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Summary

A total of 1,833 mixed-sex growing-finishing pigs (PIC, 337 × 1050; initially 58.5 ± 1.62 lb) were used in a 112-d growth trial to determine the effects of adding L-Carnitine throughout the entire grow-finishing period or for just the last 28 d before marketing on growth performance and carcass characteristics. There were 26 replicate pens per treatment and 20 (group 1) or 27 (group 2) pigs per pen in a completely randomized design. There were three treatment diets: 1) control with no added L-Carnitine; 2) diets containing 50 ppm of L-Carnitine for the entire trial; and 3) control diet until d 84 and then a diet containing 50 ppm of L-Carnitine. On day 84, half of the control pens were randomly assigned to the diet containing 50 ppm of L-Carnitine. The experimental diets were corn-soybean meal-DDGS-based and were fed in 4 phases. From d 0 to 84, statistical analyses compared the 52 pens of pigs fed the control diets to the 26 pens of pigs that were fed diets with L-Carnitine. From d 85 until market, comparisons were made using all 3 treatments. In the first 28 d, pigs fed L-Carnitine had greater ($P < 0.002$) BW, ADG, and ADFI and similar F/G ($P = 0.459$) as those fed the control diet. No evidence for differences ($P > 0.13$) were observed in growth performance from d 29 to 56 and from d 57 to 84. From d 0 to 84, pigs fed L-Carnitine had a tendency ($P = 0.052$) for greater ADFI, but there was no evidence ($P > 0.14$) of differences for ADG, F/G, removals, and mortalities. From d 85 to market and overall, there was no evidence of differences ($P > 0.22$) for ADG, ADFI, F/G, or removals and mortalities. For carcass traits, no difference ($P > 0.54$) in HCW, yield, backfat, lean, and loin depth were detected between treatments. In conclusion, added L-Carnitine improved performance in the early grow-finishing phase, but due to greater variation, this statistical difference did not last until market, resulting in the same overall performance. Feeding L-Carnitine only for the last 28 d also did not elicit growth and carcass improvements.

¹ Funding, wholly or in part, was provided by the National Pork Board.

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Introduction

L-Carnitine is a feed additive involved in the transport of fatty acids into the mitochondria to produce energy. With this mechanism, L-Carnitine can enhance the ability to efficiently use fat for energy and improve protein synthesis,³ which can be translated into improved growth performance and carcass leanness. Although the literature provides numerous studies with L-Carnitine supplementation in swine diets, results are equivocal. Furthermore, to our knowledge, there is a need to understand the effect of adding L-Carnitine only in late-finishing phases when pigs are less feed efficient. Therefore, the objective of this study was to determine the effects of adding L-Carnitine throughout the entire grow-finishing period or just 28 d prior to marketing on growth performance and carcass characteristics of pigs raised in a commercial environment.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at a commercial research-finishing site in southwest Minnesota. The barns were naturally ventilated and double-curtain-sided. Each pen was equipped with a 5-hole stainless steel dry self-feeder and a bowl waterer for *ad libitum* access to feed and water.

Animals and diets

Two groups of pigs (1,833 total pigs; PIC 337 × 1050; initially 58.5 ± 1.62 lb) were used in a 112-d growth trial. Pigs were housed in mixed gender pens with 20 (group 1) and 27 (group 2) pigs per pen and 26 pens per treatment (13 replications per group) in a completely randomized design. There were three treatment diets: 1) control with no added L-Carnitine; 2) diets containing 50 ppm of L-Carnitine for the entire trial; and 3) control diets until d 84 and then a diet containing 50 ppm of L-Carnitine fed until marketing. In each group, 26 pens were assigned to a control diet (with no L-Carnitine added) and 13 pens to a diet containing 50 ppm of L-Carnitine. On d 84, 13 pens from the control treatment were randomly assigned to the diet with L-Carnitine. Experimental diets were corn-soybean meal-DDGS-based and fed in four phases (Table 1). L-Carnitine was added to the diets via the vitamin and trace mineral premix, with all other premix ingredients being equal. All diets consisted of the same basal formulation and were fed in meal form. Phase 1 was fed from 60 to 100 lb, phase 2 from 100 to 160 lb, phase 3 from 160 to 225 lb, and phase 4 from 225 lb to market.

