1999 Animal Science Research Report

EFFECT OF SUPPLEMENTAL DIETARY VITAMIN E ON THE COLOR AND CASE-LIFE OF TOP LOIN STEAKS AND GROUND CHUCK PATTIES IN VARIOUS CASE-READY RETAIL PACKAGING SYSTEMS

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Story in Brief

Ground chuck and top loin steaks from cattle fed diets supplemented with either 0 or 500 IU vitamin E/hd/d for at least 100 d, were packaged utilizing two case-ready beef packaging systems. Random samples were taken at fabrication in order to determine the vitamin E concentrations. Cuts were stored at 39^0 F for 0 to 14 d for ground chuck samples and additionally for 0 to 22 d for top loin steak samples. At 2-d intervals, products were removed from storage and displayed in a retail case at 36 to 43^0F for 8 d. Twice daily, objective and subjective measures of display color properties were obtained. Lipid oxidation was measured on display d 0, 4, and 8 for each supplementation by storage group combination. Higher concentrations of vitamin E were found in Vitamin E than in Control products for both case-ready package types. Lipid oxidation was markedly reduced across the display period for both Vitamin E products compared with Controls. Vitamin E steaks were shown to retain their red lean color more consistently throughout the display period for most storage display days. Compared with Control, vitamin E increased color retention when displayed 3 d or more. Maximum display life increased with vitamin E by approximately 3 d and 1.3 d for top loin steaks and ground chuck patties, respectively. This study suggests that vitamin E would be very useful in overcoming the oxidative problems associated with case-ready retail beef systems by providing extended periods of storage and display.

Key Words: Color, Case-Life, Beef, Packaging

Introduction

Over the past several years, many changes in retail meat products have occurred. One such change has been the progressive movement toward the reduction of labor and enhanced food safety by utilizing "case-ready" fresh poultry, fish, and pork products. Currently all poultry and most pork products arrive at retail stores as "case-ready" requiring minimal handling and processing prior to retail display. These value-added sections can easily be kept fully stocked and very presentable with limited labor as well as minimal oversight by the meat merchandisers. These advantages help make poultry and pork products more attractive and convenient to consumers than conventionally fabricated beef items. Fabrication and packaging of beef, on the other hand, requires the majority of the time and labor in today□s retail meat department.

A major limiting factor in the production of "case-ready" beef products is unstable lean color (Effertz, 1997; Schut, 1998) due to the elevated myoglobin content. A bright, cherry red lean color is perceived to indicate beef freshness (Kropf, 1980).

Currently most case-ready systems involve the utilization of either vacuum or modified atmosphere (MAP) packaging systems. Vacuum packaging systems do not allow for beef products to "bloom" (i.e., turn bright red) during retail display. One drawback to high oxygen MAP systems is an increase in lipid oxidation as a result of the pro-oxidant atmosphere created (Houben et al., 1998). Lipid oxidation products have been shown to reduce color display life of conventionally packaged retail beef products (Schaefer et al., 1995) and create an undesirable warmed-over flavor in cooked beef products (St. Angelo, 1996). Vitamin E is helpful in reducing lipid oxidation by acting as a free radical quencher (Faustman et al., 1990). The utilization of vitamin E in branded "case-ready" programs could potentially help the packer/processor provide a more consistent, made to order, longer-lasting product to the retailer and eventually to the ultimate consumer. This study is designed to investigate the ability of dietary vitamin E supplementation to increase the performance of ground chuck and beef top loin steaks in case-ready applications through reduction of lipid and muscle pigment oxidation.

Materials and Methods

Meat Sample Preparation. Boxed beef subprimals, strip loins (IMPS #180a) and neck-off chuck rolls (IMPS #116), were obtained from carcasses of beef cattle that had been fed diets supplemented with either 0 or 500 IU vitamin E/hd/d. Approximately 12 top loin steaks (0.60 in thick) were hand cut for each treatment group (n = 66/treatment). Whole neck off chuck rolls were ground and mixed. Patties were then formed for each treatment group separately (n = 42/treatment). Two ground chuck patties were then placed into individual Cryovac® Barrier Foam Trays with Dry-loc meat pads. These two patties were stacked and all analyses were performed on the top patty. Both top loin steaks and ground chuck patties were then packaged in Cryovac® Peelable Vacuum Skin Packs or Cryovac® Barrier Foam Packs, respectively.

