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Quality evaluation method for frozen surimi by suwari speed and activation energy

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Introduction

Surimi based products such as kamaboko and chikuwa are Japanese traditional processed foods. In recent years, owing to improvement of health consciousness in overseas, the production and consumption of kamaboko, in particular imitation of crab leg has been increasing. In contrast, the production in Japan has been gradually decreased [1]. However, surimi based products accounts for 31.5% of total consumption of fisheries processed foods. It is the highest amount in the products, so still an important product [2].

Surimi based product has elastic and viscous texture. These physical properties are named Ashi. It's unique texture is expressed by forming macromolecular network structure of fish meat protein. Myosin, the main component of fish meat protein, is mainly responsible for the Ashi. The physical properties of surimi based product greatly affected by heating profile. Especially, it is important to control the unique phenomenon of Suwari (sitting) at 20 to 40 °C and Modori at around 50 °C. Cross-linked polymerization between myosin molecules occurs during sitting by transglutaminase in surimi [3-6]. On the other hand, the Modori occurs by the protease, which is named MIP (Modori inducting protease) [7]. Sitting and Modori are caused of enzymatic reaction, so it is greatly affected by temperature and time. In addition, the reaction pattern differs depending on the fish species and surimi grade [8, 9].

Hygiene management systems such as HACCP have been introduced for the fisheries product industries [10]. However, there are no apparent standards for quality evaluation of frozen surimi. Currently, manufactures evaluate safety and quality according to their own standards by measure of thermal gel, prepared from a part of purchased frozen surimi.

In this study, we focused on the sitting speed and the activation energy in the sitting [8]. And it was examined whether these values are suitable for quality evaluation of frozen surimi or not.

Materials and methods

Materials

Frozen surimi of Alaska pollock (SA and RA grade), Blue grenadier (FA and KA grade) and Threadfin bream (SA and KA grade) were purchased from Nichimou Co., Ltd. (Tokyo). And divined blocks of about 1kg were kept at -25°C until used.

Methods

Preparation of sitting thermal gel
Frozen surimi kept at -25°C was thawed in a refrigerator set at 4°C over night. Thawed surimi was ground on a food processor (MK-K48P, Panasonic, Osaka, Japan) or a high-speed food cutter (UMC-5, Stephan, Chiba, Japan) for 30-60 seconds. Next, it was added 30% water and ground for 30-60 seconds. Finally, it was added 2.5% salt and ground for about 1 minute to become meat paste. Meat paste was stuffed into a casing film (Φ23 mm) and heated at 20, 25 and 30°C in water bath (THERMO MINDER SM-05R, TAITEC, Saitama, Japan) to produce sitting thermal gel (Suwari gel).

Measurement of breaking strength
Sitting thermal gels prepared at different temperature and time were measured for breaking strength (gw) on a rheometer (NRM-3002D, Rheotech, Tokyo, Japan) by using a cylindrical plunger (5 mm in diameter) at a stage speed of 6.0 cm/min. The sample was divided into 2.5 cm thick, and the average of the three samples was used as measurement value.

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Measurement of sitting speed

The date obtained by breaking strength measurement was plotted on Y axis and the sitting time on X axis in a semilogarithmic graph and an approximate curve was drawn. The time (T1/2) to reach half of the maximum breaking strength (BSmax) was determined, and the reciprocal was taken as the sitting speed K (s^{-1}).

Analysis of activation energy

The logarithmic value of the sitting speed was plotted in corresponding to the reciprocal value (1/T) of the absolute temperature (Arrhenius plot). The activation energy of each result was calculated using the following equation.

Ea=-2.303・Rd (logK)/d R: Gas constant (1.98cal/deg).

Results

From the results of the breaking strength measurement, the maximum breaking strength in a low grade was lower than that in a high grade irrespective of fish species. However, the proportion between both grade greatly varied depending on the fish species. In Alaska pollock, the maximum breaking strength increased with high temperature in both grade surimi. In Blue grenadier, the highest value was shown at 25°C. In the SA grade surimi of Threadfin bream, the maximum strength were almost same at three temperatures. In KA grade of Threadfin bream, the higher the temperature, the lower the maximum breaking strength. Comparing between fish species, the values of high grade was high in the order of Alaska pollock > Threadfin bream > Blue grenadier. And the value of low grade was high in order of Threadfin bream > Alaska pollock > Blue grenadier.

From the results of the sitting speed analysis, the speed of high grade surimi was faster than that of low grade regardless of fish species. The activation energy analysis showed that the value of the high grade was lower than that of the low grade. Comparing among three fish species, the value of high grade was high in order of Alaska pollock > Threadfin bream > Blue grenadier. In the case of the low grades, the value was high in the order of Threadfin bream > Alaska pollock > Blue grenadier.

Discussion

In this study, Suwari phenomenon was compared among six kinds of surimi from three fish species. Alaska pollock and Blue grenadier inhabit in cold sea and Threadfin bream in warm sea. From the result of breaking strength, it was suggested that formation of surimi gel was species-specific. In addition, it seemed not to be related with their habitant temperatures. All surimi except of KA grade from Thredfin bream, the braking strengths of Suwari gel increased with high heating temperature. This result implied that the protease related in the Modori at 30°C and the sitting was suppressed in the surimi of KA grade from Threadfin bream. And, the large difference in breaking strength between surimi grades exhibited that the qualities of frozen surimi were different from each other.

The activation energies of the high grade were high in order of Alaska pollock > Threadfin bream > Blue grenadier, which was opposite to the result of breaking strength. The values of low grade surimi increased in order of Threadfin bream > Alaska pollock > Blue grenadier. This result would be caused of the date of KA grade surimi from Threadfin bream at 30°C. Between the grades, the low grade was found to have a large activation energy and difficult sitting. By comparing the breaking strength, sitting speed and activation energy, it may be possible to compare the difference in grade of the same fish and fish species. Therefore, it is considered that breaking strength, sitting speed and activation energy are suitable for the indicator of quality evaluation.

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