

Effects of vitamin E on color stability of strip loin steaks from cattle fed distillers grains

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STORY IN BRIEF

Two hundred and five crossbred steers were fed 35% wet distillers grains with the supplementation of four different levels of vitamin E (α -tocopheryl acetate): 0 IU/hd/d (CON), 125 IU/hd/d, 250 IU/hd/d, and 500 IU/hd/d for 97 d. Strip loins (n = 185) were collected and processed on d 4 and d 7, post harvest, respectively. Chucks were ground and separated into 0.23 kg samples. Strip loins were faced and cut into 2.54 cm steaks and packaged in either polyvinyl chloride overwrapped (**PVC**) or modified atmosphere packages (**MAP**), for further color evaluation. A consumer panel was utilized to indicate which treatments impacted retail acceptability and purchase decisions. At 0 h, panelists recorded that only for the CON diet, steaks were a duller red color than the other treatment groups, whereas at 12 h through 132 h, the 500 IU/hd per day and 250 IU/hd per day groups were brighter than the CON and 125 IU/hd per day groups. Ultimately, 500 IU/hd/d of vitamin E should be supplemented to cattle fed distillers grain based diets when products are packaged in MAP to maximize retail shelf life retention.

Key Words: beef, color stability, palatability, vitamin E, wet distillers grain

INTRODUCTION

One of the greatest factors that impacts beef retail markets is the amount of profit loss due to meat discoloration. At the point in which beef products begin to darken, a retailer is forced to do one of three things: 1) discount or mark down the price of the product, 2) convert the product to a new product of lesser value (ex. grinding to hamburger), or 3) discard the product at a 100% loss. Thus, retailers may be more interested in how many hours of acceptable retail display they can gain before 10% of the products in a display case begin to discolor, rather than when the average of all the cuts in the display case is unacceptable (Zerby et al., 1999). Therefore, studies have been conducted to increase color stability in lean. Not only did Arnold et al. (1992) determine that alpha-tocopherol (vitamin E) is effective in extending the color stability of displayed beef, but Faustman et al. (1998) confirmed that vitamin E supplementation of beef cattle diets is an effective procedure for enhancing the lipid and color stability of meat products subsequently obtained from animals. The objectives of this study were to determine the impacts of pre-harvest vitamin E supplementation on color stability and consumer acceptability of steaks and ground beef from cattle fed wet distillers grains.

MATERIALS AND METHODS

The Oklahoma State University Institutional Review Board (IRB) and IACUC approved the experimental protocol used in the present study.

Dietary Treatments. Crossbred steers (n=240) were fed at Oklahoma Panhandle State University's extension and research feedlot facility to evaluate animal performance in response

to feeding a base diet of dry rolled corn (55% on a dry matter basis) and wet distillers grain (35% on a dry matter basis), with the supplementation of α -tocopheryl acetate. The steers were allotted to one of four vitamin E supplementation treatment groups (6 pens per treatment, 10 steers per pen): 0 IU/hd per day the control group (CON); 125 IU/hd per day, 250 IU/hd per day; or 500 IU/hd per day for 97 d.

Harvest and Data Collection. The steers were shipped to a commercial processing facility in Dodge City, KS, on one of two different slaughter dates (harvest group 1 processed on July 27, 2009, n = 80; harvest group 2 processed on August 17, 2009, n = 125), resulting from the difference in final body weight over the six different weight blocks. On the day of harvest, trained Oklahoma State University personnel completed tag transfer and collected hot carcass weights (HCW).

Strip Loin Collection. Immediately following data collection, carcasses were railed into the sales cooler onto one of two grade rails (Choice or Select), to allow for tagging of strip loins. Approximately 60% of the carcasses were graded USDA Choice by a USDA grader, and the other 40% graded USDA Select. Chuck rolls were only collected from carcasses in the initial harvest group. A total of 69 chuck rolls were collected from the right side of each carcass (17-CON; 16-125 IU/hd per day; 19-250 IU/hd per day; 17-500 IU/hd per day). All strip loins from the right side of each carcass were tagged on both harvest dates and a total of 185 loins were collected (53-CON; 45-125 IU/hd per day, 46-250 IU/hd per day; 41-500 IU/hd per day). Any carcasses that graded Prime or No Roll were not utilized during strip loin collection. All products were fabricated according to Institutional Meat Purchase Specifications (IMPS; USDA, 1996), where strip loins for IMPS #180 with a purchaser specified option (PSO) of 2.5 cm x 0 cm, and vacuum packaged at the plant.

