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Abstract

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Keywords

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EFFECTS OF MODIFIED TALL OIL, CHROMIUM NICOTINATE, AND L-CARNITINE ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF GROWING-FINISHING GILTS[1]

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Summary

A trial was conducted to investigate the interactive effects of modified tall oil (MTO), chromium nicotinate (CrNic), and L-carnitine on growth performance and carcass characteristics of finishing gilts. For the overall trial, MTO increased ADG and ADFI, and CrNic improved F/G. A CrNic × MTO interaction occurred for belly firmness; feeding CrNic in diets without MTO improved firmness, but feeding it in diets with MTO decreased firmness. Feeding L-carnitine did not have any beneficial effects on either growth performance or carcass characteristics. The results of this trial indicate that either CrNic or MTO will improve growth performance with minimal effects on carcass characteristics.

(Key Words: Modified Tall Oil, Chromium Nicotinate, L-Carnitine, Gilts.)

Introduction

Modified tall oil is an oily coproduct from the kraft (sulfate) paper process and contains high levels (~70%) of conjugated linoleic acid. Prior work at Kansas State University has shown MTO to be an effective carcass modifier in finishing swine in terms of reducing backfat and increasing carcass lean content. When fed in conjunction with high levels of vitamin E, MTO improves and maintains fresh pork color over time, delays lipid oxidation, and increases shelf life of the longissimus muscle. Earlier work has also shown that both CrNic and L-carnitine improve fresh pork color and may work synergistically. However, this earlier study did not evaluate the effects of CrNic and L-carnitine on the further stability of pork color. Modified tall oil, CrNic, and L-carnitine are all known to potentially improve growth performance and carcass characteristics in growing pigs, and all may play a role in the maintenance of pork color. Therefore, this study was undertaken to determine if feeding them in combinations would additively improve growth performance and carcass characteristics of finishing weight gilts.

Procedures

Procedures used in this experiment were approved by the Kansas State University Institutional Animal Care and Use Committee (Protocol No. 1525). A total of 80 crossbred gilts (initially 100 lb; PIC L326 or 327 × C22, Franklin, KY) was used. Pigs were blocked on the basis of initial weight and ancestry and randomly allotted to one of eight dietary treatments with five replicate pens per treatment.

Diets were fed in meal form in two phases (100 to 160 and 160 to 235 lb; Table 1). Modified tall oil was substituted for soybean oil on an equal weight basis, and

[1]Appreciation is expressed to Hercules, Inc., Wilmington, DE, for providing the modified tall oil used in this experiment and to Lonza, Inc., Fair Lawn, NJ, for providing the chromium nicotinate and L-carnitine and for partial financial support of this experiment.

[2]Northeast Area Extension Office, Manhattan, KS.

[3]Lonza, Inc., Fair Lawn, NJ.

CrNic and L-carnitine were mixed with the complete diet to achieve the experimental diets, which were arranged as a 2 × 2 × 2 factorial design with two levels of MTO (0 or 0.50%), two levels of CrNic (0 or 50 ppb), and two levels of L-carnitine (0 or 50 ppm). This is the first study to have supplemental oil in diets also containing MTO, and thus, gives insight into the ability of MTO to elicit biological responses when supplemental fat is also present.

Pigs were housed in an environmentally controlled finishing barn with two pigs in each 4 ft × 4 ft totally slatted-floored pen. They were allowed ad libitum access to feed and water through one single-hole self-feeder and a nipple waterer. Pigs were weighed every 14 d in order to determine ADG, ADFI, and F/G.

Pigs were slaughtered when their average weight reached 235 lb. Standard carcass measurements; visual analyses of the longissimus for coloring, marbling, and firmness; longissimus drip loss, and color spectrophotometry of the adipose tissue and longissimus muscle were determined for each pig at 28 h postmortem (drip loss = 48 h postmortem). During fabrication of the carcasses (26 h postmortem), bellies from the right sides of all pigs were removed and evaluated for firmness.

