FACTORS AFFECTING CARCASS AND MEAT QUALITY OF THE HANWOO

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Background

Studies have shown that the fat embedded in the muscle or muscular tissue makes the meat juicy, tender, and tasty. These findings were reported by Parrish (1974) and Donald and Merkel (1993). Estimating quality of meat varies from country to country. Factors such as intramuscular fat content and maturity are important, since they directly affect the meat's tenderness, juiciness, and flavor. Parrish (1974) reported that intramuscular fat explained approximately 12-14% of tenderness. However, according to Gregory, Cundiff and Koch (1995), tenderness was reduced for highly marbled meat, while May, Dolezal, Gill, Ray and Buchanan (1992) reported that high WB-shear force reduced juiciness, flavor, and tenderness. The study also showed that tenderness had a correlation efficient of 0.19 and 0.73 for intramuscular fat content and juiciness, respectively. In addition, Miller, Carr, Ramsey, Crockett and Hoover (2001) reported that WB-shear force lower than 3.0 was tender, while that higher than 5.7 was tougher. Laila (1996) reported that correlation coefficients in relation to objective meat color and intramuscular fat content were 0.07 for L*, 0.06 for a*, and 0.12 for b* values.
However, Shackelford, Wheller, Meade, Reagan, Byrnes, and Koohmaraie (2001) reported that consumer preferences were significantly affected by doneness. As mentioned earlier, the intramuscular fat content was the prime factor affecting the meat quality in the U.S (Donald and Merker, 1993). Thus, according to Talamantes, Long, Smith, Jenkins, Ellis, and Cartwright (1986), beef production system for the effective fat deposit in muscles is important because carcass fat deposit is significantly correlated with intramuscular fat content. Considering sex as a variable, Hardt, Greene & Lunt (1995) observed that heifers had a higher intramuscular fat, with lower maturity and received a higher carcass quality grade.

Objectives

This study determined the meat quality of the Hanwoo (Korean native cattle) as a result of the diversity in the production system for sex and market weight. The physico-chemical traits and palatability of 773 *M. longisimus dorsi* muscles obtained from Hanwoo cattle were evaluated.

Materials and methods

Animals: A total of 773 cattle were sampled from 24 farms across the country and slaughtered in the National Livestock Research Institute (NLRI) slaughterhouse. Longissimus samples (2.5 kg) were taken from the 13th rib of each animal.
Analysis of objective and subjective meat quality:WB-shear force was determined by cooking steaks of 3-cm thickness of *m. longissimus dorsi* (LD) in a 70 ˚C water bath for 60 min. These were cooled in running water (ca. 18 ˚C) for 30 min so that core temperature reached below 30 ˚C. Eight cores were made, each measuring 1.27 cm in diameter. The shear force was measured by using a V-shaped shear blade at 400 mm/min speed (Wheeler et al., 2000). Cooking loss was calculated as percent of weight changes during cooking for WB-shear force measurement. Objective meat color was determined by using a Minolta Chromameter (CR301, Minolta, Japan) on a freshly cut surface of the WB-shear force block after a 30-min blooming at 1°C. Water-holding capacity was determined according to the filter paper method described by Ryoichi, Degychi, and Nagata (1993). Briefly, 0.5g of muscle tissue was placed on glass, and filter paper was pressed against the meat sample at 35-50 kg/cm^2 for 2 min. Water-holding capacity was calculated by using a planimeter. Sensory characteristics were determined by 10 semi-trained panelists who were randomly selected from a total of 15 recruits. They estimated the values of tenderness, flavor intensity, juiciness by using a six-point scale.
Statistical analysis:ANOVA, Duncan-test, and correlation coefficients were determined by using SAS package (1996). The following analyses of variations were performed to estimate the effects of sex and live weight on carcass quality. Yijk = μ + SEXi + WTCLASSj + (SEXxWTCLASS)ij + eijk, where Yijk =

carcass quality,μ = mean, SEXi = sex effect of ith carcass (i = 1, 2, 3), WTCLASSj = carcass weight effect of jth carcass (j = 1,2,3,4,5,6), (SEX x WTCLASS)ij = interaction between ith sex and jth carcass weight, eijk = error.