Strip Loin Preparation. After aging for 7 d postmortem at 2°C, strip loins (n = 185) were removed from their vacuum packages. Strip loins were then faced on the anterior end and four 2.54 cm steaks were cut. The face steak was vacuum packaged and immediately frozen at -20°C for further analysis of α -tocopherol levels. The samples were placed in plastic trays with a soaker pad and sealed in a high oxygen (HiO₂) modified atmosphere package (MAP, approximately 75% O₂ and 25% CO₂). The first steak was placed in a Styrofoam package with a white soaker pad and over-wrapped with PVC film. This steak was then objectively color scored using a HunterLab Miniscan XE spectrophotometer and immediately placed under retail lighting. The final three steaks were placed in white MAP packages and designated to one of three display periods: MAP 1-d retail display, MAP 3-d retail display, and MAP 7-d retail display. All MAP packages were placed in dark storage at 2°C for an additional 7-d postmortem to simulate commercial transportation.

Subjective Color Measurement. A six-member panel of trained Oklahoma State University personnel was selected to subjectively color score all products for a 7-d period at 12-h intervals. All panelists were required to obtain a passing score using Munsell color tiles (Gretamacbeth, New Windsor, NY) prior to serving on the panel. Each panelist evaluated both the ground beef and strip steaks for muscle color, percent surface discoloration (% metmyoglobin), and overall acceptability. Muscle color was evaluated on an 8-point scale, where half-point increments were accepted (1 = very bright red or pinkish red, and 8 = tan to brown), discoloration was scored

using a 7-point scale (1 = no discoloration or 0%, and 7 = total discoloration or 100%), and overall acceptability was depicted using an 8-point scale (8 = extremely desirable/acceptable, and 1 = extremely undesirable/unacceptable).

Statistical Analysis. Data for steaks was analyzed using the mixed procedure of SAS (SAS Inst. Inc., Cary, NC) as a completely randomized split plot design with carcass as the experimental unit and strip loin or chuck being the split plot. The Analysis of Variance (ANOVA) model was used to analyze objective color attributes and subjective color attributes where treatment was the fixed effect. Strip/chuck identification was the random effect. All color data were analyzed by package type. The ANOVA model for PVC and MAP samples for subjective color attributes were analyzed using time as a repeated measure, where strip/chuck identification was the subject and treatment remained the fixed effect. Interactions were observed for all models. When interactions or main effects were significant ($\alpha = 0.05$), least square means were computed and statistically separated by pairwise t-test.

RESULTS AND DISCUSSION

Color Evaluation. Subjective color evaluation from the trained color panel of MAP packaged steaks can be found in Tables 1 through 3. An evident treatment difference in color throughout almost the entire retail display period was detected ($P < 0.05$). At 0 h panelist recorded that only the CON diet were a duller red color than the other treatment groups, whereas 12 h through 132 h, the 500 IU/hd per day and 250 IU/hd per day groups were brighter than the CON and 125 IU/hd per day groups ($P < 0.05$). At 156 h, 500 IU/hd per day was more red than 250 IU/hd per day and 125 IU/hd per day treatment was more red than 125 IU/hd per day and the CON ($P < 0.05$). Discoloration and overall acceptability of steaks in MAP packages yielded similar results, and after 36 h in retail display, there is a distinct difference between the higher levels of supplementation (500 IU/hd per day and 250 IU/hd per day) and the lower levels (125 IU/hd per day and CON) ($P < 0.05$) (Table 1 and 2). These results correspond to those of Arnold et al. (1992) which reported that, in general, the greater the amount of vitamin E fed and(or) the longer the supplementation, the longer the meat will last in retail display.

Differences in PVC overwrapped steaks for color didn't become apparent until approximately 72 h in the retail display ($P < 0.05$; Table 1). In terms of discoloration (Table 2), the PVC overwrapped steaks stayed fairly consistent until 144 h in display. At that point the diets providing more vitamin E (500 IU/hd per day and 250 IU/hd per day) had a distinctly lower amount of discoloration than the diets with lower amounts of vitamin E (125 IU/hd per day and CON) ($P < 0.05$).

Steaks packaged in both MAP and PVC stayed consistent in terms of color for the duration of retail display. At 108 h, PVC packaged strips were all considered as slightly discolored (1 – 19%), whereas MAP packaged strips weren't all deemed slightly discolored until 120 h. Zerby et al. (1999) reported that at more than 10% discoloration, in retail, meat should be discounted. This suggests that MAP packaging may be preferred for retention of product in the retail display. Consumer evaluations of muscle color for strip steaks in both MAP and PVC overwrap packages indicated that dietary treatment had an effect on retail selection of product. Although differences were not observed for PVC overwrapped packages on 3 d of evaluation, it was evident that

higher levels of vitamin E supplementation (500 IU/hd per day and 250 IU/hd per day) in a distillers grain based diet for 7 d PVC and 3 and 7 d MAP packaged product was more apt to entice consumers to purchase or deem the steaks acceptable for retention in the retail display. This panel was based strictly off of muscle color and amount of discoloration, concluding that higher amounts of vitamin E in distillers grain based diets is suggested for consumer acceptance throughout the duration of retail display.

