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P R. O'Quinn

J W. Smith II

Michael D. Tokach

See next page for additional authors

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Authors

P R. O'Quinn, J W. Smith II, Michael D. Tokach, J Scott Smith, Jim L. Nelssen, and Robert D. Goodband

EFFECTS OF MODIFIED TALL OIL VERSUS CONJUGATED LINOLEIC ACID ON FINISHING PIG GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS [1,2]

P. R. O'Quinn, J. W. Smith, II, J. L. Nelssen, M. D. Tokach [3], R. D. Goodband, and J. S. Smith

Summary

A growth trial was conducted to compare effects of modified tall oil (MTO) and conjugated linoleic acid (CLA) on growth performance, serum chemistry, and carcass composition of finishing barrows. Overall, pigs fed the control diet did not differ from pigs fed MTO or CLA supplemented diets. However, pigs fed MTO had greater ADG and ADFI than pigs fed CLA. No effect of treatment was observed for any of the measured carcass criteria or serum triglyceride levels. The results of this research do not suggest a benefit from feeding MTO or CLA to pigs but do indicate differences in ADG and ADFI that favor those fed MTO.

(Key Words: Modified Tall Oil, Conjugated Linoleic Acid, Growth, Carcass.)

Introduction

Conjugated linoleic acid (CLA) is a collective term describing several forms of linoleic acid. Linoleic acid (C18:2) has double bonds located at carbons 9 and 12 both in the *cis* configuration. Conjugated linoleic acid has either the *cis* or *trans* configuration or both located on carbons 9 and 11, 10 and 12, or 11 and 13. The *cis* 9, *trans* 11 form of CLA apparently is the biologically active form that can be incorporated into phospholipids in the body. Feeding of CLA to laboratory animals improves rate and efficiency of gain and decreases fat deposition. Tall oil is a nonaqueous layer of rosin acids and fatty acids produced during the kraft (sulfate) paper process. Modified tall oil (MTO) has intrinsic properties that make it suitable for a comparison with CLA. Therefore, the objective of this study was to compare the effects of MTO and CLA on pig growth performance, serum chemistry profiles, and carcass composition.

Procedures

A total of 36 crossbred barrows (initially 83 lb; PIC L326 × C22) was blocked on the basis of initial weight and ancestry in a randomized complete block design and randomly allotted to the three dietary treatments with six replicate pens per treatment.

Modified tall oil and CLA were substituted on an equal weight basis for soybean oil in the experimental diets. Chemical separation values for the soybean oil, CLA, and MTO samples are presented in Table 1. All diets were fed in meal form. Composition of the basal diets is given in Table 2. Diets were fed in two phases; 80 to 160 and 160 to 230 lb BW. Diets were changed when the average weight of pigs in a block of pens reached 160 lb.

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[2]Appreciation also is extended to Dr. Norman Smith of the London Health Sciences Centre, London, Ontario, Canada, for conducting the triglyceride assays.

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

Pigs were housed in an environmentally controlled finishing barn with two pigs in each 4 ft × 4 ft pen with a totally slatted floor. Pigs 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 feed efficiency (F/G). The day before slaughter, plasma blood samples were collected from each pig for analysis of triglyceride (TG) concentrations after a 3 h fast. The samples were pooled for each pen and stored frozen until analyzed.

Pigs were slaughtered when the average weight of pigs in a pen reached 230 lb BW. Standard carcass measurements; visual analyses of the longissimus for coloring, marbling, and firmness; drip loss, and Minolta colorspectrometry (Hunter L*, a*, and b*) were determined for each pig at 24 h postmortem (drip loss = 48 h postmortem).

Data were analyzed as a randomized complete block. Pen was the experimental unit for all calculations. The GLM procedure of SAS was used for the single degree of freedom contrasts among the dietary treatments. Hot carcass weight was used as a covariate in the statistical model for carcass analyses.

Results and Discussion

Growth Data. From 80 to 160 lb BW, pigs fed the diets with CLA had reduced ($P = .03$) ADG when compared to pigs fed the control diet (Table 3). Otherwise, the means of pigs fed either MTO or CLA did not differ ($P > .15$) from those of pigs fed the control diet during either growth phase or on a cumulative basis for ADG, ADFI, or F/G.

However, a difference in growth performance occurred between pigs fed MTO and CLA. Pigs fed MTO grew faster during the 80 to 160 ($P < .01$), 160 to 230 ($P = .10$), and 80 to 230 ($P = .03$) lb BW growth intervals than pigs fed CLA. This is attributable to nonsignificant improvements in ADFI and F/G from 80 to 160 lb BW and to a higher ADFI from 160 to 230 lb BW ($P = .06$) and overall ($P = .10$) ADFI for pigs fed MTO.

