

MEAT QUALITY AND SENSORY PROPERTIES OF HOLSTEIN STEERS PRODUCED WITH HIGH ENERGY LEVEL OF TOTAL MIXED RATION

Soohyun Cho*, Pilnam Seong, Sun Moon Kang, Yunseok Kim, Geunho Kang,
Soonho Choi and Beomyoung Park

Animal Products Utilization Division, National Institute of Animal Science, Rural Development Administration, 1500
Kongjipatji-ro, Iseo-myeon, Wanju-gun 565-851, South Korea

Abstract – This study was performed to investigate the physico-chemical properties of Holstein steer beef loin (*M. longissimus dorsi*) and top round (*M. semimembranosus*) muscles produced with the high energy level of total mixed ration for 18, 20, or 22 mon. For loin and top round muscles, the protein and moisture contents were higher in the 18 mon group than in the 20 and 22 mon groups. Fat content of both muscles were higher for 22 mon group compared to 18 and 20 mon groups. Loin muscles from the 18 mon group had higher Warner-Bratzler shear force (WBSF) value, whilst top round muscles from the same group had lower WBSF value than those from the other groups. However, water-holding capacity was significantly higher for both muscles from 18 mon group than that for the other groups. In meat color, both muscles had higher L* value and lower a* value in the 18 mon group than the other groups. The loin muscles from the 20 and 22 mon groups scored significantly higher for tenderness, juiciness, flavor-likeness, and overall likeness than those from the 18 mon group. Top round beef samples from the 18 mon group scored significantly higher for tenderness and overall likeness than those of the 20 and 22 mon groups.

Key Words – total mixed ration, Holstein steer, meat quality, sensory property

I. INTRODUCTION

In 2013, approximately 64,123 heads of Holstein beef cattle were slaughtered in Korea (Holstein steers, 52,423 heads; Holstein bulls, 3,749 heads) for meat production [1]. Few data are available on Holstein cattle, despite the fact that this breed provides a considerable proportion of the beef consumed throughout the world. 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 64.1%. However, the frequency of QG > 1 for Holstein bulls and steers is only 9.0%. In 2013, 95.7% of the Holstein bulls had QG 3, whereas 51.7% of the Holstein steers had QG 3, 39.0% had QG 2, 7.3% had QG 1, 1.5% had QG 1⁺, and 0.2% had QG 1⁺⁺ when they were slaughtered at 20–21 mon [1]. 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 [2]. The demand for TMR feed was increased; however, very few studies have characterized carcass, muscle, and meat quality characteristics according to the different feeding periods for the Holstein breed. Therefore, 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*) when they were fed with total mixed ration (TMR) for 18, 20, or 22 mon.

II. MATERIALS AND METHODS

A. Sample preparation

Twenty-one Holstein steers (3-4-mon-old; 150 kg of average weight) were divided into three different slaughter age groups (7 heads/group): 18, 20, or 22 mon. They were raised at the Yukpumjung Farm, Republic of Korea, and fed with the high energy level of TMR at the growth stage for 8 mon (total digestible nutrients (TDN), 77%; crude protein (CP), 17%), the early fattening stage for 7 mon (TDN, 82%; CP, 15%), and the late fattening stage (TDN, 86%; CP, 13%) for 1, 3, or 5 mon. At the end of each fattening period, animals were slaughtered at

Yukpumjung Co., Ltd., Republic of Korea, and then processed. After the carcasses were chilled at 4°C for 24 hr, the right side of the carcass was boned and trimmed to domestic fabrication. The striploin (*M. longissimus dorsi*) and top round (*M. semimembranosus*) muscles were separated, vacuum-packaged, and then stored at 2°C for the analyses of meat quality and sensory evaluation.

B. Chemical and meat quality analysis

Protein, fat, moisture, and collagen content were analyzed using the Food Scan™ Lab 78810 (Foss Tecator Co., Ltd., DK), according to the method of the Association of Official Analytical Chemists [3]. Warner-Bratzler shear force (WBSF) value was measured on steaks (25 mm thick) cooked until internal temperature attained 75°C according to the method of Wheeler et al. [4] using an Instron Universal Testing Machine (Model 5543, UK). Water-holding capacity (WHC) was measured using the method of Ryoichi et al. [5]. The cooking loss (CL) was expressed as a percentage of the initial sample weight [6]. Color values were measured using a CR-301 chroma meter (Minolta Co., Osaka, Japan) for CIE standard lightness (L^*), redness (a^*), and yellowness (b^*) after a 30 min blooming at 2°C [7].

C. Sensory evaluation

For Korean roast thin-slice-style cooking, the beef strips were cooked on a tin plate equipped with a water jacket (at 245–255°C). 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). Flavor ranged from extreme dislike (0) to extreme like (100); overall liking ranged from extreme dislike (0) to extreme like (100).

D. Statistical Analysis

Each animal within the same slaughtering age group was treated as a replicate. Data were analyzed by the Student-Newman-Keuls' multiple comparison using the General Linear Model Procedure of the SAS program [8]. The significance level was set at $P < 0.05$.