Data were analyzed as a randomized complete block. Pen was the experimental unit for all calculations. The GLM procedures of SAS were used for all analyses. The data were analyzed as a 2 × 2 × 2 factorial with main effects of MTO (0 or 0.50% of the diet), CrNic (0 or 50 ppb), and L-carnitine (0 or 50 ppm). The statistical model included main effects and all possible interactions of the main effects. Hot carcass weight was used as a covariate in the statistical model for carcass analyses, and belly weights and lengths were used as covariates in the statistical model for analyses of belly firmness.

Results and Discussion

Growth Data. From 160 to 235 lb, pigs fed CrNic grew faster (P = .09) and were more efficient (P = .08) compared to pigs fed other dietary treatments (Table 2). Pigs fed MTO consumed more feed (P = .06) during this same time period; however, feeding L-carnitine and CrNic together reduced (P = .07) ADFI during this final phase of growth. These results led to overall increases in ADG (P = .03) and ADFI (P = .10) for pigs fed MTO and an improvement in feed efficiency (P = .02) for pigs fed CrNic. Feeding L-carnitine did not elicit any growth performance responses in this group of growing-finishing gilts.

Carcass Characteristics. Dietary treatment combinations did not affect (P>.10) carcass characteristics such as backfat thickness, longissimus muscle area, percentage lean, drip loss, shrink loss, or firmness and marbling of the longissimus (Table 3). Feeding L-carnitine decreased visual color appraisal of the longissimus, but improved it when fed in conjunction with MTO (P = .10). The combination of MTO and CrNic resulted in an interaction (P = .07) for adipose a* values; CrNic reduced a* values in diets not containing MTO, but increased them in diets containing MTO. The response in adipose a* values also affected (P = .04) hue angle and a*/b* values. Thus, CrNic reduced the redness (a* values) of fat by itself, but increased it in diets containing MTO. These a* values are indicative of a slight browning or discoloration, though it probably was not detectable by visual appraisal. However, the whiteness of the fat (L* values) was not affected (P>.10) by dietary treatment. Feeding CrNic alone improved belly firmness, but feeding it with MTO decreased firmness (P<.05). Although both MTO and CrNic alone may improve belly firmness, the responses to MTO appeared to be substantially larger.

The relatively small values for belly firmness may be related to the leanness of the gilts, the light market weights, the effects of added fat, or a combination thereof. Even though the magnitude of the response was small, MTO still evoked a belly-firming effect when fed in conjunction with additional dietary fat. Because of the relatively light slaughter weights, the gilts still should

have had high protein deposition versus fat deposition; thus, this trial also gives insight into the ability of MTO to elicit biological responses when fed to lightweight, high-lean gilts. This is of importance, because most of the increases in percentage lean from feeding MTO have come from reductions in backfat and not from increases in muscling.

Aside from potential improvements in belly firmness from CrNic and MTO, feeding CrNic, L-carnitine, or MTO did not elicit any beneficial carcass responses in the current experiment. Feeding either MTO (ADG and ADFI) or CrNic (F/G) alone may improve growth performance, but L-carnitine was not beneficial in the diets of growing-finishing pigs in this trial.

Table 1. Composition of Basal Diets (As-Fed Basis)

Ingredient, %	Growing[a]	Finishing[b]
Corn	66.50	76.93
Soybean meal (46.5% CP)	27.70	18.53
Soybean oil[c]	3.00	2.00
Limestone	1.04	.88
Monocalcium phosphate	.88	.78
Salt	.35	.35
Vitamin premix	.25	.25
Trace mineral premix	.15	.15
Antibiotic[d]	.13	.13
Total	100.00	100.00

[a]Diets were fed from 100 to 160 lb and were formulated to contain 1.00% lysine, .65% Ca, and .55% total P.

[b]Diets were fed from 160 to 235 lb and were formulated to contain .75% lysine, .55% Ca, and .50% total P.

[c]Modified tall oil was substituted on an equal weight basis for soybean oil; CrNic and L-carnitine were incorporated into the complete diet to give the additional dietary treatments.

[d]Provided 100 g/ton tylosin.

