

## Original Article

# Effect of birth and slaughter seasons on Hanwoo carcass characteristics

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### ABSTRACT

**Background:** The climate of Korean peninsula is characterized by four distinct seasons. In recent years, global warming has accelerated, and summers in Korea are typically hot and humid. However, the precise extent of climatic damage caused in Hanwoo farming has not yet been reported, by long raise periods. This study was conducted to investigate the effects of birth and slaughter season on economical carcass characteristics in Hanwoo cattle.

**Methods:** Hanwoo steer carcass data was collected from the Korean Institute for Animal Products Quality Evaluation database for 2021-2022. Hanwoo birth and slaughter season was classified as spring (March-May), summer (June-August), fall (September-November), and winter (December-February).

**Results:** The carcass mass and loin area were significantly higher in winter- and spring-born Hanwoo than in summer- and fall-born cattle. However, back fat thickness was significantly higher in winter- and spring-slaughtered steers than in summer-slaughtered cattle. In addition, the marbling score was highest in summer-slaughtered steers, but meat yield grade differed between Hanwoo steers of different ages.

**Conclusions:** Out results indicate that carcass mass and loin area were correlated with birth season, whereas back fat thickness and marbling score were related with slaughter season. These results will contribute to improving meat production quality in the Hanwoo industry.

**Keywords:** birth, carcass character, Hanwoo, season, slaughter

## INTRODUCTION

Hanwoo is a native Korean cattle breed raised over long periods in the Korean Peninsula. Recently, Hanwoo was recognized for its good meat quality during an evaluation of Korean economic development. According to Korean statistical data from KOSIS (Korean Statistical Information Service), 3,584,049 Hanwoo were grown in 2022 in

South Korea (KOSIS, 2022). According to the database of Korea Institute for Animal Products Quality Evaluation, 869,147 Hanwoo were slaughtered in 2022, for which carcass characteristics were recorded (Korea Institute for Animal Products Quality Evaluation, KAPE, 2022). The carcass characteristics include age, birth season, slaughter season, carcass weight, back fat thickness, loin area, marbling score, and yield grade. However, these data do

not test correlations between carcass characteristics and environmental effects.

The climate of Korea is characterized by four distinct seasons: spring, summer, fall, and winter. The contrast between winter and summer is striking; winter is bitterly cold and dry due to the Siberian air mass, while summer is hot and humid due to the Pacific air mass. In recent years, global warming has accelerated, and the Korean Peninsula has been affected more than other regions. Summers in Korea are typically hot and humid, as evidenced by mean climate data (Piao and Baik, 2015). These changing weather conditions affect farm animal production rates. Our previous studies have shown that Hanwoo birth weight and weaning weight significantly decrease in summer, correlating with a reduction in carcass weight (Cho et al., 2021; Park et al., 2022).

Hanwoo steers are usually slaughtered at 29.4 months old, making it challenging to assess the effects of environmental conditions on their production. Korean four seasons were commonly classified each three month as spring (March-May), summer (June-August), fall (September-November), and winter (December-February). According to this reason, we considered and classified into 27-, 30-, and 33-month-olds to analyze correlations between carcass characteristics with their birth and slaughter seasons. In this study, we collected Hanwoo steer slaughter data from the Korea Institute for Animal Products Quality Evaluation database for 2021-2022. The carcass characteristics were classified according to their birth and slaughter season and we tested for correlations between seasonal data and different carcass characteristics. Moreover, this study is significant in that it analyzed a large database of Hanwoo cattle in South Korea.

## MATERIALS AND METHODS

### Data collection

Data on slaughter characteristics were collected from Korea Institute for Animal Products Quality Evaluation database for the year 2021-2022. In total, 19,129 27-month-old, 79,652 30-month-old, and 34,860 33-month-old Hanwoo steers were enumerated, considering their birth and slaughter seasons. Seasons were classified as spring (March-May), summer (June-August), fall (September-November), and winter (December-February).

