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Feed Consumption, Body Weight Gain and Carcass Characteristics of Jeju Native Cattle and Its Crossbreds Fed for Short Fattening Period

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ABSTRACT : This study was conducted to compare the growth performance and carcass evaluation of Jeju native cattle (JNC) and its crossbreds (CBK = 25 JNC: 50 Charolais: 25 Brahman and BCBK = 62.5 JNC: 25 Charolais: 12.5 Brahman) fed for a short fattening period. Eight male calves each of JNC (80.40±10), CBK (113.50±12.3), and BCBK (100.3±9.5) were weaned at 4 month of age and were fed similar diets for 18 months of their age. All animals were fed a growing ration until 12 months of age and thereafter switched to a fattening ration for a period of 6 months. Final body weight (BW) and BW gain were significantly higher in CBK and BCBK compared with JNC. The CBK and BCBK gained 27.42% and 25.99% more BW, respectively, compared with JNC. The CBK and BCBK animals consumed significantly less DM than JNC to gain a unit of BW. Body weight gain, DM intake and feed conversion efficiency were similar between CBK and BCBK. Weight of hot and cold carcass, ribs, boneless meat and *Longissimus dorsi* muscle area were significantly different among JNC and its crossbreds. The heaviest carcass was observed in CBK followed by BCBK and JNC. Carcass, chest and femur lengths were greater in CBK and BCBK compared with JNC. Chest width, chest depth and hip width were similar in JNC and its crossbreds. Femur width was significantly greater in CBK compared with BCBK and JNC. Femur depth and chest girth were significantly greater in CBK and BCBK compared with JNC. Weight and fat yield in different carcass cuts were greater in crossbreds compared to JNC. Percent moisture, crude ash, and crude protein of meat were similar in JNC and its crossbreds. Percent crude fat in beef was significantly greater in JNC compared with its crossbreds. Beef shear force value, percent water holding capacity, juiciness and tenderness were significantly greater for JNC compared to its crossbreds. In conclusion, CBK and BCBK have shown greater growth rates and produced heavier carcasses with good degree of fatness when compared with JNC. (**Key Words :** Jeju Native Cattle, Growth, Carcass, Charolais, Beef, Crossbreds)

INTRODUCTION

Beef consumption in Korea has increased over the years with increasing per capita income. Highly marbled beef generally fetches a higher price in the Korean market because of consumer's preference (Seo et al., 2006; Myung and Sun, 2007; Park et al., 2007). The Koreans utilize a unique management program to produce this high quality beef, which includes feeding the cattle a ration high in roughage for a longer period (Yang et al., 1999; Mears et al., 2001; Lee et al., 2003). Generally, native beef cattle in Korea are slaughtered between 24 to 30 months of age. Jeju native cattle (JNC) originate from Jeju Island in the Republic of Korea. Black and yellowish brown coat colored JNC attain 450 kg body weight (BW) at maturity (Lee et al., 2007). The JNC is closely related to Wagyu (Japanese black cattle) and Hanwoo (Korean Native cattle). However, JNC have shorter body stature, slower growth rate, attain lower weight at maturity and possesses poor reproductive ability compared to other specialized beef breeds (Paek et al., 1993; Lee et al., 2007). About 18,990 head of JNC are presently being raised on Jeju Island. Growth and reproductive performance in JNC can be improved either through an intense selection process or by crossbreeding with specialized beef breeds. Selection is a long and steady process and crossbreeding is always preferable to take advantage of heterosis to produce commercial beef cattle (Wheeler et al., 2004).

The JNC was bred to Charolais and Brahman in an attempt to produce a synthetic breed with higher growth performance and better marbling ability (Lee et al., 2007).

