VARIATION IN SURFACE COLOR OF HANWOO(KOREAN NATIVE CATTLE) BEEF AS INFLUENCED BY LIGHT INTENSITY OF DISPLAY CONDITION

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Background

Color of fresh meat is an important quality attribute which determines whether the consumer will purchase the product. Fresh meat color is largely dependent on the chemical state of myoglobin, a heme-containing protein. Accumulation of the undesirable brown color of fresh meat is due to oxidation of oxymyoglobin to metmyoglobin(Renerre, 1990). In general, low pH favors of myoglobin oxidation, due in part to destabilization of the heme-protein linkage(Livingston & Brown, 1981). Also, retail display lighting influences meat discoloration during storage(Kropf, 1980). Marriott et al.(1967) demonstrated increased color deterioration of fresh meat at -1℃ under direct illumination, and concluded that illumination caused an increase in meat surface temperature, enhancing bacterial growth.

Objective

The objective of this study was to investigate the effects of light exposure and light intensity on surface color of Hanwoo(Korean native cattle) beef.

Methods

Sample preparation. The *Longissimus* muscles used in this study were obtained from the local slaughter house. According to pH at 24 hours postmortem, beef carcasses were grouped into 3 groups(A group, pH 5.33; B group, pH 5.43; C group, pH 5.69). Muscles were sliced(1.2 cm thickness), then overwrapped in polyethylene wrap film(oxygen transmission rate 35,273 cc/m^2/24hr/atm, thickness 0.01 mm). According to display condition, 'Dark' group was covered loosely with aluminium foil to block the light. 'Light1000' and 'Light3000' groups were placed at a distance of 50 cm and 30 cm from the light source(Natural white fluorescent bulbs), respectively. The light intensities at the surface of these samples were 1,000 lux and 3,000 lux, respectively. Samples were held at 4±1℃ and 40±1% for 7 days.

Analytical procedures. CIE L^*(lightness), a^*(redness), and b^*(yellowness) values for Illuminant C were measured by a color difference meter(CR-310, Minolta Co., Tokyo, Japan). Also, Chroma(C^*) and hue-angle(h°) values were calculated as $C^*=(a^{*2}+b^{*2})^{1/2}$, and $h^\circ= \tan^{-1}(b^*/a^*)$, respectively. The relative content of myoglobin, metmyoglobin and oxymyoglobin at the meat surface was calculated by the method of Kryzwicki(1979) using reflectance at 473, 525, 572, and 730 nm. Percent reflectance differences at 630 nm minus 580 nm(R630-R580) were used the indicate differences in redness. The pH value was determined by homogenizing 10 g sample with 100 ml distilled water for 1 min. TBARS was measured according to the modified method of Sinnhuber & Yu(1977). Data were analyzed by analysis of variance(ANOVA) and computed by using the SAS General Linear Model procedure. The relationships between the measured variables were assessed by Pearson correlation coefficients.

Results and discussions

As shown in Table 1 and 2, no difference($p>005$) in CIE L^* value among display condition, display time also had no effect on CIE L^* value. But CIE a^*, b^*, C^* values, oxymyoglobin(%) and R630-R580 were significantly($p<0.05$) lower in light-exposed samples (Light1000 and Light3000) than in those held in the dark(Dark). Hue-angle value, metmyoglobin(%) and TBARS were significantly ($p<0.05$) higher in Light3000 group. TBARS which represent fat rancidity tended to increase as display time increased, but it was not significantly different until 3 days of storage. All characteristics except CIE L^* value were significantly($p<0.05$) changed during storage.

As shown in Figure 1, CIE a^* and C^* values decreased during storage at 4±1℃ whether or not the beef was light-exposed. However, these declined more rapidly in the light-exposed sample. In particular, Light3000 group was more accelerated compared to Light1000 and Dark groups. CIE a^*, b^*, C^* values and R630-R580 of B(pH 5.43) and C(pH 5.69) samples increased during the first day of display except Light3000 group, then gradually decreased over time. CIE a^* value positively correlated with C^* value, oxymyoglobin(%) and R630-R580. Also, CIE a^* value inversely correlated with metmyoglobin(%) and TBARS.

As discussed above, these results indicate that dark group was redder than Light1000 and Light3000 groups. And, as Dark group showed more desirable properties in overall terms, storage in the dark showed the optimum storage condition. Namely, surface color characteristics of Hanwoo beef were influenced by both display condition and display time.

Conclusions

Hanwoo beef surfaces accumulated more metmyoglobin in the light than in the dark. Also, the rate of decrease in redness during refrigerated storage was enhanced by light exposure and increase of light intensity. The Increase of light intensity promote not only discoloration but also lipid oxidation. Therefore, storage in the dark is effective in retarding the formation of a brown color in Hanwoo beef.