### Statistical analysis

One-way analysis of variance (ANOVA) was performed to compare average carcass characteristics using Statistical Analysis System (SAS) 9.4 software; the Duncan's multiple comparisons test was used for making comparisons between groups. The marbling score was substituted as 1++: 1, 1+:2, 1:3, 2:4, and 3:5. The meat yield grade was substituted as A:1, B:2, and C:3. All data are expressed as mean  $\pm$  standard deviation (SD). The null hypothesis was rejected when the probability was  $p < 0.05$ .

## RESULTS

The 27-month-old Hanwoo steer carcass data showed that the carcass mass and loin area of winter- and spring-born Hanwoo were significantly higher compared with those of summer- and fall-born cattle ( $p < 0.05$ ). The back fat thickness was significantly higher in winter-slaughtered Hanwoo ( $p < 0.05$ ). The marbling score was highest in fall-slaughtered animals, and the meat yield grade of winter- and spring-born Hanwoo was better than those of summer- and fall-born Hanwoo (Table 1).

The 30-month-old Hanwoo showed the complete opposite pattern with regard to birth and slaughter season.

**Table 1.** Carcass characteristics of 27-month-old Hanwoo steers in 2021-2022

Slaughter season	Birth season	Means of carcass mass (kg $\pm$ SD)	Means of back fat thickness (mm $\pm$ SD)	Means of loin area (cm <sup>2</sup> $\pm$ SD)	Means of marbling score	Means of meat yield grade	Individuals
Spring	Winter	437.74 $\pm$ 52.23 <sup>a</sup>	12.66 $\pm$ 4.59 <sup>b</sup>	94.14 $\pm$ 12.38 <sup>a</sup>	1.86 $\pm$ 0.68 <sup>b</sup>	2.22 $\pm$ 1.03 <sup>b</sup>	4,382
Summer	Spring	439.04 $\pm$ 52.34 <sup>a</sup>	12.37 $\pm$ 4.49 <sup>c</sup>	93.66 $\pm$ 12.19 <sup>a</sup>	1.85 $\pm$ 0.68 <sup>bc</sup>	2.24 $\pm$ 1.03 <sup>b</sup>	8,224
Fall	Summer	431.75 $\pm$ 54.26 <sup>b</sup>	12.15 $\pm$ 4.45 <sup>d</sup>	92.31 $\pm$ 12.12 <sup>b</sup>	1.82 $\pm$ 0.69 <sup>c</sup>	2.34 $\pm$ 1.06 <sup>a</sup>	3,476
Winter	Fall	429.92 $\pm$ 53.95 <sup>b</sup>	12.86 $\pm$ 4.73 <sup>a</sup>	92.05 $\pm$ 12.22 <sup>b</sup>	1.90 $\pm$ 0.70 <sup>a</sup>	2.38 $\pm$ 1.05 <sup>a</sup>	3,047

These data are indicated as means  $\pm$  standard deviation (SD,  $p < 0.05$ ).

<sup>abcd</sup>Means in the same series with different lowercase superscript letters are significantly different ( $p < 0.05$ ).

