EFFECT OF DIETARY VITAMIN E SUPPLEMENTATION FOR 30–36 WEEKS, 4 WEEKS AND 1 WEEK BEFORE SLAUGHTER ON DRIP LOSS FROM FRESH BEEF MUSCLE DURING DISPLAY

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BACKGROUND

Drip loss in fresh beef cuts is an important challenge to maintaining an attractive retail display of meat. Normally, fresh postrigor meat exudes fluid, or drip, from cut surfaces (Lawrie, 1991). Amount of drip from raw beef is influenced by the following factors: age, sex, diet, pre-slaughter stress, slaughter methods, storage time and temperature and meat properties (especially pH and intramuscular moisture and fat contents) (Lawrie, 1991). If cell membrane integrity could be stabilized postmortem, sarcoplasm should be retained in muscle cells and thereby result in less drip loss and more weight retention during storage and display. Oxidative processes may contribute to the loss of membrane integrity. There is precedence for this suggestion: less drip loss was observed from thawed pork chops obtained from pigs supplemented with vitamin E (Asghar et al., 1991). Appropriate feeding duration and dose of vitamin E and concentrations in muscles must be determined that will be effective in reducing drip losses from fresh beef steaks.

OBJECTIVES

The purpose of this work was to examine the effects of dietary vitamin E supplementation daily with 298 mg dl-α-tocopheryl acetate per kg of diet, 2,500 mg and 5,000 mg dl-α-tocopherol per animal for 30–36 weeks, 4 weeks and 1 week, respectively, before slaughter on drip loss during display in fresh beef steaks.

METHODS

30–36 weeks-dietary vitamin E (Experiment 1; Mitsumoto et al., 1995a): Nine Holstein steers and nine beef steers were fed no supplemental vitamin E, and nine Holstein steers and eight beef steers were supplemented daily with 298 mg dl-α-tocopheryl acetate per kg of diet for 211, 232 or 252 days (30, 33 or 36 weeks). Longissimus lumborum (LL) muscles were used.

4 weeks-dietary vitamin E (Experiment 2; Mitsumoto et al., 1995b): 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. Semitendinosus (ST) muscles were used.

1 week-dietary vitamin E (Experiment 3; Mitsumoto et al., 1998): 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. Psoas major (PM) and longissimus thoracis (LT) muscles were used.

Vitamin E analysis: The α-tocopherol concentrations of muscle samples were determined by the HPLC method of Arnold et al. (1993) and Mitsumoto et al. (1995b).

Drip loss analysis: Steak samples (2-cm thick x 5-cm x 5-cm) were individually placed on absorbent paper to absorb drip fluid in a 100-mL disposable weigh boat, overwrapped with oxygen-permeable PVC film and displayed under fluorescent lights at 4°C for 14 (in Experiment 1) or 10 days (in Experiment 2 and 3). Duplicate samples were weighed at sampling day (7 days postmortem) and at measurement days, and drip loss percentage was determined as weight loss relative to the sampling day.

Histological analysis (only in Experiment 1): LL muscle samples displayed for 14 days were frozen in liquid nitrogen and stored at -80°C. They were transversely sectioned at 10 μm in a cryostat and the sections were placed on glass slides. Sections were then stained with Harris Hematoxylin without fixation. Morphological integrity of muscle sections was observed with a light microscope.

Statistical analysis: Data were analyzed by the least-squares procedures (SAS, 1985; Harvey, 1988).

RESULTS AND DISCUSSIONS

Experiment 1: Dietary vitamin E supplementation for 30–36 weeks increased ($P<0.001$) α-tocopherol concentration in LL muscles (control, 1.1 mg/kg; supplemented, 6.7 mg/kg). Vitamin E-supplemented beef had lower ($P<0.001$) drip loss percentages (Figure 1A) than the control. Dietary vitamin E supplementation showed smaller ($P<0.001$) increases of drip loss (Figure 1B) during 14 days of display compared to the control. The effect of dietary vitamin E on muscle fiber disruption was greater ($P<0.05$) in Holstein than in beef steers. Vitamin E supplementation maintained cell structure of beef steak displayed for 14 days compared to the control.

Experiment 2: Dietary vitamin E supplementation for 4 weeks increased ($P<0.01$) α-tocopherol concentrations in ST muscle (control, 1.3 mg/kg; supplemented, 2.4 mg/kg). Vitamin E-supplemented beef had no differences ($P>0.05$) in drip losses.

Experiment 3: Dietary vitamin E supplementation for 1 week increased ($P<0.01$) α-tocopherol concentrations in PM and LT muscles (control, 1.7 mg/kg; supplemented, 2.6 mg/kg). Vitamin E-supplemented beef had lower ($P<0.001$) drip loss percentages (Figure 2A) than the control. Dietary vitamin E supplementation reduced ($P<0.001$) drip loss in PM muscle (Figure 2B), but not in LT muscle.

