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COMPARISON OF VITAMIN E, NATURAL ANTIOXIDANTS AND ANTIOXIDANT COMBINATIONS ON THE LEAN COLOR AND RETAIL CASE-LIFE OF GROUND BEEF PATTIES

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Story in Brief

Beef trimmings from cattle supplemented 0 or 500/IU/hd/d of α–tocopherol acetate were obtained and divided into the following treatment groups: Control (CON), Vitamin E (VITE), Duralox (DURA) and Vitamin E/Duralox combination (COMBO). Trimmings were initially ground using a 0.50 in diameter plate. Duralox™ natural antioxidant was added to half of the non-vitamin E supplemented product and to half of the vitamin E supplemented product at 0.25% of the meat weight. After coarse grinding the treatment groups were vacuum packaged and stored for 5 d prior to being finely ground twice with a 0.13 in grinding plate. Ground beef patties (approximately 0.25 lb) were placed on foam trays and overwrapped with oxygen permeable film. Packages were displayed for 5 d at 36°F in retail display cases. Twice daily, objective and subjective measurements of lean color were taken. Lipid oxidation was measured immediately following the initial grind and at 0, 2, and 4 d of display. CON patties exhibited increased oxidation values across the entire display period while VITE, COMBO and DURA treatments did not differ. Patties from treatment groups VITE and COMBO maintained their red lean color for a longer portion of the display period than did their CON and DURA counterparts. Results of this study suggest that feeding supplemental vitamin E can be used to prolong beef color and case-life.

Key Words: Vitamin E, Case-life, Natural Antioxidants, Duralox™ , Ground Beef

Introduction

Consumers are able to detect differences in color among beef products at the retail level and make purchasing decisions based on those differences. It has been estimated that 2 to 20% of all products are discounted, discarded or further processed due to discoloration and consumer perceptions of the product being rancid (Sherbeck et al., 1995). Retailers are often forced to increase the price of all of their beef products in order to compensate for the monetary loss associated with discounting and discarding beef products. This could attribute to the fact that the beef industry has lost more than 25% of their market share since 1976. If this trend continues, it is expected that they will control only 26 total percent of market share by the year 2005 (Purcell, 1997). In order for the beef industry to regain lost market share it will be imperative to provide the consumer with a fresh bright cherry red

product.

The bright cherry red color that is associated with freshness is caused when the meat surface is exposed to oxygen and becomes oxygenated. After the product "blooms", or becomes fully oxygenated, pigments start to oxidize to the metmyoglobin state. Once 70% of the myoglobin becomes oxidized the meat surface becomes discolored or brown. Meat becomes oxidized after it is exposed to oxygen for 30 min and continues for about 3 d when displayed in a retail environment (Smith et al., 1996).

Recent research indicates that natural antioxidant supplementation helps improve the case-life of beef by delaying the onset of oxidation. Feeding elevated levels of vitamin E during the finishing phase has shown to reduce lipid oxidation by serving as a free radical scavenger (Chan et al., 1998). There has also been work done suggesting that natural antioxidants such as rosemary, sage and ascorbic acid can also prolong beef shelf life and help maintain the red color that is associated with a fresh product. Research done by Wong et al. (1995) concluded that vitamin E can be combined with other natural antioxidants such as rosemary and sage to further prevent the onset of lipid oxidation. The purpose of this project is to determine if natural antioxidants, synthetic antioxidants and antioxidant combinations (vitamin E and Duralox™) are effective in prolonging acceptable lean color and increasing the case-life of beef products.

Materials and Methods

Meat Samples. Beef trimmings from cattle supplemented with either 0 or 500 IU/hd/d of α -tocopherol acetate, consisting of approximately 85% lean, were obtained from a commercial fabrication facility. Treatment groups were individually coarse ground using a 0.49 in diameter plate before Duralox™ , a natural antioxidant, was added to both vitamin E-supplemented and non-vitamin E-supplemented ground trimmings at 0.25% of the total meat weight. Treatments supplemented with Duralox™ were then allowed to mix for a period of 10 min. The coarse ground product was then stuffed into chubs, vacuum packaged and stored (41^{o}F) in the dark for a period of 5 d. Following a 5-d storage period, the coarse ground product was finely ground twice through a .13 in plate to ensure even fat distribution. Ground beef patties (approximately 0.25 lb) were formed using a plastic patty former and placed on foam trays without absorbent pads and overwrapped with oxygen permeable film. Each treatment group was packaged separately and 25 patties comprised each group. Two 10-g samples were removed from each treatment group following the initial grind and frozen (□4^{o}F) for subsequent analysis of thiobarbituric acid concentration (TBARS). Additionally, duplicate samples were also taken on d 0, 2 and 4 of retail display, and frozen to -4^{o}F for further analyses of thiobarbituric acid concentration. Packages were placed in a commercial

