The effects of sex condition, raising altitude and slaughtering season on the carcass quality characteristics of Hanwoo male cattle

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Abstract

This study was carried out to investigate the effects of sex condition, raising altitude and slaughter season on the carcass quality characteristics of Hanwoo male cattle. A total of 3,608 heads of cattle were used in this study. At 24 h post-slaughter, the carcasses were weighed and evaluated for backfat thickness, ribeye area, yield index and grade, marbling, meat color, fat color, firmness, maturity and quality grade. Ribeye area, yield index and grade, and meat color and firmness scores of carcass from bulls were significantly higher ($P < 0.001$) than those from steers. Inversely, the backfat thickness, marbling score and carcass quality grade of carcass from steers were significantly higher ($P < 0.001$) than those from bulls. Meat color score of carcass from highland was significantly lower ($P < 0.05$) than that from lowland. Marbling score and carcass quality grade from winter were highest and those from autumn were the lowest among those from other seasons. There were significant interactions between sex condition and raising altitude on ribeye area and between sex condition and slaughter season on marbling score and carcass quality grade. It was concluded that sex condition affected muscle and fat depositions, raising altitude affected meat color and slaughter season affected marbling.

Introduction

Hanwoo (Korean cattle) beef has been regarded as the most expensive and high quality beef in South Korea (Kim & Lee, 2003). In order to increase meat quality, castration is commonly practiced in some countries including Korea. Nearly 70 percent of the Korean Peninsula is covered by mountains and hills, so that cattle in this area are raised in variety altitude. In addition, the climate of Korea is characterized by four distinct seasons, i.e. spring, summer, autumn and winter. This study was carried out to investigate the effects of sex condition, raising altitude and slaughter season on the carcass quality characteristics of Hanwoo male cattle.

Materials and methods

Carcass grading data of cattle slaughtered in Taebaek slaughterhouse during four years were collected for analysis. A total of 3,608 heads of cattle were divided according to sex condition, raising altitude and slaughtering season. According to sex condition, the data was divided into bull and steer. According raising altitude, the data was divided into lowland (0-100 m) and highland (700-800 m). According to slaughtering season, the data was divided into spring (April-May), summer (June-September), autumn (October-November) and winter (December-March). The distribution of cattle was presented at Table 1.

At 24 h post-slaughter, the carcasses were weighed and evaluated by official grader for backfat thickness, ribeye (*M. longissimus*) area, marbling score (1 = devoid and 9 = abundant), meat color score (1 = brightly cherry red and 7 = extremely dark red), fat color score (1 = white and 7 = dark yellow), firmness score (1 = soft and 3 = firm), maturity score (1 = youthful and 9 = mature), yield index (68.184-[0.625 × backfat thickness (mm)] + [0.130 × ribeye area (cm^2)] – [0.024 × carcass weight (kg)] + 3.23) and grade and quality grade according to the Korean carcass grading standard (NLCF, 2004). Marbling score is about marbling that appear to ribeye area. Firmness is water folding capacity and elasticity of ribeye area in grade decision region. Maturity is about ossification of cartilage in left semiconductor backbone thorn promontory. Yield index was calculated as follows. Yield grade was scored 3 for A grade (yield index ≥ 67.50), 2 for B grade (62.00 ≤ yield index < 67.50) and 1 for C grade (yield index < 62.00). Carcass quality grade was scored 5 for 1^{++} grade (marbling score No. 8 or 9), 4 for 1^{+} grade (marbling score No. 6 or 7), 3 for 1 grade (marbling score No. 4 or 5), 2 for 2 grade (marbling score No. 2 or 3) and 1 for 3 grade (marbling score No. 1). Data was analyzed by factorial analysis in General Linear Model procedure using the SPSS 12 for windows (SPSS, 2003). Differences among means at the 5% level were determined by the Least Significant Difference test.

Table 1. Distribution of cattle slaughtered in Taebaek slaughterhouse

	Spring	Summer	Autumn	Winter	Total
Bull					
Lowland	291	689	270	510	1,760
Highland	25	91	14	58	188
Total	316	780	284	568	1,948
Steer					
Lowland	183	472	146	535	1,336
Highland	16	184	26	98	324
Total	199	656	172	633	1,660
Total					
Lowland	474	1,161	416	1045	3,096
Highland	41	275	40	156	512
Total	515	1436	456	1201	3,608

Results and discussion

Carcass yield and quality traits of cattle were presented in Table 2 and 3, respectively. Ribeye area, yield index and grade, meat color and firmness of carcass from bulls were significantly higher ($P < 0.001$) than those from steers. Inversely, the backfat thickness, marbling score and carcass quality grade of carcass from steers were significantly higher ($P < 0.001$) than those from bulls. This might because of their muscle and fat depositions differences. Lindsay (1983) stated that muscle growth is greater in males than females, and castration results in diminished muscle growth. Kirton & Morris (1989) stated that castration results in increased fat and slightly decreased muscle deposition in the carcass.