Asghar et al. (1991) reported that pork from pigs receiving the higher level of vitamin E (200 IU/kg of feed for 14 wk; 4.7 mg α-tocopherol/kg of meat) had less drip loss than pork from pigs receiving lower vitamin E levels (10 IU and 100 IU/kg of feed; 0.5 mg and 2.6 mg α-tocopherol/kg of meat, respectively). They suggested that a higher α-tocopherol concentration in meat minimizes drip loss from frozen meat upon thawing, because α-tocopherol may preserve the fluidity of cell membranes. den Hertog-Meischke et al. (1997) reported that the effect of vitamin E supplementation (2,150 IU/animal/day for 120 days) on drip loss seemed to depend on the muscle studied; drip loss of LL muscles was not influenced, whereas supplemented ST muscles lost less, and supplemented PM muscles more drip than the controls. They suggested that these differences were related to the stability of mitochondria and sarcoplasmic reticulum, as affected by dietary supplementation of vitamin E. The influence of vitamin E

supplementation on drip loss of muscles is thus not always consistent, and we believe that drip loss is affected by not only dietary vitamin E supplementation but also by moisture and fat contents of the muscle. The effect of vitamin E supplementation on drip loss needs further investigation.

CONCLUSIONS

The 30–36 weeks–dietary vitamin E supplementation reduced drip loss and muscle fiber disruption in beef steak displayed for 14 days. The 4 and 1 week(s)–dietary vitamin E supplementation, however, did not reduce drip loss during 10 days of display. A higher α–tocopherol concentration (6.7 mg/kg) in muscle would be effective in maintaining cell structure and then reducing drip loss from fresh beef steaks during retail display.

PERTINENT LITERATURE

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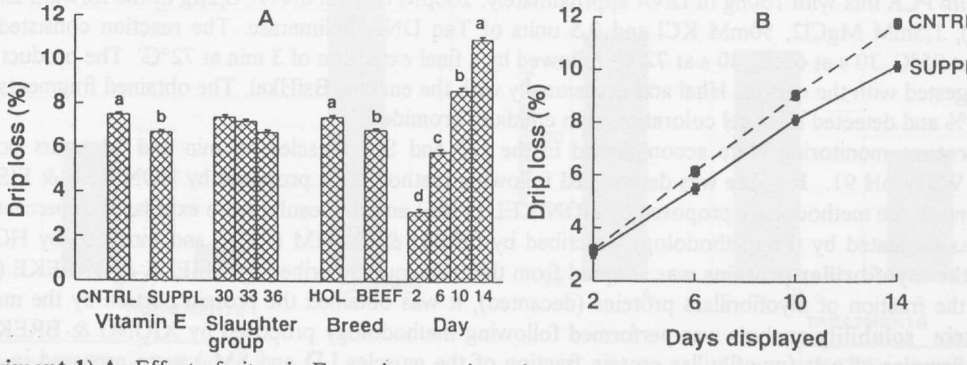

Figure 1. (Experiment 1) A: Effect of vitamin E supplementation, slaughter group, breed and day on drip loss percentage. **B:** Dietary vitamin E supplementation x day interaction for drip loss percentage. Least squares means and standard error bars are shown. a,b,c,d: within main effects, means with no common letters differ (P<0.05). CNTRL = no vitamin E supplementation; SUPPL = vitamin E supplementation; 30, 33, 36 = 30, 33 and 36 weeks; HOL = Holstein steers; BEEF = crossbred beef steers.

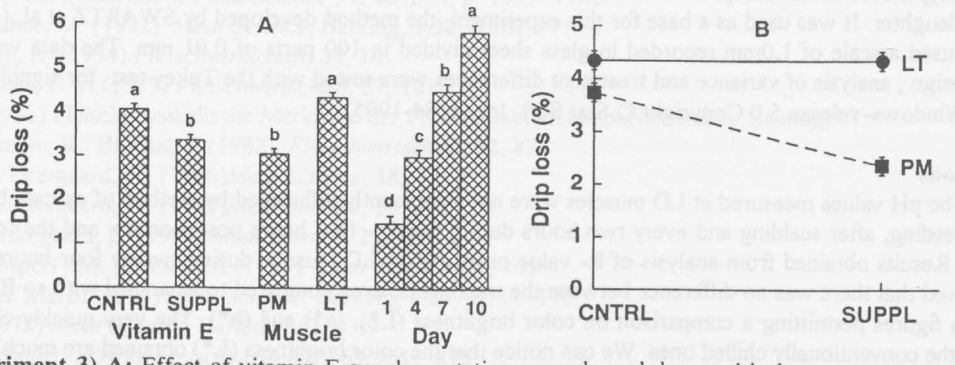

Figure 2. (Experiment 3) A: Effect of vitamin E supplementation, muscle and day on drip loss percentage. **B:** Dietary vitamin E supplementation x muscle interaction for drip loss percentage. Least–squares means and standard error bars are shown. a,b,c,d: within main effects, means with no common letters differ (P<0.05). CNTRL = no vitamin E supplementation; SUPPL = vitamin E supplementation; PM = psoas major; LT = longissimus thoracis.