Effects of rice bran and extruded soybean on growth performance, carcass characteristics, chemical composition and sensory evaluations of Hanwoo (Native Korean Cattle) steers

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Abstract – This study was conducted to determine the effects of rice bran (RB) and extruded soybean (ES) on carcass characteristics, chemical composition and sensory evaluations of Hanwoo (Native Korean Cattle). Total ninety-one (91) Hanwoo steers (27.4±0.7 months old and 713.5±70.1 kg) were assigned into either Control (32 steers), Rice Bran (RB, 31 steers) or Extruded Soybean (ES, 28 steers) considering ages and pens. Rice bran and extruded soybean was substituted 13% and 12.1% of commercial concentrates for RB and ES group, respectively. Steers were fed concentrates and rice straw as a roughage for average 86 days until finished at 30.2±0.8 months old and 750.8±79.7 kg. Steers in ES group showed the highest average daily gain (ADG) of 0.55±0.16 kg comparing to Control and RB group. Frequency of yield grade A (leaner) and B (medium) according to Korean beef carcass grading standard for RB group was 88% meaning 28.3% improvement comparing to Control group. Partial substitution of RB to commercial concentrates also improved beef quality grade (1^{++}, 1^{+}, 1, 2 and 3: in the order of the best and the worst) by showing 76% frequencies of quality grade 1^{++} and 1^{+} (35.2% improvement comparing to Control). There were no significant changes in fatty acid composition and melting point of lipid extracted from *Longissimus* muscle (LM) by substitution of RB or ES. Marbling degree (9: the most abundant, 1: devoid) had positive(+) correlations (0.210, $p<0.05$) with monounsaturated fatty acids (MUFA) whereas had negative(-) correlations (-0.230, $p<0.05$) with saturated fatty acids (SFA). Melting points showed strong positive(+) correlations (0.288, $p<0.01$) with palmitic acid ($C_{16:0}$), a major saturated fatty acid, and negative(-) correlations (-0.279, $p<0.01$) with oleic acid ($C_{18:1}$), a major MUFA in beef (correlation data are not shown). ES group showed the highest scores in sensory evaluations (5 point scale) of tenderness (4.3±0.2), juiciness (4.3±0.1), umami (4.1±0.2) and overall acceptability (4.2±0.1). In conclusion, the study implies that partial substitution of commercial concentrates with RB, a by-product of rice processing, would be beneficial to improve yield and quality grade in Hanwoo steers and substitution with ES would improve sensory evaluations for LM of Hanwoo beef by increasing umami taste related free amino acids such as glutamic acid and aspartic acid.

Key words : Beef cattle, Fatty acid composition, Yield and quality grade

I. INTRODUCTION

Korean cattle (Hanwoo, *bos taurus*) is a unique cattle breed with a high proportion (~30% for the highest) of intramuscular fat (IMF). Oleic acid ($C_{18:1}$) and palmitoleic acid ($C_{16:1}$) are two main MUFAs in *Longissimus* muscle (LM) of Hanwoo which occupy more than 99% of total MUFA. Genetic background as well as feeding program consisting high grain feeds and mostly rice straw for roughages might be underneath of highly marbled Hanwoo beef.

For over four decades, considerable scientific interest has given to the impact of dietary fat in the development of metabolic disorders which leads to cardiovascular disease (CVD). Saturated fatty acids (SFA) have been recommended to reduce in the diet. In contrast, unsaturated fatty acids (UFA) have been considered to be beneficial to CVD. Long-chain omega (n)-3 polyunsaturated fatty acids (PUFA) such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), especially, have been associated with cardiovascular health benefits (1~5). Recently, numerous scientific evidences suggest that dietary MUFA reduces key risk factors for metabolic syndrome. Dietary MUFAs promote a healthy blood lipid profile, mediate blood pressure, and favorably modulate insulin sensitivity and glycemic control (6~11).

The objective of this study was to determine the effects of rice bran and extruded soybean on carcass yield and quality grades, chemical composition and sensory evaluations of Hanwoo.

