EFFECT OF DIETARY VITAMIN E SUPPLEMENTATION ON MEAT COLOR STABILITY OF HANWOO (KOREAN NATIVE CATTLE) STEERS BEEF

Sung Ki Lee[1], Yong Sun Kim[2], Young Han Song[3] and Cheng Yun Liang[1]
[1]Department of Animal Food Science and Technology, [2]Institute of Animal Resources, [3]Division of Animal Resource Science, Kangwon National University, Chunchon, 200-701, South Korea.

Background

The color of fresh meat is an important quality attribute which determines whether the consumer will purchase the product (Faustman & Cassens, 1990). 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, 1987; Renerre, 1990). Discoloration in retail meats during conditions may occur as a combined function of muscle pigment oxidation and lipid oxidation occurring in membrane phospholipids (Sherbeck et al., 1995). It is now well established that vitamin E acts as a powerful lipid-soluble antioxidant in cell membranes (Morrissey et al., 1994), hence, one of the main purposes of dietary supplementation of animal diets with vitamin E is to delay lipid oxidation in muscle foods (Liu et al., 1995). Many experiments have indicated that vitamin E supplementation results in greater color and lipid stability in beef by delaying oxidation of phospholipids (Faustman et al., 1989; Arnold et al., 1993). Although the relation between lipid oxidation and pigment oxidation is not fully understood, it has been shown in beef that vitamin E retards the oxidation of myoglobin, and thus the loss of attractive color (Faustman et al., 1989).

Objective

The objective of this study was to determine the effects of different concentrations of dietary vitamin E supplementation on meat color and lipid stability of Hanwoo (Korean native cattle) steers beef during refrigerated storage at 1°C.

Methods

Sample preparation. Hanwoo (Korean native cattle) steers were divided into four groups. Control group (n=6) was fed a common basal diet with a vitamin E of 200 IU/head/day (Control group) for 26 months. The other groups (n=10/group) were fed a supplemented concentrate diet with a vitamin E supplement of 500, 1,000 and 2,000 IU/head/day for 6 months before slaughter. The *Longissimus* and *semimembranosus* muscles were removed about 24 hr after slaughter. Muscles were sliced (1.2 cm thickness), then overwrapped in polyethylene wrap film (oxygen transmission rate 35,273 cc/m^2/24hr/tm, thickness 0.01 mm). Samples were then held 12 days at 1°C.
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^o) values were calculated as $C^* = (a^{*2}+b^{*2})^{1/2}$, and $h^o = \tan^{-1}(b^*/a^*)$, 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. Reflectance readings were converted to absorbance[2-log(%reflectance)] and used in the equation (Demos et al., 1996). The pH value was determined by homogenizing 10 g sample with 100 ml distilled water for 1 min. Thiobarbituric acid reactive substances (TBARS) was measured according to the modified method of Sinnhuber & Yu (1977). Peroxide value (POV) was measured according to the method of Shantha & Decker (1994). Data were analyzed as a 2 (muscle) by 5 (storage time) by 4 (diet condition) factorial design using the General Linear Model procedure.

Results and discussions

No significant 3-way interactions occurred. Main effects of muscle, storage time and diet condition were significant for most of the values. As shown in Table 1, the pH was significantly ($p<0.05$) lower in 500 IU group for two muscles of Hanwoo (Korean native cattle) beef. While, that of 2,000 IU group was significantly ($p<0.05$) higher. CIE L* value was significantly ($p<0.05$) increased during refrigerated storage, and control group had significantly ($p<0.05$) lower L* value for *Semimembranosus* muscle. CIE a* and chroma (C*) values were significantly ($p<0.05$) decreased during refrigerated storage for two beef muscles, and those of 500 IU and 1,000 IU groups at 12 days of storage were significantly ($p<0.05$) higher than control and 2,000 IU groups. TBARS and POV which represent fat rancidity tended to increase as storage time increased for two beef muscles. The POV was significantly ($p<0.05$) higher in control group than in other groups. The 500 IU and 1,000 IU groups was effective in delaying lipid oxidation. As shown in Figure 1, metmyoglobin (%) of the meat surface was significantly ($p<0.05$) higher in control group than in the other groups, oxymyoglobin (%) was significantly ($p<0.05$) lower in control group. Oxymyoglobin (%) was significantly ($p<0.05$) decreased during storage for two beef muscles, these decreased more rapidly in control group. In particular, 500 IU and 1,000 IU groups had significantly ($p<0.05$) higher oxymyoglobin (%), indicating that 500 IU and 1,000 IU groups is effective in redness stability.

