EFFECT OF SEASON(ENVIRONMENTAL TEMPERATURE) ON MEAT COLOR OF HANWOO(KOREAN NATIVE CATTLE)

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Background

Color of fresh meat is an important quality attribute which determines whether the consumer will purchase the product. Meat quality is affected by pre-slaughter factors. Increased glycolysis induced either by excitation, fasting, or cold stress produce a high pH and ultimately affects meat color(Babji et al., 1982; Ngoka et al., 1982). Lawrie(1958) conclusively linked stress with the increased incidence of dark-cutting beef. In USA and Canada, a seasonal peak has been observed in dark-cutting incidence in November and again in last spring(Munns and Burrell, 1966), implicating cold, wet conditions as contributing stress factors. Higher environmental temperature affect the animal's ability to keep the body temperature constant, inducing higher post-mortem muscle temperature and poorer meat quality(Honkavaara, 1989). Also, Warriss(1991) concluded that meat quality appeared significantly damaged in higher environmental temperature.

Objective

The objective of this study was to investigate the effects of season(environmental temperature) on meat color and pH value of Hanwoo(Korean native cattle).

Methods

A total of 1,278 heads of Hanwoo(Korean native cattle) were used during the four seasons of 2000. Cattle were slaughterd in the spring, summer, fall, and winter seasons, respectively(Table 1). All animals were slaughtered at local slaughter house on day of transport. The carcass traits and grade were estimated by the Korean grading system. The meat color and pH of Hanwoo beef were measured on the *longissimus* muscle at 24 hr postmortem. 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^o) values were calculated as $C^*=(a^{*2}+b^{*2})^{1/2}$, and $h^o= \tan^{-1}(b^*/a^*)$, respectively. The pH value was measured with portable pH meter(IQ200, IQ Scientific Instrument, Inc., USA). Data were analyzed by analysis of variance(ANOVA) using the SAS General Linear Mode procedure. The relationships between the measured variables were assessed by Pearson correlation coefficients.

Results and discussions

Main effects were significant for the color values(Table 2). The interaction between season and sex was not significant for the color values and pH value(Table 2). As shown in Table 3, environmental temperature in the winter season was significantly lower($p<0.05$) than those in other seasons. Transport distance and time were not significantly different in the four seasons. The effects of season on meat color and pH value are shown in Table 4. CIE L^*, a^*, b^*, C^* values, and hue angle were significantly($p<0.05$) lower($p<0.05$) in cattle slaughtered in the winter season. The L^* value was significantly higher($p<0.05$) in cattle slaughtered in the spring and fall seasons. The pH value was significantly higher($p<0.05$) in the summer and winter seasons.

The effects of season and sex on meat color and pH value are shown in Table 5. The steers showed the highest L^*, a^*, b^*, C^* values, and hue angle. The L^* value and hue angle of the steers were not significantly different($p<0.05$) among four seasons. But L^* value of the cows was significantly lower in the winter season than in others seasons, the bulls was significantly lower in the spring and winter seasons. There was a significantly lower($p<0.05$) a^* value in the cows and bulls as compared with the steers. The environmental temperature positively correlated with L^*, a^*, b^*, C^* values, and hue angle.

Also, As discussed above, these results indicate that cattle slaughtered in the winter season were less redder and less lighter than those in other seasons, showed more undesirable properties in overall terms.

Conclusions

Season at slaughter is of great importance for meat color. Namely, meat color of Hanwoo(Korean native cattle) beef were influenced by environmental temperature. In particular, the poorest meat color was associated with cold season(winter) when compared with hot season(summer).

Pertinent literature

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Ngoka, D.A., Froning, G.W., Lowry, S.R., Babji, A.S. 1982. Poultry Sci. **61**:1996.

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Table 1. Number of tested Hanwoo(Korean native cattle) under different seasons and sex groups

Seasons	Sex groups			Mean
	Cows	Bulls	Steers	
Spring	194	110	21	325
Summer	131	159	7	297
Fall	145	152	19	316
Winter	170	154	16	340
Total	640	575	63	1278

Table 2. Probabilities of the F-statistic for main effects and interactions

	Season	Sex	Season*Sex
L^*	0.0014	0.0001	0.2649
a^*	0.0001	0.0001	0.1700
b^*	0.0001	0.0001	0.2962
C^*	0.0001	0.0001	0.1906
h^0	0.0001	0.0001	0.4329
pH	0.0033	0.0049	0.1467

Table 3. Environmental temperature, carcass traits, and transport conditions of Hanwoo(Korean native cattle) by seasons

