EFFECTS OF MODIFIED TALL OIL AND CREATINE MONOHYDRATE ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS, AND MEAT QUALITY OF GROWING-FINISHING BARROWS[1]

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Summary

A trial was conducted to evaluate the effects of modified tall oil (MTO; .50% of the diet) and creatine monohydrate (CMH; 25 g/pig/day for 10 days prior to slaughter) on performance, carcass characteristics, and meat quality of finishing barrows. Feeding MTO improved ADG and F/G during the growing phase and improved F/G over the entire trial and during the 10 day CMH loading period. Feeding MTO reduced backfat, but neither CMH nor MTO affected other carcass characteristics or meat quality measures at 24 h postmortem. These data suggest that MTO improves performance and reduces backfat with little effect on meat quality, whereas CMH does not appear to be beneficial to growing-finishing swine.

(Key Words: Modified Tall Oil, Creatine Monohydrate, Barrows, Meat Quality.)

Introduction

Prior work at Kansas State University has shown that MTO is an effective feed additive for improving growth performance and carcass leanness of growing-finishing pigs. Modified tall oil also has been shown to increase belly firmness and may potentially play a role in improving pork quality. Creatine is a nutritional supplement routinely taken by athletes to increase muscle mass. This increase in muscle mass is initiated by a hydration of the cell that leads to the stimulation of proteolysis. This stimulation should increase percentage lean and potentially increase the tenderness of pork. Modified tall oil increases carcass lean content primarily through reductions in backfat, whereas CMH supplementation should increase percentage lean through actual increases in protein content. Therefore, we postulated that feeding MTO and CMH together would increase weight gains, improve carcass leanness, and improve measures of meat quality.

Procedures

Pigs used in this experiment were terminal offspring of PIC L326 or 327 boars × C22 sows (PIC, Franklin, KY). Experimental procedures were approved by the Kansas State University Institutional Animal Care and Use Committee (Protocol No. 1639).

The 80 crossbred barrows (initially 100.1 lb BW) were blocked on the basis of initial weight and ancestry in a randomized complete block design and allotted randomly to one of four dietary treatments arranged as a 2 × 2 factorial with 10 replicate pens per treatment. Because two of the four dietary treatments were not implemented until 10 days preslaughter, there were 20 replicate pens per dietary treatment until then.

Diets were fed in two phases (100.1 to 173.9 and 173.9 to 259.0 lb BW; Table 1).

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Preselected pens of pigs were changed to CMH-supplemented diets at 10 days preslaughter (237.0 lb BW). Modified tall oil was substituted on an equal weight basis for soybean oil, and CMH (99% creatine) was substituted on an equal weight basis (.75% of the total diet) for ground corn to achieve the additional dietary treatments. The targeted level of creatine intake chosen for this experiment (25 g/d for 10 days) was based on prior research with swine at the University of Missouri.

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, respectively. Pigs were weighed every 14 d in order to determine ADG, ADFI, and F/G and also at the beginning and end of the CMH loading period. Serum samples also were obtained from one pig per pen at the beginning and end of the CMH loading period for determination of initial and final creatinine levels. Creatinine is the sole metabolite of creatine. Feed was not withheld from pigs prior to blood sampling, which was conducted only on pigs not being slaughtered. This was done so that the potential stress of blood sampling would not interfere with or influence measures of meat quality. Serum creatinine samples were stored frozen until analyzed.

One pig (closest to the average weight of all pigs) per pen was slaughtered after 10 days of receiving CMH (average slaughter weight of 259.0 lb). Standard carcass measurements; visual analyses of the longissimus for coloring, marbling, and firmness; drip loss; water-holding capacity; ultimate pH; and color spectrophotometry (L*, a*, and b*) were obtained for each pig at 24 h postmortem (drip loss = 48 h postmortem). Boneless loins were removed from the right sides of all carcasses, vacuum packaged, and stored for 14 days at 39°F. Then purge loss, drip loss, water-holding capacity, pH, visual analysis, and color spectrophotometry were determined again after loins were removed from vacuum bags and allowed 15 min for standardization. A 1-in-thick chop also was also taken from each loin and used for the determination of Warner Bratzler shear force values using a v-blade attachment for an Instron Model 5401 compression machine. The speed of the v-blade during all measurements was 5 mm/min. Cores (.5 in. diameter) used for the tenderness evaluations were taken parallel to the muscle fiber orientation. Prior to testing, chops were cooked to an internal core temperature of 158°F. Raw and cooked chop weights were recorded and used for the determination of percentage thawing and cooking losses.

