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Influence of meat exudates on the quality characteristics of fresh and freeze-thawed pork

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ABSTRACT

The influence of the accumulated exudates released from pork loin of itself on the quality characteristics of fresh and freeze-thawed pork during cold storage was investigated. Pork loins were divided into four groups (fresh pork with exudates, fresh pork without exudates, freeze-thawed pork with exudates and freeze-thawed pork without exudates) and stored at 1.0 °C for 7 days. Exudate amount increased due to freeze-thawing and with storage, and most quality traits such as drip loss, cooking loss, tenderness, lightness, redness, and moisture content were affected by freeze-thawing ($p < 0.05$). Freeze–thaw increased drip loss but decreased moisture content, cooking loss, tenderness, lightness and redness of meat ($p < 0.05$). Microbial growth was solely affected by exudate removal and the removal of initial exudates decreased microbial growth ($p < 0.05$). Exudates were positively correlated with total protein content and total plate count but negatively correlated with pH and cooking loss. Therefore, removing meat exudates and avoiding freeze can slow down the quality deterioration of pork during cold storage.

1. Introduction

Water (approximately 75%) is the main component of lean meat (Huff-Lonergan & Lonergan, 2005) and can escape from meat as purge or drip according to physical and biochemical factors after conversion of muscle to meat. In general, meat exudates; that is, purge or drip loss, can average 1–3% in fresh cuts (Offer & Knight, 1988), and up to 10% weight loss is observed in fresh pork carcass weight (Melody, Lonergan, Rowe, Huiatt, Mayes, & Huff-Lonergan, 2004). Drip loss is exacerbated by cutting, heating, grinding, pressing, and particularly, freeze-thawing. Up to 18.27% drip loss is observed by freeze-thawing pork (Xia, Kong, Liu, & Liu, 2009).

Meat exudates contain mainly water-soluble sarcoplasmic proteins, which are one major protein groups of myofibrillar muscle proteins, and contain a blend of nucleotides, amino acids, peptides, proteins, and many soluble enzymes (Savage, Warriss, & Jelley, 1990). Thus, exudates (drip or purge loss) are closely related to muscle protein oxidation and denaturation which are responsible for muscle pH decline, discoloration, and toughness (Joo, Kauffman, Kim, & Park, 1999; Traore et al., 2012). It is generally agreed that the control of water-holding capacity (WHC) is very important to reduce exudates from meat to a minimum, so a large number of studies on factors affecting WHC or quality traits influenced by WHC have been conducted (Bertram, Purslow, & Andersen, 2002; Honikel, Kim, Hamm, & Roncales, 1986; Jeong, Kim, Yang, & Joo, 2011; Joo, Kauffman, Kim, & Kim, 1995; Kauffman et al., 1993; Payne, Durham, Scott, & Devine, 1997; van de Wiel & Zhang, 2007; Warner, Kauffman, & Greaser, 1997). Nevertheless, the loss of exudates from meat is unavoidable, because some loss of moisture occurs due to the presence of water in a free form in muscle tissue (Joo & Kim, 2011).

Consumers purchase pork, beef, or chicken from retail stores, and the meats purchased may be eaten or not. The uneaten meat might be repacked and stored in a refrigerator or a freezer. In general, purge loss (meat juice) from meat is released onto the packaging bag or paper. When the consumer repacks the meat, purge loss can be removed or not. Studies concerning drip or purge loss have been confined to identifying exudation amount or its relationship with other meat qualities (Aaslyng, Bejerholm, Ertbjerg, Bertram, & Andersen, 2003; Jeong et al., 2009; Lawson, 2004). However, the influence of meat exudates on meat quality during cold storage has not been identified. Therefore, we hypothesized that the presence of exudates affects meat quality such as meat color, muscle pH, tenderness, lipid oxidation, and microbial growth. The interaction between the presence of exudates and freeze-thawing was also investigated, because freezing is a representative method for preserving muscle foods.

2. Materials and methods

2.1. Sample preparation

Nine porcine *longissimus thoracis et lumborum* (LTL) muscles (moisture, 73.65 ± 0.22%; crude fat, 1.87 ± 0.17%; crude protein,

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23.23 ± 0.24%; crude ash, 1.01 ± 0.13%) were removed from chilled carcasses at a commercial slaughtering house 24 h postmortem. The porcine LTL muscles were cut into 3 cm-thick steaks (n = 80) of similar weight (195.2 ± 1.4 g). Each sample was individually placed in a polyethylene plastic bag, divided into four groups (20 steaks per each group). A refrigerator (RF903ETPETM, Samsung, Korea) was prepared for cold and freeze storage, and the refrigerator's capacity is 901 L (cold room: 349 L, freeze room: 552 L) and it has a French door. This refrigerator's cold room and freeze room temperatures can be adjusted from 0 to 5 °C and from −17 to −23 °C, respectively. Before storing the samples, the temperatures of the cold room and freeze room were adjusted to 1 °C and −20.0 °C, respectively, and a thermocouple thermometer (TM-9126, Lutron electronic enterprise Co., LTD, Taiwan) was used to check the temperature every 2 h. The samples were arranged irregularly in the cold room and the freeze room and they were arranged not to overlap or contact each other. The samples treated by two different conditions: cold storage at 1.0 ± 0.5 °C (C1 and C2) for 48 h; freezing at −20 ± 0.5 °C (T1 and T2) for 24 h and thawing at 1.0 ± 0.5 °C for 24 h. After 48 h of storage, exudates were removed from sample groups C2 and T2, and all samples were stored at 1.0 ± 0.5 °C for 5 days. Five steaks per each group at different storage days were tested. A diagram for sample preparation was presented in Fig. 1.