Table 1. Least squares means for muscle color¹ scores given to MPA² (n = 185) and PVC³ (n = 185) packaged strip loin steaks throughout a 7-d period in the retail display case

	Treatments				SEM
	Control	125 iu/hd per day	250 iu/hd per day	500 iu/hd per day	
MAP Package					
0 h	3.31 ^b	3.14 ^a	2.97 ^a	2.98 ^a	0.05
12 h	3.51 ^b	3.48 ^b	3.25 ^a	3.24 ^a	0.04
24 h	3.62 ^b	3.60 ^b	3.32 ^a	3.33 ^a	0.03
36 h	3.75 ^b	3.79 ^b	3.49 ^a	3.45 ^a	0.04
48 h	4.02 ^b	4.17 ^b	3.76 ^a	3.58 ^a	0.07
60 h	4.46 ^b	4.17 ^b	3.83 ^a	3.66 ^a	0.09
72 h	4.64 ^b	4.51 ^b	4.21 ^a	3.91 ^a	0.06
84 h	4.68 ^b	4.62 ^b	4.17 ^a	4.09 ^a	0.05
96 h	5.35 ^c	4.82 ^b	4.23 ^a	4.06 ^a	0.11
108 h	4.96 ^b	5.21 ^b	4.45 ^a	4.29 ^a	0.08
120 h	5.41 ^b	5.35 ^b	4.84 ^a	4.65 ^a	0.05
132 h	5.79 ^b	5.47 ^b	4.98 ^a	4.73 ^a	0.09
144 h	5.84	5.69	5.72	5.08 ^a	0.11
156 h	6.17 ^c	5.92 ^c	5.54 ^b	5.14 ^a	0.06
PVC Package					
0 h	3.24	3.22	3.11	3.14	0.05
12 h	3.29	3.25	3.12	3.20	0.03
24 h	3.41	3.39	3.28	3.28	0.03
36 h	3.54	3.53	3.39	3.52	0.03
48 h	3.85	3.80	3.62	3.68	0.03
60 h	4.05	4.05	3.85	3.89	0.04
72 h	4.14 ^b	4.11 ^b	3.84 ^a	3.85 ^a	0.04
84 h	4.29 ^b	4.22 ^b	4.00 ^a	4.02 ^a	0.04
96 h	4.53 ^b	4.47 ^b	4.21 ^a	4.22 ^a	0.04
108 h	4.78 ^b	4.61 ^b	4.27 ^a	4.32 ^a	0.05
120 h	5.00 ^b	4.88 ^b	4.47 ^a	4.52 ^a	0.05
132 h	5.26 ^b	5.08 ^b	4.68 ^a	4.62 ^a	0.06
144 h	5.55 ^b	5.36 ^b	5.03 ^a	4.86 ^a	0.06
156 h	6.04 ^b	5.83 ^a	5.53 ^a	5.32 ^a	0.06

^{abc}Means in the same row without a common superscript are different ($P < 0.05$).

¹Muscle color was measured on an 8-point scale (1 = very bright red or pinkish red, and 8 = tan to brown).

²Modified atmosphere package (75% O₂ and 25% CO₂).

³Polyvinyl chloride overwrapped package.

Table 2. Least squares means for muscle discoloration¹ values given to MPA² (n = 185) and PVC³ (n = 185) packaged strip loin steaks throughout a 7-d period in the retail display case

