Effects of Aging Period Prior to Freezing on Meat Quality of Hanwoo Muscle (Longissimus dorsi)

Hyun-Wook Kim¹, Eui-Soo Lee², Yun-Sang Choi³, Ji-Hun Han¹, Hack-Youn Kim⁴, Dong-Heon Song¹, Seul-Gi Choi¹ and Cheon-Jei Kim¹, ⁴*

¹Department of Food Science and Biotechnology of Animal Resources, Konkuk University, Seoul 143-701, Korea
²R&D Center, Chicken University; Genesis Inc., Icheon 467-813, Korea
³Food and Biological Resources Examination Division, Korean Intellectual Property Office, Daejeon 302-701, Korea
⁴Research Institute for Meat Science and Culture, Konkuk University, Seoul 143-701, Korea

Abstract

This study was conducted to evaluate the effect of the aging period prior to freezing on the meat quality of Hanwoo longissimus dorsi (LD) muscle. Three different combinations of aging and freezing periods (0/90, 20/70, and 40/50) were examined using LD muscle at 24 h postmortem under an identical storage time of 90 d. The pH and lightness slightly increased with increasing aging period. However, there were no significant (p>0.05) differences in redness and yellowness. The solitary freezing treatment (0/90) had the significantly (p<0.05) lowest moisture content. The un-aged treatment had a significantly (p<0.05) higher total loss than the aged treatments due to an increase in thaw drip loss. The aging significantly improved the myofibrillar fragmentation index and shear force of Hanwoo LD muscle (p<0.05). In addition, the aged treatments produced a higher flavor, tenderness, juiciness, and overall acceptability relative to un-aged treatment. However, there was no significant (p>0.05) difference in shear force and sensorial properties between 20 and 40 d aging prior to freezing. Therefore, 20 d aging prior to freezing may be a sufficiently effective strategy to improve the tenderness and sensorial properties of Hanwoo LD muscle.

Key words: aging, freezing, Hanwoo, tenderness

Introduction

After slaughter, the muscle of mammals, such as beef, hog, and lamb etc., begin undergoing various biochemical changes such as the depletion of ATP (adenosine triphosphate) and glycogen under anaerobic conditions. These changes result in rigor-mortis of pre-rigor muscle, which eventually decreases the tenderness due to changes in pH and the contraction of myofibrillar proteins (Faustman, 1994; Savell et al., 2005). Meat aging is one of the most commonly used methods to enhance the toughness caused by rigor-mortis and to improve the taste and flavor (Sitz et al., 2006). According to Faustman (1994), the meat tenderness during aging is affected by two proteolytic enzymes and specific conditions (pH and temperature) that influence the enzymatic activity are extremely impor-

*Corresponding author: Cheon Jei Kim, Department of Food Science and Biotechnology of Animal Resources, Konkuk University, Seoul 143-701, Korea. Tel: 82-2-450-3684, Fax: 82-2-444-6695, E-mail: kimcj@konkuk.ac.kr
ing and packaging after a freeze-thaw cycle on color stability of ovine muscle. However, the effects of different combinations of aging and freezing periods under identical storage conditions after slaughter on meat quality have not been studied. In addition, studies on the aging of Hanwoo have been limited to examining the effect of aging temperature, period, and packing method (Choi et al., 1995; Kim et al., 2007). Therefore, the objective of this study was to evaluate the effects of the aging period prior to freezing on the meat quality of Hanwoo longissimus dorsi muscle.

Materials and Methods

Raw material collection and sample preparation
A total of nine Hanwoo cows (each of three Hanwoo cows in three replications), which ranged in age from 24 to 27 mon (average live weights: 570.2 kg; average carcass weights: 320.5 kg), were obtained from the local municipal slaughterhouse. The processing of carcasses was as follows: After splitting and bleeding, the carcasses were washed and immediately moved to a chilling room (2±1°C). 24 h post-mortem, the carcasses were judged by an official grader according to the Korean carcass grading procedure (National Livestock Cooperatives Federation, NLCF, 1998). Based on this grading system, carcasses classified as 1++ (quality and yield grade) were obtained to collect longissimus dorsi (LD) muscle. Samples of LD were taken from between the 12th and 13th rib of each carcass, and were sliced into a thickness of about 2.5 cm to maintain the original shape of the muscle. All samples were vacuum-packaged in polyethylene bags and divided into three groups. Each group was treated as follows (aging period/freezing period): 0/90 (un-aged treatment) = immediately freezing in a -20°C freezer immediately after aging period in refrigerator, 20/70 (intermediate aged treatment) = 20 d of aging period in a 2°C refrigerator, followed by 70 d storage at -20°C, and 40/50 (long-term aged treatment) = 40 d of aging in a 2°C refrigerator, followed by 50 d storage at -20°C). The sample at post-mortem 24 h is marked 0 d of aging period (un-aged), and all samples were stored using different combinations of aging and freezing time over the same 90 d storage period.

Each frozen LD sample was unpacked to measure the weight of the frozen sample, and then was repacked using a vacuum package machine. The samples were thawed in running water (approximately 15±1°C) for analysis of meat quality. To evaluate the thawing time, the center temperature of the sample was pre-tested using a digital thermometer (Tes-1305, Tes Electrical Corp., Taiwan) equipped with a data logger (RS-232, Tes Electrical Corp., Taiwan) by inserting an iron constantan thermocouple. The thawing time was calculated by measuring the time required for the sample to reach 4°C using these pieces of equipment. Each frozen-thawed sample was unpacked to measure the pH, instrumental color, moisture content, sarcomere length, myofibrillar fragmentation index (MFI), and nucleotide relative compounds. All analysis was performed in triplicate.

pH measurements
The pH values of frozen-thawed Hanwoo muscle were determined with a pH meter (Model 340, Mettler-Toledo GmbH, Switzerland). The pH values of samples were measured by blending a 5 g sample with 20 mL distilled water for 60 s in a homogenizer at 8,000 rpm (Ultra-Turrax SK15, Janke & Kunkel, Germany).

Instrumental color evaluation
Instrumental color were determined using a colorimeter (Minolta Chroma meter CR-210, Japan; illuminate C, calibrated with a white plate, CIE L'=+97.83, CIE a'=-0.43, CIE b'=+1.98). Five measurements for each of five locations on surface of thawed Hanwoo muscle were taken. CIE L' (lightness), CIE a' (redness), and CIE b' (yellowness) values were recorded.

Moisture content
Moisture content of the samples was determined using AOAC (2000) procedures. Moisture content (950.46B, oven air-drying method) was determined by weight loss after 12 h of drying at 105°C in a drying oven (SW-90D, Sang Woo Scienticfic Co., Korea).

Thaw drip, cooking, and total loss
Thaw drip loss (%) was determined for individual samples by calculating the weight differences between frozen sample (approximately 250 g) and thawed sample. After thaw drip loss determination, the samples were bagged within polyethylene bags and then immersed in a 75°C water bath (Model 10-101, Daehan Co., Korea) for 30 min and cooled at room temperature for 2 h. After cooling, the cooked samples were weighed. Cooking loss (%) was determined by weighing the meat before and after cooking. Also, total loss (%) was determined for individual samples by calculating the weight differences between frozen sample and cooked sample. Each expression is as...