Data were analyzed as a randomized complete block. Pen was the experimental unit for the growth performance data and individual pig (one pig/pen) for the carcass characteristics and serum creatinine measurements. The GLM procedure of SAS was used for the single degree of freedom contrast between the two dietary treatments during the growing-finishing period of the growth trial. All subsequent data including the last 10 days of the finishing period were analyzed as a 2 × 2 factorial arrangement with main effects of MTO (0 or .50% of the diet) or CMH (0 or 25 g/d for 10 days preslaughter). The statistical model included main effects and interactions of the main effects. Hot carcass weight was used as a covariate in the statistical model for carcass analysis.

Results and Discussion

Growth Data. Feeding MTO improved ($P<.05$) ADG and F/G during the growing period, but had no effect ($P>.15$) on growth performance during the finishing period (Table 2). The early improvements in feed efficiency also carried through for improved ($P = .10$) F/G from MTO over the total trial. The 10-day addition of CMH numerically ($P = .11$) improved ADG and F/G, presumably from increased water retention (Table 3). Modified tall oil improved ($P = .02$) F/G and increased ($P = .08$) ADG during the CMH loading period. An interaction ($P = .09$) of MTO and CMH was observed for ADFI; feeding CMH increased ADFI when diets contained MTO but reduced feed intake when diets did not contain MTO.

Carcass Characteristics. Feeding 25 g of CMH per pig for 10 days prior to slaughter had no effect (P>.20) on carcass characteristics or serum creatinine levels (Table 4). Feeding MTO reduced (P<.05) tenth and last rib backfat, which also resulted in reduced (P = .05) average backfat. Modified tall oil did not affect (P>.10) other carcass characteristics or serum creatinine levels.

Meat Quality. Dietary treatment did not affect (P>.10) any measured parameter of meat quality at 24 h postmortem (Table 5).

Feeding CMH did not affect (P>.20) any measured parameter of meat quality at 14 d postmortem (Table 6), but feeding MTO increased (P = .02) L* values and tended to increase (P<.10) thawing and cooking losses of chops. The changes in L* values (paleness) were small and probably not detectable by the eye as evidenced by the lack of visual color response. Modified tall oil did not affect (P>.15) other measures of meat quality at 14 d postmortem including pH, other color determinations, drip loss, water-holding capacity, or shear force.

Consistent with prior reports, MTO appears to be a potential growth promoter and improves carcass leanness through reductions in backfat. Modified tall oil also appears to have minimal impact on meat quality by itself, although increases in intramuscular marbling from MTO alone have been reported. When fed in conjunction with elevated levels of vitamin E, MTO helps to decrease oxidation and increase shelf-life and color stability. Under the conditions of this study, CMH supplementation was not beneficial in the diets of growing-finishing pigs. However, different approaches to CMH supplementation could be employed involving different lengths of supplementation, different levels of supplementation, or a combination thereof. More work is necessary to determine if CMH can be used successfully in swine diets, but supplementation of MTO should improve growth performance and reduce backfat.

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

Ingredient, %	Growing[a]	Finishing[b]	10-d Preslaughter[c]
Corn	69.24	78.58	77.83
Soybean meal (46.5% CP)	27.47	18.39	18.39
Limestone	1.06	.89	.89
Monocalcium phosphate	.85	.76	.76
Soybean oil[d]	.50	.50	.50
Salt	.35	.35	.35
Vitamin premix	.25	.25	.25
Trace mineral premix	.15	.15	.15
Antibiotic[e]	.13	.13	.13
Creatine monohydrate[f]	----	----	.75
Total	100.00	100.00	100.00

[a]Growing diets were fed from 100.1 to 173.9 lb BW and were formulated to contain 1.00% lysine, .65% Ca, and .55% total P.

