Soohyun Cho (1) shc0915@korea.kr, _Beomyoung Park(2), Pilnam Seong 3, Jinhyoung Kim 4 Yeonho Choi 5 Donghun Kim 6_

(1)National Institute of Animal Science, Animal Products Research and Development division
(2)National Institute of Animal Science, Animal Products Research and Development division
(3)National Institute of Animal Science, Animal Products Research and Development division
(4)National Institute of Animal Science, Animal Products Research and Development division
(5)National Institute of Animal Science, Hanwoo Experimental Station
(6)National Institute of Animal Science, Animal Products Research and Development division

Abstract The objective of this study was to investigate the role of cut, quality grade and cooking methods on palatability of Hanwoo beef. 10 cuts (short plate, top sirloin, striploin, loin, chuck tender, eye of round, chuck roll, bottom round, top round and brisket) were obtained from thirty carcasses (15 Hanwoo steers with 1++ quality grade for high quality beef, and 15 Hanwoo bulls with 3 quality grade for low quality beef). Beef samples (n=8,850) from each cut were prepared by 3 cooking methods (grill, Korean-style roast, Korean-style boil) and served to 1,300 consumers for sensory test. The results of the study showed that palatability scores were significantly different between two quality grade (p<0.05) for loin, striploin, top sirloin in 3 cooking methods. However, Korean quality grade did not affect the palatability scores of eye of round and partially affected those of chuck tender, chuck roll and bottom round, top round depending on the cooking. For the distribution of the palatability grades, short plate, top sirloin, striploin and loin showed higher frequencies (%) in 'satisfactory' or above grade group while top round, bottom round, chuck roll, chuck tender tended to higher frequencies in 'unsatisfactory' grade when they were cooked and served to consumers in the same manner. Among three cooking methods, Korean consumers significantly preferred the roast cooking to grill or boil cooking.

S. H. Cho is with the National Institute of Animal Science, Suwon, South Korea 441-706 (phone: 9231-290-1703; fax: 8231-290-1697; e-mail: shc0915@rda.go.kr). B. Y. Park is with the National Institute of Animal Science, Suwon, South Korea 441-706 (e-mail: byp5252@rda.go.kr). P. N. Seong is with the National Institute of Animal Science, Suwon, South Korea 441-706 (e-mail: spn2002@rda.go.kr). J. H. Kim is with the National Institute of Animal Science, Suwon, South Korea 441-706 (e-mail: jhkim702@rda.go.kr). J. M. Lee is with the National Institute of Animal Science, Suwon, South Korea 441-706 (e-mail: jm9758@rda.go.kr). Y. H. Choi is with the National Institute of Animal Science, Suwon, South Korea 441-706 (e-mail: ychoy000@rda.go.kr). D. H. Kim is with the National Institute of Animal Science, Suwon, South Korea 441-706 (e-mail: kd8485@rda.go.kr).

Index terms : Hanwoo beef, quality grade, cut, cooking method, consumer testing

I. INTRODUCTION

Beef palatability was important factor for consumer satisfaction. The eating quality of beef has been evaluated in a number of consumer studies [5, 10]. They reported that tenderness, juiciness and flavor were highly correlated with overall acceptability and intramuscular fat. In Korea, beef quality was evaluated by the carcass grading system based on meat color, fat color, texture, and maturity of loin muscle and intramuscular fat contents and there were 5 quality grades such as 1++, 1+, 1, 2, 3. According to the statistics data of 2007, 71.5% Hanwoo steers produced 1++ grade when compared to 59.7% Hanwoo cow and 2.9% bulls[1]. A series of studies on the interaction between consumer group and cooking methods implied that that consumer satisfaction was largely dependent on how meat was cooked, and by whom the meat was evaluated [9] However, USDA quality grade did not affect palatability of top sirloin steaks [7, 8].