Table 2. Growth Performance of Pigs Fed Modified Tall Oil, Chromium Nicotinate, or L-Carnitine[a]

	MTO, %												
	0	0	0	0	.50	.50	.50	.50					
	CrNic, ppb												
	0	50	0	50	0	50	0	50					
	L-Carnitine, ppm									Probability Values (P =)			
Item	0	0	50	50	0	0	50	50	CV	CrNic	L-Carn.	MTO	Interactions[b]
100 to 160 lb													
ADG, lb	2.23	2.05	2.19	2.21	2.17	2.29	2.26	2.29	7.48	.95	.33	.13	.15
ADFI, lb	5.22	4.85	5.13	5.21	5.19	5.07	5.20	5.15	8.51	.40	.52	.72	.36
F/G	2.34	2.36	2.34	2.35	2.39	2.21	2.31	2.26	6.60	.31	.80	.25	.19
160 to 235 lb													
ADG, lb	1.92	2.03	1.95	2.01	2.02	2.17	1.99	2.11	9.97	.09	.77	.15	.68
ADFI, lb	5.43	5.49	5.55	4.92	5.54	6.03	5.84	5.52	11.22	----	----	.06	[c]
F/G	2.86	2.74	2.85	2.49	2.75	2.78	2.97	2.62	12.74	.08	.68	.69	.17
100 to 235 lb													
ADG, lb	2.06	2.04	2.06	2.11	2.09	2.23	2.13	2.19	6.27	.19	.70	.03	.28
ADFI, lb	5.48	5.38	5.52	5.18	5.54	5.67	5.71	5.42	6.64	.20	.60	.10	.17
F/G	2.67	2.65	2.67	2.47	2.65	2.54	2.70	2.47	7.02	.02	.41	.64	.20

[a]Values are means of two pigs per pen and five replicate pens per dietary treatment.

[b]Refers to the P-value of the most significant of all possible interactions (2- and 3-way).

[c]Chromium nicotinate × L-carnitine, P = .07; other interactions, nonsignificant, P>.35.

Table 3. Carcass Characteristics of Pigs Fed Modified Tall Oil, Chromium Nicotinate, or L-Carnitine[a,b]

	MTO, %												
	0	0	0	0	.50	.50	.50	.50					
	CrNic, ppb												
	0	50	0	50	0	50	0	50					
	L-Carnitine, ppm									Probability Values (P =)			
Item	0	0	50	50	0	0	50	50	CV	CrNic	L-Carn.	MTO	Int.[c]
Shrink loss, %	1.15	1.16	1.20	1.04	1.05	1.24	1.25	1.18	36.80	.99	.83	.71	.46
Dressing %	74.15	74.49	74.30	74.95	74.64	73.81	74.81	74.63	1.41	----	.12	----	[d]
Backfat, in.													
First rib	1.43	1.40	1.43	1.49	1.43	1.44	1.41	1.43	8.18	.96	.71	.47	.73
Last rib	.76	.70	.78	.84	.76	.78	.79	.79	8.65	.87	.25	.64	.41
Last lumbar	.68	.63	.67	.69	.68	.72	.68	.67	12.56	.76	.41	.58	.65
10^{th} rib	.65	.59	.64	.72	.69	.66	.63	.65	15.00	.86	.83	.39	.30
Average[e]	.96	.91	.96	1.00	.96	.98	.96	.96	7.62	.84	.87	.99	.64
LMA, in^2	5.70	5.86	5.85	5.96	6.01	6.11	6.08	6.30	7.22	.44	.39	.15	.70
Lean, %[f]	53.97	54.96	54.35	53.52	54.07	54.41	54.76	54.98	3.06	.79	.50	.79	.45
Longissimus													
Visual color[g]	2.70	2.70	2.40	2.00	2.10	2.10	2.30	2.15	16.88	.49	----	----	[h]
Firmness[g]	2.35	2.35	2.50	2.10	2.25	2.30	2.50	2.30	18.10	.60	.43	.40	.31
Marbling[g]	2.15	2.00	2.20	1.90	1.85	1.95	2.25	1.95	15.60	.16	.29	.80	.21
L*[i]	58.72	58.78	58.71	60.99	62.25	60.05	58.27	59.52	7.24	.80	.68	.60	.23
a*[i]	8.47	8.70	8.54	8.43	8.26	8.77	8.76	8.78	15.95	.71	.86	.81	.64
b*[i]	15.70	16.48	16.40	17.03	16.76	16.91	16.11	16.96	9.26	.22	.74	.56	.35
Hue angle[i]	61.96	62.29	62.61	63.72	63.97	62.75	61.56	62.59	4.01	.70	.88	.93	.15
Saturation index[i]	17.86	18.64	18.50	19.02	18.70	19.07	18.35	19.11	10.20	.32	.77	.62	.59
a*/b*[i]	.53	.53	.52	.50	.49	.52	.54	.52	10.54	.68	.89	.92	.15