Table 2. The carcass yield traits of cattle slaughtered in Taebaek slaughterhouse

Items	Carcass weight (kg)	Backfat thickness (mm)	Ribeye area (cm^2)	Yield index	Yield grade
Sex condition (SC)					
Bull	391.70±44.90	6.43±3.11^{y}	88.72±10.10^{x}	69.71±2.09^{x}	2.79±0.43^{x}
Steer	386.96±42.90	10.69±4.55^{x}	84.69±9.04^{y}	66.67±3.18^{y}	2.30±0.64^{y}
Raising altitude (RA)					
Lowland	390.28±43.10	8.25±4.31	87.10±9.87	68.41±3.02	2.58±0.58
Highland	384.88±49.20	9.26±4.77	85.45±9.50	67.76±3.20	2.45±0.63
Slaughter season (SS)					
Spring	392.06±43.93	8.27±4.36	87.16±9.45^{x}	68.39±3.08	2.59±0.59
Summer	388.19±44.62	8.39±4.41	86.07±10.21^{y}	68.37±2.96	2.54±0.60
Autumn	387.33±44.28	7.98±4.27	87.35±9.56^{x}	68.68±2.96	2.62±0.57
Winter	390.84±43.28	8.60±4.42	87.49±9.59^{x}	68.08±3.17	2.56±0.58
Interaction[1]					
SC × RA	ns	ns	*	ns	ns
SC × SS	ns	ns	ns	ns	ns
RA × SS	ns	ns	ns	ns	ns
SC × RA × SS	ns	ns	ns	ns	ns

$^{x-y}$ Means ± s.d. in same column with different superscripts are significantly different at $P < 0.05$.
[1] The significance interaction between treatments are * = $P < 0.05$ and ns = non-significant.

There were no significant difference carcass traits between carcass from lowland and highland except meat color. Meat color of carcass from highland was significantly lower ($P < 0.05$) than that from lowland. This might due to their higher myoglobin content as their adaptation to the reduced oxygen availability in the atmosphere at higher altitude. Miller (1994) stated that myoglobin content was directly related to final muscle color, as myoglobin content increase, the muscle food increase in color intensity from white or pink to very dark red.

There were no significant difference carcass traits among slaughter season except ribeye area, marbling score, maturity and carcass quality grade. The ribeye area of carcass from summer was significantly smaller ($P < 0.05$) than that from other seasons. The maturity score of carcass from summer

season was highest among that from other seasons and the lowest was that from winter season. Marbling score and carcass quality grade from winter season were highest among those from other seasons and the lowest were those from autumn season.

Table 3. The carcass quality traits of cattle slaughtered in Taebaek slaughterhouse

Items	Marbling score	Meat color score	Fat color score	Firmness score	Maturity score	Quality grade
Sex condition (SC)						
Bull	1.53±1.02^{y}	5.03±0.49^{x}	3.00±0.19	1.95±0.25^{x}	2.13±0.35	1.37±0.63^{y}
Steer	5.05±2.14^{x}	4.85±0.45^{y}	2.99±0.21	1.32±0.47^{y}	2.12±0.33	3.28±1.08^{x}
Raising altitude (RA)						
Lowland	3.07±2.39	4.96±0.47^{x}	2.99±0.20	1.68±0.48	2.12±0.34	2.20±1.29
Highland	3.63±2.39	4.88±0.50^{y}	3.00±0.18	1.57±0.50	2.16±0.38	2.50±1.28
Slaughter season (SS)						
Spring	3.04±2.44^{y}	4.95±0.54	2.96±0.26	1.71±0.47	2.14±0.38^{xy}	2.19±1.32^{y}
Summer	3.04±2.31^{y}	4.94±0.48	3.00±0.20	1.68±0.48	2.15±0.37^{x}	2.18±1.24^{y}
Autumn	2.81±2.22^{z}	5.01±0.44	2.98±0.18	1.71±0.47	2.10±0.31^{yz}	2.06±1.20^{z}
Winter	3.46±2.51^{x}	4.92±0.45	3.00±0.17	1.60±0.49	2.10±0.30^{z}	2.42±1.34^{x}
Interaction[3]						
SC × RA	ns	ns	ns	ns	ns	ns
SC × SS	*	ns	ns	ns	ns	*
RA × SS	ns	ns	ns	ns	ns	ns
SC × RA × SS	ns	ns	ns	ns	ns	ns

$^{x-y}$ Means ± s.d. in same column with different superscripts are significantly different at P <0.05.
[1] The significance interaction between treatments are * = P <0.05 and ns = non-significant.

There was significant interaction between sex condition and raising altitude on the ribeye area. There were significant interactions between sex condition and slaughter season on the marbling score and carcass quality grade. There were no significant interactions between raising altitude and slaughter season and among sex condition, raising altitude and slaughter season.

Conclusions

Sex condition affected muscle and fat depositions on the carcass, raising altitude affected meat color and slaughter season affected marbling.

References

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