II. MATERIALS AND METHODS

Total ninety-one (91) Hanwoo steers (average 27.4±0.7 month-old and 713.5±70.1 kg) were assigned into either Control (32 steers), Rice Bran (RB, 31 steers) or Extruded Soybean (ES, 28 steers) group considering ages and pens. RB and ES was substituted 13% and 12.1% of commercial concentrates, respectively. Steers were fed concentrates and rice straw as roughage (Table 1) for average 86 days until finished at 30.2±0.8 month-old (average BW 750.8±79.7 kg). Carcass yield and quality grades were determined by Korean Beef Carcass Standard (12). LM samples between 13th rib and 1st lumbar were taken and homogenized for chemical analysis and frozen for sensory evaluations. Fatty acid composition was analyzed after lipid extraction (13) and esterification (14) using gas chromatography (Supelco, Bellefonte, USA). Melting points were determined using capillaries filled with lipid. Free amino acid contents were determined using amino acid analyzer (Hitachi, Tokyo, Japan). Sensory evaluations for LM were performed by trained panelists for tenderness, juiciness, umami and overall palatability in a scale of 5 points. The data were analyzed using SPSS (ver. 21.0) and the significances among groups were tested by Duncan's multiple range tests at the level of 0.05.

Table 1. Chemical composition of concentrates and rice straw.

	Concentrates			Rice straw
	Control	Rice Bran	Extruded Soybean	
Moisture	13.55	12.01	11.98	32.08
C-Protein	14.45	14.11	17.91	3.30
Ether Extract	3.45	5.00	5.00	1.26
C-Fiber	8.85	8.33	7.93	23.27
C-Ash	5.88	5.86	5.41	9.73
NFE	53.82	54.69	51.77	30.36
Ca	0.85	0.64	0.66	0.21
P	0.46	0.62	0.46	0.10
NDF	28.86	27.68	26.24	45.35
ADF	14.29	13.90	14.07	26.17
TDN	72.00	72.74	74.96	31.86

III. RESULTS AND DISCUSSION

Steers fed concentrates replaced 12.1% with extruded soybean (ES) showed the highest total gain and average daily gain (ADG) comparing to either Control or Rice Bran (RB) fed animals (Table 2). This might be because of high protein contents (17.91%) contained in ES concentrates whereas Control and RB concentrates were 14.45 and 14.11%, respectively.

Table 2. Effects of rice bran and extruded soybean on growth performances of Hanwoo steers

	Control	Rice Bran	Extruded Soybean
BW, kg;			
Initiation	727.7±74.6	726.8±70.1	686.1±63.7
Termination	758.7±72.8	760.3±79.7	733.5±66.6
Total gain	31.0±15.8[a]	33.5±32.2[ab]	47.4±13.4[b]
ADG	0.36±0.19[a]	0.39±0.39[ab]	0.55±0.16[b]

Table 3. Effects of rice bran and extruded soybean on yield grade of Hanwoo steers

Items	Control	Rice Bran	Extruded Soybean
Cold carcass, ㎏	447.3±48.8	443.3±46.5	429.6±40.9
Dressing, %	59.0	58.3	58.6
Back fat, ㎜	13.8±4.23	11.48±3.33	14.11±3.51
LM area, ㎠	90.5±10.8	96.8±11.9	95.0±9.0
Yield grade[1)]	2.0±0.7	1.6±0.7	2.1±0.6
A	7(21.8%)	12(48.0%)	4(14.2%)
B	15(46.8%)	10(40.0%)	15(53.5%)
C	10(31.2%)	3(12.0%)	9(32.1%)

[1)]Converted to numeric values : A=1, B=2 and C=3. A=leaner, B=medium, C=fatter.

