MEAT QUALITY AND SENSORY PROPERTIES OF DIFFERENT MUSCLES FROM KOREAN HANWOO BULLS

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Key Words: bulls, meat quality, sensory property

Introduction

Different beef muscles vary in proteolysis, rigor shortening, and/or connective tissue, muscle location potentially contribute to meat quality and palatability. Extensive knowledge of meat tenderness variation and meat palatability has been developed for the longissimus (Rhee et al., 2004) since it has low variation in sensory detectable connective tissue and sarcomere length relative to most muscle. Certain beef cuts with lower quality need to be improved in the value of meat quality relative to loin cuts. On the other hand, the price difference between bulls and steers is a result of the lower quality grade and consumer acceptance of bulls at the retail level because of darker in color and coarser in texture (Jeremiah, 1978) although bulls grow more rapidly, utilize feed more efficiently and produce leaner carcasses with less fat and more meat than steers (Seideman et al., 1982). The objective of this study was to investigate the variation of meat quality characteristics and palatability traits for different muscles from Hanwoo bulls beef.

Materials and methods

Animals : A total of 10 bulls (~24 month of age, 550-650kg of live weight) were sampled from the National Livestock Research Institute's (NLRI) breeding program. All bulls were transported to the National Livestock Research Institute and conventionally slaughtered for three consecutive days. The carcasses were placed in a 1□ chiller until the following day and divided into retail cuts using the domestic standard processing procedures (2001). Tricep brachii (TB), Bicep femoris (BF), Middle gluteal (MG), Rectus abdominis(RA), Longissimus dorsi (LD), Semitendinosus (ST) and Semimembranosus (SM) muscles were obtained from each carcass and analyzed for meat quality and sensory evaluation.

Analytical methods **:** Chemical compositions were analyzed by using methods of Association of Official Analytical Chemists (AOAC) (1996). Water-holding capacity (WHC) was measured by using the method of Ryoichi et al.(1993). Warner Bratzler-shear force(WBS) was measured on cooked steaks(25-mm thick) according to the method described by Wheeler et al.(2000). Color values on freshly cut surface of the WBS block were measured by a chroma meter (Minolta Co. CR 301) for lightness (L), redness (a) and yellowness (b) of CIE after a 30-min blooming at 1℃. Cooking loss was calculated as a percent for the weight changes during cooking for WBS measurement.

Sensory evaluation : The sample preparation and sensory testing were followed by the protocol of Gee & Polkinghorne. (2002). Two hundred and fifty Korean consumers were recruited in the Seoul, Kyunggi-do, Kangwon-do, Choongchung-do, Kyungsang-do, and Chunla-do region. To prepare Korean-style roasted beef strips, each muscle was removed and vacuum-packed and aged for 7 days at a 1℃ chiller. The frozen meat blocks were tempered at 4 °C and sliced into 75 x 20 x 4mm, parallel to the fiber direction. The sensory samples were vacuum-packed separately and stored at -20°C until analysis. For sensory evaluation, the strips were thawed to approximately 4ºC. Individual strips were cooked by placing these on the tin plate equipped with a water jacket (ca. 245-255ºC). The strips were turned at the first pooling of liquid on the surface of the sample, or at the start of shrinkage. The cooked strips were immediately served to each panelist for evaluation.

Statistical analysis : Data were analyzed by using the SAS program (1996) and means were separated by the Student-Newman-Keuls' test. To determine the breed effect on samples, data were analyzed as one-factor randomized block experiments with treatments. The level of significance was $p<0.05$.