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Table 1. Ingredients and chemical composition of concentrate and Italian ryegrass (*Lolium multiflorum*)

Ingredients (% of DM)	Growing ration	Fattening ration	Italian rye grass
Corn	30.00	30.98	-
Wheat bran	16.40	10.05	-
Rice bran	5.14	7.12	-
Cassava meal	5.15	13.77	-
Cotton seed meal	5.00	-	-
Corn germ meal	7.11	7.00	-
Gluten feed	11.00	7.75	-
Palm kernel meal	9.00	14.00	-
Molasses	7.00	6.00	-
Vitamin mineral mixture	0.20	0.20	-
Limestone	3.00	2.10	-
Salt	0.50	0.50	-
Monensin	-	0.03	-
$NaHCO_3$	0.50	0.50	-
Chemical composition			
Dry matter	86.92	86.60	88.30
Crude protein	15.99	12.70	8.53
Ether extract	2.58	3.86	1.86
Neutral detergent fiber	20.80	26.30	58.95
Acid detergent fiber	10.70	10.30	35.71
Ash	6.80	4.55	8.42
Ca	1.55	0.34	-
P	0.60	0.30	-
TDN[1]	70.00	74.00	53.8

[1] Total digestible nutrient was calculated using equation of NRC (2001).

In this attempt, JNC cows were first crossed using Brahman semen to produce G_1 Brahman was used because of its unique abilities to tolerate high environmental temperature and tick resistance (Peacock et al., 1981). These qualities can help improve beef cattle performance under the sub-tropical conditions of Jeju Island. The G_1 animals have shown good growth performance, but their meat quality was inferior to JNC when compared according to the Korean beef grading system (unpublished data). Thus the G_1 animals were crossed with Charolais to produce CBK (25 JNC: 50 Charolais: 25 Brahman) and the CBK was back-crossed to JNC to produce a three breed synthetic named as BCBK which is 62.5 JNC: 25 Charolais: 12.5 Brahman. Growth performance, and carcass evaluation of JNC and its crossbreds fed for a long fattening period (24 months slaughtering age) were compared and presented elsewhere (Lee et al., 2007).

In this paper we are reporting comparative growth performance and carcass characteristics of JNC, CBK and BCBK fed for a short fattening period (18 months slaughtering age).

MATERIALS AND METHODS

Animals and feeding

Eight male calves each of JNC (80.40±10 kg), CBK (113.50±12.3 kg), and BCBK (100.3±9.5 kg) were weaned at 4 months of age and were fed similar diets for 18 months of their age. Two animals were housed in each pen on a cemented floor. All animals were fed a growing ration until 12 months of age and thereafter switched to a fattening ration for a period of 6 months. Concentrate rations, and Italian ryegrass (*Lolium multiflorum*) hay were offered *ad libitum* (10% refusals) throughout the experiment and water was made available for 24 h from a drinking bowl in each pen. Chemical composition of growing and fattening rations and of Italian rye grass is presented in Table 1. All experimental procedures were approved by the ethics committee for the use of animals in experiments, Sub-tropical Agriculture Research Institute, Republic of Korea.

Body weight and feed intake

Initial and final BW of animals were measured. Concentrate and roughage intake was monitored weekly for two consecutive days. Weekly feed and refusal samples were analysed for DM using procedure described in AOAC (1995). Total and daily concentrate and roughage DM intakes were calculated.

Slaughtering and carcass evaluation

All animals were slaughtered at 18 months of age for carcass evaluation. Animals were transferred to a slaughter house 2 days prior to slaughtering and were offered only water for 48 h before they were stunned using a captive bolt. All animals were slaughtered and weights of internal organs and different carcass cuts were measured using the procedures described by Lee et al. (2007).

Chemical, physical and sensory evaluation

Samples of loin muscles at the 8th–13th thoracic vertebrae from both carcass sides were removed, and transported to a meat science laboratory. Loin samples were carefully trimmed of all subcutaneous fat, epimysium and peripheral muscles so that only the completely trimmed *Longissimus dorsi* muscle remained. Samples from the right carcass side were used to evaluate meat quality characteristics, and samples from the left carcass side were used to evaluate eating quality. The samples were packaged in polyethylene bags using a chamber-type heat sealing vacuum packaging system, stored in the dark at 2°C in a chilling room and evaluated after 2 days.

