results

The emulsified product displayed higher water-holding capacity and whiteness compared to the control. The texture of the emulsified product showed high scores in sensory evaluation. Microscopic observation revealed that the sizes of ice crystals in the frozen emulsified products were smaller and frozen damage of thawed products was lower compared to in control products. These results showed that the emulsification of fish oil positively affects not only the quality of commercial surimi-based products, but also on the quality changes during frozen storage.

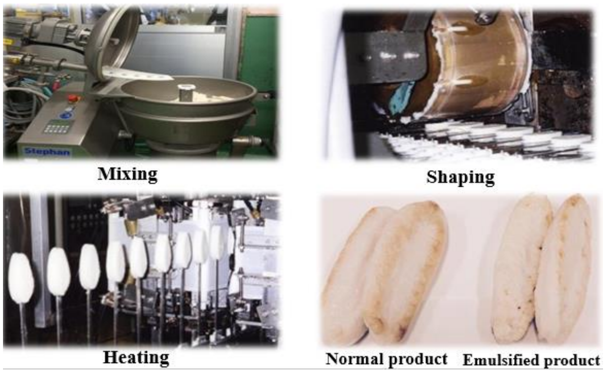

Fig. 1. Photo of samples produced in the manufacture.

Discussion

It was assumed that formation of large ice crystals damaged the sample structure, and water was easily released from the matrix. For emulsified sample, it was expected that the protein and fish oil droplet interaction at the interface, the protein membrane surrounding the surface of oil particles may suppress the formation and growth of ice crystals during freezing and frozen storage, as a result, the decrease in water-holding capacity during frozen storage is associated with the structural changes by ice crystals formation, resulting the increasing drip loss after thawing. Thus emulsification of fish oil have positive effect on the quality of commercial surimi-based products as well as heat-induced surimi gels.

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