INFLUENCE OF DIETARY SUPPLEMENTATION OF MODIFIED TALL OIL AND VITAMIN E ON PORK CHOP QUALITY, DISPLAY COLOR STABILITY, WARNER-BRATZLER SHEAR, AND SENSORY PANEL TRAITS

A. T. Waylan, P. R. O'Quinn, J. A. Unruh, R. D. Goodband, J. L. Nelssen, J. C. Woodworth, M. D. Tokach[1], and S. I. Koo[2]

Summary

Seventy-two crossbred (PIC) barrows were used to determine the influence of feeding modified tall oil (MTO, 0 or .5% of diet) and vitamin E (0, 10, or 50 IU/lb of feed) on display color stability, Warner-Bratzler shear, and sensory panel traits of pork chops. Feeding MTO in combination with high levels of vitamin E to pigs during both the growing and finishing phases improved display color stability and delayed lipid oxidation of the pork loin chops without affecting tenderness and sensory evaluations. Therefore, feeding swine MTO (.5%) with high levels of vitamin E (50 IU/lb of feed) can increase the shelf-life stability of pork and potentially reduce monetary losses from deteriorated product.

(Key Words: Modified Tall Oil, Vitamin E, Pork Chop.)

Introduction

Modified tall oil (MTO) is a by-product of the pulp and paper industry and has a high content of conjugated linoleic acid (66.6%). Supplementation of swine diets with MTO has decreased backfat, increased lean percentage, and increased belly firmness. Vitamin E is an effective lipid-soluble antioxidant that protects cell membranes from oxidation and deterioration. Feeding MTO to pigs may assist in the tissue absorption of vitamin E. Therefore, the combination of MTO and vitamin E potentially could improve pork quality characteristics through enhanced vitamin E uptake. The objective of this study was to determine the influence of diet supplementation of MTO and vitamin E on pork display and sensory characteristics.

Procedures

In a 2 × 3 factorial arrangement, 72 crossbred (PIC) barrows were blocked by initial BW (100 lb) and ancestry and randomly allotted to one of six dietary treatments. Two pigs were fed in each pen with six replicate pens per treatment. The main effects were two levels of MTO (0 or .5% of diet) and three levels of dl-α-tocopheryl acetate (0, NE; 10, LE; and 50 IU/lb of feed, HE). The corn-soybean meal-based growing diet was fed from 100 lb to 180 lb BW and was formulated to contain 1.0% lysine. The corn-soybean meal-based finishing diet was fed from 180 lb to 260 lb BW and was formulated to contain .75% lysine.

Pigs were harvested humanely using standard industry procedures approved by the Kansas State University Animal Care Committee. At 28 h postmortem, the right side of each carcass was fabricated into the wholesale cuts of ham, loin, belly, spareribs, and shoulder. From the wholesale loin, a 9-in. boneless loin was removed from the tenth rib and posterior, vacuum packaged, and aged for an additional 6 d at 39°F. At 7 d postmortem, each loin was faced at the tenth rib surface and cut into 1-in. chops. Cutting anterior to posterior, chops were assigned as follows: 1) display color, 2) 0 d thiobarbituric acid reacting substance (TBARS), 3)

[1]Northeast Area Extension Office, Manhattan, KS.
[2]Department of Human Nutrition.

4 d TBARS, 4) sensory panel, and 5) Warner-Bratzler shear force (WBS).

Display chops were packaged in PVC film and displayed at 36°F under continuous lighting. Visual display color was evaluated by nine panelists trained according to meat color evaluation guidelines to the nearest .5. The 5-point color scale consisted of 1 = bright grayish-pink or reddish-pink, 2 = grayish-pink or reddish-pink, 3 = slightly dark pink/red to brown, 4 = moderately dark pink/red to brown, and 5 = dark pink/red to brown. A score of 3.5 indicated a point when the product had sufficient visual color deterioration to potentially be unsaleable. Instrumental spectral data for ratio of reflectance %R630/%R580 and CIE L*a*b* values were measured. Color was evaluated on 0, 1, 2, 4, 6, and 8 d of display.