Moisture, protein and lipid contents in each sample were determined according to AOAC methods (AOAC, 1995). Ash content was determined as the residue after combustion at 650°C for 6 h. Cooking loss, shear force and water holding capacity of beef were measured using procedures described by Lee et al. (2007).

For sensory evaluation, each steak was cooked on pre-heated grilling units at approximately 150°C to an internal temperature of 40°C, turned and removed when they reached 70°C internally. Temperature was monitored with a digital thermometer placed in the geometric center of the steak. Steaks were wrapped in aluminum foil and placed in a preheated oven (65°C) until served to panelists. All cooked steaks were evaluated by panelists for flavor, tenderness and juiciness. A scale of 1-9 was used for sample rating where 1 is undesirable flavor, extremely tough and dry, and 9 is desirable flavor, extremely tender and juicy. Each panel member was supplied natural water to rinse the mouth. The average of the 8 panelists' values was used as the flavor, tenderness and juiciness score for each sample.

Statistical analysis

Data on all growth and carcass traits were presented as mean±standard error. Data on various growth and carcass traits were analysed as a completely randomised design by analysis of GLM covariance (SAS, 1994). Initial body weight was included in the model as a covariate for the analyses of growth parameters and feed efficiency. For carcass yield analysis hot carcass weight was used as a covariant. The significant ($p<0.05$) differences among means were separated by application of Duncan's Multiple Range test (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Mean birth weight (kg) of CBK (33.5±0.59) and BCBK (27.8±0.82) was greater ($p<0.05$) than JNC (23.4±0.45). At weaning, CBK and BCBK attained greater ($p<0.05$) BW than JNC (Table 2). In this study, JNC, CBK and BCBK calves were raised with their dams for four months of age before weaning. Higher BW of CBK and BCBK at weaning may be ascribed to their greater birth weights and better maternal ability of crossbred cows than JNC cows. The Charolais breed was used to produce a crossbred of JNC because it produces heavier calves which can grow faster than other beef breeds (Cundiff et al., 1993). Peacock et al. (1981) reported 20% higher weaning weight for Charolais than for Brahman calves. As backcrosses to JNC were the daughters of G_1 cows, the better performance of BCBK compared with JNC calves during the pre-weaning period could be the result of better maternal ability and higher milk production of crossbred cows compared with JNC cows.

Final BW (at 18 months) and BW gain were greater ($p<0.05$) in CBK and BCBK compared with JNC (Table 2). The CBK and BCBK gained 27.42 and 25.99% more BW at 18 month of age compared with JNC, respectively. Average total and daily concentrate and roughage DM consumption were greater in CBK and BCBK compared with JNC (Table 2). The CBK and BCBK animals consumed significantly less ($p<0.05$) DM for a unit BW gain than JNC. Body weight gain, DM intake and feed conversion efficiency were not different between CBK and BCBK (Table 2). Hanwoo, Wagyu and JNC are known for their genetic ability to produce highly marbled beef (Yang et al., 1999; Lee et al., 2003; Moon et al., 2003), but they grow at a lesser rate than specialized western beef cattle like Charolais. Mir et al. (1999) reported that animals with continental inheritance grew faster than animals with 1/2 or 3/4 Wagyu inheritance. Myers et al. (1999) also reported that Wagyu cattle grew more slowly than British cattle. Similarly, other workers (Mears et al., 2001; Kuber et al., 2004; Wheeler et al., 2004) reported rapid gain and higher finishing BW of crossbreds (Wagyu×Charolais, Wagyu ×Limousin, and Wagyu×Hereford) cattle compared with purebred Wagyu. In the current study, animals with JNC inheritance had the lowest slaughter weight. Greater BW gain, DM consumption and better feed conversion efficiency in CBK and BCBK compared with JNC may be ascribed to the effects of heterosis and the inheritance of Charolais genes in the crossbreds.