Carcass Characteristics. No effect of dietary treatment ($P>.15$) was observed for any of the measured carcass quality criteria (Table 4).

Serum Chemistry. The feeding of MTO or CLA to pigs did not affect ($P>.20$) fasted serum TG levels (Table 4).

In this study, supplementing diets fed to pigs with MTO or CLA did not have beneficial effects in terms of growth performance, carcass composition, or serum TG levels. However, both pigs fed the control diet and pigs fed MTO had good overall growth performance. Additionally, pigs fed CLA or MTO were similar in carcass quality, and both were numerically better than the control group.

Some differences exist between the two feed additives. Tonalin™ CLA 60 is a by-product of the sunflower oil extraction industry, whereas the MTO used in this experiment is a byproduct of the kraft paper process. Neither CLA nor MTO is currently approved for use as a feed additive in swine diets.

The differences observed in the growth performance of pigs fed MTO and CLA are not readily explainable. The MTO was entirely unsaturated, whereas the CLA contained a large amount of saturated fatty acids (< 12%). However, the data do imply that the *cis* 9, *trans* 11 form of CLA may not be the biologically active form. Diets containing MTO and CLA each had similar amounts of this isomer, but the diet containing MTO produced significantly better ADG. Several explanations are possible for the different biological response: 1) the different isomeric profiles of the fatty acids in the two compounds; 2) the large amount of saturated fatty acids present in CLA; 3) the larger relative concentration of actual conjugated linoleic acids present in MTO (+ ~ 15%); or 4) an isomer in higher concentration in MTO (i.e., *trans* 9, *trans* 11).

In conclusion, more research is needed to determine if MTO can be used as an effective growth promotant and carcass modifier for swine. However, the results of this study do indicate that pigs fed MTO had greater ADG than those fed CLA.

Table 1. Compositions of Soybean Oil, Modified Tall Oil, and Conjugated Linoleic Acid[a]

Item	Soybean Oil	MTO (Kraft paper process)	Tonalin™ CLA 60 (Sunflower-derived)
Unsaponifiables, % max	N/A	2.8	1.0
Iodine value[b]	130	162	139
Specific gravity	N/A	0.91	0.92
Acid value, mg KOH/g	N/A	195	199
Fatty acid composition, %			
Conjugated linoleic acid	----	69	58.4
Total linoleic acid	52	78	64.9
Oleic acid	25	22	22.7
Saturated fatty acids	16	<1	12.3

	Chemical Analyses[c]		
Item, %	Soybean oil[d]	Pamolyn MTO	Tonalin™ CLA 60
Palmitic acid, 16:0	15.96	0.46	7.65
Stearic acid, 18:0	4.11	0.07	5.15
Oleic acid, 18:1	20.34	19.84	24.73
Linoleic acid, 18:2 (*c*9, *c*12)	50.65	2.29	4.81
CLA, 18:2			
c&*t*, 9, 11 mix	ND[e]	20.52	21.33
*t*9, *t*11	ND	14.80	3.90
*c*10, *c*12	ND	13.98	10.38
*t*10, *c*12	ND	14.37	16.40
3 CLA peaks	ND	8.83	3.79
Unknown	ND	4.83	1.85
Total CLAs	ND	72.50	55.80
Total	91.06	100.00	100.00

[a]Values for the products are guaranteed analyses from the companies providing the products and represent the minimum or maximum value when specified or the average when a range of values was given.
[b]A measure of the degree of unsaturation of fats and oils.
[c]Analyses were conducted at Kansas State University using gas chromatography.
[d]Soybean oil contains small amounts of myristic acid (14:0), linolenic acid (18:3), and eicosenoic acid (20:1), which were not present in the CLA and MTO samples. This accounts for soybean oil not adding to 100%.
[e]Not detectable.

Table 2. Composition of Basal Diets (As-Fed Basis)

Ingredient, %	Grower[a]	Finisher[b]
Corn	69.29	78.63
Soybean meal (46.5% CP)	27.47	18.39
Limestone	1.06	.89
Monocalcium phosphate	.85	.76
Soybean oil[c]	.50	.50
Salt	.35	.35
Vitamin premix	.20	.20
Trace mineral premix	.15	.15
Antibiotic[d]	.13	.13
Total	100.00	100.00

[a]Grower diets were fed from 80 to 160 lb BW and were formulated to contain 1.00% lysine, .65% Ca, and .55% total P.
[b]Finisher diets were fed from 160 to 230 lb BW and were formulated to contain .75% lysine, .55% Ca, and .50% total P.
[c]Soybean oil was substituted on an equal basis with MTO and CLA to give the three experimental treatments.
[d]Provided 100 g/ton tylosin.