Daily feed additions to each pen were accomplished using a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) able to record feed amounts for individual pens. Pigs were weighed approximately every 14 d to determine ADG, ADFI, and F/G. On d 98, the 2 (group 1) and 3 (group 2) heaviest pigs in each pen were selected and marketed, but not included in the final pen carcass data. On the last day of the trial, final pen weights were obtained and the remaining pigs were tattooed with a pen identification number and transported to a U.S. Department of Agriculture-inspected packing plant (JBS Swift, Worthington, MN) for carcass data collection. Carcass measurements included HCW, loin depth, backfat, and percentage lean. Percentage lean was calculated from a plant proprietary equation. Carcass yield was calculated by

³ Owen, K. Q., H. Ji, C. V. Maxwell, J. L. Nelssen, R. D. Goodband, M. D. Tokach, G. C. Tremblay, and S. I. Koo. 2001. Dietary L-carnitine suppresses mitochondrial branched-chain keto acid dehydrogenase activity and enhances protein accretion and carcass characteristics of swine. *J. Anim. Sci.* 79:3104–3112.

dividing the pen average HCW by the pen average final live weight obtained at the farm, discounting culled pigs that did not meet the packing plant standards.

Statistical analysis

Data were analyzed using the GLIMMIX procedure of SAS version 9.4 (SAS Institute, Inc., Cary, NC) in a complete randomized design with pen serving as the experimental unit and initial BW serving as a covariate when it reduced the Bayesian Information Criteria. Random effect of group was included in the model for all response variables. Hot carcass weight served as a covariate for the analysis of backfat, loin depth, and lean percentage. Results from the experiment were considered significant at $P < 0.05$ and a marginally significant between $P > 0.05$ and $P \leq 0.10$.

Results and Discussion

From d 0 to 28, there were improvements for ADG ($P = 0.001$) and ADFI ($P = 0.002$) observed for pigs fed L-Carnitine compared to the control resulting in heavier ($P = 0.001$) BW on d 28 (Table 2). No difference was observed for F/G. From d 29 to 56 and d 57 to 84, there was no evidence of differences ($P > 0.131$) for ADG, ADFI, and F/G among treatments.

On d 84, pigs fed L-Carnitine tended ($P = 0.063$) to be heavier than pigs fed control diets. From d 0 to 84, the L-Carnitine treatment had a tendency ($P = 0.052$) for greater ADFI; however, no differences ($P > 0.144$) were observed for ADG, F/G, removals, mortality, and total removal and mortalities.

From d 85 to market and overall (d 0 to 112), pigs on the control, L-Carnitine, and late L-Carnitine treatments had similar ($P > 0.221$) ADG, ADFI, F/G, removals, mortality, and total removals and mortality. Final BW was not affected ($P = 0.180$) by dietary treatment. When evaluating carcass characteristics, no differences ($P > 0.540$) were observed for HCW, carcass yield, backfat, percentage lean, and loin depth between treatments.

In conclusion, this study provided no evidence that feeding L-Carnitine had an impact on growth performance, losses, or carcass characteristics when added to the late-finishing diet only. Although pigs fed L-Carnitine had carcasses that averaged 2 lb heavier, this improvement was not statistically different. Finally, added L-Carnitine improved performance in the early grow-finishing phase compared to control. However, this effect was not detectable at market, with no impact on overall growth performance, removals and mortalities, or carcass characteristics when added for the entire grow-finishing period or just the 28 d prior to marketing.

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Table 1. Diet composition (as-fed basis)¹

Item	Phase 1	Phase 2	Phase 3	Phase 4
Ingredients, %				
Corn	54.71	61.05	65.95	68.45
Soybean meal, 46% CP	17.34	11.20	6.68	4.22
DDGS	25.00	25.00	25.00	25.00
Calcium carbonate	1.45	1.40	1.30	1.25
Monocalcium P, 21% P	0.30	0.20	----	----
Salt	0.40	0.40	0.40	0.40
L-Lys-HCl	0.48	0.45	0.43	0.43
DL-Met	0.02	----	----	----
L-Trp	0.03	0.03	0.03	0.04
Thr ²	0.11	0.10	0.08	0.08
Tribasic copper chloride	0.03	0.03	0.03	0.03
Phytase ³	0.05	0.05	0.03	0.02
Vitamin-trace mineral premix	0.15	0.15	0.15	0.15
L-Carnitine ⁴	+/-	+/-	+/-	+/-
Calculated analysis				
SID AA, %				
Lys	1.08	0.91	0.78	0.72
Ile:Lys	60	60	60	60
Leu:Lys	155	168	183	190
Met:Lys	29	30	33	34
Met and Cys:Lys	56	59	64	66
Thr:Lys	62	59	64	65
Trp:Lys	18.4	18.1	18.0	18.3
Val:Lys	71	73	76	77
SID Lys:NE, g/Mcal	4.53	3.75	3.17	2.91
NE, kcal/lb	1,082	1,100	1,116	1,123
Ca, %	0.67	0.61	0.53	0.50
STTD P, %	0.43	0.39	0.33	0.31
Chemical analysis, %				
CP, %	20.4	17.9	16.1	15.2
NDF, %	13.1	13.2	13.3	13.3

¹Phases 1, 2, 3, and 4 were fed from 60 to 100, 100 to 160, 160 to 225, and 225 lb to market, respectively.