Weights of hot and cold carcass, ribs and boneless meat were noticed significantly different ($p<0.05$) among JNC,

Table 2. Mean (±standard error) feed intake, body weight (BW) gain and feed efficiency of Jeju native cattle and its crossbreds

Parameters (kg)	JNC[1]	CBK[2]	BCBK[3]
Initial BW (4 months age)	80.40±10.2[c]	113.50±12.3[a]	100.3±9.5[b]
Final BW (18 months)	414.50±20.5[c]	573.88±23.1[a]	551.75±16.2[b]
Total BW gain (4-18 months)	334.10±16.2[b]	460.38±16.5[a]	451.45±14.0[a]
Average daily BW gain	0.78±0.13[b]	1.08±0.11[a]	1.06±0.10[a]
Total DM intake (4-18 months)	3,367.0±33.2[b]	4,036.0±40.9[a]	3,950.0±36.8[a]
Total roughage intake	2,647.0±50.4[b]	3,090.0±48.2[a]	3,040.0±36.3[a]
Total concentrate intake	820.0±15.6[b]	946.0±22.6[a]	910.0±17.0[a]
Average daily DM intake	7.89±0.5[b]	9.45±0.4[a]	9.25±0.3[a]
Average daily roughage intake	6.20±0.3[b]	7.24±0.3[a]	7.12±0.3[a]
Average daily concentrate intake	1.92±0.2[b]	2.22±0.11[a]	2.13±0.12[a]
Feed conversion efficiency [4]	10.08±0.3[a]	8.77±0.3[b]	8.75±0.2[b]

[1] Jeju native cattle. [2] CBK = 25% JNC: 50% Charolais: 25% Brahman. [3] BCBK= 62.5% JNC: 25% Charolais: 12.5% Brahman.

[4] Feed conversion efficiency = kg of feed consumed per kg of live weight gain.

[a-c] Means within a row followed by a different letter are significantly different ($p<0.05$).

Table 3. Mean (±standard error) hot, cold, boneless and retailed cut carcass weight of Jeju native cattle and its crossbreds

Parameters (kg)	JNC[1]	CBK[2]	BCBK[3]
Hot carcass weight	250.70±8.62[c]	352.55±29.98[a]	311.73±27.95[b]
Hot carcass weight (left)	125.20±3.98[c]	173.35±16.79[a]	156.78±14.77[b]
Hot carcass weight (right)	125.50±4.76[c]	179.20±16.83[a]	154.95±13.20[b]
Cold carcass weight	246.35±8.17[c]	360.53±36.75[a]	307.28±27.44[b]
Cold carcass weight (left)	123.10±3.71c	178.88±17.30[a]	154.43±14.67[b]
Cold carcass weight (right)	123.25±4.61[c]	176.65±16.31[a]	152.85±12.79[b]
Shrinkage weight	4.35±0.47	5.78±1.40	4.45±1.16
Excluded ribs weight	204.80±4.76[c]	298.38±29.66[a]	257.09±25.44[b]
Boneless meat weight	173.74±3.53[c]	256.88±25.73[a]	219.89±21.35[b]
Trimmed carcass fat	24.76±4.67[b]	33.39±4.78[a]	26.80±7.76[b]
Retailed cut weight	148.98±3.44[c]	223.49±21.29[a]	193.09±23.07[b]

[1] Jeju native cattle. [2] CBK = 25% JNC: 50% Charolais: 25% Brahman. [3] BCBK= 62.5% JNC: 25% Charolais: 12.5% Brahman.
[a-c] Means within a row followed by a different letter are significantly different ($p<0.05$).