Results and discussion

Intramuscular fat content increased with increasing live weights for cows (3.07-4.00), bulls (1.00-1.96), and steers (2.75-4.22). Cows and steers contained higher intramuscular fat than bulls when live weight was lighter than 500 kg ($P < 0.05$). Maturity ranged from 1.00 to 2.02, with higher scores for heavier weights. Bulls matured faster than steers and cows ($P < 0.05$). The results showed a faster calcification for cows compared with that of other groups. A lighter meat color for cows and steers than that of bulls was thought to be related to the higher intramuscular fat content for these groups. Cows had a whiter fat color than that of other groups within the same weight group. Frequency of carcass quality grade "1" increased with a corresponding increase in live weights, and cows and steers had a higher frequency than that of bulls ($P < 0.05$). Sex significantly affected the intramuscular fat content, maturity, meat color, fat color, and texture ($P < 0.01$), while live weights (Table 3) had significant effects on intramuscular fat and maturity ($P < 0.01$). Carcass quality grade had a higher correlation with intramuscular fat content (r=0.87), meat color (r=0.32), and texture (r=-0.54); but had a relatively weaker correlation with fat color (r=0.07) and maturity (r=-0.04). These results were similar with those of the previous studies conducted by Griffin (1992) and Dikeman, Cundiff, Gregory, Kemp and Koch (1998). They all reported that high slaughter weights resulted in higher carcass quality grade. In addition, Mckenna et al. (2002) reported that higher slaughter weights resulted in higher intramuscular fat, but did not affect maturity. For meat color, that of bulls was darker than that of cows and steers. This result was consistent with that of Seideman, Cross, Oltjen and Schanbacher (1982). In terms of sex as a variable, Park et al. (2002) reported that the difference in sex for Hanwoo cattle significantly affected carcass quality factors, where intramuscular fat content was highly correlated with carcass quality grade (r=0.81). This finding is also consistent with that of the previous study.

Protein content decreased with increasing marbling scores from 22.4% to 16.6% ($P < 0.01$), while intramuscular fat content increased from 5.16 to 19.46% ($P < 0.01$). Similarly, moisture content decreased from 71.24% to 61.04% ($P < 0.01$) and ash content decreased from 0.95% to 0.67% ($P < 0.01$). Average protein content of Hanwoo meat (21.28%) was similar with that of the European breed (21.43%) as reported by Browning, Huffman, Egbert & Jungst, 1990 and that of the Japanese black cattle (20.4%) according to Konishi, Nade, Maeda & Uchiyama (1995). On the other hand, intramuscular fat content was lower than 11.9% in the Japanese black cattle (Konishi, Nade, Maeda & Uchiyama, 1995), and higher than 5.91% in the cross breeds (Miller, Ramsey, Claborn & Wu, 1995). In addition, the current result was consistent with that of the previous study (Jones, Savell & Cross, 1990) who reported that intramuscular fat content increased with increasing marbling score and carcass quality grade. Meanwhile, data on moisture obtained in this study (69.34%) was lower than 72.9-75% as reported by Van Koevering, Gill, Owens, Dolezal, and Strasia (1995) and Corah, Tatum, Morgan, Mortimer, and Smith (1995). For ash content, it is generally known that it is approximately 1% in beef muscle, and the ash content obtained from this study was similar with that obtained from the previous report (Miller, Cross, Baker, Byers & Recio, 1988) which showed that ash content was similar between breeds.

The results showed that higher fat contents significantly increased tenderness (from 3.35 to 4.46), flavor (from 4.22 to 4.76), and juiciness (from 3.99 to 4.70). These findings support the observation that intramuscular fat is the most significant variant that explains approximately 7-15% of meat tenderness (Parrish, 1974). These findings also agree with those of the previous report (Shackelford, Wheeler & Koohmarmie, 1995) which showed significant correlation between marbling score and meat tenderness. Likewise, the results agreed with those of Lorenzen et al.(2003) who reported that meat flavor and juiciness were improved by 0.3 and 0.4 between low select and top choice. Mckenna et al. (2004) similarly reported that increase in marbling score improved overall sensory characteristics.