Conclusions

The meat from vitamin E-supplemented Hanwoo (Korean native cattle) was effective in increasing color stability and retarding lipid oxidation than was the control meat. And dietary vitamin E supplementation with 500 IU/head/day and 1,000 IU/head/day of Hanwoo beef extended color display life compared to the control and 2,000 IU/head/day.

Pertinent literature

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Table 1. Effects of dietary vitamin E supplementation on pH, meat color, TBARS and POV in Hanwoo (Korean native cattle) steers beef during refrigerated storage at 1°C.

	Storage days	*M. Semimembranosus* Control	*M. Semimembranosus* 500 IU	*M. Semimembranosus* 1,000 IU	*M. Semimembranosus* 2,000 IU	*M. Longissimus* Control	*M. Longissimus* 500 IU	*M. Longissimus* 1,000 IU	*M. Longissimus* 2,000 IU
PH	0	5.42$^{a\ AB}$	5.26$^{b\ C}$	5.39$^{a\ B}$	5.48$^{b\ A}$	5.31$^{bc\ B}$	5.19$^{b\ C}$	5.34$^{a\ B}$	5.44$^{b\ A}$
	3	5.41$^{a\ B}$	5.28$^{a\ D}$	5.34$^{b\ C}$	5.47$^{b\ A}$	5.29$^{c\ C}$	5.24$^{a\ D}$	5.32$^{a\ B}$	5.41$^{bc\ A}$
	6	5.36$^{a\ B}$	5.27$^{ab\ C}$	5.35$^{b\ B}$	5.46$^{b\ A}$	5.29$^{bc\ C}$	5.26$^{a\ D}$	5.32$^{a\ B}$	5.45$^{b\ A}$
	9	5.38$^{a\ AB}$	5.29$^{a\ C}$	5.34$^{b\ BC}$	5.40$^{c\ A}$	5.32$^{ab\ B}$	5.25$^{a\ D}$	5.29$^{b\ C}$	5.38$^{c\ A}$
	12	5.41$^{a\ B}$	5.28$^{ab\ C}$	5.39$^{a\ B}$	5.58$^{a\ A}$	5.35$^{a\ B}$	5.25$^{a\ C}$	5.32$^{a\ B}$	5.57$^{a\ A}$
L^*	0	40.98$^{b\ B}$	40.91$^{b\ B}$	41.90$^{c\ A}$	42.38$^{b\ A}$	39.96$^{c\ A}$	39.30$^{c\ A}$	40.09$^{c\ A}$	40.21$^{b\ A}$
	3	40.83$^{b\ C}$	44.10$^{a\ A}$	42.18$^{c\ B}$	43.86$^{ab\ A}$	40.14$^{c\ B}$	42.10$^{ab\ A}$	41.16$^{b\ AB}$	41.94$^{a\ A}$
	6	42.07$^{a\ B}$	44.30$^{a\ A}$	43.87$^{b\ A}$	44.44$^{a\ A}$	41.60$^{b\ B}$	43.15$^{a\ A}$	42.07$^{ab\ AB}$	42.71$^{a\ AB}$
	9	42.23$^{a\ C}$	44.79$^{a\ A}$	43.40$^{ab\ B}$	44.29$^{a\ AB}$	41.90$^{b\ AB}$	42.25$^{ab\ AB}$	41.34$^{b\ B}$	42.63$^{a\ A}$
	12	42.78$^{a\ B}$	44.54$^{a\ A}$	44.58$^{a\ A}$	44.37$^{a\ A}$	43.51$^{a\ A}$	41.85$^{b\ B}$	42.62$^{a\ AB}$	42.01$^{a\ B}$
a^*	0	21.63$^{a\ A}$	20.31$^{b\ B}$	22.37$^{a\ A}$	20.50$^{a\ B}$	22.46$^{a\ A}$	20.11$^{cd\ C}$	21.39$^{b\ B}$	20.50$^{b\ C}$
	3	20.94$^{a\ A}$	21.66$^{a\ A}$	21.59$^{a\ A}$	20.90$^{a\ A}$	22.95$^{a\ AB}$	23.53$^{a\ A}$	22.28$^{a\ B}$	22.39$^{a\ B}$
	6	19.09$^{b\ B}$	20.54$^{b\ A}$	20.14$^{b\ A}$	19.65$^{a\ AB}$	21.25$^{b\ B}$	22.60$^{b\ A}$	21.03$^{b\ B}$	21.31$^{ab\ B}$
	9	17.31$^{c\ B}$	19.07$^{c\ A}$	19.41$^{b\ A}$	15.90$^{b\ C}$	19.80$^{c\ A}$	20.55$^{c\ A}$	19.81$^{c\ A}$	18.51$^{c\ B}$
	12	16.02$^{d\ B}$	18.12$^{d\ A}$	18.16$^{c\ A}$	14.34$^{c\ C}$	17.73$^{d\ B}$	19.49$^{d\ A}$	19.03$^{c\ A}$	15.76$^{d\ C}$
b^*	0	10.48$^{bc\ B}$	10.13$^{d\ B}$	11.83$^{a\ A}$	10.75$^{b\ B}$	10.86$^{b\ A}$	9.51$^{c\ B}$	10.57$^{bc\ A}$	9.75$^{bc\ B}$
	3	11.34$^{a\ B}$	11.71$^{a\ AB}$	11.76$^{a\ AB}$	12.09$^{a\ A}$	11.64$^{a\ A}$	11.68$^{a\ A}$	11.34$^{a\ A}$	11.53$^{a\ A}$
