CHEMICAL COMPOSITION, MEAT COLOR, SHEAR FORCE, COOKING LOSS, WATER HOLDING CAPACITY AND FATTY ACIDS OF HOLSTEIN STEER BEEF BY DIFFERENT FATTENING PERIODS

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Abstract – This study was performed to investigate the physico-chemical properties of Holstein steer beef with loin (*longissimus dorsi*) and top round (*semimembranosus*) from finished Holstein steer at different fattening period (at 18, 21, and 24 months). The loin and top round muscles finished from 24 months had higher intramuscular fat contents (%) than the other groups (p<0.05) but the protein contents were not significantly different among three feeding period groups (p>0.05). The L*, a*, b* values were significantly higher for loin muscles from 21 and 24 months old groups than those of 18 months old group. The loin muscles from 24 months old were lowest in Warner-Bratzler shear force (WBS) (3.69 kg), however, water holding capacity(WHC) (54.53%) were significantly higher for loin muscles from 21 months old among three groups (P<0.05). There were not significant differences in cooking loss (%) for different fattening periods as well as muscles (P>0.05). In fatty acid composition, the loin muscles from 24 months old contained significantly higher MUFA contents and significantly lower SFA and PUFA contents than the other groups (p<0.05).

Key words: meat quality, quality grading, feeding periods

I. INTRODUCTION

Meat quality of breeds was mostly concentrated on age, length of fattening periods and weight of animals. Holstein breed was imported to Korea since 1903 and was the premier dairy breed with a high potential for milk production. However, the meat from Holstein was marketed at a low price due to its low quality and palatability. In Korea, 2.9 million head of cattle were raised for meat production (Hanwoo 2,950; Holstein bull and steer 130). Although beef consumption in 2011 increased to 505 MT by 38.4%, the beef production from Holstein bull and steers decreased to 26 MT by 16% when compared to those in 2008. Korean consumers preferred high marbled beef especially for Hanwoo and their frequencies of > Quality grade 1 (QG 1) were 62.4%. However, QG quality grading frequencies (> QG 1) of Holstein bull and steer beef were only 15.48%. Holstein steers (15.3%) produced higher quality beef than bulls (0.18%). Ninety four percent of the Holstein bulls had QG 3 whereas forty three percent had > QG 1 among Holstein steers when they were slaughtered at 20-21 month [1]. Therefore, the demand for a longer feeding period was increased; however, very few studies have been carried out to characterize carcass, muscle and meat quality characteristics depending on different feeding periods for Holstein breed. The objective of this study was to investigate the physico-chemical properties of Holstein steer beef with loin (*longissimus dorsi*) and top round (*semimembranosus*) produced from different feeding periods at 18, 21, and 24 months.

II. MATERIALS AND METHODS

Sample preparation: A total of 18 Holstein steers (18, 21 and 24 months old, 350-500kg of live weight) were finished at Yukpumjung farm and divided by 3 groups (6 head/group) to slaughter at Yukpumjung Co. LTD. in Korea. They were fed with the growth stage for 8 months, the early fattening stage for 7 months and the late fattening stage for 1-7 months of the rest periods. The quality grade (QG) has five possible values (1^{++}, 1^{+}, 1, 2, 3) and the QG is based on marbling score, lean meat color, fat color, firmness and texture of lean meat, and maturity of the exposed *longissimus dorsi* (LD) muscle at the thirteenth rib interface [2]. The

right side carcasses from each animal were divided into 3 groups received and two cuts (*longissimus lumborum*, LD) and top round (*semimembranosus*, SM) were separated, vacuum packaged and stored at 2°C for 3 days for meat quality analysis.

Analytical methods: Chemical compositions were analyzed by using methods of Association of Official Analytical Chemists [3]. Water-holding capacity (WHC) was measured by using the method of Ryoichi et al. [4]. Warner Bratzler-shear force (WBS) was measured on cooked steaks (25-mm thick) according to the method described by Wheeler et al. [5]. Color values on freshly cut surface of the WBS block were measured by a chroma meter (Minolta Co. CR 301) for lightness (L), redness (a) and yellowness (b) of CIE after a 30-min blooming at 1°C. Cooking loss was calculated as a percent for the weight changes during cooking for WBS measurement. Amino acid analysis was performed by Amino acid analyzer (Alpha, LKB-4150, Hitachi, Japan) (Hitachi, model 835). For fatty acid analysis, total lipids were extracted by using chloroform-methanol (2:1, v/v) according to the procedure of Folch et al. [6]. An aliquot of the lipid fraction was methylated as described by Morrison and Smith [7]. Fatty acid methylesters were analyzed by a gas chromatograph (Varian 3400) fitted with a fused silica capillary column, Omegawax (205, 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 260°C. Nitrogen was used as the carrier gas. Results were expressed as percentages, based on the total peak area.

Statistical analysis: Data were analyzed by using the SAS program [8] and means were separated by the Student-Newman-Keuls' test. The level of significance was $p<0.05$.

III. RESULTS AND DISCUSSION

The mean live weights were 383.8, 436.1 and 478.9 kg and the quality grading frequencies for > QG1 were 0, 29 and 38% when they fed up to 18, 21 and 24 months old in this experiment (Table was not shown). In the chemical composition of loin and top round muscles, the moisture contents (%) were significantly higher for the 18 month old group and the fat contents (%) were significantly higher for the 24 month old group than the other groups ($p<0.05$) (Table 1). The intramuscular fat contents were often linked with beef palatability by consumers and play an important role in purchasing decision and price in Korea. Meat color was a further important factor of the visual appearance of meat. Chambaz et al. [9] reported that lightness was inversely correlated to heme iron content and heme iron contents of muscle increases with age especially up to 24 months of age and then remains relatively stable [10]. The longer fattening period resulted in high intramuscular fat content. The protein content was not significantly different among three feeding period groups ($p>0.05$).

