PHYSICO-CHEMICAL MEAT QUALITY AND SENSORY PROPERTIES OF LOIN MUSCLES FROM KOREAN HANWOO BEEF PRODUCED WITH SUPPLEMENT OF RUMINANT PROTECTIVE COATED AMINO ACID AND VITAMINE C ADDITIVES

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Abstract –This study was performed to investigate the physico-chemical properties of Hanwoo steer beef loin *(m. longissimus dorsi)* muscles produced with the supplement of ruminant protective coated amino acid and vitamin C additives. T1 had significantly higher intramuscular fat contents (12.5%) than the other groups (7.58, 8.77%) (p<0.05). The loin muscles from T1 (11.50) and T2 (10.54) had significantly lower CIE b values than the control (13.34) groups (p<0.05). There were not significant differences in water holding capacity and cooking loss among 3 groups. The loin muscles from T1 contained significantly lower total contents of saturated fatty acids (42.86%) and higher total contents of monounsaturated fatty acids (55.66%) than those from control and T2 groups (p<0.05). The results from the sensory evaluation showed that the loin muscles from T1 had significantly higher scores in flavor-likeness and overall likeness than the other groups (p<0.05). Therefore, the additive condition of T1 had desirable effect on the meat quality in Hanwoo production.

Key Words – Hanwoo steer, additives, meat quality, sensory property

I. INTRODUCTION

In 2014, approximately 920,944 heads of Hanwoo beef cattle were slaughtered in Korea (steers, 442,929; cows, 448,120, bulls 29,895) for meat production [1]. Korean consumers prefer highly marbled beef, especially from Hanwoo, and the frequency of beef with quality grade (QG) 1 is 65% 1^{++} 9.5, 1^{+} 22.8, 1 32.7). Most livestock farmers expect their cattle to have > QG 1. Feeding periods were extended for fattening until the finishing at 30–32 months. Long term of feeding periods resulted in paying for high expense of labor, feed and environment. Raising beef prices have made it difficult for foodservice operators to maintain profitable margin while continuing to meet customers' price and palatability expectation [2]. It had been reported that supplement of ruminant protective coated amino acid and vitamin C additives improved the growth performance and meat quality of Hanwoo bulls [3]. Therefore, the objective of this study was to investigate the physico-chemical properties of Hanwoo steer beef loin *(m. longissimus dorsi)* when they were fed with supplement of ruminant protective coated amino acid and vitamin C additives.

II. MATERIALS AND METHODS

A. Sample preparation

Fifteen Hanwoo steers (twenty-eight months old; live weight, 450–600 kg) were divided into 3 groups (5 heads/group). They were raised with the Hanwoo feeding program of NIAS as Table 1. For the treatment group, supplement of ruminant protective coated amino acid and vitamin C additives were provided (Table 2). At the end of late fattening periods, the animals were transported to the abattoir of NIAS and slaughtered. After the carcasses were chilled at 4°C for 24hrs, the right side of the carcass was boned and trimmed to domestic fabrication. The loin *(m. longissimus lumborum*, LD) muscles

were separated, vacuum-packaged, and stored at 2°C for analysis of meat quality and sensory evaluation.

B. Chemical and meat quality analysis

Protein, fat, moisture, and collagen content were analyzed using the Food Scan™ Lab 78810 (Foss Tecator Co., Ltd., DK), according to the method of the Association of Official Analytical Chemists [4]. Color values were measured using a CR-301 chroma meter (Minolta Co., Osaka, Japan) for CIE standard lightness (*L**), redness (*a**), and yellowness (*b**) after a 30 min blooming at 2°C [5]. Water-holding capacity (WHC) was measured using the method of Ryoichi *et al.* [6]. The cooking loss was expressed as a percentage of the initial sample weight [7]. WBSF was measured on cooked steaks (25 mm thick) according to the method of Wheeler *et al.*, [8] using an Instron Universal Testing Machine (Model 5543, UK).

C. Sensory evaluation

For Korean roast thin-slice-style cooking, the beef strips were cooked on a tin plate equipped with a water jacket (at approximately 245°C–255°C). Scoring was performed using 6-point scale evaluation. Tenderness ranged from very tough (1) to very tender (6); juiciness ranged from very dry (1) to very juicy (6). Flavor ranged from extreme dislike (1) to extreme like (5); overall liking ranged from extreme dislike (1) to extreme like (6).