Table 3. Growth Performance of Barrows Fed Modified Tall Oil or Conjugated Linoleic Acid[a]

					Contrast Probability Values (P<)		
Item	Control (1)	MTO (2)	CLA (3)	CV	1 vs 2	1 vs 3	2 vs 3
80 to 160 lb							
ADG, lb	2.30	2.35	2.17	4.24	.35	.03	<.01
ADFI, lb	5.78	5.79	5.57	5.63	.93	.28	.25
F/G	2.51	2.46	2.57	5.04	.49	.43	.15
160 to 230 lb							
ADG, lb	2.26	2.37	2.11	11.4	.44	.35	.10
ADFE, lb	7.14	7.45	6.72	8.95	.41	.27	.06
F/G	3.17	3.14	3.21	7.50	.79	.80	.61
80 to 230 lb							
ADG, lb	2.28	2.36	2.14	7.28	.39	.17	.03
ADFI, lb	6.44	6.60	6.13	7.30	.56	.27	.10
F/G	2.83	2.79	2.87	5.14	.64	.62	.34

[a]Values are means for two pigs/pen and six replicate pens/treatment.

Table 4. Carcass Characteristics of Barrows Fed Modified Tall Oil or Conjugated Linoleic Acid[a,b,c]

Item	Control (1)	MTO (2)	CLA (3)	CV	Contrast Probability Values (P<) 1 vs 2	1 vs 3	2 vs 3
Shrink loss, %	2.12	2.18	2.17	8.68	.55	.47	.77
Backfat, in							
First rib	1.45	1.35	1.37	9.15	.21	.38	.93
Tenth rib	.92	.87	.87	16.89	.57	.34	.59
Last rib	.77	.72	.72	10.81	.31	.68	.71
Last lumbar	.77	.77	.71	11.56	.99	.83	.82
Average[d]	.98	.93	.93	7.27	.24	.36	.98
LMA, in^2	5.68	5.67	5.45	7.68	.97	.23	.22
Lean %[e]	50.95	51.35	51.15	4.65	.77	.34	.45
Dressing %	72.65	72.32	71.61	1.31	.57	.61	.93
Visual color[f]	2.65	2.50	2.60	7.28	.20	.39	.90
Firmness[f]	3.18	3.07	3.15	21.70	.78	.65	.51
Marbling[f]	2.48	2.83	2.82	19.05	.27	.26	.76
Hunter L*[g]	50.93	52.70	52.66	6.14	.53	.65	.47
Hunter a*[g]	10.80	11.00	12.01	25.53	.93	.99	.96
Hunter b*[g]	7.00	7.57	7.89	29.31	.76	.82	.71
Hue angle[g]	43.86	48.60	44.92	9.84	.27	.79	.37
Saturation index[g]	13.11	13.36	14.39	22.80	.93	.64	.71
A:B ratio[g]	1.55	1.45	1.53	7.28	.33	.79	.45
Drip loss, %	3.03	2.98	2.83	43.00	.93	.21	.23
Triglycerides[h]	33.33	40.17	41.17	29.58	.32	.26	.88

[a]Values are means for two pigs/pen and six replicate pens/treatment.
[b]Hot carcass weight was used as a covariate in the statistical analysis.
[c]Carcass length (mean = 31.98 in) and muscle score (mean = 2.53) were not affected (P > .15) by dietary treatment.
[d]Average backfat is the average of the first and last rib and last lumbar fat depths.
[e]Lean percentage was derived from NPPC equations with 5% fat.
[f]Scoring system of 1 to 5: 2 = grayish pink, traces to slight, or soft and watery; 3 = reddish pink, small to modest, or slightly firm and moist; and 4 = purplish red, moderate to slightly abundant, or firm and moderately dry for color, firmness, and marbling, respectively.
[g]Means were derived from three sample readings per loin. Measures of dark to light (Hunter L*), redness (Hunter a*), yellowness (Hunter b*), red to orange (hue angle), or vividness or intensity (saturation index).
[h]Values represent the pooled results of both pigs/pen bled the day before slaughter, and triglyceride levels are expressed as mg/dL.