Packaging. Within 20 min of retail fabrication, meat samples were packaged, using Cryovac® Peelable VSP film. The over-wrap layer was removed, exposing an oxygen permeable layer, to allow the product to bloom for retail display. Cryovac® Barrier Foam Trays containing ground chuck patties were packaged using Cryovac® Lid 550 barrier film. This created a self-contained modified atmosphere package (MAP) containing 80% oxygen and 20% carbon dioxide. Packages within each treatment group were then randomly assigned an identification number that corresponded to a particular storage and display time. Six ground chuck

patties (3/treatment) or twelve top loin steaks (6/treatment) were placed in individual cardboard boxes for storage.

Storage and Display. Individual packages were stored in cardboard boxes in the absence of light for 2, 4, 6, 8, 10, 12, or 14 d at 36^0 F for ground chuck and additionally for 16, 18, 20, and 22 d for top loin steaks. After their designated storage time was achieved, individual packages were removed from their boxes and placed in a commercial retail display case for 0, 4, or 8 d under cool-white florescent light at 36 to 39^0F. Top loin steak packages were "peeled" to remove the barrier layer, allowing the product to contact oxygen immediately prior to display. Packages were rotated randomly in the case once daily and new packages were added to random locations in the case. Products were removed after 0, 4 or 8 d of display for analysis of lipid oxidation.

Lipid Oxidation. On d 0, 4, and 8 of retail display, duplicate samples for each treatment by storage group combination were removed from the case and frozen at -4^0F until further analyzed. Thiobarbituric Acid, reactive substances (TBARS), analysis was performed using the test procedure described by Witte et al. (1970) with the following modifications: a 10 g sample was used in the extraction step, and 30 ml of the resulting slurry was centrifuged at 3000 rpm for 30 min prior to filtration. Results were reported as thiobarbituric acid reactive substances (TBARS).

Results and Discussion

Alpha-Tocopherol Concentrations Tissue concentration analysis for vitamin E in randomly selected samples from top loin steaks revealed 64% higher levels than in Control samples (P=.03). Similarly it was found that vitamin E concentrations were 61.5% higher in Vitamin E ground chuck samples than in Controls (P=.02). Steak tissue vitamin E concentrations were found to be significantly lower (P<.01) than tissue concentrations in ground chuck samples when analyzed in the absence of treatment effects. Differences in concentrations between steaks and ground chuck could be attributed to differences in vitamin E accumulation rates of their muscles of origin (Arnold et al., 1993). Liu et al. (1996) suggested that there is no clear explanation for such differences.

Lipid Oxidation. Lipid oxidation over the entire storage period for Peelable VSP packaged top loin steaks, as indicated by TBARS accumulation, was not significantly affected by treatment (P>.05). Further analysis revealed that differences on these days were attributed to uncharacteristically high TBARS values in CON products. VITE top loin steaks demonstrated no significant (P>.10) increase in TBARS accumulation immediately prior to display during the entire 22-d storage in cardboard boxes. Similarly no differences (P>.10) were exhibited in TBARS accumulation during storage of Control steaks, with the noted exceptions at d 6 and 20. These analyses

suggest that the anaerobic conditions of Peelable VSP packaging is sufficient in retarding lipid oxidation during storage of top loin steaks for up to 22 d. This could be expected due to lack of O_2 needed in the initiation and propagation of lipid oxidation reactions.

Regression analysis of TBARS accumulation in top loin steaks packaged in Peelable VSP over the display period showed statistically similar regression lines within treatments. Lipid oxidation occurred at similar rates in VITE steaks stored for up to 16 d ($P>.05$). Vitamin E steaks stored 18 d (not represented graphically) exhibited higher than expected values after 4 d of display (0.97 TBARS) when compared with values at d 0 (0.07 TBARS) and d 8 (0.03 TBARS). Comparisons across treatments revealed that VITE supplementation significantly reduced the occurrence of lipid oxidation after 4 or 8 d of display by 42.3 and 51.3%, respectively.

Analysis of TBARS data for packaged ground chuck in Barrier Foam Packs revealed significant treatment effects during both storage and display ($P<.01$). Vitamin E patties demonstrated significant reductions ($P<.01$) in lipid oxidation when compared with Control over the entire storage period, with the exception of d 6 where no differences ($P>.05$) were found. Vitamin E TBARS values at d 6 were untraditionally high. Noting this exception, no significant difference ($P>.05$) was observed within individual treatments until the storage period reached 10 d or more where both Vitamin E and Control patties exhibited increases in TBARS accumulation ($P<.05$).