Table 3. Effects of rice bran and extruded soybean on quality grade of Hanwoo steers

Items	Control	Rice Bran	Extruded Soybean
Marbling score[1)]	5.6±1.8^{a}	7.0±1.3^{b}	6.4±1.8^{c}
Meat color[2)]	5.1±0.5	4.7±0.7	4.9±0.5
Fat color[3)]	2.9±0.4	2.9±0.4	2.9±0.3
Texture[4)]	1.2±0.4	1.0±0.2	1.0±0.2
Maturity[5)]	2.1±0.3	2.0±0.4	2.1±0.3
Quality grade[6)] :	2.3±0.85^{a}	1.96±0.73^{b}	2.07±0.86^{c}
1^{++}	6(18.7%)	7(28.0%)	9(32.1%)
1^{+}	12(37.5%)	12(48.0%)	8(28.5%)
1	12(37.5%)	6(24.0%)	11(39.2%)
2	2(6.2%)	0.0(0.0%)	0.0(0.0%)
3	0.0(0.0%)	0.0(0.0%)	0.0(0.0%)

[1)]9=the most abundant, 1=devoid, [2)]7=dark red, 1=bright, [3)]7=yellowish, 1=white, [4)]3=coarse, 1=fine, [5)]9=mature, 1=youthful, [6)]Converted to numeric value : 1^{++}=1, 1^{+}=2, 1=3, 2=4, 3=5. 1^{++}=the best, 3=the worst.

Table 4. Effects of rice bran and extruded soybean on fatty acid composition and melting point of LM of Hanwoo steers

	Control	Rice Bran	Extruded Soybean
		Fatty acid, %	
$C_{14:0}$	3.4±0.1^{b}	3.8±0.1^{a}	3.7±0.1^{ab}
$C_{14:1}$	1.5±0.1	1.6±0.1	1.5±0.1
$C_{16:0}$	27.0±0.3	27.8±0.4	27.6±0.3
$C_{16:1n7}$	6.2±0.1	6.3±0.2	5.9±0.1
$C_{18:0}$	9.9±0.2	9.8±0.4	10.1±0.3
$C_{18:1}$	1.4±0.0	1.5±0.1	1.6±0.1
$C_{18:1n\text{-}9}$	48.0±0.5	46.7±0.5	47.1±0.4
$C_{18:1n7}$	0.2±0.0	0.2±0.0	0.2±0.0
$C_{18:2}$	1.9±0.1	1.9±0.1	2.0±0.1
$C_{18:3}$	0.07±0.00^{c}	0.08±0.00^{bc}	0.09±0.00^{a}
$C_{18:2,\ 9\text{-}cis,11\text{-}trans}$	0.11±0.01	0.11±0.01	0.11±0.01
$C_{18:2,\ 10\text{-}trans,12\text{-}cis}$	0.02±0.00	0.02±0.00	0.02±0.00
SFA	40.6±0.5	41.6±0.5	41.5±0.4
UFA	59.4±0.5	58.4±0.5	58.5±0.4
MUFA	57.3±0.5	56.3±0.5	56.3±0.4
PUFA	2.1±0.1	2.1±0.1	2.2±0.1
U/S	1.5±0.0	1.4±0.0	1.4±0.0
M/S	1.4±0.0	1.4±0.0	1.4 ±0.0
Melting point, ℃	23.9±0.5	25.1±0.5	23.9±0.6

Table 5. Effects of rice bran and extruded soybean on sensory evaluations of LM of Hanwoo steers

	Control	Rice Bran	Extruded Soybean
Tenderness	3.4±0.2^{b}	3.4±0.2^{b}	4.3±0.2^{a}
Juiciness	3.6±0.2^{b}	3.5±0.16^{b}	4.3±0.1^{a}
Umami	3.5±0.2^{b}	3.6±0.1^{b}	4.1±0.2^{a}
Overall Palatability	3.5±0.2^{b}	3.5±0.1^{b}	4.2±0.1^{a}

IV. CONCLUSION

From the results obtained, it is recommended to feed rice bran, a major agricultural by-product in Korea, or extruded soybean (mostly imported) either as a substitute or supplement of commercial concentrates to finishing Hanwoo steers. The study, especially implies that partial substitution of commercial concentrates with RB would be beneficial to improve yield and quality grade of Hanwoo steers and substitution with ES would improve sensory evaluations of Hanwoo beef by increasing umami taste related free amino acids such as glutamic acid and aspartic acid.

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