THE EFFECT OF L-CARNITINE ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF GROWING-FINISHING PIGS[1]

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Summary

Ninety-six crossbred pigs (initially 75 lb BW) were used to investigate the effect of increasing dietary carnitine on growth performance and carcass characteristics in growing-finishing swine. Pigs (48 barrows and 48 gilts) were blocked by weight, ancestry, and sex in a randomized complete block design (two pigs per pen and eight pens per treatment). Dietary carnitine replaced cornstarch in the control diet to achieve added dietary carnitine levels of 25, 50, 75, 100, and 125 ppm. Grower (75 to 125 lb) and finisher (125 to 227 lb) diets were formulated to contain 1.0% lysine and .80%, respectively. All diets were corn-soybean meal-based, contained .15% L-lysine HCl and 2.5% soy oil, and were fed in meal form. When the mean weight for pigs in a pen reached 227 lb, one pig per pen was slaughtered to determine carcass characteristics. Dietary carnitine did not influence growth performance during the growing or finishing phases. However, for the overall trial, the mean of all pigs fed dietary carnitine had numerically improved average daily gain (ADG) and feed efficiency (F/G) when compared with pigs fed the control diet. Dietary carnitine reduced average backfat thickness and tenth rib backfat depth and increased longissimus muscle area, with 50 ppm providing the maximum response. These data suggest that 50 ppm L-carnitine fed during the growing-finishing phase had no effect on growth performance but resulted in increased muscle deposition and reduced fat accretion as measured by longissimus muscle area and average and tenth rib backfat depth.

(Key Words: Growing-Finishing, L-Carnitine, Performance.)

Introduction

Recent research at the University of Georgia has shown that supplementing finishing diets with L-carnitine results in a small reduction in backfat thickness. A similar response was observed at the Coastal Plains Research Center; however, these results were based on ultrasonic readings with no actual carcass measurements recorded. Recent research at KSU has shown that feeding L-carnitine during the growing-finishing phases resulted in a 16% improvement in longissimus muscle area, with small reductions in backfat thickness and daily lipid accretion rates. More recently, research conducted at the University of Wagenhagen (Netherlands) reports that pigs fed 40 ppm of L-carnitine had 10% higher ADG, 9% better F/G, 14% less average backfat thickness, and 4% more muscle. However, limited research has been conducted addressing the appropriate level of L-carnitine needed during the growing and finishing phases. Therefore, this research was conducted to determine the dietary carnitine level needed to elicit optimum response of growth performance and carcass composition characteristics in growing-finishing swine.

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

Procedures

Ninety-six crossbred pigs (initially 75 lb BW) were used. Pigs (48 barrows and 48 gilts) were blocked by weight, ancestry, and sex in a randomized complete block design (two pigs per pen and eight pens per treatment). Two pigs were housed per pen (4 ft × 4 ft) in an environmentally controlled finishing barn with total slatted flooring. There were eight replicate pens per treatment (four replicate pens per sex). Each pen contained a single-hole self-feeder and a nipple waterer to provide ad libitum access to feed and water. Pig weights and feed disappearance were recorded every 14 d to determine ADG, ADFI, and F/G.

Basal diets were formulated for the grower and finisher phase (Table 1). Dietary carnitine replaced cornstarch in the basal diets to achieve added dietary carnitine levels of 25, 50, 75, 100, and 125 ppm. Grower diets (75 to 125 lb) were formulated to contain 1.0% lysine and finisher diets (125 to 227 lb) were formulated to .80% lysine. All diets were corn-soybean meal-based, contained .15% L-lysine HCl and 2.5% soy oil, and were fed in meal form. All other nutrients either met or exceeded NRC (1988) estimates for the 110 to 240 lb pig.

When the mean weight for pigs in a pen reached 227 lb, one pig per pen was slaughtered, and standard carcass measurements were recorded. Also, 25-gram samples of muscle, heart, and liver tissues were taken to analyze for tissue carnitine levels.

Data were analyzed as a randomized complete block design. Pigs were blocked on the basis of initial weight and sex with pen as the experimental unit. Analysis of variance was performed using the GLM procedure of SAS, and linear and quadratic polynomials were evaluated.

Results and Discussion

Dietary carnitine did not linearly or quadratically influence growth performance during the growing or finishing phases ($P > .10$) (Table 2). However, pigs fed 50 ppm of L-carnitine, had 10% ($P = .04$) higher ADG, and were 7% ($P = .05$) more efficient than pigs fed the control diet during the grower phase. This shows that carnitine might be influencing fatty acid metabolism by providing more energy to the pig, allowing for more rapid and efficient growth. For the overall trial, the mean of all pigs fed dietary carnitine was numerically higher for ADG ($P = .16$) and F/G ($P = .12$) when compared to pigs fed the control diet.

Dietary carnitine reduced average backfat and tenth rib backfat depth (quadratic, $P < .05$) and increased longissimus muscle area (quadratic, $P = .13$) (Table 3). Dietary carnitine improved (quadratic, $P < .05$) percentage lean and muscle, with 50 ppm L-carnitine providing the optimum response. A sex effect occurred for tenth rib backfat depth ($P < .01$), longissimus muscle area ($P < .01$), percentage muscle ($P < .01$) and lean ($P < .01$) with gilts being leaner and having larger longissimus muscle areas. These data support earlier research at Kansas State University suggesting that dietary L-carnitine causes an increase in loin muscle area and a slight decrease in backfat parameters. Currently, plans are under way to address possible modes of action dealing with L-carnitine.