The extent of lipid oxidation was measured as TBARS at 0 and 4 d of display. The 0-d TBARS chops were cut, immediately packaged, crust frozen at -40°F for 30 min, vacuum packaged, and stored at -40°F. The 4-d TBARS chops were displayed in the cases for 4 d as previously described and then stored at -40°F. Values for duplicate samples from each chop were averaged and expressed as mg malonaldehyde/kg DM.

The pork chops for WBS were thawed, weighed, and cooked to an internal temperature of 160°F in a Blodgett dual-air-flow oven. Chops were cooled at room temperature (70°F) for 1 h, reweighed, and subsequently chilled before six .5-in.-diameter cores were removed parallel to the muscle fibers and sheared perpendicular to the muscle fibers using a WBS attachment on an Instron Universal Testing Machine. Percentages of thawing and cooking losses were calculated.

The pork chops for sensory evaluation were cooked to an internal temperature of 160°F. Chops were removed from the oven and immediately cut into cubes of .5 in. × .5 in.×cooked chop thickness. A trained seven-member descriptive-attribute sensory analysis panel evaluated two samples from each chop. Six sensory traits of myofibrillar tenderness, connective tissue amount, overall tenderness, juiciness, flavor intensity, and off-flavor were evaluated on an 8-point scale.

The experimental design was a 2 × 3 factorial in a randomized complete block design using initial weight and ancestry to establish blocks. Statistical analyses were performed with the GLM procedure of SAS using the pen mean as the experimental unit. For comparisons pertaining to measurements over time, a split-plot analysis using the Mixed procedure of SAS was conducted to account for repeated measurements that included the fixed effects of treatment and display day. All main effect and interaction means were separated ($P<.05$) using the Least Significant Difference procedure when the respective F-tests were significant ($P<.05$).

Results and Discussion

An MTO × vitamin E × day of display interaction ($P = .02$) was observed for visual color (Figure 1). As expected, the visual panel color scores revealed a decline (increased score, $P<.01$) in fresh pork color over each day of display. At 0 and 1 d, no differences ($P>.05$) were observed among treatments. At 2 d, chops from pigs fed MTO with HE had lower ($P<.05$) color values (less deterioration) than chops from pigs fed MTO with NE. At 4 d, LM chops from pigs fed MTO with HE had less deterioration ($P<.05$) than chops from pigs fed MTO with NE, no MTO with LE, and no MTO with HE. In addition, chops from pigs fed no MTO with NE and MTO with LE had less deterioration ($P<.05$) than chops from pigs fed MTO with NE. At 6 d, chops from pigs fed MTO with HE had less deterioration ($P<.05$) than chops from pigs fed MTO with NE, no MTO with NE, no MTO with LE, and no MTO with HE. Also, chops from pigs fed MTO with LE, no MTO with NE, and no MTO with HE had less deterioration ($P<.05$) than chops from pigs fed MTO with NE. At 6 d, the MTO with HE combination was the only treatment that sustained a mean score less than 3.5. A score of 3.5 or less indicates acceptable display color that should not be discounted in a typical retail case. At 8 d,

chops from pigs fed MTO with HE had less deterioration (P<.05) than chops from all other treatments. Additionally, chops from pigs fed MTO with LE and no MTO with HE had less deterioration (P<.05) than chops from pigs fed MTO with NE. Overall, feeding pigs MTO with HE delayed pork chop display color deterioration.

Instrumental display data are presented as MTO × vitamin E interaction means in Table 1. Day of display main effect means for chop display values are presented in Table 2. The chop display L* values were similar (P = .54) for pigs fed MTO (56.92) and no MTO (57.33). The vitamin E × day of display interaction (P<.001) means for CIE L* values are presented in Figure 2. At 0, 1, 2, and 4 d of display, no differences (P>.05) for L* were observed among levels of vitamin E. At 6 and 8 d of display, chops from pigs fed HE had lower (P<.05) L* values (were darker) than chops from pigs fed NE or LE. Overall, a darker color was maintained over the display period for chops from pigs fed HE. This may be associated with the visual color stability observed in chops from pigs fed MTO with HE.

