Effects of Various Thawing Methods on the Quality Characteristics of Frozen Beef

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Abstract

In this study, the quality characteristics due to the influence of various thawing methods on electro-magnetic and air blast frozen beef were examined. The loin and round of second grade Hanwoo were sliced into 5-7 cm thickness and packed with aerobic packaging. The packaged beef samples, which were frozen by air blast freezing at -45°C and electro-magnetic freezing at -55°C, were thawed by 4 thawing methods with refrigeration (4 ± 1°C), room temperature (RT, 25°C), cold water (15°C), and microwave (2450 MHz). These samples were thawed to the point, which were core temperature reached 0°C. Analyses were carried out to determine drip and cooking loss, water holding capacity (WHC), moisture contents and sensory evaluation. Frozen beef thawed by microwave indicated a lower drip loss (0.66-2.01%) than the other thawing methods (0.80-2.50%). Cooking loss after electro-magnetic freezing indicated 52.0% by microwave thawing for round compared with 41.8% by refrigeration, 50.1% by RT, and 50.8% by cold water. WHC thawing by microwave with electro-magnetic freezing didn’t showed any difference depending on the thawing methods, while moisture contents was higher thawing by microwave with electro-magnetic freezing than refrigeration (71.9%), RT (75.0%), and cold water (74.9%) for round. The texture of sensory evaluation for round thawed by microwave result was the highest than refrigeration (4.7 point), RT (6.4 point) and cold water (6.6 point), while sensory evaluation was no significant difference. Therefore, it was shown that microwave thawing is an appropriate way to reduce the deterioration of meat quality due to freezing.

Key words: frozen meat, thawing method, beef, moisture contents, water holding capacity

Introduction

The application of freezing for the preservation of foods has been practiced for several years in order to maintain quality during storage, distribution and marketing (Haneonian and Mittal, 2004; Li and Sun, 2002). Most frozen foods are able to maintain the freshness by inhibiting the growth and proliferation of microorganisms other than psychotropic microbes (Tomanik et al., 1998). Frozen meats are used after thawing. The most common methods to thaw frozen food include RT thawing, cold water thawing, steam thawing and contact thawing. These thawing methods are time consuming and require external heating, after which change in the quality of the meat occur (Kang et al., 2007). Changes which take place during the thawing processes of frozen meat include the growth of microorganisms, weight loss due to drip loss, and color change (Berry, 1994; Kondratowicz et al., 2008), effect of WHC (Miller et al., 1980; Sebranek, 1979; Zhuang, 2012), increase of rancidity (Lannari and Zaritzky, 1991; Sebranek et al., 1978), denaturation of protein (Wagner and Anon, 1985; Wagner and Anon, 1986) and softening of tissues, which results in a changes which are quite apparent to the consumer (Fennema, 1973; Jason, 1974; Kim et al., 1990).

Recently, various thawing methods have been actively researched using high-pressure thawing, microwave thawing, ohmic thawing and acoustic thawing in order to minimize amount of drip occurring at thawing time and deterioration of quality (Dong et al., 2011; Hong et al., 2007; Kim et al., 2006; Lee and Park, 1999; Li and Sun, 2002). However, these thawing methods require special equipments or devices, the cost of which limits their availability (Li and sun, 2002). In addition, many researches have attempted to identify how freezing and thawing conditions affect meat (Mortensen, 2006; Muela, 2010; Vieira, 2009; Xia, 2009). Jung (1999) reported that rapid thawing for frozen meat results in a greater breakage of myofibril and that this has an influence upon the quality
of meat after thawing (Yu et al., 2010). Park et al. (2012) reported that refrigeration thawing is the most suitable for frozen pork, while Song and Lee (2002) reported that repeating chilling and thawing negatively affects the quality of meat. Szmáńko et al. (1995) reported that the storage period of meat frozen under -10°C did not affect the WHC. Electro-magnetic freezing has recently been used to minimize quality change during freezing. Electro-magnetic freezing is maintain super-cooling of ice crystal vibrating water molecule of freezing materials with energy in magnetic field and freeze both the inside and outside of material at the same time. Dropping the temperature below a certain level to prevents the destruction of cellular tissues, which prevents water molecules from moving (Iwasaka et al., 2011).

In this study, the effects of various thawing methods of frozen beef are characterized for electro-magnetic and air blast frozen loin and round.

**Materials and Methods**

**Samples**

Samples of this study are beef (Hanwoo) sampled one day after slaughter. The beef was used grade 2 and loin and round were sampled. The samples were cut to 5-7 cm and were packed with aerobic packaging (23×32 cm, PE) by the 500 g.

**Thawing and freezing**

For thawing beef, thawing by refrigeration at 4±1°C (MicomCA-A11AC, LG, Korea), thawing by RT, and thawing by cold water were carried out at 25°C and 15°C, respectively, and thawing by microwave was carried out using a microwave (RE-551B, 2450 MHz, 700 W, Samsung Co., Korea) until the temperature of the meat reached 0°C. Samples were evaluated until their core temperature reached at 0°C and repeated 20 time for each sample as a preparatory experiment about overheating of surface. Thawing time using refrigeration, RT, and thawing by cold water and microwave was 164.9 h, 5.0 h, 1.5 h and 0.4 h, respectively. Samples were frozen using the electro-magnetic freezing and air blast freezing method. Electro-magnetic freezing (AVI Co., Japan) samples were frozen at -55°C using refrigeration of Dine jeju Co., while air blast frozen samples were frozen at -45°C using a refrigeration of Meat bank Co. Data logger (176T4, Testo, Germany) was used to measure temperature, while a thermocouple (NiCr-Ni thermocouple, SEF GmbH, Germany) was used for sensing.

**Analysis items and methods**

Thawing time was used in sampling as a result of preparatory experiment and temperature of sample for analysis was measured after thawing. After thawing of frozen beef, physicochemical and sensory evaluation was carried out in order to compare the quality of each result and repeated three times for each sample. Sensory evaluation was carried out after heating the thawed samples and the results were applied to statistical analysis.

**Drip loss**

Drip loss (%) is measured for frozen beef until the temperature in center of meat reaches at 0°C.

\[ \text{Drip loss} \% = \frac{\text{weight before thaw} - \text{weight after thaw}}{\text{weight before thaw}} \times 100 \]

**Cooking loss**

According to specific methods of thawing, the sample weight is measured before/after cooking of the sample by heating at 75°C in a water bath, and is taken out when the temperature in center of the test material reaches at 65°C, and then cooled, after which cooking loss is calculated by following formula.

\[ \text{Cooking loss} \% = \frac{\text{weight before cook} - \text{weight after cook}}{\text{weight before cook}} \times 100 \]

**Water holding capacity (WHC)**

WHC of meat depending on each thawing method, using the modified Kristensen and Purslow (2001) method, is calculated by heating 5 g of minced meat at 70°C in a water bath for 30 min and then cooling it, and then centrifuging at 1,000 rpm for 10 min and measuring total moisture, after which is calculated by the following formula.

\[ \text{WHC} \% = \frac{\text{total water content} - \text{separated water content}}{\text{total water content}} \times 0.951 * \]

*0.951: pure water amount for meat moisture which is separated under 70°C

**Moisture contents**

Moisture content is analyzed at 105°C by an ambient drying method according to AOAC (1990).

**Sensory evaluation**

A sensory evaluation of samples was carried out based on appearance, flavor, texture, taste and overall accept-