EFFECTS OF FATTENING PERIOD ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND MEAT PROPERTIES OF HANWOO COWS

Eung Gi kwon*, Byung Ki Park, Sang Min Lee, Hyeong Cheol Kim, Sun Sik Chang, Tae Il Kim, Byoung Soo Jeon, Meing Joong Kim, Young Moo Cho, Hak Jae Chung, Soo Hyun Cho, Seok Ki Im, Seong Koo Hong

National Institute of Animal Science, RDA, Pyeongchang, Gangwon, 232-952, South Korea

*Corresponding author (phone: +82-33-330-0612; fax: +82-33-330-0660; e-mail: kug2237@korea.kr)

***Abstract*—This study was conducted to investigate the effects of different fattening period (6 or 8 months) on feed consumption, body weight gain, carcass characteristics and meat properties with 27 Korean native Hanwoo cows. Average daily gain, dry matter intake and feed conversion ratio were similar between 6 mo and 8 mo. Back fat thickness and marbling scores measured by the ultra-sound scanning were not significantly different between treatments. Carcass weight, back fat thickness, rib eye areas were not influenced by fattening period, while incidence rate of A grade was higher for 8 mo than 6 mo of feeding period. Marbling score, meat color, fat color, texture and maturity were similar between treatments. The appearances of desirable high quality grade (1^{++}, 1^{+} and 1) were higher for cows with 8 mo than 6 mo of feeding period. The moisture, protein, fat and collagen contents of loinmuscle were not influenced by two fattening period in this study. There were not significantly different in meat color (CIE *L**, *a** and *b** values) properties. Thus, the incidence rate of desirable high quality grade was affected by fattening period which had no positive effects on growth performance, carcass characteristics and meat properties.**

***Index Terms*—Hanwoo cows, fattening period, growth performance, quality grade**

I. INTRODUCTION

In recently years, slaughter percentage of Hanwoo cows and steers were 46.6 and 38.0%, respectively, and the appearacnes of desirable high quality grade (1^{++}, 1^{+} and 1) were 56.3 and 79.0%, respectively (APGS, 2009). Marbling plays a particularly important role in determining the juiciness and tenderness of beef, and is on of the main factors used to determine beef quality grade in Korea (Lee, Misztal & Bertrand, 2001; Lee, 2004). Tatum, Smith & Carpenter (1982) reported that marbling has been implicated as a contributing factor to beef palatability, and is used as one of the most important factor in evaluating the beef quality.

Generally, Hanwoo steers has been fattened until almost 30 months of age to improve meat quality through marbling in Korea because Hanwoo steers dramatically increase their marbling fat in muscle between 12 and 27 months of age (Lee et al., 2007). Fattening period is an important factor to produce desirable beef with high proportion of marbling fat in Korea (Kwon et al., 2009). Optimal fattening period and feeding program of Hanwoo steers have been sucessfully developed.

Meanwhile, cows have experience of pregnancy, parturition and nursing for a long time. Consequently, fattening period and pattern of cows differ from those of steers. However, optimal fattening period and feeding program of Hanwoo cows were not established in recent times. Thus, the present study was designed to investigate effects of two different fattening periods (i.e. 6 and 8 months) on the growth performance, carcass characteristics and meat properties in Hanwoo cows.

II. MATERIALS AND METHODS

Animals and diets

Twenty seven Hanwoo cows, 5.7±3.4 years old (parity: 1.8±1.6) and weighing an average of 463.3±65.6 kg, were distributed into 2 groups of 13 or 14 cows. The cows were assigned to 2 different fattening periods, which lasted for 6 months (6 mo) and 8 months (8 mo), respectively. In the treatments, 4 pens (5.3´ 10.6 m) which had concrete floors with sawdust bedding were arranged with 6 or 7 cows per pen. Animals were offered a commercial concentrate at 8 kg/animal/d, and rice straw was fed at 4 kg/animal/d. The chemical compositions of the experimental diets are presented in Table 1. Cows had free access to fresh water and mineral block during the whole period.

Sampling, measurements and analyses

Cows were weighed every month during the experiment period. Rice straw was fed at 09:00 h daily, and the concentrates in two equal portions at 08:00 and 16:00 h. Dietary refusals were collected and weighed every day. Feed

conversion ratio was expressed as average feed intake per daily body weight gain.