The chop display a* values, an indication of redness, were similar (P = .76) for chops from pigs fed MTO (7.05) and no MTO (6.96). However, chops from pigs fed HE (7.47) had higher (P<.05) a* values than chops from pigs receiving NE (6.52). Overall, a* values declined as days of display increased. For b* values, an indication of yellowness, no differences (P > .10) were detected among treatments. Display b* values were higher early in the display period (0-2 d) than later (4-8 d).

An MTO × vitamin E interaction (P<.05) was detected for display ratio of reflectance values (Table 1). A higher (P<.05) ratio of reflectance (indicator of more oxymyoglobin) was observed for chops from pigs fed MTO with HE than chops from pigs fed no MTO with LE, no MTO with HE, and MTO with NE. Also, chops from pigs fed MTO with LE and no MTO with NE had higher (P<.05) ratio values than chops from pigs fed MTO with NE. Ratio of reflectance values for chops decreased (P<.05) at each evaluation period. The highest numerical ratio of reflectance indicated that feeding pigs MTO with HE may result in a higher ratio of oxymyoglobin to metmyoglobin. A higher oxymyoglobin concentration would be associated with a more desirable bright reddish-pink color (less deterioration).

An interaction of MTO × vitamin E was detected (P<.05) for TBARS, which is an indicator of lipid oxidation (Table 1). The chops from pigs fed MTO with HE had numerically the lowest values and had lower (P<.05) TBARS values than chops from pigs fed MTO with NE. The TBARS values of chops at 0 d were lower (P<.05) than those of chops displayed for 4 d (Table 2).

Sensory panel and WBS traits are given in Table 3. No differences (P>.05) were detected for these palatability-related traits.

Feeding pigs MTO with high levels of vitamin E appears to preserve the integrity and delay oxidation of cellular components. As a result, display color stability of pork chops is improved.