	6	10.63$^{b\ B}$	11.48$^{ab\ A}$	11.50$^{a\ A}$	11.63$^{a\ A}$	11.11$^{ab\ A}$	11.38$^{a\ A}$	11.02$^{ab\ A}$	11.31$^{a\ A}$
	9	10.10$^{c\ C}$	10.90$^{c\ B}$	11.59$^{a\ A}$	10.66$^{b\ B}$	10.73$^{b\ A}$	10.42$^{b\ A}$	10.68$^{bc\ A}$	10.47$^{b\ A}$
	12	9.53$^{d\ B}$	11.02$^{bc\ A}$	10.88$^{b\ A}$	9.98$^{b\ B}$	10.14$^{c\ A}$	10.32$^{b\ A}$	10.36$^{c\ A}$	9.10$^{c\ B}$
C^*	0	23.99$^{a\ B}$	22.69$^{bc\ C}$	25.30$^{a\ A}$	23.16$^{a\ BC}$	24.94$^{ab\ A}$	22.24$^{cd\ C}$	23.86$^{b\ B}$	22.70$^{b\ C}$
	3	23.82$^{a\ A}$	24.64$^{a\ A}$	24.58$^{a\ A}$	24.15$^{a\ A}$	25.73$^{a\ AB}$	26.27$^{a\ A}$	25.00$^{a\ B}$	25.18$^{a\ B}$
	6	21.40$^{b\ B}$	23.53$^{b\ A}$	23.19$^{b\ A}$	22.84$^{b\ A}$	23.97$^{b\ B}$	25.31$^{b\ A}$	23.74$^{b\ B}$	24.03$^{ab\ B}$
	9	20.04$^{c\ B}$	21.97$^{cd\ A}$	22.61$^{b\ A}$	19.21$^{b\ B}$	22.52$^{c\ A}$	23.05$^{c\ A}$	22.50$^{c\ A}$	21.28$^{c\ B}$
	12	18.61$^{d\ B}$	21.22$^{d\ A}$	21.17$^{c\ A}$	17.60$^{c\ B}$	20.43$^{d\ B}$	22.05$^{d\ A}$	21.67$^{c\ AB}$	18.25$^{d\ C}$
h^0	0	25.82$^{c\ B}$	26.38$^{d\ B}$	27.86$^{c\ A}$	27.50$^{c\ A}$	25.70$^{d\ AB}$	25.19$^{c\ B}$	26.19$^{c\ A}$	25.29$^{b\ B}$
	3	28.48$^{b\ B}$	28.42$^{c\ B}$	28.51$^{c\ B}$	29.94$^{bc\ A}$	26.81$^{c\ AB}$	26.36$^{b\ B}$	26.91$^{b\ AB}$	27.21$^{b\ A}$
	6	29.13$^{b\ B}$	29.19$^{bc\ B}$	29.70$^{b\ B}$	30.60$^{b\ A}$	27.55$^{c\ A}$	26.69$^{b\ A}$	27.58$^{b\ A}$	27.24$^{b\ A}$
	9	30.22$^{a\ B}$	29.74$^{b\ B}$	30.84$^{a\ B}$	34.31$^{a\ A}$	28.40$^{b\ B}$	27.17$^{ab\ C}$	28.27$^{a\ B}$	29.68$^{a\ A}$
	12	30.79$^{a\ B}$	31.25$^{a\ B}$	30.91$^{a\ B}$	35.32$^{a\ A}$	29.82$^{a\ AB}$	27.87$^{a\ B}$	28.48$^{a\ AB}$	30.06$^{a\ A}$
TBARS[e]	0	0.21$^{c\ A}$	0.22$^{d\ A}$	0.21$^{d\ A}$	0.22$^{c\ A}$	0.25$^{b\ A}$	0.22$^{c\ A}$	0.24$^{c\ A}$	0.24$^{d\ A}$
	3	0.22$^{c\ A}$	0.24$^{cd\ A}$	0.22$^{cd\ A}$	0.25$^{bc\ A}$	0.29$^{b\ A}$	0.25$^{bc\ A}$	0.26$^{b\ A}$	0.26$^{cd\ A}$
	6	0.27$^{b\ A}$	0.26$^{bc\ AB}$	0.23$^{c\ B}$	0.26$^{b\ AB}$	0.36$^{ab\ A}$	0.27$^{b\ B}$	0.27$^{b\ B}$	0.28$^{bc\ B}$
	9	0.29$^{b\ A}$	0.28$^{b\ A}$	0.27$^{b\ A}$	0.28$^{b\ A}$	0.46$^{ab\ A}$	0.28$^{b\ B}$	0.27$^{b\ B}$	0.31$^{b\ B}$
	12	0.34$^{a\ A}$	0.34$^{a\ A}$	0.32$^{a\ A}$	0.34$^{a\ A}$	0.60$^{a\ A}$	0.34$^{a\ B}$	0.31$^{a\ B}$	0.36$^{a\ B}$
POV[f]	0	0.040$^{c\ A}$	0.014$^{c\ C}$	0.014$^{d\ C}$	0.020$^{c\ B}$	0.039$^{b\ A}$	0.016$^{d\ C}$	0.015$^{c\ C}$	0.020$^{c\ B}$
	3	0.046$^{bc\ A}$	0.018$^{b\ BC}$	0.015$^{d\ C}$	0.023$^{c\ B}$	0.044$^{b\ A}$	0.019$^{c\ C}$	0.018$^{b\ C}$	0.025$^{b\ B}$
	6	0.056$^{ab\ A}$	0.023$^{a\ B}$	0.020$^{c\ B}$	0.024$^{bc\ B}$	0.048$^{b\ A}$	0.025$^{b\ B}$	0.020$^{b\ C}$	0.027$^{b\ B}$
	9	0.060$^{a\ A}$	0.026$^{a\ B}$	0.023$^{b\ B}$	0.028$^{b\ B}$	0.060$^{a\ A}$	0.029$^{a\ B}$	0.026$^{a\ B}$	0.027$^{b\ B}$
	12	0.063$^{a\ A}$	0.025$^{a\ C}$	0.027$^{a\ BC}$	0.033$^{a\ B}$	0.060$^{a\ A}$	0.028$^{a\ BC}$	0.028$^{a\ C}$	0.034$^{a\ B}$

