EFFECTS OF VITAMIN E AND INITIAL MICROBIOLOGICAL COUNTS ON BEEF CASELIFE

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Background

Dietary supplementation of Vitamin E (α-tocopheryl acetate) to cattle increases the amount of α-tocopherol stored in their muscles, where it functions as an antioxidant that protects phospholipid bilayers of cell membranes and the heme pigment associated with muscle color, thus delaying onset of metmyoglobin formation and extending retail caselife of fresh beef (Faustman *et al.*, 1989; Mitsumoto *et al.*, 1991). Supplementing diets of feedlot cattle with 500 to 1,000 IU/head/day of vitamin E for about 100 days prior to harvest is efficacious for improving color stability and retail caselife of beef marketed in both domestic and international markets (Morgan *et al.*, 1993; Sherbeck *et al.*,. 1995; Smith *et al.*, 1996; Sanders *et al.*, 1997). With the extension of caselife, concern has developed that high levels of Vitamin E in muscle may mask or camouflage the effects of high levels of microbiological contamination on beef surfaces eventhough Chan *et al.* (1995) and Cabedo *et al.* (1998) have demonstrated that Vitamin E level in steaks and ground beef does not affect growth of spoilage or pathogenic bacteria.

Objectives

The objectives of these studies were to: (a) evaluate the effect of α-tocopheryl acetate supplementation of beef cattle on duration of acceptable muscle color during retail display of fresh beef steaks and ground beef, following different storage/distribution times, and (b) determine whether the level of initial microbiological contamination affected the appearance during retail display of beef steaks derived from cattle fed diets without and with supplemental Vitamin E.

Methods

One group of cattle received a Control diet and the second group received a diet containing supplemental α-tocopheryl acetate (500 IU/head/day for at least 100 days). Rounds, loins, chucks and chub-packages of ground beef (made from round and chuck muscles) were vacuum-packaged and stored (1°C) for 14, 28 or 42 d (subprimal cuts) or 7, 14 or 21 d (ground beef). Subprimal cuts were fabricated to generate steaks, chub-packages of ground beef were ground again, and steaks/ground beef were packaged (styrofoam tray, polyvinyl chloride film). Packages were displayed in a retail case at 0-2°C, exposed to fluorescent lighting at 1049 lux. For the other study, additional striploins were vacuum-packaged and stored for 14 d at 1°C, fabricated to generate steaks, and equal numbers of Control and Vitamin E-supplemented steaks were sterilized and/or inoculated with Low (1.7 to 1.9 $\log_{10}$ CFU/cm^2), Standard (2.3 to 2.5 $\log_{10}$ CFU/cm^2) or Inoculated (6.4 to 7.1 $\log_{10}$ CFU/cm^2) of psychrotrophic meat-spoilage microorganisms. During simulated retail display (up to 7 days), muscle surfaces of solid-muscle cuts and muscle/fat surfaces of ground beef were evaluated by use of a hand-held spectophotometer (MiniScan XE, HunterLab Associates) to obtain L*, a* and b* values, and by a highly trained panel (5 members) to obtain overall acceptability (7-point scale) ratings.

Table 1. Mean hours of simulated retail display life before steaks and ground beef from vitamin E and non-vitamin E supplemented cattle reached an unacceptable overall appearance rating of 3

	Time (h) until color reached unacceptable level		
Retail product	Non-Vitamin E mean (±SD)	Vitamin E mean (±SD)	Gain (h)
Bottom round steaks	34.8 (± 14.0)^b	60.0 (± 14.0)^a	25.2
Clod steaks	51.6 (± 17.8)	58.2 (± 16.2)	6.6
Eye of round steaks	40.2 (± 14.7)^b	69.6 (± 7.4)^a	29.4
Inside round steaks	33.0 (± 16.0)^b	41.4 (± 21.5)^a	8.4
Strip loin steaks	59.0 (± 17.3)^b	70.5 (± 7.2)^a	11.5
Tenderloin steaks	30.3 (± 11.1)	34.5 (± 6.1)	4.2
Ground beef	28.4 (± 11.7)^b	46.2 (± 8.4)^4	17.8

^{ab}Means in the same row, within a retail product, bearing different superscript letters differ (P<.05).

Results and Discussion

Pre-retail display storage time had no significant effect on caselife of steaks. Based on mean overall appearance ratings, bottom-round, eye-of-round, inside-round and striploin steaks as well as ground beef from Vitamin E supplemented cattle had longer (P<.05) acceptable retail caselife than products from Control cattle by 25.2, 29.4, 8.4, 11.5 and 17.8 h, respectively (Table 1). Though not significantly (P>.05) different, clod and tenderloin steaks from cattle fed supplemental Vitamin E had a longer acceptable display life than counterpart steaks from Control cattle by 6.6 and 4.2 h, respectively. Chan *et al.* (1996) reported that color stability was greatest for *longissimus lumborum*, intermediate for *gluteus medius* and least for *psoas major*. Liu *et al.* (1996) reported that color display life was greatest for *longissimus lumborum*, intermediate for *semimembranosus* and lowest for *gluteus medius* among muscles from Vitamin E supplemented cattle. The acceptable retail caselife for ground beef made from products of Vitamin-E supplemented cattle was longer by 10.2, 15.6 and 27.6 h, respectively, than for ground meat made from products of Control cattle, when the raw material had been stored in chub-packages for 7, 14 or 21 d (Figure 1).

When striploin steaks were sterilized/inoculated to achieve Low, Standard or Inoculated levels of contamination with meat-spoilage bacteria, psychrotrophic plate counts in steaks of all three treatments increased during retail display, and differed (P<.05) among the three initial microbiological count levels (Figure 2). Increases in counts were not affected (P>.05) by Vitamin E supplementation during retail display and counts at days 2, 4 and 6 paralleled initial inoculum levels (Figure 2). Overall appearance scores for striploin steaks from the Inoculated treatment were lower (P<.05) than overall appearance scores for steaks from Low and Standard inoculum levels at 2, 4 and 6 d of retail display, regardless of the amount of Vitamin E in the diet the cattle received (Figure 3). Striploin steaks from cattle that received the high Vitamin E diet had higher (P<.05) overall appearance scores than striploin steaks from cattle that received the Control diet for both Low and Standard inoculum levels at 4 and 6 d of retail display. Overall appearance differed (P<.05) at day-4 between Low and Standard inoculum levels for steaks from cattle that received the Control diet (Figure 3).

Conclusions

Vitamin E supplementation of cattle reduces economic losses to the retailer associated with beef muscle color deterioration, increasing caselife by 4 to 29 h (depending on the product). And, retailers must be clean, sanitary and follow good manufacturing practices to assure display of cuts with low microbiological counts in order to achieve the caselife extension benefits associated with Vitamin E supplementation of cattle.

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Figure 1. Hours of acceptable retail display for ground beef from vitamin E and non-vitamin E supplemented cattle.

Figure 2. Psychrotrophic plate counts for strip loin steaks derived from vitamin E and non-vitamin E supplemented cattle across Low, Standard and Inoculated treatments for 6 days of retail display.

Figure 3. Overall appearance scores for 6 days of retail display for strip loin steaks with Low, Standard or Inoculated initial levels of microbiological contamination, derived from vitamin E and non-vitamin E supplemented cattle.