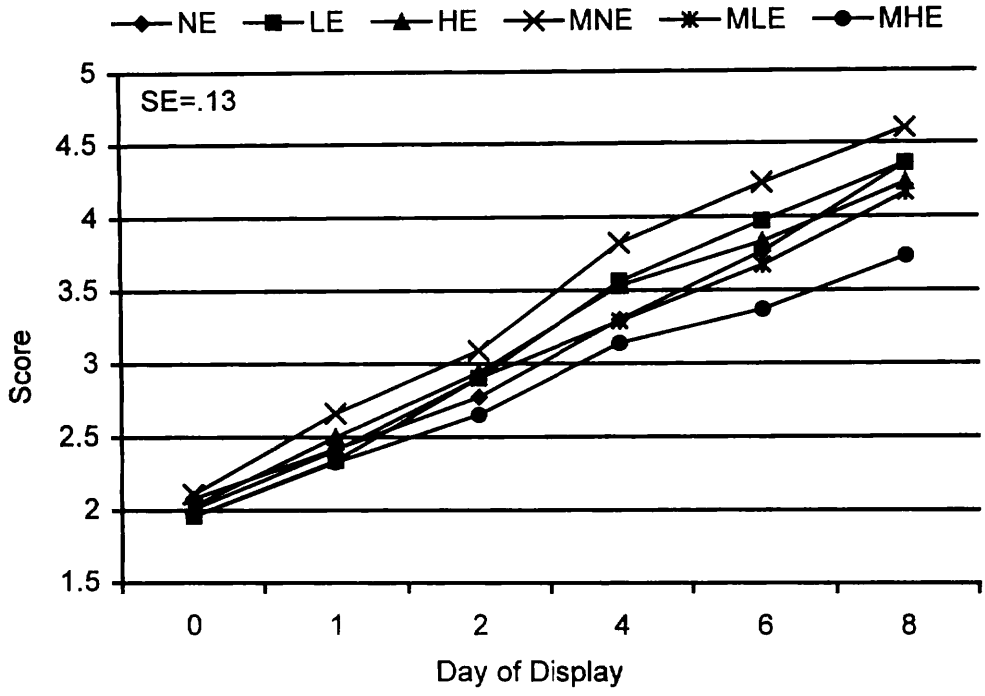

Figure 1. Influence of Modified Tall Oil, Vitamin E Supplementation, and Day of Display on Visual Color Scores of Pork Loin Chops (NE = no MTO, no vitamin E; LE = no MTO, 10 IU/lb vitamin E; HE = no MTO, 50 IU/lb vitamin E; MNE = MTO, no vitamin E; MLE = MTO, 10 IU/lb vitamin E; MHE = MTO, 50 IU/lb vitamin E).

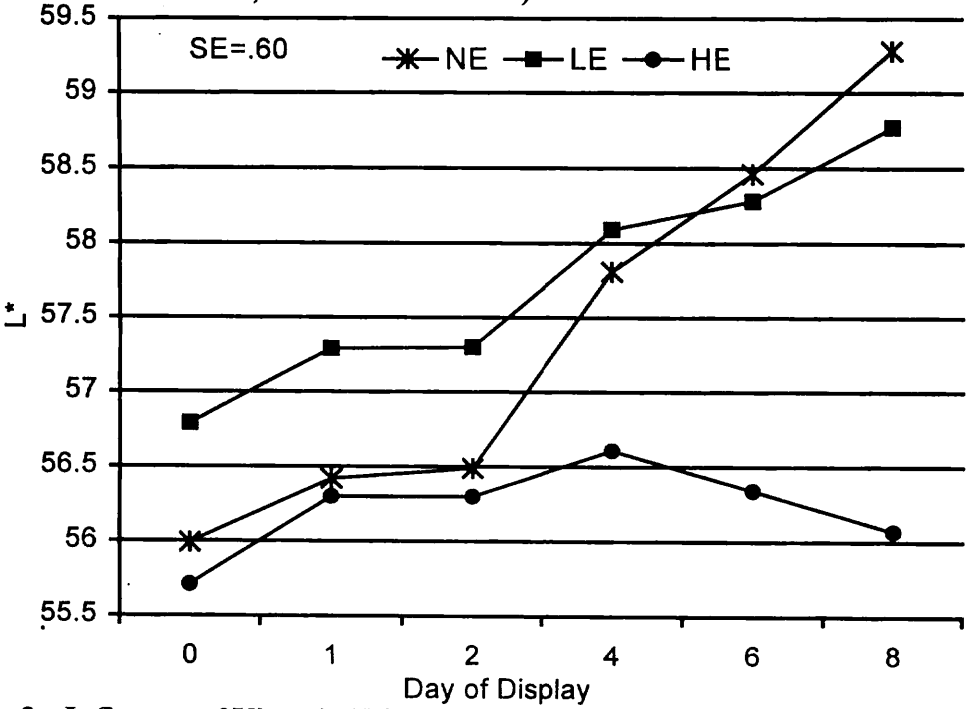

Figure 2. Influence of Vitamin E Supplementation and Day of Display on L* Values of Pork Loin Chops (NE = no vitamin E; LE = 10 IU/lb vitamin E; HE = 50 IU/lb vitamin E).