CBK and BCBK (Table 3). The heaviest carcass was observed in CBK followed by BCBK and JNC. Heavier carcass of CBK and BCBK compared with JNC could be attributed to their greater slaughter weights. The carcass weight was an important factor affecting meat quality through its effect on fattiness (Hilton et al., 1998). Rossi et al. (2000) described that a premium product (e.g., highly marbled meat in Korea) could offset the feed cost. Korean native cattle produce a light weight carcass compared with Angus and Charolais cattle when fed the same diet and finished at similar age (Lorenzen et al., 1993; Hilton et al., 1998; Park et al., 2002). Lorenzen et al. (1993) reported that the weight of Korean native cattle carcasses was approximately 80 kg lighter than that of traditional U.S. beef including *Bos indicus* breed types, dairy types and native breed types. Park et al. (2002) explained that both yield (as determined by the cold carcass weight, adjusted fat thickness and *Longissimus* muscle area) and quality (as determined by the marbling, meat color, fat color, texture and overall maturity score) grades of Korean native cattle carcasses could be improved with heavier slaughter weight. In the present study, greater slaughter weight and heavier carcass weight in CBK and BCK compared with JNC can improve both beef quality and yield grades. Weights of trimmed carcass fat, boneless meat, excluded rib and retailed cut weight were also greater ($p<0.05$) in CBK compared with BCBK and JNC (Table 3).

Longissimus dorsi muscle area and its ratio were higher ($p<0.05$) in crossbreds compared with JNC (Table 4). Higher *Longissimus dorsi* muscle in CBK and BCBK compared with JNC could be attributed to the heavier carcass of CBK and BCBK. Park et al. (2002) reported 13

Table 4. Mean (±standard error) *Longissimus* muscle area and weight of different organs of Jeju native cattle and its crossbreds

Parameters (kg)	JNC[1]	CBK[2]	BCBK[3]
Logissimus muscle area (cm^2)	67.40±3.53[b]	97.45±3.88[a]	89.50±12.79[a]
Head weight	21.00±4.08[b]	27.13±1.70[a]	21.90±1.40[b]
Leg weight (fore)	3.65±0.24[c]	5.88±0.75[a]	4.95±1.08[b]
Leg weight (rear)	3.55±0.42[c]	6.25±0.96[a]	5.25±1.28[b]
Blood weight	15.38±0.98	16.38±1.48	14.43±2.19
Hide weight	25.63±6.57[b]	44.00±9.56[a]	38.03±7.60[a]
Total internal organs weight	73.45±21.07[b]	86.25±10.08[a]	90.70±14.43[a]
Lung weight	3.75±0.29[c]	6.00±0.71[a]	4.58±0.46[b]
Heart weight	1.70±0.14[b]	2.30±0.16[a]	2.23±0.57[a]
Liver weight	4.83±0.83	5.98±0.41	5.35±0.93
Spleen weight	1.75±0.29[b]	3.10±0.64[a]	2.65±0.37[a]
Rumen and reticulum weight	6.55±0.88[b]	8.55±1.35[a]	7.63±0.98[ab]
Omasum weight	1.93±0.30[b]	3.13±0.57[a]	2.88±1.10[ab]
Abomasum weight	1.35±0.31[b]	1.65±0.24[a]	1.45±0.21[ab]
Rectum weight	1.7±0.36	1.48±0.13	1.73±0.22
Small intestine weight	6.68±1.29[b]	9.00±1.41[a]	7.78±1.30[ab]
Large intestine weight	1.95±0.20	2.50±0.30	2.40±0.45
Kidney weight	0.73±0.17[b]	0.91±0.12[a]	0.84±0.12[ab]
Sexual organs weight	2.63±0.50[b]	5.83±0.46[a]	4.84±0.92[a]

[1] Jeju native cattle. [2] CBK = 25% JNC: 50% Charolais: 25% Brahman. [3] BCBK = 62.5% JNC: 25% Charolais: 12.5% Brahman.
[a-c] Means within a row followed by a different letter are significantly different ($p<0.05$).