display case under cool-white florescent light (1,600 to 1,900 lux) at a temperature of 36^{o}F for 6 d of retail display. Packages were randomly arranged in the display case at the beginning of each day. Twice daily (8:00 a.m. and 4:30 p.m.) a trained three member panel visually evaluated each of the samples on each display day for the following attributes: lean color (8 = bright cherry-red, 1 = extremely dark brown), fat color (8 = creamy white, 1 = dark-brown or green), percent discoloration (7 = none, 1 = complete) and overall appearance (7 = extremely desirable, 1 = extremely undesirable) (Sanders et al., 1997). Overall acceptability scores were used to measure the combined effects of all of the attributes and to determine consumer acceptability of the product.

Thiobarbituric Acid Analysis. Duplicate samples were removed from ground beef patties on d 0, 2 and 4 d of display for Thiobarbituric Acid Analysis (TBA). The TBA procedure was performed using the test procedure outlined by Witte et al. (1970). The following modifications were made to the procedure: a 10 gram sample was extracted, and 30 ml of the slurry was centrifuged at 3000 RPM for 30 min prior to filtration. The results were recorded as thiobarbituric acid reactive substances (TBARS), which represent mg malonaldehyde (MDA) equivalents per kg of fresh beef.

Statistical Analysis. The least squares means option of the General Linear Model procedure of the SAS program (SAS, 1985) was used to compare means for each treatment over the entire display period as well as each treatment by day interaction. Acceptability ranges of objective and subjective ratings for lean color and overall acceptability were calculated using regression equations to determine the number of hours required to reach a score of 4.5 or less. The frequency procedure of the SAS program was performed to determine how many packages reached scores of 4.5 or less (i.e., unacceptable) per treatment per day in order to calculate how many packages were considered unacceptable per day.

Results and Discussion

***Lipid Oxidation*.** Thiobarbituric acid reactive substances (TBARS) were used to measure the amount of lipid oxidation prior to storage and on d 0, 2 and 4 of display. Patties representing the CON group exhibited the highest ($P<.05$) mean TBARS value for the entire display period when compared with VITE, COMBO and DURA (Table 1).

Subjective Color Analysis. Mean panelist color score ratings indicated that patties representing the VITE and COMBO treatments maintained a more desirable ($P<.05$) lean color for the entire display period when compared with their CON and DURA counterparts (Table 2). This supports the findings of Sanders et al., (1997) which concluded that steaks from steers supplemented with vitamin E were brighter ($P<.05$) than steaks from non-supplemented cattle. Additionally, the VITE, DURA and COMBO

treatments extended the amount of time required to reach a lean color score of 4.5, unacceptable lean color, by 0.94, 0.44 and 0.54 d, respectively (Figure 1). At 2 d of display, 100% of CON and 40% of DURA packages reached a lean color score of 4.5 compared with 0% for both VITE and COMBO packages. These data support the findings of Sherbeck et al. (1995), who indicated that 17.9% of CON ground chuck products were discounted while only 2.3% of VITE packages reached a color associated with discounts. The VITE treatment had the most desirable mean score for fat color ($P<.05$) when compared with the CON, COMBO and DURA treatments (Table 2). Patties representing the VITE and COMBO treatments showed significantly better ($P<.05$) mean ratings for percentage of discoloration when compared with the CON and DURA groups (Table 2). Overall appearance scores also indicated that treatment groups VITE and COMBO displayed more desirable ratings ($P<.05$) across the entire display period when compared with CON and DURA (Table 2). In addition, treatments VITE, DURA and COMBO extended the overall caselife of the ground beef patties by 1.36, 0.22 and 0.11 d, respectively (Figure 2). At 2 d of display, 20% of VITE, 100% of CON and 40% of DURA packages had reached an overall appearance score compared with 0% of COMBO patties.

Objective Color Measurements. Ground beef patties representing the VITE treatment had more undesirable ($P<.05$) L* values throughout the entire display period when compared with the COMBO, CON, and DURA treatments (Table 3). This could be attributed to the fact that certain shades of brown are often lighter than deep shades of red. This also contradicts the results of a previous experiment that indicated the CON treatment exhibited lower ($P<.05$) L* values than its opposing treatment groups. Minolta a* values indicated that the VITE and COMBO treatments displayed a more desirable ($P<.05$) red color than the CON and DURA patties (Table 3). The COMBO group had the highest ($P<.05$) b* mean value when compared with VITE, CON and DURA patties (Table 3).

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Table 1. Comparison of mean TBARS values for each treatment across all display days.

Treatment	Mean TBARS values	SEM
Control	.46[a]	.03
Duralox	.11[b]	.03
Vitamin E	.19[b]	.03
Combo	.11[b]	.03

[a,b]Means with differing superscripts within columns are not significantly different (P<.05).