II. MATERIALS AND METHOD

Animals, treatment, and sample preparation A total of 10 Korean Hanwoo steers (28-30months old, Korean quality grade 1++) for high quality grade beef and 10 Korean Hanwoo bulls (24-26months old, Korean quality grade 3) for low quality grade beef were slaughtered at the National Institute of Animal Science (NIAS), Suwon. Animals were slaughtered in three groups of six animals over a 3-day period. 10 cuts (short plate, top sirloin, striploin, loin, chuck tender, eye of round, chuck roll, bottom round, top round and brisket) were selected from each carcasses, vacuum packaged and stored at 2 ¢J for 7 days. After aging, 50 x 70 x 25

mm steaks were cut across the fiber direction. To prepare Korean-style roasted and boiled beef strips, frozen meat blocks were tempered at 4 °C and sliced into 75 x 20 x 4 mm, parallel to the fiber direction. The sensory samples were vacuum-packed separately and stored at -20„aC until analysis. Sensory evaluation of grill, Korean style roast and boil cooking samples The Korean¡Vstyle thin slice roast cooking was performed by using the methods described by [2]. The beef strips were cooked by placing these on the tin plate equipped with a water jacket (ca. 245-255oC). Beef strips were boiled at 100 oC for 2 minutes to cook for Korean traditional "boil dish"[2]. The sensory testing for grill was also performed according to the method described[3], which beef samples were grilled at 220-230oC by using a double surface Panini Griller for 5 min to achieve a medium degree of doneness (approximately 70oC). The cooked strips were immediately served to each panelist for evaluation. Consumers were asked to score the samples for tenderness, juiciness, flavor, and overall liking. Scoring was done on a single sheet using four 100 mm line scale with 20 mm gradients marked. The four lines for sensory traits were anchored with the following words: tenderness = very tough (0) to very tender (100); juiciness = very dry (0) to very juicy (100); flavor = dislike extremely (0) to like extremely (100). The consumers evaluated the satisfactory level for each tested sample based on the previous three sensory traits as unsatisfactory, satisfactory, very satisfactory, extremely satisfactory. Consumers to test beef samples were recruited from 4 regions (Seoul, Kyunggi, Honam and Youngnam) based on the quarter sampling of population numbers. Statistical analysis : Data were analyzed by using the SAS program (1996) [11]and means were separated by the Student-Newman-Keuls' test. The level of significance was p<0.05. The palatability grade was established by comparing the results of discriminant analysis with sensory data obtained from sensory testing by 1,300 consumers. Palatability scores with tenderness, juiciness and flavor-likeness (PS3) were obtained using principal component analysis[4]. The linear discriminant analysis with PS3 was performed for palatability grade. 4 palatability grading levels were established such as unsatisfactory, satisfactory, very satisfactory and extremely satisfactory.

III.   RESULTS AND DISCUSSION

In the previous publication, high quality grade (QG 1++) of Hanwoo beef cuts had significantly higher intramuscular fat contents (7.81~24.74%) and significantly lower pH (5.47-5.64), protein (16.94-21.15%), moisture (58.17-70.08%) and ash contents (0.60-0.79%) than low quality grade beef cuts (QG 3) (p<0.05) [2]. In that study, the intramuscular fat contents (%) of loin were significantly high and those of eye of round were significantly low among 10 cuts. The results of this study showed that the palatability properties of Korean consumers were significantly related with cooking methods, cut and quality grade (QG) (Table 1). The palatability scores (PS3) of loin, strip loin, top sirloin were significantly different from the quality grade regardless of cooking methods (p<0.05). Short plate and brisket were prepared only in Korean-style boil cooking as Korean traditional cooking method and PS3 was also significantly different depending on the quality grade. However, Korean quality grade did not affect palatability scores of chuck tender in roast and boil cooking, eye of round in roast, boil and grill cooking, chuck roll and bottom round in boil and grill cooking, top round in grill cooking when those cuts from 1++ quality and 3 quality grade beef were compared. Short plate, top sirloin, striploin and loin were higher frequencies (%) in ¡¥satisfactory¡¦ or above grade group in the palatability grading while top round, bottom round, chuck roll, chuck tender were higher frequencies in "unsatisfactory" grade when they were cooked and evaluated in the same manner (Fig. 1). Result of the sensory testing indicated that Korean consumers significantly preferred the roast cooking to grill or boil cooking. The palatability scores were followed by grill cooking for top round and loin and boil cooking for top sirloin (Fig. 2).