No effects on liver or kidney weights occurred at time of slaughter. However, heart and kidney fat weights were reduced (quadratic, $P = .08$ and $P < .01$, respectively) with increasing levels of dietary L-carnitine (Table 3). Tissue samples taken from the heart, liver, and muscle showed that the level of carnitine present in each tissue was increased (linear, $P < .01$) as the level of L-carnitine increased in the diet. This allows us to conclude that the biological activity of dietary carnitine was increased in each tissue. Thus, results noted in this trial were due to L-carnitine supplementation.

These data suggest that dietary carnitine fed during the growing-finishing phase had no effect on growth performance, but resulted in increased loin muscle area and decreased average backfat and tenth rib

backfat thickness. Fifty ppm of added L-carnitine appears to have the greatest effect on carcass traits in growing and finishing pigs.

Table 1. Composition of Growing and Finishing Basal Diets[a]

Item, %	Growing (75 to 125 lb)	Finishing (125 to 230 lb)
Corn	71.43	78.96
Soybean meal, (48% CP)	22.54	15.53
Soy oil	2.50	2.50
Monocalcium phosphate, (21% P)	1.46	1.09
Limestone	.91	.91
Salt	.35	.35
Vitamin premix	.20	.20
Trace mineral premix	.15	.15
L-lysine HCl	.15	.15
Antibiotic[b]	.20	.05
Cornstarch[c]	.11	.11
Total	100.00	100.00

[a]Growing and finishing diets were formulated to contain 1.0% and .80% lysine, respectively.
[b]Provided 40 g per ton tylosin
[c]L-carnitine replaced cornstarch in the basal diet to achieve dietary carnitine levels of 0, 25, 50, 75, 100, and 125 ppm.

Table 2. Growth Performance of Pigs Fed Increasing Dietary L-Carnitine[a]

	Dietary L-carnitine, ppm						
Phase	0	25	50	75	100	125	CV
Growing							
ADG,lb[b]	1.90	2.02	2.09	2.01	2.05	2.05	9.0
ADFI,lb	4.80	5.16	4.92	4.96	5.02	5.01	5.4
F/G[b]	2.54	2.57	2.36	2.47	2.46	2.45	7.2
Finishing							
ADG,lb	2.10	2.13	2.07	2.13	2.20	2.09	6.5
ADFI,lb	6.97	6.97	6.71	6.85	7.01	6.77	5.6
F/G	3.32	3.26	3.25	3.21	3.18	3.25	5.4
Overall							
ADG,lb	2.03	2.10	2.07	2.09	2.15	2.07	6.0
ADFI,lb	6.23	6.37	6.11	6.21	6.33	6.18	4.5
F/G	3.07	3.04	2.95	2.97	2.94	2.98	5.0

[a]A total of 96 pigs (48 barrows and 48 gilts), two pigs per pen, eight replicate pens per treatment. Average initial and final weights were 74.8 and 228 lb, respectively.
[b]Pigs fed 50 ppm L-carnitine vs control ($P < .05$).

Table 3. Carcass Characteristics of Pigs Fed Increasing Dietary Carnitine[a]

	Dietary L-carnitine, ppm						
Item	0	25	50	75	100	125	CV
Average BF, in[b]	1.25	1.26	1.14	1.19	1.22	1.28	11.5
10th rib BF, in[c]	1.19	1.22	.99	1.10	1.17	1.23	15.7
Loin muscle, in[d]	4.86	4.55	5.47	4.87	4.80	4.89	9.3
Lean, %[c]	46.04	44.86	49.54	46.91	45.91	45.61	6.1
Muscle, %[c]	51.56	50.83	53.95	52.26	51.51	51.20	3.9
Liver wt, g	1,423	1,349	1,409	1,491	1,400	1,384	10.7
Heart wt, g[b]	356	348	377	373	343	344	9.0
Kidney wt, g	356	360	347	350	355	329	15.8
Kidney fat, g[e]	1,368	1,215	1,120	1,181	1,345	1,440	19.0

[a]A total of 48 pigs (24 barrows and 24 gilts), one pig per pen and 8 pigs per treatment.
[bcde]Quadratic effect of dietary L-carnitine ($P = .10$, $P < .05$, $P = .13$, $P < .01$, respectively).

Table 4. Total L-Carnitine in Muscle, Liver, and Heart Tissue[a]

	Dietary L-carnitine, ppm						
Item	0	25	50	75	100	125	CV
Whole tissue							
Muscle, nmole per g[b]	1,019	1,294	1,437	1,752	1,836	2,254	13.3
Liver, nmole per g[b]	101	127	119	154	163	195	33.5
Heart, nmole per g[b]	758	934	940	1,216	1,152	1,324	22.1
Non-collagen protein							
Muscle, nmole per mg[b]	2.58	3.75	4.14	4.8	5.16	6.04	15.7
Liver, nmole per mg[b]	.288	.375	.40	.50	.463	.625	36.4
Heart, nmole per mg[b]	2.36	3.17	3.32	3.92	4.14	5.33	32.1

[a]Total carnitine was analyzed on a tissue extract that was subjected to heat and alkaline pH in order to hydrolyze carnitine from acyl carnitine. Results include both per gram wet weight of tissue and per milligram noncollagen protein. A total of 48 pigs (24 barrows and 24 gilts), one pig per pen and 8 pigs per treatment.
[b]Linear effect of dietary L-carnitine ($P < .01$).