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Development of a new thawing method applying electromagnetic wave irradiation

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Introduction

Food freezing technology is important to maintain food safety, and some freezing methods have been proposed to prevent deterioration of food quality during the freezing process. Most frozen foods must be thawed before further use or consumption [1], but thawing technology has not progressed comparison with freezing technology, although the thawing process influences the quality of the product. Electromagnetic radiation is typically used for communication, broadcasting and nondestructive testing, and also for medical and optical equipment. In the food processing field, it is used for microwave and electromagnetic cookers.

A need was recognized for a thawing method to minimize the thawing time and also minimize any quality loss of frozen foods. A novel electromagnetic wave irradiation device was developed and thawing tests were performed on frozen fish meat [2].

Materials and methods

Thawing tests were performed with frozen fish meat: Bigeye tuna (*Thunnus obesus*), skipjack tuna (*Katsuwonus pelamis*) and coho salmon (*Oncorhynchus kisutch*). Also tested frozen fish roe: Salted salmon roe and Alaska pollack roe.

Thawing was performed with two electromagnetic irradiation devices: FMU-2450/ 162/100 and FUH-162/ 100 (YAMAMOTO VINITA, Fig. 1).

Physical properties of thawed fish meat were measured with a creep meter (YAMADEN, RHEONER Ⅱ, RE-33005B). Freshness of the meat was determined for the composition of nucleic acid-related compounds analyzed by HPLC (JASCO). The drip amount was calculated from the weight loss after thawing. We tried this thawing method for various frozen food materials including fish meat and applied to composite materials such as sushi.

Fig. 1. Multifunctional electromagnetic irradiation devices (A, FMU-2450/162/100; B, FUH-162/100).

Results

The temperature change in the thawing process of whole skipjack tuna (about 3 kg weight) is shown in Fig. 2. Thawing by placing in a refrigerator at 4°C required about 25 hours to thaw the center of the flesh. With 300 W electromagnetic irradiation (EMI), it took about 20 minutes. For bigeye tuna block meat (10×10×10 cm), it took about 25 minutes was required. At that time, the surface of the block temperature was about 5°C, and the center was -2°C.

After thawing the dorsal ordinary muscle of coho salmon, the K value did not change with EMI thawing (14.8±1.1%, n=3), but increased markedly with refrigerator thawing (24.9 ±0.8, n=3). The breaking strength of coho salmon ordinary muscle after thawing showed a low value for refrigerator thawing compared with EMI thawing. The drip amount was markedly reduced with EMI thawing compared with refrigerator thawing (Fig. 3).

On thawing frozen shushi, the heating rate was different between the rice and the fish components (bigeye tuna): the temperature of frozen rice rose rapidly compared with that of the fish.

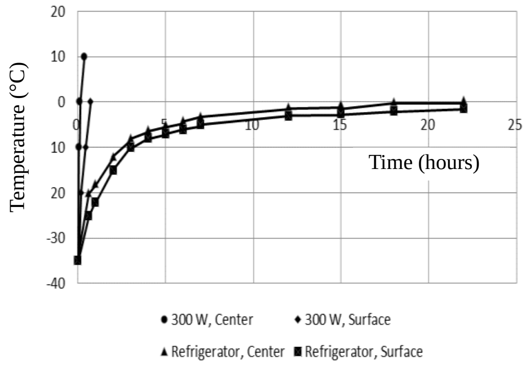

Fig. 2. Comparison with thawing curves for skipjack tuna meat using refrigerator thawing versus EMI thawing.

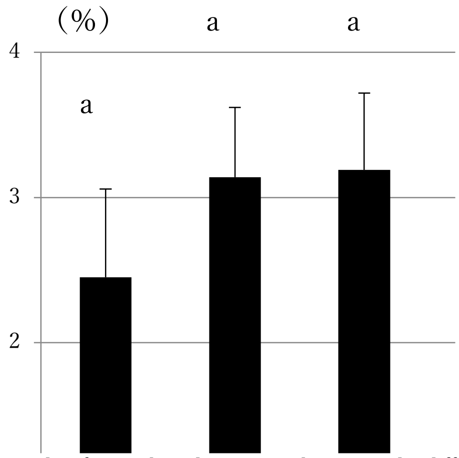

Fig. 3. Amount drip from coho salmon upon thawing under different conditions (-30°C/4°C: Freeze at -30°C and thawed in refrigerator (4°C); EMI: Thawed by an electromagnetic irradiation device).

Discussion

The thawing method using EMI at 100 MHz was able to thaw frozen fish meat very quickly in comparison with thawing in a refrigerator, and it was possible to almost uniformly thaw whole skipjack tuna and bigeye tuna block meat. 100 MHz EMI has high penetration and low heating power as compared with wavelengths used in microwave ovens (2,450 MHz) [3-5], which explains its suitability for thawing thick frozen materials. Difference of temperature rising speed due to ingredients may depend on the dielectric constant and salt concentration of the foodstuff [6,7].

The 100 MHz EMI thawing technique is therefor extremely effective as a thawing method for frozen products, so commercial tests are currently in progress.

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