Results and Discussion

Chemical compositions were significantly different among seven muscles (Table 1). Longissimus dorsi had significantly higher fat contents and lower protein and moisture content than those of the other muscles. Semimembranosus muscle was significantly higher in protein and lower in fat and moisture contents ($p<0.05$). The rectus abdominis muscle had significantly higher *L* (lightness) and *b* values (yellowness) than those of the other muscles. There were not significantly different in *a* values (redness) among 7 muscles ($p>0.05$). Semimembranosus muscle had significantly lower *L* and *b* values those of the other muscles ($p<0.05$). In cooking loss(%), triceps brachii muscle had significantly higher whereas rectus abdominis muscle had significantly lower than the other muscles ($p<0.05$). Among seven muscles, longissimus dorsi muscles had significantly lower WBS while triceps brachii muscle had significantly higher WBS values when compared to the other muscles. Longissimus dorsi and semimembranosus muscles were significantly higher in WHC while triceps brachii muscle was significantly lower in WHC when compared to the other muscles ($p>0.05$). Result from the sensory evaluation showed that longissimus dorsi and middle gluteal muscles were most tender and juicy with highest scores of overall acceptability among seven muscles ($p<0.05$)

Table 1. Quality characteristics of Korean Hanwoo bulls beef by different muscles.

Muscles	Proximate Composition (%)				CIE			CL[1] (%)	WBS[2]	WHC[3]
	Protein	Fat	Moisture	ash	L	a	b			
Bicep femoris	22.19^{abc}	1.04^{b}	75.08^{abc}	0.94^{abc}	37.22^{ab}	17.88	8.77^{ab}	30.71^{ab}	7.30^{ab}	54.32^{ab}
Longissimus dorsi	21.32^{d}	2.85^{a}	74.03^{c}	0.85^{cd}	36.47^{b}	18.98	9.50^{ab}	29.93^{ab}	6.94^{b}	55.85^{a}
Middle gluteal	22.24^{abc}	1.52^{b}	74.63^{bc}	0.94^{abc}	36.77^{ab}	17.74	9.07^{ab}	28.44^{ab}	7.59^{ab}	54.81^{ab}
Rectus abdominis	21.66^{bcd}	2.39^{a}	74.78^{abc}	0.89^{bcd}	40.28^{a}	20.78	11.11^{a}	26.97^{b}	7.90^{ab}	52.56^{bc}
Semi-membranosus	22.80^{a}	0.98^{b}	74.50^{c}	0.99^{ab}	34.99^{b}	16.89	8.12^{b}	29.73^{ab}	7.31^{ab}	56.11^{a}
Semitendinosus	22.49^{ab}	0.65^{b}	75.65^{ab}	1.01^{a}	37.27^{ab}	21.08	9.06^{ab}	28.39^{ab}	7.91^{ab}	54.66^{ab}
Tricep brachii	21.47^{cd}	1.19^{b}	75.79^{a}	0.80^{d}	35.55^{ab}	20.03	8.44^{ab}	21.61^{a}	8.22^{a}	51.99^{c}

[1]CL - cooking loss; [2]WBS Warner Bratlzer shear force; [3]WHC - water holding capacity
$^{a-c}$ Means with a same superscript within a column are not significantly different ($p<0.05$)

Table 2. Sensory properties of different muscles from Korean Hanwoo bulls beef.

Muscles	Tenderness*	Juiciness	Like-flavor	Overall acceptability
Bicep femoris	49.30^{c}	61.93^{b}	59.04^{bc}	54.87^{d}
Longissimus dorsi	69.17^{a}	70.53^{a}	66.06^{a}	68.31^{a}
Middle gluteal	68.72^{a}	68.40^{a}	64.27^{ab}	67.73^{a}
Semimembranosus	48.01^{c}	57.89^{c}	57.73^{c}	52.24^{d}
Semitendinosus	60.82^{b}	63.92^{b}	60.37^{bc}	61.64^{bc}
Tricep brachii	63.14^{b}	69.65^{a}	62.15^{abc}	65.27^{ab}

*based on 0: very tough, very dry, dislike extremely; 100: very tender, very juicy, like extremely.
$^{a-d}$ Means with a same superscript within a column are not significantly different ($p<0.05$)

Conclusions

Variation in meat quality traits and sensory properties was observed among seven muscles. This is related to the complex interaction of various biochemical traits and compositions depending on the muscles. However, this information can be used to facilitate the development of the cut-specific strategies with targeting muscle characteristics and to select the proper individual muscles in the process of added-value products.