Table 5. Mean (±standard error) carcass measurements of Jeju native cattle and its crossbreds

Parameters (cm)	JNC[1]	CBK[2]	BCBK[3]
Carcass length	216.13±3.24b	244.75±6.20[a]	232.45±12.98[a]
Chest length	66.30±1.94[b]	73.00±4.23[a]	71.90±2.19[a]
Femur length	88.00±1.15[c]	99.78±2.54[a]	95.78±4.33[a]
Chest width	63.73±1.71[b]	66.50±2.80[a]	67.83±3.62[a]
Hip width	39.55±0.68	40.78±0.78	40.40±0.45
Femur width	39.93±0.65[b]	43.68±1.57[a]	40.23±1.76[b]
Chest girth	148.38±2.75[b]	160.13±5.19[a]	156.00±6.89
Chest depth	14.63±0.34	15.63±0.35	15.80±1.18
Femur depth	19.18±1.16[b]	22.63±0.85[a]	21.95±1.32[a]

[1] Jeju native cattle. [2] CBK = 25% JNC: 50% Charolais: 25% Brahman. [3] BCBK = 67.5% JNC: 25% Charolais: 12.5% Brahman.

[a-c] Means within a row followed by a different letter are significantly different ($p<0.05$).

cm^2 smaller *Longissimus* muscle crosssectional area in Korean native cattle compared with beef carcasses slaughtered in the United States. They attributed lower *Longissimus* muscle crosssectional area in Korean native cattle to its lower slaughtering weight and lighter carcass. *Longissimus* muscle crosssectional area is an important factor in determination of yield grade in Korea, thus higher *Longissimus* muscle crosssectional area in both CBK and BCBK could improve their carcass yield grade compared with JNC.

Head weight was greater ($p<0.05$) in CBK compare with JNC and BCBK. Fore and rear leg weights were the heaviest in CBK followed by BCBK and JNC. Blood weight was similar for JNC and its crossbreds. Total internal organ and hide weights were greater ($p<0.05$) in crossbreds compare with JNC. Heart, lungs, spleen, rumen, reticulum, omasum, abomasum, small intestine, kidney and sexual organ weights were the heaviest in CBK followed by BCBK and JNC (Table 4). Liver and large intestine weights were similar in JNC and its crossbreds. Carcass, chest and femur lengths were greater ($p<0.05$) in CBK and BCBK compared with JNC (Table 4). Chest width, chest depth and hip width were similar in JNC and its crossbreds. Femur width was greater ($p<0.05$) in CBK compared with BCBK and JNC. Femur depth and chest girth were greater ($p<0.05$) in CBK and BCBK compared with JNC (Table 5). Similar results were observed when specialized beef cattle or Wagyu crossbreds were compared with pure Wagyu animals (Barker et al., 1995; Chung et al., 2006). Total carcass fat weight was greater ($p<0.05$) in CBK compared with BCBK and JNC (Table 6). Back fat thickness (at 4-5, 7-8 and 11-12 vertebra) was higher ($p<0.05$) in JNC compared to its crossbreds. Higher back fat thickness in JNC may be attributed to its early biological maturity (Lunt et al., 2005) and natural tendency to accumulate fat (Park et al., 2002).

Total kidney fat and its weight were greater ($p<0.05$) in crossbreds than in JNC. Weight of tenderloin and striploin was the highest in CBK followed by BCBK and JNC. However, fat weight in these areas was not different among JNC, CBK and BCBK (Table 6). Previous studies have demonstrated that American Wagyu (a synthetic breed produced using Angus, Hereford and Holstein) cattle exhibit adipose tissue accretion tendencies similar to those of Japanese Black cattle (Barker et al., 1995). Sirloin weight in half of the quarter was greater ($p<0.05$) in crossbreds compared to JNC. Higher weight of the different cuts may be attributed to the heavier carcass of crossbreds compared to JNC. Top round and sticking weight in the left and right half of the carcass were the heaviest in CBK followed by BCBK and JNC (Table 6). Total fat in top round followed a similar pattern. Bottom round fat and weight of each half of the carcass were greater ($p<0.05$) in crossbreds compared to JNC. Fore leg weight, shank weight, shank fat weight and thin flank weight of the carcass were the highest in CBK followed by BCBK and JNC. Total thin shank fat weight in the carcass followed a similar trend. Rib weight was greater ($p<0.05$) in crossbreds compared with JNC. Rib fat weight was not significantly different among JNC, CBK and BCBK (Table 6). Although the Korean beef grading system is a function of degree of marbling, firmness of muscle texture, fat and meat color and degree of maturity, quality grade is practically determined largely on the basis of degree of marbling. Greater carcass weight and fat in crossbred cattle compared with JNC are significantly beneficial in the Korean beef grading system. Park et al. (2002) reported that better quality grade of Hanwoo cattle was positively linked to carcass weight. A higher (better) quality grade score was resulted from heavier carcasses with thicker back fat, larger ribeye area, more red meat color, more white fat color and with a higher degree of marbling. There are some studies reporting that carcasses with a larger ribeye area resulted in a lower USDA quality grade (Lorenzen et al., 1993; Boleman et al, 1995; Miller et al., 1996). However, in Korean native cattle, ribeye area had highly positive correlations with slaughter weight and degree of marbling.