Table 2. Comparison of mean subjective color values for each treatment across all display days.

		Treatment			
Attribute	Control	Duralox	Vitamin E	Combo	SEM
Lean color	3.72[b]	3.84[b]	4.98[a]	4.90[a]	.25
Fat color	3.64[d]	3.75[c]	5.01[a]	4.58[b]	.03
Percent dscoloration	4.28[b]	4.29[b]	5.54[a]	5.11[a]	.27
Overall apearance	3.63[b]	3.74[b]	4.84[a]	4.48[a]	.23

[a,b,c,d]Numbers with differing superscripts within rows are significantly different (P<.05).

Table 3. Comparison of mean objective color measurement values for each treatment across all display days.

	Treatment				
Attribute	Control	Duralox	Vitamin E	Combo	SEM
L*	48.36[a]	48.27[a]	47.16[b]	48.24[a]	.21
a*	12.51[b]	12.64[b]	15.06[a]	15.46[a]	.54
b*	8.32[b]	9.00[ac]	8.63[bc]	9.33[a]	.09

[a,b,c]Means with differing superscripts within rows are not significantly different (P<.05).

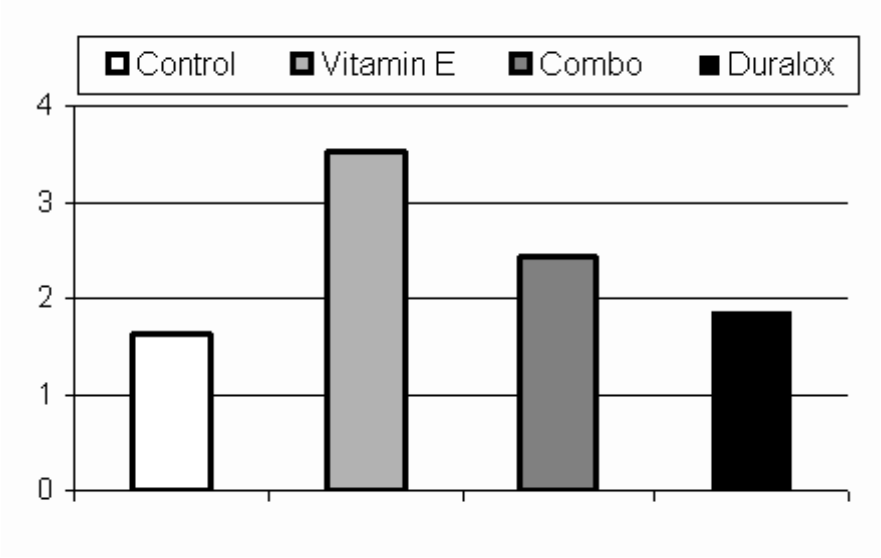

Figure 1. Comparison of the number of days required for each treatment to reach lean color score of 4.5.

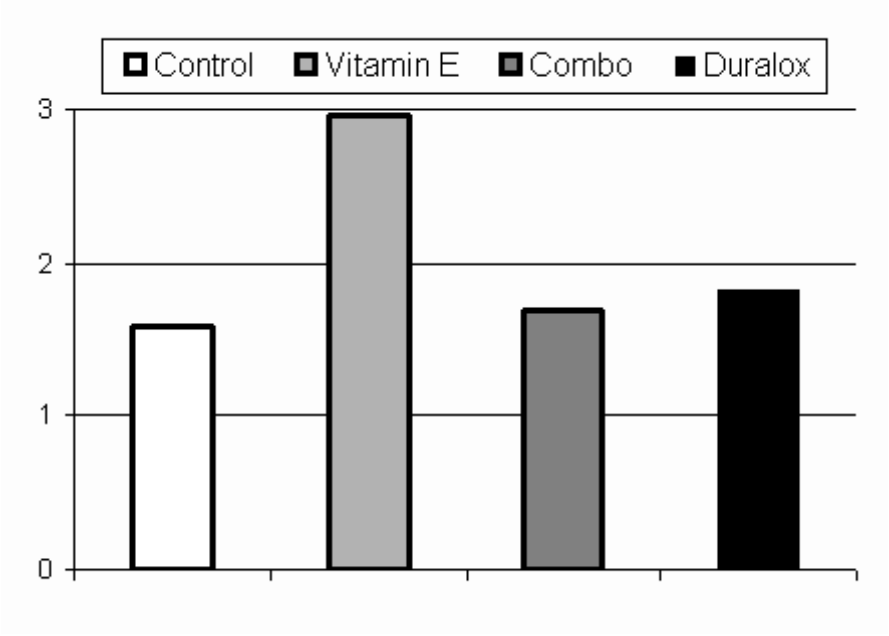

Figure 2. Comparison of the number of days required for each treatment group to reach an overall appearance score of 4.5.

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