Physicochemical Meat Quality and Sensory Property of Holstein Steer Beef Produced by Different Fattening Periods

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Abstract

This study was performed to investigate the physico-chemical properties of Holstein steer beef loin (M. longissimus dorsi) and top round (M. semimembranosus) from 18, 21 and 24-mon old. The loin and top round muscles from the 24-mon group had higher intramuscular fat content (%) than the other groups (p<0.05); however, the protein content was not significantly different among the 3 groups (p>0.05). With regard to meat color (CIE), the lightness (L*), redness (a*) and yellowness (b*) values of the loin were significantly higher for the 21- and 24-mon groups, and those of the top round were significantly higher for the 21-mon group than the same cuts in the other groups. The Warner-Bratzler shear force was the lowest at 24 mon for both the loin and top round muscles (3.69 kg); however, the water holding capacity was significantly higher for loin muscles from the 21-mon group (54.53%, p<0.05). The loin muscles from the 24-mon group contained significantly higher levels of monounsaturated fatty acid and significantly lower levels of saturated fatty acid than those in the other groups (p<0.05). The tenderness, juiciness, flavor-likeness and the overall-likeness scores were significantly higher for beef from the 21- and 24-mon groups than that from the 18-mon group. The results of this study indicate that both the slaughtering age and muscle type significantly affect meat quality. Therefore, fattening the beef for more than 4 mon during the late fattening stage would be advantageous for the meat quality of Holstein steers.

Key words: fattening period, Holstein steer, meat quality, fatty acids, sensory property

Introduction

The Holstein cattle breed was imported into Korea in 1903, and it is the premier dairy breed with a high potential for milk production. In 2011, approximately 79,529 heads of Holstein beef cattle were slaughtered in Korea (Holstein steers, 72,901; Holstein bulls, 6628) for meat production (KAPE, 2011). Few data are available on Holstein cattle, despite the fact that this breed provides a considerable proportion of the beef consumed throughout the world.

Investigations of the meat quality of different breeds have mostly concentrated on age, length of the fattening period, and the weight of the animals. Castration has been proposed as a means of enhancing meat quality, along with improvements to feeding technology and slaughtering age. Castration of bulls increases carcass backfat (Field, 1971; Knight et al., 1999), intramuscular fat content (Knight et al., 1999; Purchas et al., 2002), and tenderness (Morgan et al., 1993; Purchas et al., 2002), and it reduces the incidence of high ultimate meat pH (Knight et al., 1999; Morgan et al., 1993). Additionally, castration reduces aggressive and sexual behavior, improves animal handling, and reduces carcass bruising (Katz, 2007). The differences in performance between intact bulls and castrates mainly manifest after puberty due to the increased production of anabolic hormones by the testes (Adams et al., 1996), which is attained at 6-9 mon of age and 250-380 kg of body weight in Holstein bulls (Lunstra et al., 1978). The yield grade (YG) of Holstein bulls (YG A, 23.3%) is higher than that of Holstein steers (YG A, 1.3%). The meat from Holstein is marketed with a low price due to its low quality and palatability. Korean consumers prefer highly marbled beef, especially from Hanwoo, and the frequency of beef with quality grade (QG) 1 is 62.4%. However, the frequency of higher than QG 1 for Holstein bulls and steers is only 15.5%. In 2011, 94.5% of the Holstein bulls had QG 3, whereas 45.2% of the Holstein steers had QG 3, 40.9% had QG 2, 10.4%
had QG 1, 2.8% had QG 1+, and 0.4% had QG 1++ when they were slaughtered at 20-21 mon (KAPE, 2011). Although the overall beef consumption in 2011 increased by 38.4% to 505 metric tons (MT), beef production from Holstein bulls and steers in 2011 decreased by 16% to 26 MT when compared to that in 2008 (MIFAFF, 2012). In Japan, a Holstein cross-breed was produced to improve the meat quality of Japanese black cattle, and they were fed with grass forage or total mixed ratio for highly marbled beef (Cho et al., 2005). The demand for a longer feeding period was increased; however, very few studies have characterized carcass, muscle, and meat quality characteristics according to the different feeding periods for the Holstein breed.