Table 3. Continued

%R630/%R580[i]	2.45	2.44	2.45	2.42	2.37	2.47	2.50	2.51	14.09	.87	.72	.84	.69
Drip loss, %	4.23	5.31	4.22	5.61	5.85	5.52	5.47	6.10	25.18	.35	.27	.53	.26
Adipose													
L*[i]	83.76	83.89	84.09	83.82	84.33	84.41	85.15	84.19	1.85	.61	.65	.20	.46
a*[i]	1.52	.77	1.59	1.33	1.15	1.80	1.13	1.57	60.52	----	.73	----	[j]
b*[i]	10.31	9.24	9.32	10.17	9.91	10.17	10.19	9.79	14.82	.85	.93	.58	.17
Hue angle[i]	81.73	85.53	81.38	83.17	83.95	80.51	83.91	81.80	4.46	----	.78	----	[k]
Saturation index[i]	10.42	9.28	9.40	10.27	10.00	10.26	10.28	9.88	15.43	.83	.94	.59	.18
a*/b*[i]	.15	.08	.15	.12	.11	.17	.11	.14	53.47	----	.78	----	[k]
%R630/%R580[i]	1.36	1.29	1.31	1.34	1.32	1.32	1.32	1.30	4.47	.52	.67	.71	.16
Belly firmness, in.													
Initial	4.43	4.75	5.05	5.60	7.35	6.70	8.18	5.20	23.74	----	.81	----	[l]
1 min	4.13	4.33	4.65	5.08	6.45	5.95	7.33	4.75	21.71	----	.82	----	[l]
5 min	3.75	3.98	4.33	4.88	5.85	5.43	6.50	4.48	19.02	----	.91	----	[l]

[a]Values are means of two pigs per pen and five replicate pens per dietary treatment.

[b]Hot carcass weight was used as a covariate in the statistical model for carcass characteristics, and belly weights and lengths were used as covariates in the statistical model for belly firmness.

[c]Refers to the probability value of the most significant of all possible interactions (2 and 3-way).

[d]Modified tall oil × CrNic, P = .07; other interactions, nonsignificant, P>.10.

[e]Average backfat is the average of the first and last rib and last lumbar backfats.

[f]Lean percentage was derived from NPPC (1991) equations with 5% fat in the carcass.

[g]Scale of 1 to 5: 2 = grayish pink, soft and watery, or traces to slight; 3 = reddish pink, slightly firm and moist, or small to modest; and 4 = purplish red, firm and moderately dry, or moderate to slightly abundant for color, firmness, and marbling, respectively.

[h]Modified tall oil × L-carnitine, P = .10; other interactions, nonsignificant, P > .10.

[i]Means were derived from two sample readings per loin. Measures of dark to light (L*), redness (a*), yellowness (b*), red to orange (hue angle), vividness or intensity (saturation index), and reflectance values (%R630/%R580).

[j]Modified tall oil × CrNic, P = .07; other interactions, nonsignificant, P>.15.

[k]Modified tall oil × CrNic, P = .04; other interactions, nonsignificant, P>.15.

[l]Modified tall oil × CrNic, P<.05; other interactions, nonsignificant, P>.10.