[b]Finishing diets were fed from 173.9 to 259.0 lb BW and were formulated to contain .75% lysine, .55% Ca, and .50% total P.

[c]Diets were fed for 10 days prior to slaughter (237.0 to 259.0 lb BW) and were formulated to contain .75% lysine, .55% Ca, and .50% total P.

[d]Soybean oil was substituted on an equal weight basis for MTO to give the experimental treatments.

[e]Provided 100 g/ton tylosin.

[f]Creatine monohydrate was substituted on an equal weight basis (.75 % of total diet) for corn during the last 10 days of the finishing period to achieve the additional dietary treatments.

Table 2. Growth Performance of Barrows Fed MTO (100.1 to 237.0 lb BW)[a]

	MTO, %			Contrast Probability
Item	0	.50	CV	(P =)
100.1 to 173.9 lb BW				
ADG, lb	2.33	2.44	6.97	.04
ADFI, lb	6.21	6.21	6.56	.97
F/G	2.67	2.55	6.63	.03
173.9 to 237.0 lb BW				
ADG, lb	2.37	2.33	12.28	.66
ADFI, lb	7.57	7.31	8.40	.20
F/G	3.23	3.15	9.14	.43
100.1 to 237.0 lb BW				
ADG, lb	2.35	2.38	6.76	.52
ADFI, lb	6.81	6.68	6.04	.35
F/G	2.91	2.81	6.16	.10

[a]Values are means for two pigs per pen and 20 replicate pens per treatment.

Table 3. Growth Performance of Barrows Fed MTO, Creatine, or Both (237.0 to 259.0 lb BW)[a]

	0 MTO/CMH		.50% MTO/CMH			Probability values (P =)		
Item	0	25 g/d	0	25 g/d	CV	MTO × CMH	MT	CMH
ADG, lb	2.25	2.40	2.42	2.83	21.34	.46	.08	.11
ADFI, lb	8.19	7.96	7.81	8.36	8.70	.09	.95	.48
F/G	3.89	3.47	3.29	2.98	20.17	.80	.02	.11

[a]Values are means of two pigs per pen and 10 replicate pens per treatment.

Table 4. Carcass Characteristics of Barrows Fed MTO, Creatine, or Both[a,b]

	0 MTO/CMH		.50% MTO/CMH			Probability Values (P =)		
Item	0	25 g/d	0	25g/d	CV	MTO × CMH	MTO	CMH
Shrink loss, %	.65	.88	1.02	.83	73.99	.30	.39	.87
Backfat, in								
First rib	1.64	1.59	1.49	1.55	12.38	.39	.11	.83
Tenth rib	.94	.99	.80	.85	18.26	.96	.01	.30
Last rib	.91	.98	.82	.87	15.53	.87	.02	.24
Last lumbar	.87	.91	.78	.86	18.86	.73	.19	.28
Average[c]	1.14	1.16	1.03	1.09	13.16	.65	.05	.50
LMA, in^2	6.21	6.51	6.51	6.38	11.17	.33	.78	.76
Lean %[d]	51.14	51.24	53.19	52.22	5.56	.56	.18	.49
Dressing %	73.88	73.72	73.58	73.74	1.47	.66	.21	.36
Carcass length, in	32.35	32.86	32.75	32.53	2.29	.14	.84	.94
Serum creatinine, mg/L								
Initial	1.37	1.40	1.50	1.40	13.01	.29	.30	.52
Final	1.55	1.58	1.66	1.58	13.71	.45	.50	.70

[a]Values represent one pig per pen and 10 replicate pens per treatment.
[b]Hot carcass weight was used as a covariate in the statistical analysis.
[c]Average backfat is the average of the first and last rib and last lumbar fat depths.
[d]Lean percentage was derived from NPPC (1991) equations with 5% fat in the carcass.