**Table 2.** Carcass characteristics of 30-month-old Hanwoo steers in 2021-2022

Slaughter season	Birth season	Means of carcass mass (kg ± SD)	Means of back fat thickness (mm ± SD)	Means of loin area (cm <sup>2</sup> ± SD)	Means of marbling score	Means of meat yield grade	Individuals
Spring	Fall	452.68 ± 51.71 <sup>c</sup>	13.26 ± 4.81 <sup>b</sup>	95.11 ± 11.98 <sup>c</sup>	1.95 ± 0.69 <sup>b</sup>	2.18 ± 1.01 <sup>a</sup>	13,452
Summer	Winter	460.46 ± 51.60 <sup>a</sup>	12.92 ± 4.62 <sup>c</sup>	96.99 ± 12.31 <sup>a</sup>	1.91 ± 0.69 <sup>c</sup>	2.04 ± 0.98 <sup>c</sup>	19,171
Fall	Spring	459.30 ± 51.89 <sup>b</sup>	13.25 ± 4.70 <sup>b</sup>	96.42 ± 12.36 <sup>b</sup>	1.95 ± 0.69 <sup>b</sup>	2.04 ± 0.98 <sup>c</sup>	27,357
Winter	Summer	453.69 ± 51.78 <sup>c</sup>	13.72 ± 5.01 <sup>a</sup>	95.19 ± 12.10 <sup>c</sup>	2.00 ± 0.70 <sup>a</sup>	2.11 ± 0.99 <sup>b</sup>	19,672

These data are indicated as means ± standard deviation (SD,  $p < 0.05$ ).

<sup>abc</sup>Means in the same series with different lowercase superscript letters are significantly different ( $p < 0.05$ ).

**Table 3.** Carcass characteristics of 33-month-old Hanwoo steers in 2021-2022

Slaughter season	Birth season	Means of carcass mass (kg ± SD)	Means of back fat thickness (mm ± SD)	Means of loin area (cm <sup>2</sup> ± SD)	Means of marbling score	Means of meat yield grade	Individuals
Spring	Summer	461.83 ± 53.78 <sup>c</sup>	13.46 ± 5.06 <sup>b</sup>	95.80 ± 12.31 <sup>b</sup>	1.98 ± 0.69 <sup>b</sup>	2.06 ± 0.98 <sup>b</sup>	9,014
Summer	Fall	461.62 ± 55.07 <sup>c</sup>	12.92 ± 4.82 <sup>c</sup>	95.87 ± 12.67 <sup>b</sup>	1.94 ± 0.69 <sup>c</sup>	2.11 ± 0.99 <sup>a</sup>	4,905
Fall	Winter	464.74 ± 55.08 <sup>b</sup>	13.39 ± 4.88 <sup>b</sup>	97.12 ± 12.83 <sup>a</sup>	1.95 ± 0.70 <sup>c</sup>	1.99 ± 0.98 <sup>c</sup>	6,298
Winter	Spring	467.31 ± 55.74 <sup>a</sup>	14.40 ± 5.49 <sup>a</sup>	96.95 ± 12.71 <sup>a</sup>	2.08 ± 0.71 <sup>a</sup>	1.98 ± 0.97 <sup>c</sup>	14,643

These data are indicated as means ± standard deviation (SD,  $p < 0.05$ ).

<sup>abc</sup>Means in the same series with different lowercase superscript letters are significantly different ( $p < 0.05$ ).

The carcass mass and loin area of winter- and spring-born Hanwoo were significantly higher compared with those of the summer- and fall-born Hanwoo ( $p < 0.05$ ). The back fat thickness was significantly higher in winter-slaughtered Hanwoo and significantly lower in summer-slaughtered Hanwoo ( $p < 0.05$ ). The marbling score was highest in summer-slaughtered individuals, and the meat yield grade of winter- and spring-born Hanwoo was better than those of summer- and fall-born Hanwoo (Table 2).

In 33-month-old Hanwoo steer carcass data, the carcass weight and loin area of winter- and spring-born Hanwoo was significantly higher compared with those of the summer- and fall-born Hanwoo ( $p < 0.05$ ). The back fat thickness was significantly higher in winter-slaughtered Hanwoo. The marbling score was significantly higher in animals slaughtered in summer and fall ( $p < 0.05$ ). The meat yield grade of winter- and spring-born Hanwoo was better than those of the summer- and fall-born Hanwoo (Table 3).

