THE EFFECTS OF SUPPLEMENTAL DIETARY CARNITINE, BETAINE, AND CHROMIUM NICOTINATE ON GROWTH AND CARCASS CHARACTERISTICS IN GROWING-FINISHING SWINE[1]

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Summary

Sixty-four pigs (initially 75 lb) were used to determine the effects of dietary betaine, carnitine, and chromium nicotinate on growth performance and carcass composition. Pigs were blocked by sex, ancestry, and weight and allotted in a randomized complete block design to each of four dietary treatments. These treatments were a corn-soybean meal-based control diet and control diet plus 50 ppm carnitine, 1,000 ppm betaine, or 200 ppb chromium from chromium nicotinate. Grower diets (75 to 125 lb) were formulated to contain 1.0% lysine and finisher diets (125 to 225 lb) were formulated to contain .8% lysine. All diets were corn-soybean meal-based, were fed in meal form, and contained .15% L-lysine HCl and 2.5% soy oil. When mean weight of pigs in a pen reached 225 lb, one pig per pen was selected at random and slaughtered to obtain carcass measurements. During the grower phase, pigs fed carnitine had greater ADG and feed efficiency (F/G) than pigs fed the control diet. However, during the finishing phase and overall, no differences were observed for ADG, F/G, or ADFI. Pigs fed carnitine had larger longissimus muscle area and greater percentage muscle than pigs fed the control or betaine diets. Also, pigs fed carnitine had lower tenth rib backfat thickness compared to those fed the control diet. Average backfat thickness was lower in the pigs fed carnitine or chromium nicotinate than in pigs fed the control diet. These results indicate that additions of dietary carnitine and chromium nicotinate are viable means of increasing carcass leanness in growing-finishing pigs. Further study of the metabolism of carnitine, chromium nicotinate, and betaine is needed to examine possible modes of action in the growing-finishing pig.

(Key Words: Betaine, Carnitine, Chromium Nicotinate, Pigs, G/F.)

Introduction

The increased emphasis by consumers for lean, wholesome pork has led packers to demand leaner pigs from pork producers. To meet this demand, producers are using both genetics and nutrition to produce lean pork. One way to produce leaner market pigs is by supplementing the diets of growing-finishing swine with carcass modifiers.

Researchers have examined several compounds to determine their potential as carcass modifiers. Specifically, several research institutions have examined the effectiveness of using carnitine, chromium, and betaine to increase the leanness of finishing pigs.

Recent work at Kansas State University showed that feeding carnitine at 25 ppm increased longissimus muscle area but had no

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effect upon growth of growing-finishing swine. Work at the University of the Wageningen in the Netherlands revealed that feeding carnitine at 40 ppm to growing-finishing swine increased average daily gain 10% and resulted in a 9% better efficiency. Also, these same pigs had 14% less backfat and 4% greater percentage muscle.

Three experiments at Louisiana State University with chromium picolinate showed positive results. In these experiments, researchers found that feeding 200 ppb chromium from chromium picolinate increased longissimus muscle area by 7 to 22% and decreased tenth rib backfat depth by 14 to 22%. However, chromium supplementation did not affect the growth performance of the pigs.

Research from Australia evaluated the efficacy of supplementing growing-finishing diets with betaine. In this experiment, the researchers found that adding 1 lb of betaine per ton of feed decreased backfat thickness by 11% in gilts and 7% in boars. However, no significant differences in growth or feed utilization were found.

Therefore, our objective was to test the effect that adding carnitine, chromium, and betaine to diets had on the growth and carcass characteristics of growing-finishing swine.

Procedures

The study used 64 pigs (32 barrows and 32 gilts) with initial weight of 75 lb. The pigs were blocked by sex, ancestry, and weight and allotted in a randomized complete block design to one of four dietary treatments. The four dietary treatments were a corn-soybean meal-based control diet and control diet plus 50 ppm carnitine, 1,000 ppm betaine, or 200 ppb chromium from chromium nicotinate. There were eight replicate pens per treatment (four replicates per sex), and the treatments were assigned randomly within each block.

Diets were formulated to 1.0 and .8% dietary lysine for the growing (75 to 125 lb) and finishing (125 to 225 lb) phases, respectively. The meal diets (Table 1.) were corn-soybean meal-based with .15% *synthetic* lysine and 2.5% soy oil.

The pigs were housed with two pigs per pens in an environmentally controlled finisher barn with totally slatted floors. Pigs and feeders were weighed every 14 d to calculate ADG, ADFI, and F/G. When the mean weight of pigs in a pen reached 225 lb, one pig per pen was selected at random and slaughtered. After a 24-hour chill period, standard carcass measurements were recorded.