Table 1. Chemical composition of experimental diet for Hanwoo cows

Item	Concentrate	Rice straw
Dry matter (%)	90.52±0.12	91.43±0.08
Crude protein (%)	14.08±0.23	4.39±0.14
Ether extract (%)	4.80±0.02	2.36±0.01
Crude ash (%)	9.41±0.05	13.07±0.12
Crude fiber (%)	5.54±0.56	29.57±0.09
NDF (%)	28.05±0.68	70.21±0.96
ADF (%)	11.10±0.17	38.13±0.40

Back fat thickness and marbling score were predicted between the 13th thoracic and 1st lumbar vertebrae of cows using ultra-sound scanning equipment (Aquila, 3.5 MHz, 18 cm linear probe, Pie Medical, Netherlands) every month during the experiment. Carcass characteristics such as yield and quality grades were assessed at 24 h *post-mortem* by an experienced official grader of the Animal Products Grading Service (APGS, 2009), Korea. Quality (marbling score, meat color, fat color, texture and maturity) and yield (cold carcass weight, back fat thickness and rib eye area) characteristics were recorded. After a 24-h chill, cold carcass weights were measured and then the left side of each carcass was cut between the last rib and the first lumbar vertebrae to determine quality grade. The quality grade was determined by assessing the degree of marbling and firmness in the cut surface of the rib eye, in relation to the maturity, meat color and fat color of the carcass. The rib eye area was measured from *longissimus* muscle taken at the 13th rib and back fat thickness was also measured at the 13th rib. Yield index was calculated as follows: Yield index: 68.184-(0.625´ back fat thickness (mm))+(0.130´ rib eye area (cm^2))-(0.024´ dressed weight amount (kg))+3.23. The degree of marbling was evaluated with the Korean Beef Marbling Standard, and the scores of meat color and fat color were made using the color standard (APGS, 2009). The scores for texture and maturity were made using the APGS reference index (APGS, 2009). The grading ranges were 1 to 9 for marbling score with higher numbers for better quality (1 = devoid, 9 = abundant); meat color (1 = brightred, 7 = dark red); fat color (1 = creamy white, 7 = yellowish); texture (1 = soft, 3 = firm); maturity (1 = young, 9 = old). Moisture, protein and fat contents in each sample were determined according to the procedures of the Association of Official Analytical Chemists (AOAC, 1996). Water-holding capacity (WHC) was determined by the procedure of Ryoichi, Degychi & Nagata (1993). Warner-Bratzler shear force (WBS) was measured on steaks (2.5 cm thick) cooked in a pre-heated water bath for 60 min until the core temperature had reached 70 ℃ and then cooled in running water (ca. 18 ℃) for 30 min to reach a core temperature below 30 ℃. Eight cores of 1.27 cm diameter were made for each sample and peak force was determined using a V-shaped shear blade with a cross-head speed of 400 mm/min (Wheeler, Shackelford & Koohmaraie, 2000). Cooking loss was determined by calculating the weight difference in steaks before and after cooking, expressed as percentage of initial weight. CIE (Commission Internationale de l'Eclairage) L (lightness), a (redness), and b (yellowness) for Illuminant C were measured by a color difference meter (CR-310, Minolta Co., Tokyo, Japan).

Statistical analysis

Comparisons of growth performance, carcass characteristics and meat properties of Hanwoo cows were analyzed by t-test to compare the significant difference between the 6 mo and 8 mo feeding groups ($p<0.05$).