2.2. Exudates (%)

Exudates (%) were determined from the known weights of the steaks before and after thawing or cold storage:

$$\text{Exudates } (\%) = \frac{\text{weight of porcine steak} - \text{weight of stored (thawed) porcine steak}}{\text{weight of porcine steak}} \times 100.$$

2.3. Protein concentration and total protein content

Protein concentration (mg/ml) released from muscle samples as with meat juice was determined by the Bradford method (Bradford, 1976), and total protein content (mg) was calculated as the product of protein concentration (mg/ml) and total exudate volume (ml).

2.4. pH

pH was measured in 3.0 g muscle homogenates in 27 ml of de-ionized water using a pH-meter (MP230, Mettler-Toledo, Greifensee, Switzerland).

2.5. Moisture content, crude protein, crude ash and crude fat

Moisture content (%), crude protein, and crude ash were determined using an AOAC (1995) method. Crude fat (%) analysis was conducted by the procedure of Folch, Lees, and Sloane-Stanley (1957) with modifications. In brief, 3 g of meat sample was homogenized with 30 ml of Folch solution I (chloroform:methanol, 2:1, v/v) for 30 s and filtered with Whatman No.1 filter paper in a 100 ml graduated cylinder after stirring for 2 h at 4 °C. The filtered solution was stirred with 0.88% NaCl (25% volume of the filtered solution), and allowed to separate into two layers for 1 h at room temperature. After washing the wall of the graduated cylinder with 10 ml of Folch solution II (chloroform:methanol:H_2O = 3:47:50), the final volume of the lower layer was recorded. The upper layer was removed using an aspirator, and 10 ml of the lower layer was transferred to a dish to dry at 50 °C. The weight of the dish was measured before and after

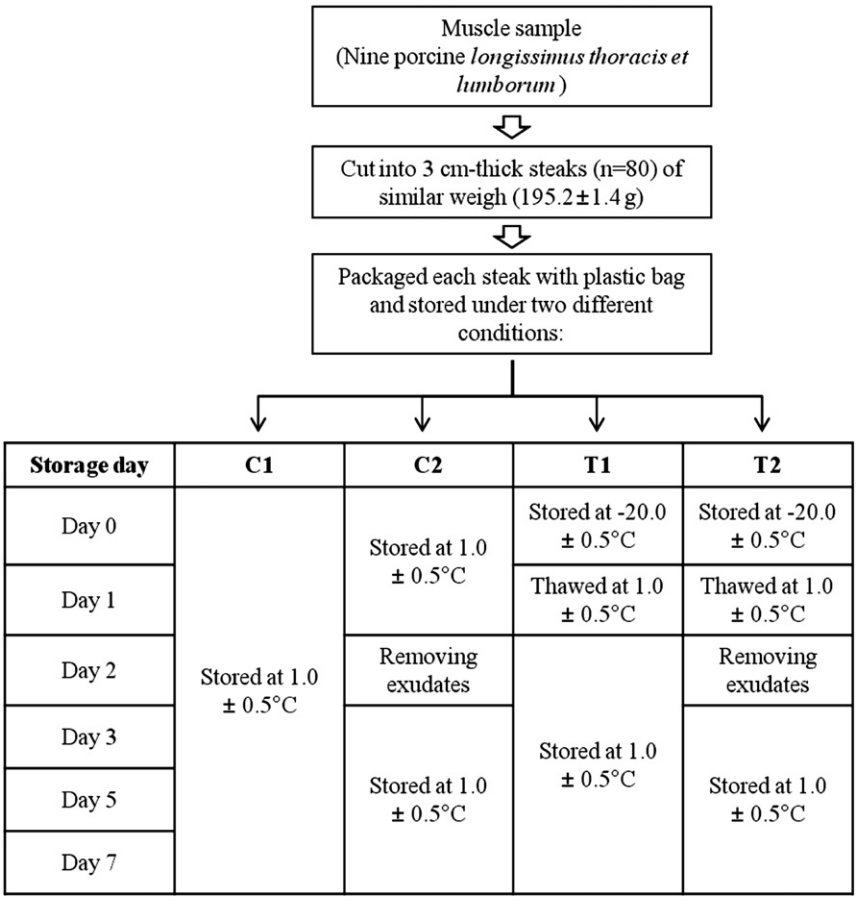

Fig. 1. A diagram for sample preparation.