## DISCUSSION

The planned breeding and evaluation systems over the past two decades have significantly improved Hanwoo production. The average estimated breeding values for carcass mass, eye muscle area, and marbling score have

increased, while backfat thickness has decreased (Alam et al., 2021). A recent study evaluated the relationships among market weight, slaughter age, yield grade, and primal cut yield in Hanwoo. The carcass cold weight, ribeye area, and backfat thickness, which affect meat quality, increased with higher market weight. The production yield of the ten major primal cuts also increased with market weight (Kwon et al., 2022). In Korea, most Hanwoo bulls are castrated to improve meat quality. Previous studies compared carcass characteristics of slaughtered Hanwoo, particularly focusing on the influence of mass and sex on yield and grade quality (Park et al., 2002). Bull carcasses had higher yields but lower quality than those of cows and steers. Additionally, the grade quality of steer carcasses was higher than that of cows due to higher marbling scores, greater carcass mass, and lower maturity scores.

Few studies have examined the influence of climatic effects on Hanwoo carcass characteristics. Previous study analyzed carcass characteristics of Hanwoo based on sex, rearing altitudes, and slaughter seasons (Panjono et al., 2009). It suggested that the marbling score and ribeye area of winter-slaughtered steers were significantly higher than those of steers slaughtered in other seasons. However, this study only analyzed 1,660 steers in a specific area, and the slaughter age was not fixed, so the dataset does not represent general field results. In the present study, a

total of 133,641 steers from throughout South Korea were considered and classified into 27-, 30-, and 33-month-olds to analyze correlations between carcass characteristics with their birth and slaughter seasons.

Another study compared carcass characteristics relative to roughage intake in Hanwoo but found no difference between roughage levels (Kim et al., 2015). Additionally, Hanwoo meat color was influenced by environmental temperature, with cattle slaughtered in winter (at temperatures below 5°C) producing meat with more undesirable color properties (Kim et al., 2003). Conversely, a study found that a fermented total mixed ration (FTMR)-treated group had higher meat quality grades, carcass mass, fat thickness, and marbling score (Kim et al., 2018). Piao and Baik (2015) indicated that the marbling score and quality grade of Hanwoo steer carcasses were generally best in fall and worst in spring, which was consistent with our present data for 27- and 33-month-old Hanwoo.

The Hanwoo breed has undergone intensive selection for meat quality and production traits, resulting in significant genetic improvements in carcass weight and eye muscle area (Park et al., 2013; Lee et al., 2014). Hanwoo is considered the most expensive yet highest quality beef in Korea, primarily because Hanwoo steers are fattened for over 31 months to improve the marbling score. However, studies have shown that meat quality factors such as sirloin size, backfat thickness, marbling score, and carcass weight do not significantly differ between steers slaughtered at 27 and 31 months (Jeong et al., 2020).

Meat quality is determined by various factors, including intramuscular fat content, meat color, fat color, and tenderness (Geay et al., 2001; O'Quinn et al., 2018). Among these, intramuscular fat content and tenderness are considered the most important in determining beef quality and consumer taste preferences. Therefore, marbling scores for intramuscular fat content and the Warner-Bratzler shear force for meat tenderness are crucial for determining carcass prices in the Korean beef market. Hanwoo cattle are earmarked with a 12-digit identification number from birth to slaughter, allowing traceability of their management history and providing information to consumers (Chung et al., 2018). This traceability, including management information such as herd, farm, year of birth, and carcass data, can help estimate the meat quality of Hanwoo.

Recently, price adjustments for Hanwoo indicated that

a higher grade appearance is important for efficient farm management. However, Hanwoo cows grow longer and for different periods than other classes, making it difficult to analyze correlations between carcass characteristics and environmental effects.

## CONCLUSION

In this study, we analyzed correlations between Hanwoo steer carcass characteristics and their birth and slaughter seasons. We found that carcass weight and loin area were related to birth season, while backfat thickness and marbling score were related to slaughter season. These facts were interpreted carcass mass were related with growth rate in childhood and carcass quality were related with maturity in Hanwoo. These results contribute to providing high-quality meat in the Hanwoo industry.

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