Pertinent literature

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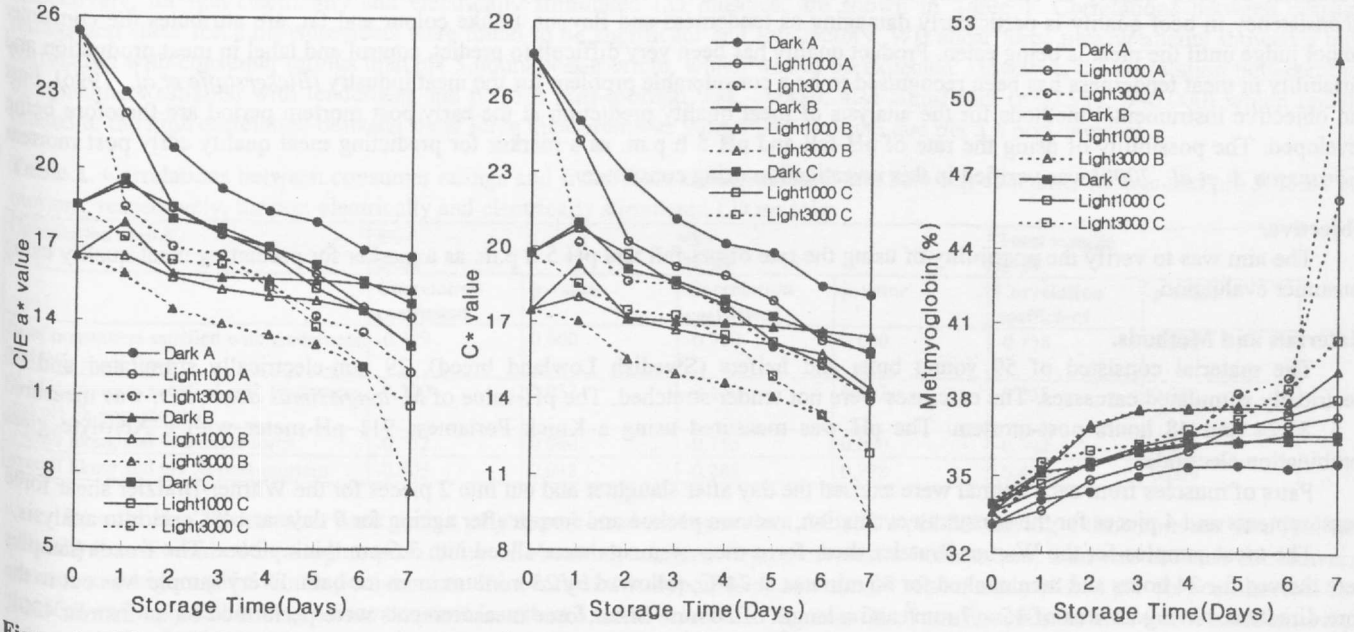

Figure 1. Effects of display condition on CIE a* value, chroma(C*) value and metmyoglobin(%) according to pH conditions in Hanwoo(Korean native cattle) beef surface during storage at 4±1℃(A: pH 5.33, B: pH 5.43, C: pH 5.69).

Table 1. Display condition effects on quality characteristics of Hanwoo(Korean native cattle) beef[d]

Display condition	L*	a*	b*	C*	h°	Metmyoglobin (%)	Myoglobin (%)	Oxymyoglobin (%)	R630-R580	TBARS
Dark	40.12^{a}	18.22^{a}	7.40^{a}	19.67^{a}	21.88^{c}	35.10^{c}	4.06^{b}	60.84^{a}	14.60^{a}	0.58^{c}
Light1000	39.89^{a}	17.32^{b}	7.32^{a}	18.81^{b}	22.82^{b}	35.77^{b}	4.07^{b}	60.16^{b}	13.27^{b}	0.77^{b}
Light3000	40.16^{a}	15.83^{c}	6.87^{c}	17.28^{c}	23.73^{a}	36.93^{a}	4.54^{a}	58.53^{c}	10.87^{c}	0.90^{a}

$^{a-g}$Means in the same column with different superscripts are significantly different($p<0.05$).
^{d}Means pooled over display time and pH groups.

Table 2. Display time effects on quality characteristics of Hanwoo(Korean native cattle) beef[h]

Display time (Days)	pH	L*	a*	b*	C*	h°	Metmyoglobin (%)	Myoglobin (%)	Oxymyoglobin (%)	R630-R580	TBARS
0	5.42^{a}	40.42^{a}	21.90^{a}	8.84^{a}	23.64^{a}	21.53^{d}	33.61^{f}	4.95^{a}	61.44^{ab}	16.56^{a}	0.25^{e}
1	5.33^{c}	39.61^{a}	18.92^{b}	7.75^{b}	20.44^{b}	22.14^{cd}	34.80^{e}	4.91^{a}	61.93^{a}	14.86^{b}	0.38^{de}
2	5.38^{b}	39.78^{a}	17.24^{c}	7.09^{c}	18.64^{c}	22.21^{cd}	35.68^{d}	4.51^{ab}	61.01^{b}	13.69^{b}	0.45^{de}
3	5.38^{b}	39.94^{a}	16.58^{cd}	6.92^{c}	17.98^{cd}	22.50^{bcd}	36.23^{c}	4.35^{b}	60.20^{c}	12.20^{c}	0.55^{cde}
4	5.38^{b}	40.08^{a}	15.98^{de}	6.79^{cd}	17.37^{de}	22.88^{bc}	36.59^{c}	3.72^{c}	59.70^{c}	11.14^{cd}	0.70^{cd}
5	5.26^{d}	39.84^{a}	15.20^{ef}	6.50^{cde}	16.54^{ef}	23.03^{bc}	37.01^{b}	3.57^{c}	58.64^{d}	10.59^{d}	0.82^{c}
6	5.33^{c}	40.38^{a}	14.36^{f}	6.22^{de}	15.66^{f}	23.36^{b}	37.33^{b}	3.31^{c}	58.17^{d}	10.12^{d}	1.24^{b}
7	5.36^{bc}	40.11^{a}	12.98^{g}	6.14^{e}	14.37^{g}	25.85a	40.20^{a}	3.27^{c}	54.87^{e}	7.86^{e}	1.57^{a}

$^{a-g}$Means in the same column with different superscripts are significantly different($p<0.05$).
^{h}Means pooled over display condition and pH groups.