EFFECT OF HOUSING SYSTEM AND CASTRATION ON THE COLOR STABILITY OF HANWOO BEEF DURING REFRIGERATED STORAGE

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Introduction

The appearance of meat is of primary importance in modern marketing as most consumers "buy by the eye" (Schulz, 1989). One of the most important components in physical appearance is color, which the consumer uses as an indicator for the quality and freshness of the products (Naumann et al., 1957). The color of meat depends on the concentration of the meat pigments, essentially myoglobin, and the chemical state of myglobin (Renerre, 1990). Meat color is determined by the relative amount of three myoglobin derivatives; (a) reduced myoglobin, deoxymyoglobin, which is the purple pigment of deep muscle and known from meat under vacuum, (b) oxygenated myoglobin, oxymyoglobin, which is bright cherry red and considered to signify fresh meat by the consumer, and (c) oxidized myoglobin, metmyoglobin, which grey-brown.

The consumer associates the grey-brown color with non-fresh products and it is therefore undesirable. The color stability, or proneness to accumulate grayish-brownish metmyoglobin, on the meat surface is related to many intrinsic (e.a. sex) and extrinsic (e.a. environment) factors. Therefore, the objective of this study was to investigate the effect of housing system and castration on the color stability of Hanwoo beef during refrigerated storage.

Materials and Methods

Thirty heads of 6 months aged male cattle were randomly divided into three groups. The first group was tethered while the other groups were loose housed. The tethers were double right and left neck-bar tethers and were 90 cm in length. The pen size was 4×8 cm^2 for 5 heads of loose cattle. The third group was castrated while the other groups were not castrated. All of groups were fed *ad libitum* with commercial concentrate and rice straw as a finishing diet. The first and second groups were slaughtered at 21 months of aged while the third group was slaughtered at 26 months of aged. Seven heads of every group were randomly collected for meat quality analysis (n=7/group). The *M. longissimus* from each carcass were cut into a 1 cm-thickness and stored at 4±0.2℃ for 7 days. The color measurements were taken for each sample directly after a minimum 60 min bloom time.

The CIE L^* (lightness), a^* (redness), and b^* (yellowness) color values were measured using a chroma meter (CR-400, Konica Minolta Sensing Inc., Japan) with a light source of illuminant C/observer 2° standardized to a white tile (Y=93.6, x=0.3134, and y=0.3194). The relative metmyoglobin and oxymyoglobin concentration at the meat surface was measured by Krzywicki (1979) using reflectance at 473, 525, 572, and 730 nm. Reflectance readings were converted to absorbance [2-log (% reflectance)] and used in the following equation (Demos et al., 1996). Percent reflectance differences at 630 nm minus 580 nm (R_{630}-R_{580}) were used to indicate differences in redness (Strange et al., 1974). Reflectance at selected wavelengths was measured by a dual beam spectro -photometer (UV-2401PC, Shimadzu, Japan) provided with a diffuse reflectance attachment adjusted to 100% reflectance with a $BaSO_4$ block. Data was analyzed as a 3 (treatment) × 4 (storage time) factorial design using the GLM (General Linear Model) procedure of SAS (1999) program. Differences among means at the 5% level were determined by the Duncan's multiple range tests.

Results and Discussion

CIE color values. Effect of housing system and castration on the CIE color values of Hanwoo beef during refrigerated storage is presented in Table 1. The L^* (lightness) and b^* (yellowness) values were significantly lower in beef of loose steers as compared to those from tethered and loose bulls during 7 days of storage ($P<0.05$). On the other hand, the a^* (redness) value was significantly higher in beef from loose steers than those from tethered and loose bulls after 2 days of storage ($P<0.05$).