III. RESULTS AND DISCUSSION

Table 2. Effect of fattening period on growth performance of Hanwoo cows

Item	6 mo	8 mo
Body weigh gain (kg)		
Initial BW	457.8±69.1	469.2±61.0
Final BW	619.3±59.6	646.2±62.0
Average daily gain	0.69±0.11	0.68±0.09
Feed intake (kg)		
Concentrate	8.00±0.00	8.00±0.00
Rice straw	3.11±0.48	3.44±0.36
Dry matter intake	10.09±0.44	10.39±0.33
Feed conversion ratio	15.00±2.64	15.61±2.60

Average daily gain (ADG) was not significantly different between treatments, although final BW tended to be higher for 8 mo than 6 mo (Table 2). Concentrate, rice straw and dry matter intake (DMI) were similar in cows on different fattening period. Also, feed conversion ratio was not affected by two fattening period in this study. Therefore, fattening period had no positive effects on ADG, DMI and feed conversion ratio, although 8 mo had higher final body weight compared with 6 mo. In the present study, ADG of cows was higher that of Jeong et al. (2006) who reported that ADG of cows was 0.57 kg during 8 mo fattening period. The result showed that increased ADG was related to lower age and parity of cows than previous study which used older cows (age: 8.5±2.5, parity: 6.5±1.7).

Table 3. Effects of fattening period on back fat thickness and marbling score measured using the ultra-sound scanning of Hanwoo cows

Item	Months	6 mo	8 mo
Back fat thickness (mm)	0	4.36±2.18	5.08±2.69
	1	4.79±2.76	5.35±2.10
	2	5.36±3.02	5.85±2.13
	3	5.82±3.15	6.46±2.16
	4	6.14±3.01	7.08±1.60
	5	6.96±3.89	8.15±2.07
	6	7.86±4.21	8.81±2.20
	7	-	8.65±1.65
	8	-	8.65±1.96
Marbling score	0	1.86±0.99	1.85±1.23
	1	1.93±1.03	2.08±1.33
	2	2.29±1.03	2.46±1.45
	3	2.50±1.12	2.69±1.38
	4	2.93±1.53	2.92±1.44
	5	3.36±1.84	3.00±1.62
	6	4.07±2.22	3.46±1.69
	7		4.38±1.78
	8		4.46±1.78

Back fat thickness and marbling scores measured by the ultra sound scanning were not affected by two fattening period treatments (Table 3). In carcass yield traits, rib eye area, back fat thickness, yield index were similar between 6 mo and 8 mo (Table 4). In the incidence rate of yield grades for A, B, and C, the 6 mo feeding treatments resulted in 43, 50 and 7%, respectively, whereas, the 8 mo feeding treatments resulted in 62, 38 and 0%, respectively.

Table 4. Effect of fattening period on carcass characteristics of Hanwoo cows

Item	6 mo	8 mo
Carcass weight (kg)	336.9±38.2	362.9±31.7
Yield traits[1]		
Back fat thickness (mm)	9.07±4.11	9.54±3.08
Rib eye area (cm^2)	84.36±7.44	86.31±5.99
Yield index	68.60±3.36	67.99±2.16
Yield grade (A:B:C, numbers of head)	6:7:1	8:5:0
Quality traits[2]		
Marbling score	3.86±2.17	4.00±1.41
Meat color	5.07±0.26	5.08±0.27
Fat color	3.21±0.56	3.08±0.27
Texture	1.79±0.41	1.54±0.50
Maturity	5.79±2.21	5.54±1.95
Quality grade (1^{++}:1^{+}:1:2:3, numbers of head)	1:2:0:9:2	0:1:6:4:2

[1] Area was measured from *longissmus* muscle taken as 13th rib and back fat thickness were also measured at 13th rib; Yield index was calculated using the following equation: 68.184-(0.625´ back fat thickness (mm))+(0.130´ rib eye area (cm^2))-(0.024´ dressed weight amount (kg)); Carcass yield grades from C (low yield) to A (high yield).

[2] Grading ranges are 1 to 9 for marbling score with higher numbers for better quality (1 = devoid, 9 = abundant); meat color (1 = bright red, 7 = dark red); fat color (1 = creamy white, 7 = yellowish); texture (1 = soft, 3 = firm); maturity (1 = young, 9 = old); quality grades from 3 (low quality) to 1^{++}(very high quality).

In carcass quality traits, marbling score, meat color, fat color, texture and maturity were similar between the cow groups of two fattening period treatments. The incidence rate of desirable high quality grade (1^{++}, 1^{+} and 1) of beef based on consumer's demand were 21 and 54% in 6 mo and 8 mo, respectively.

Moisture, protein, fat and collagen contents were not affected by different fattening period. Warner-Bratzler shear force, cooking loss, water-holding capacity and meat color (CIE *L**, *a** and *b** values) were similar between 6 mo and 8 mo.