The effect of display on the TBARS accumulation in ground chuck patties is presented in Table 1. Vitamin E patties maintained significantly lower ($P<.05$) TBARS values at all but two comparisons, where Vitamin E samples were numerically lower than Control patties. Comparisons of least squares means within individual treatments across all storage days indicate that no differences were present ($P=.65$) between 0 and 4 d of display for Vitamin E ground chuck patties. However, there were differences for the Control patties. In fact, the mean TBARS values for all storage periods indicated that Vitamin E patties displayed 8 d had less ($P<.01$) average lipid oxidation than Control products displayed 0 d. This suggests the overwhelming benefit of vitamin E supplementation in the reduction of lipid oxidation of ground chuck patties packaged in these systems. This study suggests that vitamin E would be invaluable in protecting ground chuck patties against lipid oxidation when utilized in high oxygen Barrier Foam packaging applications.

Subjective Color Analysis. Vitamin E top loin steaks showed extended display acceptability for lean color scores on all but d 2, 4, and 10 (Figure 1). The maximum lean benefit was achieved on d 18 where lean color for Vitamin E steaks was acceptable throughout the display period and Control steaks discolored after only 1.07 d of display. When all storage days were

considered, Vitamin E steaks retained acceptable lean color for an average of 7.58 d while Control steaks retained acceptable lean color for an average of only 4.12 d. Percent discoloration data for top loin steaks also revealed significant ($P<.01$) differences between treatments.

Comparison of fat color for top loin steaks showed no TRT differences ($P>.10$) between storage days. The average benefit for Vitamin E steaks was 0.84 d, which also suggests that fat color was similar for both treatments. Comparisons of least squares means showed no difference ($P>.10$) between storage days until d 18 and 20 where average acceptability was higher ($P<.01$) for Vitamin E steaks.

For all storage days Vitamin E steaks remained acceptable for over 5 d of display except on d 14 (1.99 d) and 20 (4.21 d). This suggests that in order to achieve traditional display life in retail applications Control products in Peelable VSP film should not be stored longer than 10 d, while the storage period of Peelable VSP packaged top loin steaks could be extended to 22 d. By utilizing vitamin E beef in this system, a retailer could benefit from added flexibility of the product

As expected, acceptance for all visual variables of ground chuck patties decreased ($P<.01$) as the storage time increased. Treatment differences existed over all factors resulting in vitamin E supplemented ground chuck maintaining higher levels of acceptability for a greater portion of the display period. When all storage days were considered, lean color acceptance was improved by an average of 1.65 d with vitamin E supplementation. Vitamin E patties showed improved lean color acceptability over Control patties after all storage periods. Lean color gradually decreased over the storage period for both treatments, except for a non-uniform increase at d 10 for Vitamin E patties. Similar trends were exhibited in fat color and percent discoloration, which were improved by vitamin E supplementation by 1.29 d and 1.39 d, respectively. The noted difference after 10 d of storage was also seen in these factors.

Maximum display life was increased by an average of 1.34 d with vitamin E supplementation when considered across all storage periods (Figure 2). This study indicates the ability of vitamin E supplementation to provide extended storage and display stability of both Barrier Foam packaged ground chuck and Peelable VSP packaged top loin steaks. This, in turn, provides the retailer with a long lasting, bright red, display ready product.

Implications

This research shows that vitamin E supplementation has significant effects in reducing the oxidative processes that create undesirable characteristics in case-ready beef. Vitamin E supplementation was shown to maintain color and visual acceptance scores for longer periods of display in both Peelable

VSP packaged top loin steaks and Barrier Foam packaged ground chuck patties. Extending the storage and display life of case-ready beef products, vitamin E has the potential to help beef compete better with other case-ready protein sources. The combination of case-ready packaging and vitamin E supplementation can help beef products become more appealing and convenient to today□s retail consumer.

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Acknowledgments

The authors thank Cryovac and Sealed Air Corporation for their support of this research.

Table 1. Effect of retail display on TBARS accumulation in barrie foam packaged ground chuck patties.