IV. CONCLUSION

The results of this study showed that the palatability properties of beef were significantly related with cooking methods, cut and quality grade when evaluated by Korean consumers.

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Table 1. Numbers of beef samples cooked by roasting, grilling and boiling and evaluated sensory properties for the experiment (n=27,832)

Breed	Cooking methods			Total beef sample numbers
	Roast	Grill	Boil	
Bull	1,706	691	1,993	4,390
Steer	9,870	4,490	9,082	23,442
Total	11,576	5,187	11,075	27,832

Table 2. Mean and standard deviation of sensory variables in palatability grades(n=27,832)

| Palatability grade	Beef sample numbers (%)	Tenderness[*] Mean (SD)[**]	Juiciness Mean (SD)	Flavor Mean (SD)
Unsatisfactory	7,458 (26.79)	32.27 (18.89)	41.81 (20.56)	45.70 (20.33)
Satisfactory	9,843 (35.36)	58.94 (17.71)	62.66 (16.52)	63.52 (15.69)
Very satisfactory	6,795 (34.41)	77.78 (13.75)	77.87 (13.18)	76.50 (13.36)
Extremely satisfactory	3,742 (13.44)	90.18 (10.56)	89.70 (10.19)	87.03 (11.71)

[*]Palatability evaluation based on tenderness = very tough (0), very tender (100); juiciness = very dry (0), very juicy (100); flavor = very dislike (0), very like (100); overall acceptability = very dislike (0), very like (100).
[**]Mean (Standard deviation)

Table 3. Classification of palatability grading with PS3 in discriminant analysis .

Palatability grade	Grouping category				Sum of row
	Unsatisfactory	Satisfactory	Very satisfactory	Extremely satisfactory	
Unsatisfactory	5,775*	1,482	171	26	7,454
Satisfactory	1,941	5133	2374	391	9,839
Very satisfactory	94	1247	3413	2,039	6,793
Extremely satisfactory	19	71	660	2992	3742
Sum of column	7,829	7,933	6,618	5,448	27,828

*Sample frequency; **The resubstitution error rate : 35.04%
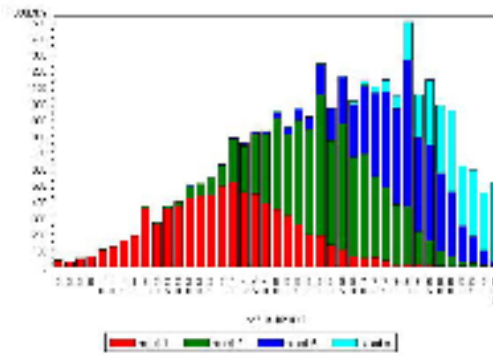
(a) distribution of palatability grading
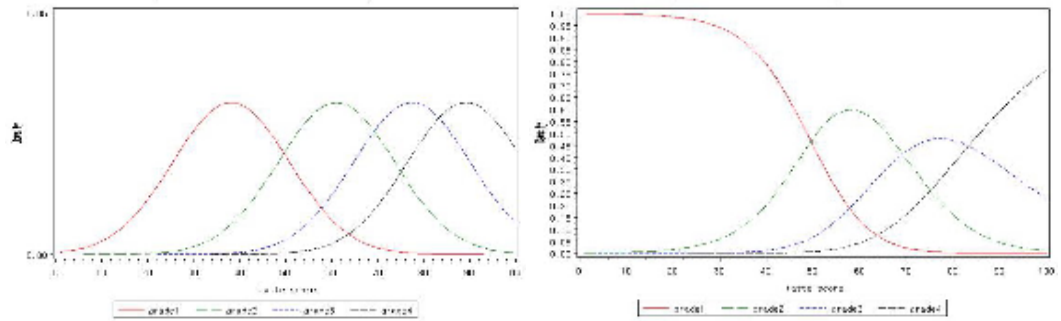
(b) Estimated density plot and posterior probability curve of palatability grading

Fig 1. Discriminant analysis using ps3 evaluated by Korean consumers (n=3,976)

Grade 1, unsatisfactory; Grade 2, satisfactory; Grade 3, very satisfactory; Grade 4, extremely satisfactory