Table 5. Longissimus Quality Measures of Barrows Fed MTO, Creatine, or Both (24 h Postmortem)[a]

	0 MTO/CMH		.50% MTO/CMH			Probability Values (*P* =)		
Item	0	25 g/d	0	25 g/d	CV	MTO×CMH	MTO	CMH
pH	5.41	5.39	5.39	5.40	1.95	.59	.70	.83
Visual color[b]	2.60	2.40	2.45	2.40	22.16	.67	.70	.51
Firmness[b]	2.95	2.80	2.60	2.80	23.57	.40	.64	.64
Marbling[b]	2.60	2.30	2.35	2.40	20.78	.27	.79	.58
L*[c]	56.58	57.19	57.80	56.80	4.84	.36	.64	.82
a*[c]	9.97	9.35	9.98	9.26	19.76	.94	.95	.27
b*[c]	19.28	18.16	18.74	17.48	17.20	.95	.55	.24
Hue angle[c]	62.61	62.92	62.08	62.29	2.65	.93	.27	.62
Saturation index[c]	21.71	20.43	21.24	20.49	15.06	.80	.84	.32
a*/b*[c]	.52	.51	.53	.53	6.90	.90	.28	.57
%R630/%R580[c]	2.87	2.72	2.78	2.69	13.18	.78	.58	.30
%R610/%R580[c]	2.47	2.33	2.39	2.32	13.07	.75	.66	.31
Drip loss, %	5.01	4.20	5.48	5.74	50.30	.51	.13	.98
Water-holding capacity, %[d]	3.36	3.49	3.92	3.60	19.74	.32	.15	.67

[a]Values represent one pig per pen and 10 replicate pens per treatment.

[b]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.

[c]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), or reflectance values (%R630/%R580 and %R610/%R580).

[d]Determined by dividing the area of the meat by the area of the fluid after compression with a Carver press.

Table 6. **Longissimus Quality Measures of Barrows Fed MTO, Creatine, or Both (14 d Postmortem)[a]**

	0 MTO/CMH		.50% MTO/CMH			Probability Values (P =)		
Item	0	25 g/d	0	25 g/d	CV	MTO × CMH	MTO	CMH
pH	5.43	5.43	5.42	5.42	1.84	.97	.65	.75
Visual color[b]	2.40	2.45	2.45	2.40	14.57	.64	.64	.63
Firmness[b]	2.90	2.90	2.95	2.90	11.40	.81	.99	.66
Marbling[b]	2.50	2.40	2.20	2.35	23.13	.48	.19	.81
L*[c]	55.01	54.99	56.66	56.75	4.08	.94	.02	.96
a*[c]	19.41	21.12	20.87	20.79	11.21	.23	.44	.27
b*[c]	6.90	7.65	7.65	7.72	14.09	.31	.23	.23
Hue angle[c]	21.19	19.93	20.13	20.35	10.40	.28	.64	.45
Saturation index[c]	21.13	22.46	22.22	22.17	8.28	.24	.49	.28
a*/b*[c]	2.67	2.77	2.73	2.70	6.16	.24	.96	.60
%R630/%R580[c]	2.65	2.79	2.70	2.67	8.78	.25	.64	.48
%R610/%R580[c]	2.28	2.38	2.33	2.89	7.96	.22	.74	.59
Drip loss, %	1.59	1.65	1.19	1.49	82.03	.77	.48	.66
Water-holding capacity, %[d]	3.77	3.57	3.98	3.65	23.21	.81	.59	.34
Loin purge loss, %	2.93	2.60	3.12	3.50	43.37	.37	.16	.88
Chop thawing loss, %	7.05	6.88	7.62	7.53	15.78	.91	.10	.73
Chop cooking loss, %	26.53	25.81	29.17	29.53	24.62	.76	.09	.92
Chop shear force, kg	2.55	2.60	2.71	2.87	17.83	.73	.17	.51

[a]Values represent one pig per pen and 10 replicate pens per treatment.

[b]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.

[c]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), or reflectance values (%R630/%R580 and %R610/%R580).

[d]Determined by dividing the area of the meat by the area of the fluid after compression with a Carver press.