Percent moisture, crude ash and crude protein of meat were similar in of JNC, CBK and BCBK (Table 7). Percent meat crude fat was significantly greater ($p<0.05$) in JNC compared with its crossbreds. Fat accretion may be

Table 6. Mean (±standard error) weight and fat distribution in different carcass cuts of Jeju native cattle and its crossbreds

Parameters (kg)	JNC[1]	CBK[2]	BCBK[3]
Total carcass fat weight	27.48±2.24^{c}	36.46±2.12^{a}	30.30±2.78^{b}
Backfat thickness (11-12)	0.48±0.03^{a}	0.38±0.05^{b}	0.40±0.09^{b}
Backfat thickness (7-8)	0.48±0.04^{a}	0.38±0.02^{b}	0.39±0.02^{b}
Backfat thickness (4-5)	0.65±0.02^{a}	0.50±0.04^{b}	0.43±0.02^{c}
Kidney fat weight	0.73±0.07^{b}	0.91±0.10^{a}	0.86±0.12^{a}
Tender loin weight	4.70±0.07^{c}	6.98±0.03^{a}	5.63±0.06^{b}
Tender loin fat weight	0.69±0.25	0.78±0.18	0.71±0.23
Sir loin weight	5.65±0.24^{b}	9.00±0.80^{a}	8.25±0.58^{a}
Strip loin weight	29.43±0.86^{c}	42.18±1.71-	35.38±2.50^{b}
Strip loin fat weight	2.08±0.28	2.63±0.23	2.43±0.20
Top round weight	15.98±1.40^{c}	25.93±2.11^{a}	21.55±1.25^{b}
Top round fat weight	1.55±0.31^{c}	2.61±0.28^{a}	1.85±0.26^{b}
Bottom round weight	24.78±0.65^{b}	37.80±2.56^{a}	33.50±1.81^{a}
Bottom round fat weight	2.43±0.29^{b}	3.83±0.25^{a}	2.56±0.40^{b}
Fore leg weight	18.25±0.73^{c}	27.40±1.81^{a}	23.20±1.50^{b}
Fore leg fat weight	1.64±0.32	1.98±0.28	1.70±0.44
Shank weight	11.48±0.32^{c}	18.60±1.20^{a}	15.25±0.87^{b}
Shank fat weight	1.73±0.24^{c}	3.25±0.32^{a}	2.30±0.28^{b}
Thin flank weight	21.20±2.00^{b}	29.80±3.04^{a}	28.35±3.12^{a}
Thin flank fat weight	11.28±1.98^{b}	15.48±1.30^{a}	12.29±1.92^{b}
Rib weight	28.35±1.14^{c}	38.48±3.77^{a}	34.70±3.15^{b}
Rib fat weight	2.71±0.69	3.03±0.61	2.50±1.03

All measurements were on total carcass (right and left halves).

[1] Jeju native cattle. [2] CBK = 25% JNC: 50% Charolais: 25% Brahman. [3] BCBK = 62.5% JNC: 25% Charolais: 12.5% Brahman.

