EFFECT OF DIETARY VITAMIN E SUPPLEMENTATION FOR 4 WEEKS AND 1 WEEK BEFORE SLAUGHTER ON COLOR AND LIPID STABILITY DURING DISPLAY IN JAPANESE BLACK STEER BEEF

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SUMMARY

Effects of dietary vitamin E supplementation for 4 weeks and 1 week before slaughter on meat color and lipid stability during display in raw beef steaks from Japanese Black steers were studied. Dietary vitamin E with 2,500 mg dl-α-tocopherol/animal/day for 4 weeks maintained redness, and retarded metmyoglobin formation and lipid oxidation in beef steak during display compared to the control. Dietary vitamin E with 5,000 mg dl-α-tocopherol/animal/day for 1 week was effective for improving lipid stability.

INTRODUCTION

Color and lipid stability in retail beef are very important for both beef retailers and consumers. Various attempts have been made to reduce pigment and lipid oxidation in beef by dietary vitamin E supplementation: with 370 IU/animal/day for about 10 months (Faustman et al., 1989), with 1,200 IU/animal/day for 38 days and 67 days (Mitsumoto et al., 1991), and with 430 or 1,360 IU/animal/day for 211, 232 and 252 days (Arnold et al., 1993). It is not known if supplementing cattle at the higher dosage for short-term feeding is effective as levels at lower dosage for long-term feeding.

The purpose of this work was to examine the effects of dietary vitamin E supplementation with 2,500 mg and 5,000 mg dl-α-tocopherol per animal daily for 4 weeks and 1 week, respectively, before slaughter on meat color and lipid stability during display in raw beef steaks from Japanese Black steers.

MATERIALS AND METHODS

4 weeks-dietary vitamin E (Experiment 1; Mitsumoto et al., 1995): Three Japanese Black steers were fed no supplemental vitamin E and three Japanese Black steers were supplemented with 2,500 mg dl-α-tocopherol per animal daily for 4 weeks before slaughter. Steak samples (1-cm thick and 50-mm diameter) of semitendinosus (ST) muscles were over-wrapped with PVC film and displayed under fluorescent lights at 4°C for 10 days.

1 week-dietary vitamin E (Experiment 2; Mitsumoto et al., 1994): Four Japanese Black steers were fed no supplemental vitamin E and four Japanese Black steers were supplemented with 5,000 mg of dl-α-tocopherol per animal daily for 1 week before slaughter. Steak samples of psoas major (PM) and longissimus thoracis (LT) muscles were used.

Vitamin E analysis: The α-tocopherol concentrations of plasma and tissue samples were determined by the HPLC method of Mitsumoto et al. (1995).

Meat color and metmyoglobin analyses: CIE (Commission Internationale de l'Eclairage) L*, a* and b* values were obtained at day 1, 4, 7 and 10 using a spectrophotometer, and surface metmyoglobin percentages were determined by the method of Stewart et al. (1965) at the same measurement days.

Lipid oxidation analysis: 2-Thiobarbituric acid reactive substances (TBARS) were measured by the method of Witte et al. (1970) at day 1, 4, 7 and 10. TBARS values were expressed as mg malonaldehyde (MDA) / kg meat.

Statistical analyses: Data were analyzed by the least-squares procedures (Harvey, 1988).

RESULTS AND DISCUSSION

Experiment 1: Dietary vitamin E supplementation for 4 weeks increased ($P<0.05$) α-tocopherol concentrations in plasma, liver, kidney fat and ST muscle. Vitamin E-supplemented beef had higher a* values ($P<0.001$) and b* values ($P<0.05$), and lower metmyoglobin percentages ($P<0.001$) and TBARS values ($P<0.001$) compared to the control. Dietary vitamin E for 4 weeks maintained a* value (redness) (Figure 1A), and delayed metmyoglobin formation (Figure 2A) and lipid oxidation (Figure 3A) during display compared to the control.

Experiment 2: Dietary vitamin E supplementation for 1 week increased ($P<0.01$) α-tocopherol concentrations in plasma, liver, and PM and LT muscles. Vitamin E-supplemented beef had higher a* values ($P<0.05$), and lower metmyoglobin percentages ($P<0.01$) and TBARS values ($P<0.001$) compared to the control. Dietary vitamin E for 1 week showed larger redness (Figure 1B), and smaller metmyoglobin formation (Figure 2B) after day 4 to day 10 compared to the control. Dietary vitamin E for 1 week retarded lipid oxidation (Figure 3B) during 10 days of display compared to the control.

Greene et al. (1971) reported that consumers would reject beef containing over 30% to 40% metmyoglobin. In experiment 1, 30% metmyoglobin was exceeded after about day 8 in the control and after day 10 in vitamin E-supplemented beef (Figure 2A). In experiment 2, 30% metmyoglobin was exceeded after day 4 in the control and also in vitamin E-supplemented beef (Figure 2B). The data indicated that dietary vitamin E for 4 weeks improved color stability during display in beef steak compared to that for 1 week, and that both treatments of dietary vitamin E were effective for lipid stability during display compared to the control.