For loin and top round muscles, the protein and moisture contents were higher in the 18 mon group than in the 20 and 22 mon groups ($P < 0.05$) (Table 1). Fat contents of both muscles were higher for 22 mon group comparatively to 18 and 20 mon groups ($P < 0.05$). Visible intramuscular fat (IMF) or marbling is an important meat characteristic which is appreciated by the consumer because of its positive effects on taste, juiciness, and tenderness [9]. Kang et al. [10] reported that Holstein steers contained high IMF when they were fed with TMR containing brewers dried grain for 6-23 mon. Some studies on dry beef cows have found that high-energy finishing diets improved the color characteristics, increased marbling and IMF, reduced the shear force value, and improved the sensory-panel tenderness scores [11-12]. Total collagen contents were not significantly different among three groups for the loin and top round muscles ($P > 0.05$). Loin muscles from the 18 mon group had higher WBSF value, whilst top round muscles from the same group had lower WBSF value than those from the other groups ($P < 0.05$) (Table 1). However, WHC was significantly higher for the loin and top round muscles from 18 mon group than those for the other groups ($P < 0.05$). There were no significant differences in the CL of loin muscles among three groups ($P > 0.05$). The loin and top round muscles had higher L^* value and lower a^* value in the 18 mon group than the other groups (Table 1). The a^* value was the highest for 22 mon group. Sung et al. [13] reported that the L^* value and heme pigment content were not significantly different among the meats from cattle slaughtered at 17, 18, and 19 mon of ages, but the a^* and b^* values increased as the slaughter age increased. The results of the sensory evaluation are shown in Table 2. For the loin, the samples from the 20 and 22 mon groups scored significantly higher for tenderness, juiciness, flavor-likeness, and overall likeness than those from the 18 mon group ($P < 0.05$). Top round samples from the 18 mon group scored significantly higher for tenderness and overall likeness than those from the 20 and 22 mon groups ($P < 0.05$).

Table 1. Chemical composition and meat quality of loin and top round muscles from Holstein steers fed on the high energy level of total mixed ration for 18, 20, or 22 mon

III. RESULTS AND DISCUSSION

Items ¹	Loin			Top round		
	18	20	22	18	20	22
Protein	23.26 ±0.22 ^a	21.40 ±0.49 ^b	20.61 ±0.71 ^b	23.65 ±0.19 ^a	21.49 ±0.26 ^b	20.34 ±0.69 ^b
Fat	5.56 ±0.50 ^b	6.62 ±0.88 ^{ab}	7.92 ±0.40 ^a	4.95 ±0.63 ^c	6.37 ±0.38 ^b	7.03 ±0.46 ^a
Moisture	71.63 ±0.21 ^a	69.31 ±0.42 ^b	68.41 ±0.31 ^b	72.71 ±0.89 ^a	67.60 ±0.82 ^b	69.06 ±0.64 ^b
Collagen	1.68 ±0.03	1.79 ±0.18	1.66 ±0.14	1.79 ±0.05	1.88 ±0.13	1.61 ±0.12
WBSF	3.59 ±0.74 ^a	2.99 ±0.21 ^b	2.69 ±0.45 ^b	57.12 ±2.28 ^a	55.14 ±1.06 ^{ab}	53.60 ±1.03 ^b
WHC	58.75 ±0.76 ^a	54.14 ±1.11 ^b	55.11 ±0.90 ^b	2.80 ±0.25 ^b	3.44 ±0.16 ^a	3.88 ±0.05 ^a
CL	27.14 ±1.20	26.05 ±2.41	28.90 ±0.83	31.55 ±0.27 ^b	28.55 ±0.28 ^c	33.12 ±0.40 ^a
L*	40.96 ±2.43 ^a	37.69 ±1.51 ^b	35.01 ±0.66 ^b	39.24 ±0.70 ^a	36.27 ±1.43 ^b	37.61 ±1.03 ^b
Meat color	a* 18.44 ±1.56 ^b	21.58 ±1.29 ^{ab}	23.17 ±2.24 ^a	21.65 ±1.30 ^b	21.01 ±1.53 ^b	25.28 ±0.52 ^a
	b* 9.37 ±0.65	10.51 ±0.60	10.91 ±0.56	11.65 ±0.46	12.26 ±0.84	12.89 ±0.79

*Mean ± S.E.

^{a-c}Means in the same column within the same category with different letters are significantly different ($P < 0.05$).

¹WBSF: Warner-Bratzler shear force; WHC: water-holding capacity; CL: cooking loss.

Table 2. Sensory evaluation of loin and top round muscles from Holstein steers fed on the high energy level of total mixed ration for 18, 20, and 22 mon

Items	Loin			Top round		
	18	20	22	18	20	22
Tender-ness	80.22 ±2.19 ^b	85.60 ±1.66 ^a	84.75 ±1.89 ^a	73.44 ±3.53 ^a	63.07 ±3.84 ^{ab}	58.05 ±4.67 ^b
Juiciness	68.78 ±2.81 ^b	78.84 ±2.44 ^a	81.90 ±2.52 ^a	72.56 ±3.21	72.74 ±3.20	71.34 ±4.69
Flavor-likeness	67.33 ±3.14 ^b	79.90 ±2.08 ^a	82.70 ±2.17 ^a	70.09 ±3.54	68.85 ±4.08	67.13 ±4.75
Overall likeness	69.72 ±3.34 ^b	82.07 ±1.92 ^a	82.76 ±2.25 ^a	67.96 ±3.65 ^a	61.31 ±3.62 ^{ab}	57.95 ±4.45 ^b

*Mean ± S.E.

^{a-b}Means in the same column within the same category with different letters are significantly different ($P < 0.05$).

IV. CONCLUSION

The meat quality and sensory properties were significantly different in the 18, 20, and 22 mon groups fed on the high energy level of TMR. However, further research was needed to investigate the feeding period effect of the high energy level of TMR at the same age group of Holstein steers.

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