	Open display					
	0 d		4 d		8 d	
Storage	VITE	CON	VITE	CON	VITE	CON
2d	.34^{a}	1.38^{b}	1.11^{b}	1.53^{b}	1.23^{b}	2.92^{c}
4d	.31^{a}	1.84^{b}	.61^{a}	2.33^{b}	.95^{c}	2.39^{b}
6d	1.31^{ab}	1.80^{bc}	.75^{a}	2.03^{c}	2.07^{c}	3.19^{d}
8d	.38^{a}	1.25^{b}	.57^{a}	2.58^{c}	1.24^{d}	3.18^{e}
10d	1.01^{a}	2.58^{b}	.72^{a}	2.76^{bc}	.89^{a}	3.23^{c}

12d	.90[a]	1.87[b]	.86[a]	2.80[d]	1.58[b]	3.52[d]
14d	1.15[a]	2.26[b]	1.16[a]	2.75[bc]	1.23[a]	3.33[c]
[a,b,c,d]Means in the same row are significantly different (P<.05) if letters differ.						

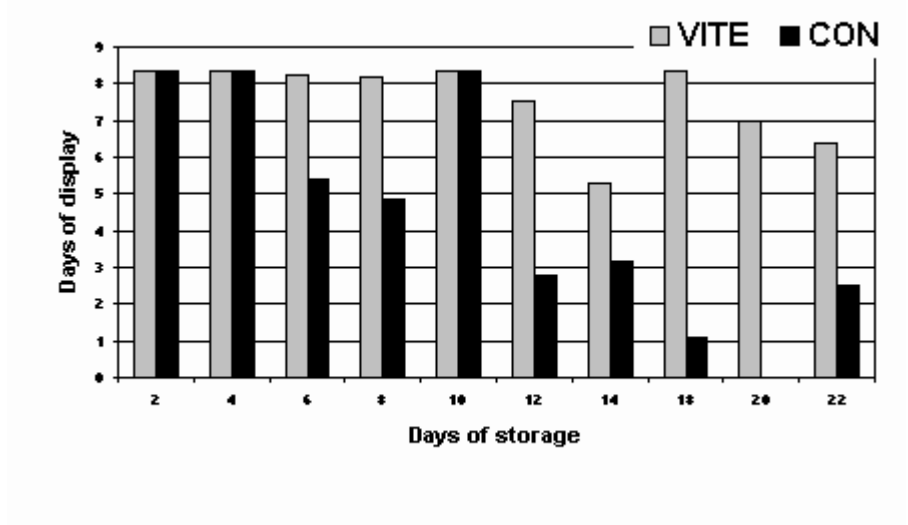

Figure 1. Comparison of lean color scores for Peelable VSP packaged top loin steaks represented as days of display to reach unacceptable score.

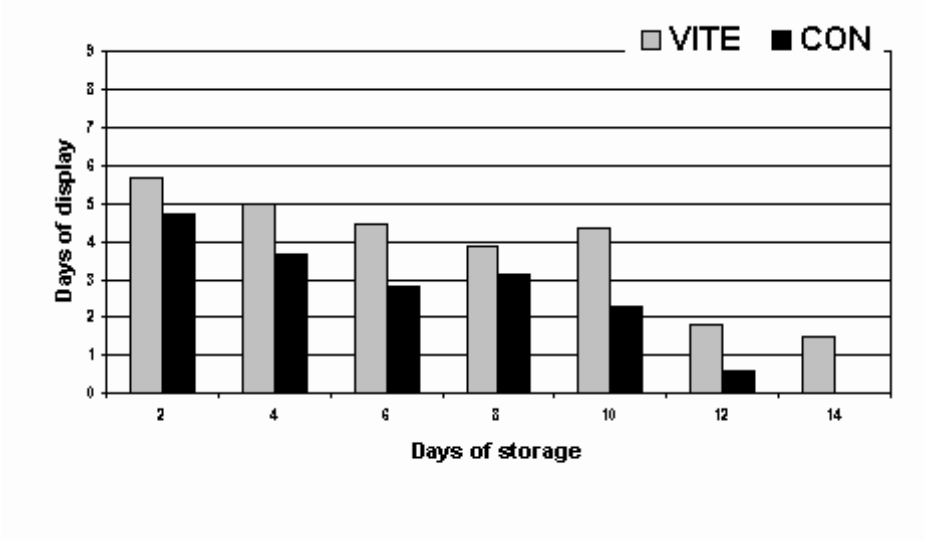

Figure 2. Comparison of overall acceptance scores for barrier foam packaged ground chuck patties represented as days of display to reach unacceptable score.

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