Table 5. Effect of fattening period on chemical composition and physical properties of Hanwoo cows

Item	6 mo	8 mo
Chemical composition		
Moisture (%)	64.47±3.82	66.40±4.07
Protein (%)	21.11±0.99	20.50±1.17
Fat (%)	12.63±4.48	11.68±5.21
Collagen (%)	1.76±0.13	1.84±0.16
Physical characteristics		
Warner-Bratzler shear force (kg/0.5 inch^2)	4.27±0.56	4.67±0.34
Cooking loss (%)	24.67±2.07	25.23±2.45
Water-holding capacity (%)	58.07±2.74	58.42±2.48
Meat color (CIE)		
*L**	32.30±2.21	33.81±2.67
*a**	18.36±1.82	19.12±1.16
*b**	7.89±1.11	8.34±0.62

Thus, the present results indicated that there was no significantly different in carcass characteristics, chemical composition, physical characteristics and meat color between two fattening period. However, quality grade of Hanwoo cows could be improved as increasing the fattening period with feed intake.

IV. CONCLUSION

The present findings indicated that different fattening periods resulted in similar growth performance, carcass characteristics and meat properties in Hanwoo cows. However, 8 mo fattening had positive effect on the appearances of desirable high quality grade of beef based on consumer's demand. Therefore, the present results indicated that optimal fattening period could be 8 months in Hanwoo cows.

REFERENCES

Animal Products Grading Service (APGS). (2009). Grade Rule for Cattle Carcass in Korea. Available: http://www.ekape.or.kr/gradeinfo/statistics/

AOAC. (1996). Official Methods of Analysis, Association of Official Analytical Chemists, Washington, DC.

Jeong, J., Lee, S. S., Park, N. H., Sung, N. I., Jang, Y. H., Choi, S. H., Song, M. K., Suh, H. K., & Lee, M. I. (2006). Effects of melengesterol acetate, selenium and vitamin E supplemental feeding on growth, carcass and longissimus dorsi muscle traits in Hanwoo cull cows. *Kor. J. Anim. Sci. Technol.*, 48, 255-268.

Kwon, E. G., Park, B. K., Kim, H. C., Cho, Y. M., Kim T. I., Chang, S. S., Oh, Y. K., Kim, J. H., Kim, Y. J., Kim, E. J., Im, S. K. & Choi, N. J. (2009). Effects of fattening period on growth performance, carcass characteristics and lipogenic gene expression in Hanwoo steers. *Asian-Aust. J. Anim. Sci.*, 22, 1654-1660.

Lee, D. H. (2004). Methods of genetic parameter estimations of carcass weight, longissimus muscle area and marbling score in Korean cattle. *Kor. J. Anim. Sci. Technol.*, 46, 509-516.

Lee, D. H., Misztal, I., & Bertrand, J. K. (2001). Bayesian analysis of carcass traits using multivariate threshold animal models and Gibbs sampling with missing records in Korean cattle. *Kor. J. Anim. Sci. Technol.*, 43, 9-22.

Lee, S.-H., Park, E.-W., Cho, Y. M., Kim, S.-K., Lee, J.-H., Jeon, J.-T., Lee, C.-S., Im, S.-K., Oh, S.-J., Thompson, J. M., & Yoon, D. (2007). Identification of differentially expressed genes related to intramuscular fat development in the early and late fattening stages of Hanwoo steers. *J. Biochem. Mol. Biol.*, 40, 757-764.

Ryoichi, s., Degychi, T., & Nagata, Y. (1993). Effectiveness of the filter paper press methods for determining the water holding capacity of meat. *Fleishwirtsch*, 73, 1399.

Tatum, J. D., Smith, G. C., & Carpenter, Z. L. (1982). Interrelationships between marbling, subcutaneous fat thickness, and cooked beef palatability. *J. Anim. Sci.*, 34, 777-784.

Wheeler, T. L., Shackelford, S. D., & Koohmaraie, M. (2000). Relationship of beef longissimus tenderness classes to tenderness of gluteus medius, semimembranos, and biceps femoris. *J. Anim. Sci.*, 78, 2856-2861.