Table 1. Chemical composition of loin and top round muscles for Holstein steers by different fattening periods.

Fattening time(month)	Moisture (%)	Protein (%)	Fat (%)	Collagen (%)
Loin				
18	70.59± 0.28[a]	20.29± 0.21	5.49± 0.40[b]	1.69± 0.03[b]
21	67.17± 0.52[b]	20.65± 0.10	8.19± 0.57[a]	1.78± 0.05[b]
24	66.38± 0.86[b]	20.15± 0.27	9.62± 1.08[a]	1.93± 0.06[a]
Top round				
18	73.07± 0.19[a]	20.82± 0.16	2.79± 0.14[b]	1.68± 0.03[ab]
21	70.86± 0.29[c]	21.09± 0.34	2.96± 0.16[b]	1.63± 0.05[b]
24	71.90± 0.27[b]	21.07± 0.14	4.31± 0.52[a]	2.19± 0.03[a]

[*]Mean ± S.E.
[a-c] Means in the same column within the same category with different letters are significantly different ($p<0.05$).

In meat color properties, L*, a*, b* values were significantly higher for loin muscles from the 21 and 24 month old groups than those of the 18 month old group (Table 2). The loin muscles from the 24 month old were lowest in Warner-Bratzler shear force (WBS) (3.69 kg), however, water holding capacity (WHC) (54.53%) was significantly higher for loin muscles from the 21 month old among the three groups ($p<0.05$). The

top round muscles from the 21 month old group had significantly higher L*, a*, b* values and WHC (54.93%), whereas those had significantly lower WBS values (4.45 kg) when compared to the other groups (P<0.05). There were no significant differences in cooking loss (%) for different fattening periods as well as for muscles (p>0.05).

Table 2. Meat color, cooking loss (%), Warner-Bratzler shear force (WBS) and water holding capacity (WHC) of loin and top round muscles for Holstein steers by different fattening periods.

Fattening time (month)	Meat color			Cooking loss (%)	WBS (kg)	WHC (%)
	L	a	b			
Loin						
18	28.04±0.38^{b}	13.24±0.21^{b}	4.67±0.11^{b}	25.65±0.75	3.75±0.31^{a}	56.86±0.89^{b}
21	31.06±0.61^{a}	14.97±0.62^{a}	5.68±0.24^{a}	25.32±0.94	3.89±0.42^{a}	59.53±0.78^{a}
24	31.60±0.54^{a}	15.46±0.47^{a}	5.90±0.22^{a}	25.32±0.94	3.89±0.42^{b}	54.44±0.66^{c}
Top round						
18	35.31±0.85^{b}	19.20±0.53^{b}	7.85±0.34^{b}	33.03±0.54	6.00±0.17^{a}	53.63±0.64^{ab}
21	38.85±0.77^{a}	23.00±0.39^{a}	11.90±0.25^{a}	31.94±1.53	4.45±0.17^{b}	54.93±0.86^{a}
24	34.69±1.06^{b}	19.53±0.62^{b}	7.88±0.38^{b}	32.63±0.39	4.59±0.38^{b}	52.26±0.66^{b}

*Mean ± S.E.

a-c Means in the same column within the same category with different letters are significantly different (p<0.05).

In fatty acid composition, the loin muscles from the 24 month old group contained significantly higher MUFA contents and significantly lower SFA and PUFA contents than the other groups (p<0.05) (Table 3).

IV. CONCLUSION

The fattening up to 21-24 months increased the meat quality with the increase of marbling contents for Holstein steers. This study showed the possibilities of high quality beef production with the extension of fattening periods for Holstein steer.

Table 3. Fatty acid composition (%) of loin muscles from Holstein steers by different fattening periods.

Fatty acids	Fattening periods (months)		
	18	21	24
C14:0	3.34±0.12	3.23±0.20	3.20±0.24
C16:0	31.90±0.58	30.85±0.70	30.86±0.68
C16:1n7	3.23±0.19	2.67±0.35	3.27±0.19
C18:0	15.70±0.67	16.50±0.72	13.81±0.88
C18:1n7	0.25±0.04	0.20±0.02	0.31±0.02
C18:1n9	43.10±1.15	44.05±1.17	46.24±0.92
C18:2n6	2.18±0.14	2.29±0.19	2.09±0.18
C18:3n3	0.04±0.01	0.04±0.01	0.04±0.00
C18:3n6	0.05±0.00	0.04±0.00	0.04±0.01
C20:1n9	0.02±0.00	0.02±0.00	0.05±0.01
C20:4n6	0.18±0.06	0.14±0.02	0.09±0.02
MUFA/SFA	0.92±0.05	0.93±0.05	1.05±0.05
PUFA/SFA	0.05±0.00	0.05±0.01	0.05±0.00
SFA	50.94±1.22^{a}	50.57±1.39^{a}	47.87±1.06^{b}
MUFA	46.61±1.31^{b}	46.93±1.21^{b}	49.87±0.97^{a}
PUFA	2.46±0.20	2.51±0.20	2.26±0.19

*Mean ± S.E.

a-b Means in the same row within the same category with different letters are significantly different (p<0.05).

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