The results showed that WB-shear force and cooking loss decreased as marbling score increased, with averages of 5.2 kg and 29.4% ($P < 0.01$), respectively. On the other hand, water-holding capacity significantly increased ($P < 0.01$) at an average of 47.39%. The result was similar to that in the Japanese black cattle (5.6 kg) as reported by Konishi, Nade, Maeda & Uchiyama (1995), and for and in the Angus and Hereford (5.06-5.38 kg) as reported by May, Dolezal, Gill, Ray & Buchanan (1992). Meanwhile, studies by Cross, Savell and Francis (1986) showed water-holding capacity results as higher than 39.0-43%. But the significant increase in water-holding capacity with increasing marbling score tended to be similar with that of Kim and Lee's study (2003). Their study showed that the water-holding capacity increased from 51.3% to 55.6% from a carcass quality grade of 3 to 1. Van Koevering, Gill, Owens, Dolezal and Strasia (1995) reported 21.7-31.7% of cooking loss and Konishi, Nade, Maeda and Uchiyama (1995) reported 29.2% for American-Japanese black cattle, the current result was similar with the previous results.

Sex significantly ($P < 0.01$) affected the chemical composition and sensory characteristics. Sex also had significant ($P < 0.01$) effects on the objective color measurements (Table 6), and lightness had a low correlation with intramuscular fat content (r=0.17, Table 7). As far as slaughter weight is concerned, it significantly affected fat, moisture, and protein contents ($P < 0.01$), but this did not influence sensory characteristics. The significant differences in fat content between the sex groups and between slaughter weights indicated that these factors influenced fat deposition within the examined *longissimus* muscle. This result was consistent with that obtained by Miller, Cross, Baker, Byers and Recio (1988), where sex significantly affected the intramuscular fat content. The significant correlation between intramuscular fat content and juiciness (r=0.35), tenderness (r=0.23), and flavor (r=0.34); and between marbling score and juiciness (r=0.39), tenderness (r=0.26), and flavor (r=0.42) demonstrated that the amount of fat played a significant role in sensory characteristics. This result agreed with that of the previous studies (James, Mcbble & Jack, 1967; Shackelford, Wheeler & Koohmarmie, 1995) in that juiciness and tenderness received significantly higher scores from highly marbled muscles. Table 7 shows the effect of sex and slaughter weight on the objective meat quality traits. The result shows that sex had a significant effect on WB-shear force, but slaughter weight had no such effect. Sex also significantly affected water-holding capacity, and this result was similar with that of Waggoner, Dikeman, Brethour and Kemp (1990). WB-shear force significantly correlated with ($P < 0.01$) with juiciness (r=-0.29), tenderness (r=-0.34), flavor (r=-0.29), and intramuscular fat content (r=-0.32). The significant relationship between WB-shear force and intramuscular fat was similar with the result obtained by Gregory, Cundiff and Koch (1995). In addition, negligible effect of sex, slaughter weight, and intramuscular fat content on cooking loss was similar to that observed by Jones, Savell and Cross (1990). The high correlation between intramuscular fat content and moisture (r=-0.92) was similar to the previous result of Parrish (1974). On the other hand, the objective meat tenderness for carcass quality grades 2 and 3 was higher than 4.32 kg for Angus (Tatum, Smith & Carpenter, 1982) and 4.54 kg for Hereford (Patil, Goetsch, Lewis & Geird, 1993) for Angus. This suggests that the chiller aging treatment is required for the quality grade. Objective meat color of CIE L, a and b dimensions significantly ($P < 0.01$) increased as marbling scores increased from 1 to 7. Sex had significant ($P < 0.01$) effects on the objective color measurements (Table 6), and lightness had a low correlation with intramuscular fat content (r=0.17, Table 7). Subjective meat and fat color assessed by a 7-point scale indicated that higher intramuscular fat content reduced the subjective color scores of 4.54-4.80 for meat color and 2.58-3.04 for fat color. The result of objective color dimensions (i.e., CIE L, a and b) indicated that lightness and yellowness were similar with the previous results (Shackelford, Wheeler & Koohmarmie, 1995; Laila, 1996), but redness was stronger for Hanwoo beef.

Conclusions

As marbling degree increased, Warner-Bratzler shear force and cooking loss correspondingly decreased, while the water-holding capacity increased ($P < 0.01$). In the panel tests, the scores of tenderness, flavor, and juiciness increased ($P < 0.01$) with increasing marbling degrees. The shear force values had a negative correlation with juiciness, tenderness, and flavor. Sex of Hanwoo had significant effects on the carcass quality grade factors. The results of this study suggest a need for comparative studies on the range of marbling scores based on intramuscular fat content, and on objective and subjective meat quality for increasing sub-class of carcass grading which is included in the currently used four classes of carcass quality grading in Korea.

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