D. Statistical Analysis

Each animal within the same slaughtering age group was treated as a replicate. Data were analyzed by the Student-Newman-Keuls' multiple comparison using the General Linear Model Procedure of the SAS program [9]. The significance level was set at $P<0.05$.

Table 1. Chemical composition of basal diet and rice straw

Ingredient (%)	Concentrate		Rice straw
	Early fattening stage (13-21 months)	Late fattening stage (22-28 months)	
Dry matter (%)	87.79	87.43	91.43
Crude protein (%)	13.00	12.38	4.39
Crude fat (%)	3.74	4.11	2.36
Crude ash (%)	9.04	7.51	13.07
NDF[1)] (%)	27.61	25.34	70.21
ADF[2)] (%)	10.84	10.12	38.13
TDN[3)] (%)	71.00	74.00	44.00

[1)]Neutral detergent fiber, [2)]Acid detergent fiber, [3)]Total digestible nutrients.

Table 2. Supplement of Feeding conditions for Hanwoo steers

Treatment	T1	T2
Control	Ruminant protective coated Amino acid +Vitamin C	Ruminant protective coated Vitamin C
No additive supplement	Feeding 100g from 16 month-old	Feeding 100g from 16 month-old

III. RESULTS AND DISCUSSION

In chemical compositions, T1 had significantly higher intramuscular fat contents (12.5%) than the other groups (7.58, 8.77%) ($p<0.05$) (Table 3). However, the protein, moisture and collagen contents were not significantly different among 3 groups. Visible intra- muscular fat (IMF) or marbling is an important meat characteristic which is appreciated by the consumer because of its positive effects on taste, juiciness, and tenderness [11]. There were not significant differences in the CIE *a* value (lightness) and CIE *b* values (redness) among 3 groups ($p>0.05$). The loin muscles from T1 (11.50) and T2 (10.54) had significantly lower CIE b values than the control (13.34) groups ($p<0.05$). There were not significant differences in Water holding capacity

and cooking loss among 3 groups. The loin muscles from T1 had significantly lower WB-shear force values (4.25 kg) than those from control (5.38 kg)and T2 (5.16 kg) groups (p<0.05) (Table 3). In the comparison of fatty acid compositions, the loin muscles from T1 contained significantly lower total contents of saturated fatty acids (SFA) (42.86%) and higher total contents of monounsaturated fatty acids (MUFA)(55.66%) than those from control and T2 groups (p<0.05). However, there were not significantly different in total contents of polyunsaturated fatty acids (PUFA). The results from the sensory evaluation showed that the loin muscles from T1 had significantly higher scores in flavor-likeness and overall likeness than the other groups (p<0.05). The tenderness and juiciness scores were not significantly different among 3 groups (p>0.05).

Table 3. Chemical composition, physico-chemical meat quality and sensory properties of loin muscles obtained from Hanwoo beef fed with the supplement of ruminant protective coated amino acids and vitamin C additives

Items		Control	T1	T2
Protein (%)		21.00	20.62	20.25
Moisture (%)		68.10	64.46	65.66
Fat (%)		7.58	12.54	8.77
Collagen (%)		1.77	1.79	1.87
Meat color	L	35.85	37.65	35.17
	a	21.23	22.64	20.75
	b	13.34[a]	11.50[b]	10.54[b]
Water holding capacity(%)		59.95	58.96	60.14
Cooking loss (%)		24.89	25.41	22.37
WB-shear force (kg)		5.38[a]	4.25[b]	5.16[a]
Total contents of fatty acids (%)	SFA	46.79[a]	42.86[b]	46.18[a]
	MUFA	51.75[b]	55.66[a]	52.46[b]
	PUFA	1.46	1.48	1.36
Sensory properties	Tenderness	2.92	3.64	3.00
	Juiciness	3.23	3.90	3.40
	Flavor-likeness	3.86[b]	4.40[a]	4.01[b]
	Overall likeness	3.17[b]	3.88[a]	3.28[b]

*Control, No additive treatments; T1, Supplement with additive containing coated amino acids and Vitamin C; T2, Supplement with additive containing Vitamin C only

[a-b] Means in the same row with different superscripts differ significantly (P < 0.05).

IV. CONCLUSION

Feeding group with supplement of ruminant protective coated amino acid and vitamin C additives for 12 months had the moderate contents of intramuscular fat in loin muscle. They also had significantly lower WB-shear force and higher sensory preference in the flavor-likeness and overall-likeness than those of control and feeding group with vitamin C only when slaughtered at 28 months-old.

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