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FATTY ACID PROFILES OF DIFFERENT MUSCLES FROM KOREAN HANWOO BULLS

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Key Words: bulls, meat quality, sensory property

Introduction

Fatty acids compositions were different depending on genotype, breed, feeding condition, sex, fat deposition, and the differences in muscle fiber type between muscles are reflected in differences of fatty acid composition (Wood et al., 2004). Previous studies suggest that the fatty acid composition of ruminant meats can have an influence on meat flavor, along with other important quality attributes, and this is very much influenced by the diet given to the animal (Wood et al., 1999; Cho et al., 2005). Flavor is an important characteristics of meat quality relating to the eating satisfaction that is perceived by the consumer (Love, 1994). The consumer's choice to purchase beef is guided by the perception of healthiness as well as a variety of sensory traits including color, tenderness, juiciness, and aroma or flavor (Verbeke & Viaene, 1999). Therefore, it is worthwhile considering differences in meat quality at the consumer level with respect to both sensory traits and health aspects (Raes et al., 2003). The objective of this study was to compare the levels of important fatty acid compositions in the intramuscular fat of different muscles from Korean Hanwoo bulls beef.

Materials and methods

Animals : A total of 10 bulls (~24 month of age, 550-650kg of live weight) were sampled from the National Livestock Research Institute's (NLRI) breeding program. All bulls were transported to the National Livestock Research Institute and conventionally slaughtered for three consecutive days. The carcasses were placed in a 1□ chiller until the following day and submitted to standard processing procedures and divided into retail cuts. Tricep brachii (TB), Bicep femoris (BF), Middle gluteal (MG), Rectus abdominis(RA), Longissimus dorsi (LD), Semitendinosus (ST) and Semimembranosus (SM) muscles were obtained from each carcass and analyzed for meat quality and sensory evaluation.

Analytical methods **:** Total lipids were extracted by using chloroform-methanol (2:1, v/v) according to the procedure of Folch et al.(1957). An aliquot of the lipid fraction was methylated as described by Morrison and Smith(1964). Fatty acid methylesters were analyzed by a gas chromatograph (Varian 3400) fitted with a fused silica capillary column, Omegawax (205, 30 m × 0.32 mm I.D., 0.25 μm film thickness). The injection port was at 250□ and the detector was maintained at 260□. Nitrogen was used as the carrier gas. Results were expressed as percentages, based on the total peak area.

Statistical analysis : Data were analyzed by using the SAS program (1996) and means were separated by the Student-Newman-Keuls' test. The level of significance was $p<0.05$

Result and discussion

For all muscles, fatty acids, ranked from the most important ones, were oleic acids (C18:1n9)>palmitic acids (C16:0)>stearic acids (C18:0) in the intramuscular fat (Table 1). Early research demonstrated that the concentration of oleic acid (C18:1n9) in beef is positively correlated with its overall palatability (Wood et al., 2004). The seven muscles differed significantly in the content of several fatty acids, especially, C16:0, C18:1n7, C18:2n6, and C20:4n6. C16:0 and C!8:1n7 were significantly higher ($p<0.05$) in Rectus abdomininis muscles than the other muscles. Oleic acid (C18:1) contents were higher in triceps brachii muscle than the other muscles, but there was no significant difference among the muscles ($p>0.05$). The linoleic acid (C18:2n6), an essential fatty acid, was significantly higher in semimembranosus and triceps brachii muscles than the other muscles, while it was significantly lower in longissimus dorsi and rectus abdominis muscles ($p<0.05$). Proportions of other essential fatty acids, arachidonic acid (C20:4n6) was significantly higher in biceps femoris, semimembranosus and semitendinosus muscles than the other muscles ($p<0.05$). There was not significantly different in the proportions of monounsaturated fatty acids among seven muscles ($p>0.05$). Triceps brachii and Semimembranosus had significantly higher levels of *n*-6 and PUFA contents. For longissimus dorsi muscle, the proportion of saturated fatty acids was highest, whereas that of the polyunsaturated fatty acids was lowest among the seven muscles.