[a-c] Means within a row followed by a different letter are significantly different ($p<0.05$).

influenced by many factors including breed or genotype, age or live weight, physiological status or gender and feeding regime. The breed effect has been reported by several authors as one of the major factors affecting carcass fat deposition (Barker et al., 1995; Lunt et al., 2005; Moon, 2006). Previous studies have demonstrated that American Wagyu cattle exhibit adipose tissue accretion tendencies similar to those of Japanese Black cattle (Barker et al., 1995). Marbling is a prime theme in the Korean beef industry, as consumers judge meat quality on the basis of the degree of marbling and they are willing to pay premium for a highly marbled product (Animal products grading service report, 2001). In 2001, the prime Hanwoo striploin received more than three US dollars premium per kilogram compared to that for an average quality. Under the Korean beef market circumstances, carcass quality is largely determined by marbling score (Park et al., 2002; Irie et al., 2006) and consequently breeders and producers are forced to improve marbling. Cooking loss of meat was similar for JNC and its crossbreds. Meat sheer force value, percent water holding capacity, juiciness and tenderness were significantly greater ($p<0.05$) for JNC compared to its crossbreds (Table 7). Tenderness is the most important textural characteristic of meat and has the greatest influence on consumer acceptance. It is established that beef *Longissimus* tenderness decreases as the percentage of *Bos*

Table 7. Mean (±standard error) carcass chemical composition and sensory evaluation of Jeju native cattle and its crossbreds

Parameters	JNC[1]	CBK[2]	BCBK[3]
Moisture (%)	71.55±2.22	72.88±1.53	72.13±0.87
Crude Ash (%)	1.04±0.02	1.00±0.06	1.25±0.05
Crude protein (%)	21.91±0.64	22.56±0.30	23.04±0.32
Crude fat (%)	5.58±0.82^{a}	3.81±0.60^{b}	3.59±0.53^{b}
Cooking loss (%)	37.98±2.46	38.29±2.18	38.98±1.23
Shear force (kg/cm^2)	6.75±0.78^{a}	9.77±0.42^{b}	8.82±0.58^{b}
Water holding capacity (%)	43.57±3.73^{a}	38.43±1.83^{b}	36.92±2.65^{b}
Juiciness	4.67±0.59^{a}	3.92±0.22^{b}	3.72±0.42^{b}
Tenderness	4.33±0.39^{a}	3.29±0.32^{b}	3.38±0.30^{ab}
Flavor	4.96±0.48	4.21±0.59	4.57±0.46

[1] Jeju native cattle. [2] CBK = 25% JNC: 50% Charolais: 25% Brahman. [3] BCBK = 62.5% JNC: 25% Charolais: 12.5% Brahman.

[a-c] Means within a row followed by a different letter are significantly different ($p<0.05$).

indicus inheritance increases (McKeith et al., 1985; Wheeler et al., 1994; Shackelford et al., 1995). Brahman inheritance in crossbreds probably has decreased the tenderness in crossbreds of JNC compared to JNC. Shear force values were slightly negatively related to intramuscular fat content in most studies (Seideman et al., 1987; Fiems et al., 2000). However, Renand et al. (2001) also found that tenderness or mechanical strength was not closely related to the intramuscular fat content. Meat flavor was similar for JNC, CBK and BCBK. Many authors found that flavor and juiciness was only slightly positively related to the intramuscular fat content (Dikeman et al., 19886; Van et al., 1992).

In conclusion, CBK and BCBK have shown greater BW gain, slaughtering weight and carcass yield compared with JNC. Fat yield was also greater in CBK and BCBK carcasses compared with JNC. Meat shear force value, percent water holding capacity, juiciness and tenderness were greater for JNC compared to its crossbreds. Yield grades in Korea are influenced by muscling and carcass size as determined by loin-eye area, fat thickness and carcass weight. The CBK and BCBK both produce a heavier carcass with a good degree of fatness.

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