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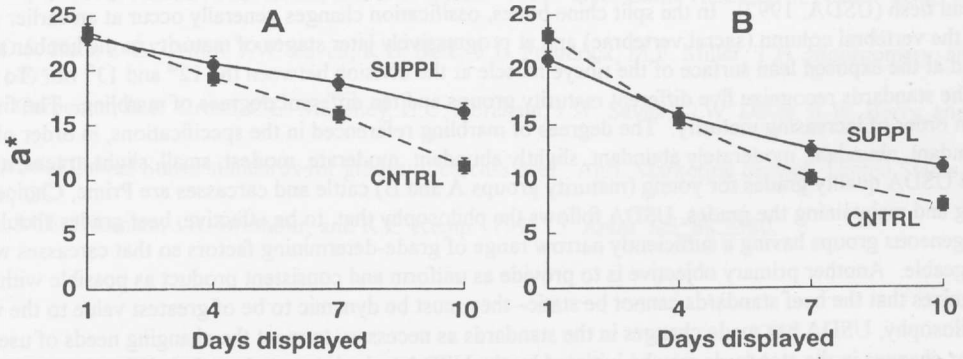

Figure 1. Relationship of dietary vitamin E supplementation x day on a* values. Least–squares means and standard error bars are shown. CNTRL = control beef; SUPPL = vitamin E–supplemented beef.
A: Dietary vitamin E with 2,500 mg dl–α–tocopherol/animal/day for 4 weeks. Semitendinosus muscles were used.
B: Dietary vitamin E with 5,000 mg dl–α–tocopherol/animal/day for 1 week. Psoas major and longissimus thoracis muscles were used.

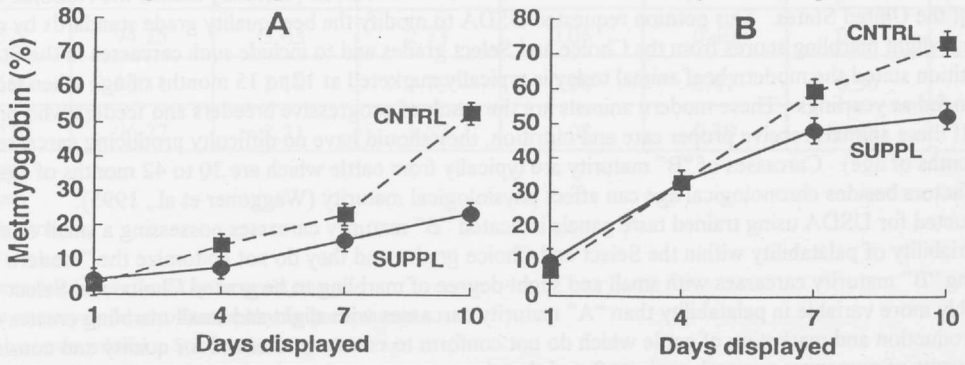

Figure 2. Relationship of dietary vitamin E supplementation x day on metmyoglobin percentages. Least–squares means and standard error bars are shown. CNTRL = control beef; SUPPL = vitamin E–supplemented beef.
A: Dietary vitamin E with 2,500 mg dl–α–tocopherol/animal/day for 4 weeks. Semitendinosus muscles were used.
B: Dietary vitamin E with 5,000 mg dl–α–tocopherol/animal/day for 1 week. Psoas major and longissimus thoracis muscles were used.

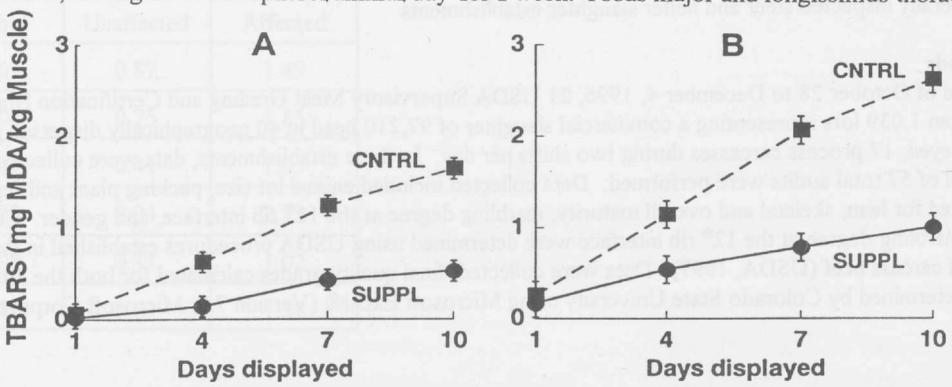

Figure 3. Relationship of dietary vitamin E supplementation x day on TBARS values. Least–squares means and standard error bars are shown. CNTRL = control beef; SUPPL = vitamin E–supplemented beef.
A: Dietary vitamin E with 2,500 mg dl–α–tocopherol/animal/day for 4 weeks. Semitendinosus muscles were used.
B: Dietary vitamin E with 5,000 mg dl–α–tocopherol/animal/day for 1 week. Psoas major and longissimus thoracis muscles were used.