Table 1. Fatty acid profiles of intramuscular fat in seven muscles from Korean Hanwoo bulls beef.

	Bicep femoris	Longissimus dorsi	Middle gluteal	Rectus abdominis	Semi-membranosus	Semi-tendinosus	Triceps brachii
C14:0	2.54	2.62	2.74	2.53	2.54	2.63	2.34
C16:0	25.15^{ab}	24.81^{ab}	24.83^{ab}	25.99^{a}	25.60^{ab}	25.46^{ab}	23.95^{b}
C18:0	16.16	18.12	17.29	16.57	16.13	16.33	18.02
C16:1 *n*-7	3.75	3.16	3.36	3.82	3.41	3.76	2.93
C18:1 *n*-7	0.11^{b}	0.06^{b}	0.06^{b}	0.26^{a}	0.08^{b}	0.07^{b}	0.05^{b}
C18:1 *n*-9	46.41	47.08	46.17	46.40	45.58	45.44	45.97
C18:2 *n*-6	4.30^{ab}	3.03^{b}	4.04^{ab}	3.27^{b}	4.92^{a}	4.53^{ab}	5.26^{a}
C18:3 *n*-3	0.11	0.20	0.17	0.14	0.15	0.17	0.17
C18:3 *n*-6	0.03	0.03	0.02	0.06	0.02	0.07	0.03
C20:1 *n*-9	0.17	0.12	0.19	0.12	0.17	0.15	0.17
C20:2 *n*-6	0.07	0.11	0.09	0.09	0.09	0.14	0.09
C20:3 *n*-6	0.27	0.34	0.22	0.36	0.24	0.28	0.34
C20:4 *n*-6	0.95^{a}	0.32^{c}	0.82^{ab}	0.41^{bc}	1.08^{a}	0.98^{a}	0.70^{abc}
n-3	0.11	0.20	0.17	0.14	0.15	0.17	0.17
n-6	5.62^{abc}	3.84^{c}	5.20^{abc}	4.17^{bc}	6.35^{a}	5.99^{ab}	6.42^{a}
SFA	43.84^{b}	45.54^{a}	44.86^{ab}	45.10^{ab}	44.27^{ab}	44.42^{ab}	44.30^{ab}
MUFA	50.43	50.42	49.77	50.59	49.24	49.43	49.11
PUFA	5.73^{abc}	4.05^{c}	5.37^{abc}	4.32^{bc}	6.50^{a}	6.16^{ab}	6.59^{a}
MUFA/SFA	1.15	1.11	1.11	1.12	1.11	1.10	1.11
PUFA/SFA	0.13^{abc}	0.09^{c}	0.13^{abc}	0.10^{bc}	0.14^{ab}	0.14^{ab}	0.15^{a}

$^{a-d}$ Means with a same superscript within a row are not significantly different ($p<0.05$)

Conclusion

Seven muscles (Tricep brachii, Bicep femoris, Middle gluteal, Rectus abdominis, Longissimus dorsi, Semitendinosus and Semimembranosus) from Hanwoo bulls beef contained significantly different fatty acid compositions for C16:0, C18:1n7, C18:2n6, and C18:4n6. Not only the amount of fat is important in the human diet, but the nature of that fat has also important implications for well-being and health. Therefore, it may be possible to produce the individual cut with less palmitic acid (C16:0), more oleic acid (C18:1n9), a low n-6: n3 PUFA ratio and a high MUFA/SFA ratio to provide consumers a healthier beef product.

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