	Environmental temperature (℃)	Carcass traits					Transport conditions	
		Carcass weight(kg)	Backfat thickness(mm)	Ribeye area(cm^2)	Yield index	Carcass quality grade[d]	Distance(km)	Time(min)
Spring	16.36	316.55^{ab}	6.29^{ab}	74.24^{ab}	67.17^{a}	1.61^{a}	30.44^{a}	37.27^{a}
Summer	25.15	348.66^{a}	6.04^{b}	72.58^{c}	69.33^{a}	1.67^{a}	30.43^{a}	36.28^{a}
Fall	16.48	309.70^{b}	6.37^{ab}	73.29^{bc}	69.31^{a}	1.71^{a}	29.48^{a}	35.24^{a}
Winter	-3.35	316.62^{ab}	6.71^{a}	75.08^{a}	69.28^{a}	1.58^{a}	29.43^{a}	34.91^{a}

[a-c]Means in the same column with different superscripts are significantly different($p<0.05$).
[d]1^+ grade(good)=4, 1 grade=3, 2 grade=2, 3 grade=1

Table 4.Effects of season on meat color and pH value of Hanwoo(Korean native cattle)[d]

	L^*	a^*	b^*	C^*	h^0	pH
Spring	36.32^{a}	22.41^{b}	8.60^{b}	24.02^{b}	20.81^{b}	5.38^{c}
Summer	35.46^{b}	22.62^{b}	8.91^{a}	24.35^{b}	21.26^{a}	5.42^{a}
Fall	36.25^{a}	23.25^{a}	8.93^{a}	24.91^{a}	20.73^{b}	5.39^{bc}
Winter	35.07^{c}	22.07^{c}	7.93^{c}	23.46^{c}	19.53^{c}	5.41^{ab}

[a-c]Means in the same column with different superscripts are significantly different($p<0.05$).
[d]Means are pooled over season and sex group.

Table 5. Effects of season and sex on meat color and pH valueof Hanwoo(Korean native cattle) beef

Items	Seasons	Sex groups		
		Cows	Bulls	Steers
L^*	Spring	$36.70^{b\,A}$	$35.30^{c\,A}$	$38.15^{a\,A}$
	Summer	$36.55^{a\,A}$	$34.49^{b\,B}$	$36.88^{a\,A}$
	Fall	$36.92^{a\,A}$	$35.45^{b\,A}$	$37.51^{a\,A}$
	Winter	$35.73^{b\,B}$	$34.07^{c\,B}$	$37.58^{a\,A}$
a^*	Spring	$22.25^{b\,C}$	$22.42^{b\,B}$	$23.89^{a\,AB}$
	Summer	$22.72^{a\,B}$	$22.53^{a\,B}$	$22.82^{a\,B}$
	Fall	$23.26^{b\,A}$	$23.07^{b\,A}$	$24.66^{a\,A}$
	Winter	$22.26^{b\,C}$	$21.68^{b\,C}$	$23.90^{a\,AB}$
b^*	Spring	$8.61^{b\,B}$	$8.40^{b\,A}$	$9.66^{a\,AB}$
	Summer	$9.10^{a\,A}$	$8.75^{a\,A}$	$8.94^{a\,B}$
	Fall	$9.02^{b\,A}$	$8.70^{b\,A}$	$10.01^{a\,A}$
	Winter	$8.12^{b\,C}$	$7.58^{b\,B}$	$9.26^{a\,AB}$
C^*	Spring	$23.87^{b\,B}$	$23.94^{b\,B}$	$25.77^{a\,AB}$
	Summer	$24.53^{a\,A}$	$24.20^{a\,AB}$	$24.50^{a\,B}$
	Fall	$24.94^{b\,A}$	$24.67^{b\,A}$	$26.62^{a\,A}$
	Winter	$23.69^{b\,B}$	$22.97^{b\,C}$	$25.63^{a\,AB}$
H^0	Spring	$20.97^{b\,B}$	$20.32^{c\,B}$	$21.81^{a\,A}$
	Summer	$21.59^{a\,A}$	$20.98^{a\,A}$	$21.29^{a\,A}$
	Fall	$20.92^{b\,B}$	$20.40^{b\,B}$	$21.93^{a\,A}$
	Winter	$19.85^{b\,C}$	$19.01^{c\,C}$	$21.05^{a\,A}$
pH	Spring	$5.39^{a\,AB}$	$5.37^{ab\,B}$	$5.33^{b\,A}$
	Summer	$5.41^{a\,A}$	$5.44^{a\,A}$	$5.33^{b\,A}$
	Fall	$5.36^{ab\,B}$	$5.43^{a\,A}$	$5.34^{b\,A}$
	Winter	$5.41^{a\,A}$	$5.42^{ba\,A}$	$5.38^{a\,A}$

[a-c]Means in the same row with different superscripts are significantly different($p<0.05$).
[A-C]Means in the same column with different superscripts are significantly different($p<0.05$).