	Treatments				SEM
	Control	125 iu/hd per day	250 iu/hd per day	500 iu/hd per day	
MAP Package					
12 h	1.02	1.05	1.02	1.03	0.008
24 h	1.04	1.08	1.02	1.03	0.009
36 h	1.10	1.16	1.02	1.06	0.02
48 h	1.26 ^a	1.33 ^b	1.05 ^a	1.18 ^a	0.03
60 h	1.46 ^b	1.53 ^b	1.16 ^a	1.23 ^a	0.04
72 h	1.42 ^b	1.28 ^b	2.07 ^a	2.02 ^a	0.07
84 h	2.42 ^b	2.33 ^b	1.36 ^a	1.43 ^a	0.09
96 h	3.22 ^b	2.95 ^b	1.61 ^a	1.61 ^a	0.11
108 h	3.76 ^b	3.40 ^b	1.93 ^a	1.79 ^a	0.12
120 h	4.42 ^b	4.07 ^b	2.53 ^a	2.17 ^a	0.13
132 h	4.78 ^b	4.60 ^b	2.85 ^a	2.31 ^a	0.14
144 h	5.05 ^c	4.86 ^c	3.18 ^b	2.42 ^a	0.14
156 h	5.43 ^c	5.31 ^c	4.00 ^b	2.71 ^a	0.15
PVC Package					
12 h	1.05	1.03	1.03	1.03	0.007
24 h	1.08	1.09	1.14	1.11	0.02
36 h	1.22	1.23	1.21	1.25	0.02
48 h	1.26	1.30	1.29	1.29	0.01
60 h	1.39	1.46	1.38	1.41	0.02
72 h	1.54	1.53	1.47	1.50	0.02
84 h	1.63	1.61	1.53	1.60	0.03
96 h	1.89	1.78	1.69	1.77	0.03
108 h	2.42	2.40	2.22	2.26	0.04
120 h	2.53	2.41	2.33	2.25	0.05
132 h	3.00	2.79	2.91	2.59	0.07
144 h	3.42 ^b	3.28 ^b	3.33 ^b	2.75 ^a	0.09
156 h	1.81	1.74	2.73	3.73	0.10

^{abc}Means in the same row without a common superscript are different ($P < 0.05$).

¹All % muscle discoloration was measured on a 7-point scale (1 = no discoloration or 0 %, and 7 = total discoloration or 100%).

²Modified atmosphere package (75% O₂ and 25% CO₂).

³Polyvinyl chloride overwrapped package.

Table 3. Least squares means for overall acceptability¹ values given to MAP² (n = 185) and PVC³ (n = 185) packaged strip loin steaks throughout a 7-d period in the retail display case

	Treatments				SEM
	Control	125 iu/hd per day	250 iu/hd per day	500 iu/hd per day	
MAP Package					
0 h	6.98 ^b	6.97 ^b	7.14 ^a	7.11 ^a	0.03
12 h	6.73 ^b	6.68 ^b	6.94 ^a	6.88 ^a	0.03
24 h	6.26 ^b	6.36 ^b	6.62 ^a	6.58 ^a	0.03
36 h	6.10 ^b	6.04 ^b	6.43 ^a	6.42 ^a	0.04
48 h	5.97 ^b	5.84 ^b	6.29 ^a	6.51 ^a	0.09
60 h	5.51 ^b	5.49 ^b	6.17 ^a	6.20 ^a	0.09
72 h	4.50 ^b	4.61 ^b	5.66 ^a	5.66 ^a	0.09
84 h	4.17 ^b	4.28 ^b	5.51 ^a	5.57 ^a	0.10
96 h	3.56 ^b	6.69 ^b	5.31 ^a	5.46 ^a	0.12
108 h	3.16 ^b	3.33 ^b	4.96 ^a	4.99 ^a	0.12
120 h	2.73 ^b	2.76 ^b	4.20 ^a	4.70 ^a	0.12
132 h	2.28 ^c	2.36 ^c	3.84 ^b	4.43 ^a	0.12
144 h	2.02 ^c	2.16 ^c	3.38 ^b	4.16 ^a	0.12
156 h	1.81 ^c	1.74 ^c	2.73 ^b	3.73 ^a	0.11
PVC Package					
0 h	6.86	6.77	6.88	6.83	0.07
12 h	6.89	6.82	7.01	6.83	0.06
24 h	6.51	6.44	6.61	6.71	0.07
36 h	6.32	6.19	6.40	6.24	0.05
48 h	6.01	5.96	6.18	6.04	0.05
60 h	5.81	5.75	6.02	5.83	0.05
72 h	5.84 ^b	5.76 ^b	6.12 ^a	6.01 ^a	0.05
84 h	5.59	5.64	5.95	5.80	0.05
96 h	5.18 ^b	5.30 ^b	5.65 ^a	5.56 ^a	0.06
108 h	4.75 ^b	4.97 ^b	5.40 ^a	5.28 ^a	0.07
120 h	4.31	4.57	4.68	4.90	0.08
132 h	3.18 ^b	3.51 ^b	3.98 ^a	4.21 ^a	0.09
144 h	2.52 ^b	2.85 ^b	3.23 ^a	3.60 ^a	0.09
156 h	2.13 ^b	2.30 ^b	2.62 ^a	2.86 ^a	0.09

^{abc}Means in the same row without a common superscript are different ($P < 0.05$).

¹Overall acceptability was measured on an 8-point scale (8 = extremely desirable/acceptable, and 1 = extremely undesirable/unacceptable).

²Modified atmosphere package (75% O₂ and 25% CO₂).

³Polyvinyl chloride overwrapped package.

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