²Thr Pro, CJ America Bio, Fort Dodge, IA.

³Optiphos Plus 2500 G (Huvepharma Inc. Peachtree City, GA) provided 567.3 units of phytase FTY/lb of diet with an assumed release of 0.13% STTD P.

⁴50 ppm of L-Carnitine were added to diets via the vitamin and trace mineral premix.

Table 2. Growth performance and carcass characteristics of finishing pigs fed a diet with or without L-Carnitine, or with L-Carnitine the last 28 d prior to marketing^{1,2}

Item ³	Treatment			SEM	P-value
	No L-Carnitine	L-Carnitine	Late L-Carnitine		
BW, lb					
d 0	58.5	58.5	-	1.62	0.985
d 28	102.0	104.2	-	0.98	0.001
d 56	162.7	164.6	-	1.20	0.148
d 84	225.1	228.1	225.1	1.31	0.063
d 112	281.6	284.7	282.4	1.29	0.180
d 0 to 28					
ADG, lb	1.60	1.68	-	0.072	0.001
ADFI, lb	3.55	3.67	-	0.114	0.002
F/G	2.21	2.19	-	0.036	0.459
d 29 to 56					
ADG, lb	2.09	2.08	-	0.042	0.738
ADFI, lb	5.32	5.39	-	0.058	0.294
F/G	2.55	2.59	-	0.042	0.131
d 57 to 84					
ADG, lb	2.20	2.24	-	0.022	0.171
ADFI, lb	6.70	6.78	-	0.120	0.248
F/G	3.04	3.03	-	0.043	0.568
d 0 to 84					
ADG, lb	1.96	2.00	-	0.044	0.159
ADFI, lb	5.18	5.28	-	0.064	0.052
F/G	2.63	2.64	-	0.029	0.571
Removals, %	5.3	3.7	-	2.03	0.144
Mortality, %	1.8	2.3	-	0.60	0.481
Rem + Mort., % ⁴	7.7	6.6	-	1.94	0.404
d 85 to Market					
ADG, lb	2.12	2.14	2.18	0.022	0.355
ADFI, lb	5.62	5.74	5.68	0.121	0.506
F/G	2.65	2.71	2.62	0.043	0.551

continued

Table 2. Growth performance and carcass characteristics of finishing pigs fed a diet with or without L-Carnitine, or with L-Carnitine the last 28 d prior to marketing^{1,2}

Item ³	Treatment			SEM	<i>P</i> -value
	No L-Carnitine	L-Carnitine	Late L-Carnitine		
Overall (d 0 to 112)					
ADG, lb	1.97	2.00	1.98	0.017	0.300
ADFI, lb	5.66	5.73	5.62	0.109	0.236
F/G	2.87	2.86	2.84	0.038	0.221
Removals, %	5.7	4.2	5.8	2.40	0.371
Mortality, %	1.8	2.3	1.8	0.60	0.779
Rem. + Mort., % ⁴	7.6	6.6	7.8	2.11	0.700
Carcass characteristics					
HCW, lb	207.5	209.7	207.8	2.81	0.705
Yield, %	72.9	72.8	72.8	0.10	0.989
Backfat, in.	0.65	0.65	0.64	0.016	0.774
Lean, %	56.4	56.3	56.6	0.29	0.755
Loin depth, in.	2.50	2.48	2.48	0.021	0.540

¹A total of 1,833 pigs across two groups were used in a 112-d trial. Each pen contained 20 (group 1) and 27 pigs (group 2) and each treatment had 26 replicate pens.

²Treatment diets consisted of a control without L-Carnitine, 50 ppm of L-Carnitine fed for the entire experiment, or 50 ppm of L-Carnitine fed during the last 28 d prior to marketing.

³Until d 84, comparisons were made between 52 pens on the control diet and 26 pens fed L-Carnitine.

⁴Represented by the sum of removals and mortalities.

⁵Carcass weight at processing plant divided by the final BW at the farm.