Surface myoglobin concentration. Effect of housing system and castration on the surface myoglobin concentration of Hanwoo beef during refrigerated storage is presented in Table 2. The surface metmyoglobin concentration was significantly higher in beef from loose bulls and steers as compared to those from tethered bulls during 7 days of storage ($P<0.05$), and it was significantly higher in those from loose steers than in those from loose bulls until 2 days of storage ($P<0.05$). The surface oxymyoglobin concentration was lower in beef from loose bulls and steers than in those from tethered bulls during 7 days of storage, and there were significant differences between those from loose and tethered cattle at 0, 5, and 7 days (P<0.05). The R_{630}-R_{580} value was significantly lower in beef from loose bulls and steers as compared to those from tethered bulls during 7 days of storage (P<0.05).

Table 1. Effect of housing system and castration on the CIE color values of Hanwoo beef during refrigerated storage

Items	Storage time (day)	Tethered	Loose	
		Bull	Bull	Steer
L^* (Lightness)	0	41.03 ± 2.67^a	40.93 ± 1.81^a	38.80 ± 2.31^b
	2	40.56 ± 2.19^a	40.80 ± 2.31^a	39.16 ± 2.34^b
	5	40.82 ± 2.29^a	41.05 ± 2.62^a	39.71 ± 2.56^b
	7	40.86 ± 2.06^a	40.63 ± 2.73^a	39.79 ± 2.36^b
a^* (Redness)	0	18.36 ± 2.04	18.15 ± 1.82	18.42 ± 2.37
	2	19.03 ± 2.03^b	19.01 ± 1.83^b	19.94 ± 2.14^a
	5	17.62 ± 2.01^b	17.83 ± 1.81^b	18.89 ± 2.56^a
	7	16.88 ± 2.45^c	17.73 ± 1.92^b	18.29 ± 2.44^a
b^* (Yellowness)	0	9.23 ± 1.22^a	8.90 ± 1.08^a	8.46 ± 1.47^b
	2	9.97 ± 1.29^a	9.91 ± 1.14^a	9.54 ± 1.19^b
	5	9.36 ± 1.17^a	9.32 ± 1.21^a	9.02 ± 1.40^b
	7	9.28 ± 1.48^a	9.46 ± 1.43^a	8.84 ± 1.49^b

[a-c] Means±SD in same row with different superscripts are significantly different (P<0.05).

Table 2. Effect of housing system and castration on the surface myoglobin concentration of Hanwoo beef during refrigerated storage

Items	Storage time (day)	Tethered	Loose	
		Bull	Bull	Steer
MetMb, %	0	15.42 ± 3.53^c	16.97 ± 5.13^b	20.50 ± 3.38^a
	2	18.88 ± 4.51^c	21.20 ± 6.61^b	24.04 ± 3.96^a
	5	22.09 ± 3.99^b	25.26 ± 5.38^a	26.12 ± 4.07^a
	7	23.58 ± 3.93^b	26.94 ± 5.78^a	27.28 ± 4.05^a
OxyMb, %	0	69.24 ± 6.34^a	66.80 ± 6.29^b	64.68 ± 7.10^c
	2	66.40 ± 12.32	64.42 ± 11.71	64.96 ± 6.16
	5	64.55 ± 7.55^a	61.15 ± 6.99^c	62.93 ± 6.04^b
	7	64.25 ± 6.04^a	57.25 ± 7.93^c	59.30 ± 6.84^b
R_{630}-R_{580}	0	23.38 ± 3.61^a	22.26 ± 7.10^b	19.73 ± 3.13^c
	2	21.75 ± 4.02^a	19.46 ± 6.16^b	18.65 ± 4.61^b
	5	20.27 ± 4.32^a	16.44 ± 6.04^b	16.68 ± 4.51^b
	7	18.97 ± 3.84^a	15.44 ± 6.84^b	15.93 ± 3.98^b

[a-c] Means±SD in same row with different superscripts are significantly different (P<0.05).

Conclusions

Housing system and castration affected the color stability of beef, and loose housing and castration resulted in a reduction in the color stability of beef. Moreover, castration led to make a darker and redder beef.

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