The objective of this study was to investigate the physico-chemical properties of Holstein steer beef loin (M. longissimus dorsi) and top round (M. semimembranosus) from 18, 21, and 24-mon-old after they were fattened for different periods.

Materials and Methods

Sample preparation

Eighteen Holstein steers (18, 21, and 24 mon old; live weight, 350-500 kg) were finished at the Yukpumjung farm and divided into 3 groups (6 heads/group) for slaughter at Yukpumjung Co. Ltd. in Korea. They were fed at the growth stage for 8 mon, the early fattening stage for 7 mon, and then the late fattening periods were divided into 1, 4 and 7 mon. At the end of each fattening periods (18, 21 and 24 mon-old), the animals were slaughtered and processed.

The right side of each carcass was hung by the Achilles tendon and chilled at 4°C. Approximately 48 h post-mortem, the quality grade was assigned from 5 possible values (1++, 1+, 1, 2, 3) based on the marbling score, lean meat color, fat color, firmness, texture of lean meat, and maturity of the exposed longissimus dorsi (LD) muscle at the thirteenth rib interface (National Livestock Cooperatives Federation, 1998). The right side of the carcass was deboned and trimmed to domestic fabrication. The loin (M. longissimus lumborum, LD) and top round (M. semimembranosus, SM) were separated, vacuum-packaged, and stored at 2°C or 3 days for analysis of meat quality. For fatty acid analysis, each sample, consisting of approximately 100 g of tissue, was vacuum-packaged and stored at 20°C until the analysis was conducted (approximately 2 wk post-mortem).

Chemical and meat quality analysis procedures

Protein, fat, moisture, and collagen content were analyzed using the Food ScanTM Lab 78810 (Foss Tecator Co., Ltd., Denmark), according to the method of the Association of Official Analytical Chemists (AOAC, 2006). Water-holding capacity (WHC) was measured using the method of Ryoichi et al. (1993). Color values on a freshly cut surface of the Warner-Bratzler shear force (WBSF) block were measured using a CR-301 chroma meter (Minolta Co., Japan) for CIE standard lightness (L*), redness (a*), and yellowness (b*) after a 30 min blooming at 2°C (Commision Internationale de Leclairage, 1986). The cooking loss (%) was calculated as the percent of weight change during cooking for the WBSF measurement. For cooking loss determination, the samples were freshly cut into blocks (50×50×25 mm) and weighed (initial weight). Individual meat blocks were placed in a water-bath at 80°C for 40 min. The samples were removed from the water-bath, cooled in cold water, and weighed. The cooking loss was expressed as a percentage of the initial sample weight (Honikel, 1998). WBSF was measured on cooked steaks (25 mm thick) according to the method of Wheeler et al. (2000) using an Instron Universal Testing Machine (Model 5543, UK). Total lipids of beef samples were extracted by using chloroform-methanol (2:1, v/v) according to the procedure of Folch et al. (1957). An aliquot of total lipid extract was methylated as described by Morrison and Smith (1964). Fatty acid methyl esters were analyzed by a gas chromatograph (Star 3600, Varian technologies, USA) fitted with a fused silica capillary column, omega205 (30 m × 0.32 mm i.d., 0.25 μm film thickness). The injection port was at 250°C and the detector was maintained at 300°C. Results were expressed as percentages based on the total peak area.

Sensory evaluation

For Korean roast thin-slice-style cooking, the beef strips were thawed at 4°C in the refrigerator. Individual strips were cooked by placing them on a tin plate equipped with a water jacket (at approximately 245-255°C). Strips were turned at the first pooling of liquid on the surface of the sample or at the start of shrinkage. The cooked strips were immediately served to 7 trained sensory panelists for evaluation. The panelists were asked to score the samples for tenderness, juiciness, flavor, and overall liking. Scoring was performed on a single sheet using four 100 mm lines from 0 to 100, with 20 mm gradients marked. Tenderness ranged from very tough (0) to very tender (100); juiciness ranged from very dry (0) to very juicy (100).