Table 1. Influence of Modified Tall Oil and Vitamin E Supplementation on Display Instrumental Color and TBARS[e] Measurements of Pork Loin Chops

	Supplementation[a]						
MTO, %	0	0	0	.5	.5	.5	
Item Vit. E	0	10	50	0	10	50	SE
Instrumental Color[b]							
L*[c]	56.50	58.57	56.93	58.32	56.93	55.52	.80
a*[d]	6.86	6.98	7.05	6.19	7.05	7.90	.32
b*	20.22	20.65	20.36	20.18	20.45	20.33	.21
%R630/%R580	2.11^{gh}	2.00^{fg}	2.07^{fg}	1.92^{f}	2.13^{gh}	2.25^{h}	.06
TBARS[e]	3.11^{fg}	3.18^{fg}	3.18^{fg}	3.41^{g}	3.07^{fg}	2.86^{f}	.10

[a]MTO = Modified tall oil and Vit. E = dl-α-tocopheryl acetate/lb feed.
[b]Measure of lightness (L*), redness (a*), yellowness (b*), vividness or intensity (saturation index), or indicator of the amount of oxymyoglobin present (ratio of reflectance %R630/%R580).
[c]Vitamin E × day of display interaction (See Figure 2).
[d]Pigs fed 50 IU vitamin E/lb of feed had higher ($P < .05$) values than pigs fed no vitamin E.
[e]Thiobarbituric acid reacting substance, mg malonaldehyde/kg DM.
[f,g,h]Means in the same row with a different superscript letter differ ($P < .05$).

Table 2. Influence of Day of Display on Instrumental Color and TBARS[c] Measurements of Pork Loin Chops

	Day						
Item	0	1	2	4	6	8	SE
Instrumental Color[a]							
L*[b]	56.16	56.67	56.70	57.50	57.69	58.04	.34
a*	8.66^{h}	8.37^{h}	7.63^{g}	7.45^{f}	5.77^{e}	4.15^{d}	.22
b*	21.50^{h}	21.12^{g}	20.60^{f}	19.30^{d}	19.61^{d}	20.06^{e}	.20
%R630/%R580	2.79^{d}	2.47^{e}	2.23^{f}	1.84^{g}	1.66^{h}	1.48^{i}	.04
TBARS[c]	.19^{d}	--	--	1.10^{e}	--	--	.11

[a]Measure of lightness (L*), redness (a*), yellowness (b*), or indicator of the amount of oxymyoglobin present (ratio of reflectance %R630/%R580).
[b]Vitamin E × day of display interaction (See Figure 2).
[c]Thiobarbituric acid reacting substance, mg malonaldehyde/kg dry matter.
[d,e,f,g,h,i]Means in the same row with a different superscript letter differ ($P < .05$).

Table 3. Influence of Modified Tall Oil and Vitamin E Supplementation on Pork Cookery, Warner-Bratzler Shear and Sensory Panel Evaluations

	Supplementation[a]						
MTO, %	0	0	0	.5	.5	.5	
Item Vit. E	0	10	50	0	10	50	SE
Thawing loss, %	2.57	2.72	2.92	2.69	2.61	2.74	.19
Cooking loss, %	25.23	27.22	27.63	26.79	25.67	27.10	.92
Shear force, lb	5.64	6.26	6.83	6.66	6.44	6.15	.17
Sensory Evaluation[b]							
Myofibrillar tenderness	6.43	6.16	5.86	6.14	6.02	6.26	.16
Connective tissue	7.59	7.55	7.47	7.65	7.57	7.60	.07
Overall tenderness	6.55	6.32	6.01	6.30	6.25	6.44	.16
Juiciness	5.33	5.21	5.25	5.35	5.15	5.32	.12
Flavor intensity	5.67	5.72	5.74	5.69	5.67	5.69	.06
Off-flavor	7.79	7.83	7.82	7.82	7.85	7.91	.07

[a]MTO = Modified tall oil and Vit. E = dl-α-tocopheryl acetate/lb feed.

[b]Scores of 1 to 8: myofibrillar/overall tenderness (5 = slightly tender, 6 = moderately tender, 7 = very tender); connective tissue (7 = practically none, 8 = none); juiciness (4 = slightly dry, 5 = slightly juicy); flavor intensity (5 = slightly intense, 6 = moderately intense); off-flavor (7 = practically none, 8 = none).