Results and Discussion

During the growing period (75 to 125 lb; Table 2), pigs fed carnitine grew faster and more efficiently ($P<.05$) than pigs fed the control diet. Pigs fed the betaine and chromium diets had intermediate values for ADG and F/G. No differences occurred between treatments for ADFI. Also, no differences were detected between the diets for ADG, ADFI, or F/G in the finishing portion of this trial (125 to 225 lb) or for the entire experiment.

When pigs were slaughtered at 225 lb, differences in carcass traits were found between pigs fed the different carcass modifiers (Table 3). Pigs fed carnitine and chromium had lower last rib, last lumbar fat, and average backfat (average of midline first rib, last rib, and last lumbar fat depths) depths ($P<.05$) as compared with pigs fed the control diet. Pigs fed the carnitine diet also had lower tenth rib backfat thicknesses than pigs fed the control and betaine ($P<.05$) diets.

Pigs fed the carnitine diet had larger logissimus muscle area than pigs fed either the control or betaine diets ($P<.05$). Furthermore, the pigs fed the carnitine diet had higher values for percentage muscling and percentage lean than pigs fed the control and betaine diets ($P<.05$).

In conclusion, carnitine, betaine, and chromium from chromium nicotinate did not

affect the overall growth performance in this trial. However, carnitine decreased average backfat depth and increased longissimus muscle area, percent lean, and percent muscle. Chromium resulted in numerically higher percentage lean and percentage muscle. These results indicate that both carnitine and chromium are viable carcass modifiers for the growing-finishing pig. However, further study of the metabolism of carnitine, betaine, and chromium is needed to further examine possible modes of action in the finishing pig.

Table 1. Basal Diet Composition[a]

Item, %	Growing (75 to 125 lb)	Finishing (125 to 225 lb)
Corn	71.43	78.81
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	.20
Cornstarch[c]	.11	.11
Total	100.00	100.00

[a]Growing (75 to 125 lb) diets were formulated to 1.0% lysine, .75% Ca, and .65% P. Finishing (125 to 225) diets were formulated to .8% lysine, .65% Ca, and .55% P.
[b]Provided 40 g/ton tylosin.
[c]Carnitine (.005%), betaine (.1%), and chromium nicotinate (1.3 g/ton) replaced cornstarch to provide the experimental diets.

Table 2. The Effect of Carnitine, Betaine, and Chromium on Growth of Growing-Finishing Swine[a]

Item	Control	Carnitine	Betaine	Chromium	CV
Growing					
ADG, lb	1.90[b]	2.09[c]	2.01[bc]	2.03[bc]	8.1
ADFI, lb	4.79	4.92	4.87	4.99	7.2
F/G	2.54[b]	2.36[c]	2.42[bc]	2.46[bc]	6.2
Finishing					
ADG, lb	2.10	2.07	2.17	2.09	7.7
ADFI, lb	6.97	6.71	6.92	6.87	6.0
F/G	3.32	3.25	3.19	3.28	5.8
Overall					
ADG, lb	2.03	2.07	2.12	2.07	6.7
ADFI, lb	6.23	6.11	6.24	6.25	5.4
F/G	3.07	2.95	2.95	3.02	5.2

[a]A total of 64 pigs, two pigs/pen, eight replicate pens/treatment, and four replicate pens/sex.
[bc]Means in row with different superscripts differ ($P < .05$).

Table 3. The Effects of Carnitine, Betaine, and Chromium on Carcass Characteristics[a]

Item	Control	Carnitine	Betaine	Chromium	CV
Fat depth, in					
Tenth rib	1.19[b]	.99[c]	1.15[bc]	1.06[bc]	14.9
Last rib	1.10[b]	.95[c]	1.02[bc]	1.00[c]	8.8
Last lumbar	1.06[b]	.91[c]	.99[bc]	.94[c]	10.2
Average[d]	1.25[b]	1.14[c]	1.21[bc]	1.14[c]	7.3
Loin muscle area, in^2	4.87[b]	5.42[c]	4.79[b]	5.03[bc]	9.7
Lean, %[e]	46.05[b]	49.49[c]	46.30[b]	47.94[bc]	5.5
Muscle, %[f]	51.56[b]	53.94[c]	51.81[b]	52.96[bc]	3.5

[a]Thirty two pigs, eight pigs/treatment; four pigs/sex were slaughtered at 225 lb to collect carcass measurements.
[bc]Means with different superscripts differ ($P < .05$).
[d]Average backfat was calculated as the average of first rib, last rib, and last lumbar fat depths.
[e]Lean, % was calculated from NPPC equation for percent lean with 5% fat.
[f]Musc, % was calculated from NPPC equation for percent muscle with 10% fat.