[a-d]Means in the same column with different superscripts are significantly different ($p<0.05$).
[A-D]Means in the same row within a muscle with different superscripts are significantly different ($p<0.05$).
[e]Thiobarbituric acid reactive substances (mg MA/kg)
[f]Peroxide value (meq peroxides/kg)

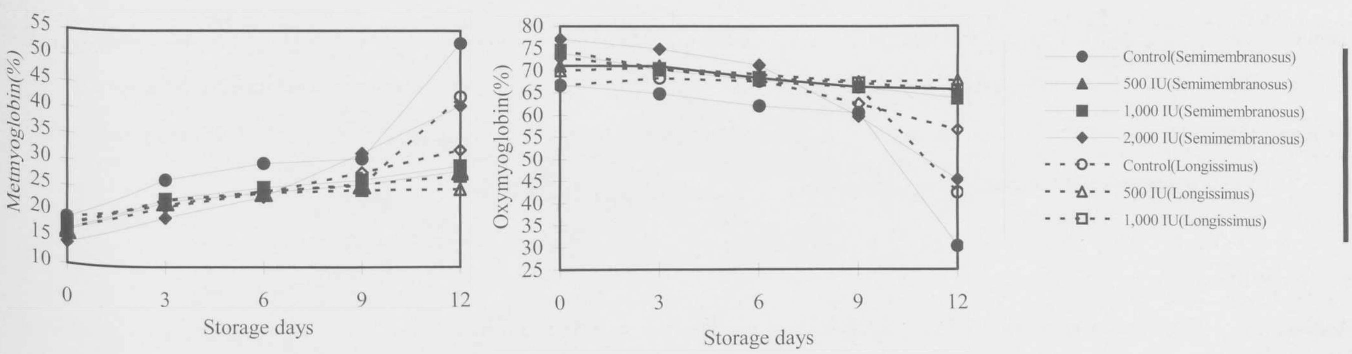

Figure 1. Effects of dietary vitamin E supplementation on metmyoglobin and oxymyoglobin in Hanwoo (Korean native cattle) steers beef surface during refrigerated storage at 1°C.