INTERACTIVE EFFECTS BETWEEN PAYLEAN (RACTOPAMINE·HCl) AND DIETARY L-CARNITINE ON FINISHING PIG GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS

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Summary

Growth performance, carcass characteristics, and meat quality were evaluated from 126 pigs fed combinations of Paylean and L-carnitine arranged in a 3 × 3 factorial. Dietary L-carnitine (0, 25, or 50 ppm) was fed from 74 lb until slaughter, and Paylean (0, 4.5, or 9 g/ton) was fed the last 4 weeks prior to slaughter. These results suggest that Paylean, but not L-carnitine, increases ADG and improves F/G. However, L-carnitine enhances meat quality by improving visual color, L* (darker color), b* (less yellow), a*/b*, and Hue angle (more red and less orange) when fed with Paylean. L- carnitine also decreases drip loss and saturation index (vividness or intensity) and increases 24-h pH.

(Key Words: Carnitine, Paylean, Meat Quality.)

Introduction

In 1999 Paylean was approved by the FDA for use in finishing pig diets. Extensive research has shown that Paylean improves growth performance and carcass leanness in pigs by directing nutrients away from fat deposition and towards lean deposition. To support the increased lean tissue deposition, pigs fed Paylean need a higher dietary lysine (protein) level than pigs not fed Paylean. The increase in protein deposition is very rapid during the first 2 weeks when Paylean is fed. During this time, it is possible that pigs may be in an energy dependent phase of growth and are not consuming enough feed to maximize protein deposition. Adding carnitine to the diet could increase the amount of energy available for protein deposition and increase the response to Paylean. Therefore, the objectives of this experiment were to evaluate the effects of Paylean dosage and dietary carnitine on growth performance and carcass parameters of growing-finishing pigs and to evaluate differences in longissimus quality indicators, such as color, marbling and firmness.

Procedures

One hundred twenty-six gilts (initially 73.6 lb, PIC C22 × L326) were allotted by weight and ancestry in a randomized complete block design to each of the 9 experimental treatments in a 3 × 3 factorial arrangement. There were 2 pigs per pen and 7 replicates per treatment. Pigs were housed in an environmentally controlled building with 4 × 4-ft slatted-floor pens. Each pen had a one-hole self-feeder and a nipple waterer to allow ad libitum access to feed and water.

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Pigs were fed a corn-soybean meal diet (Table 1) with added L-carnitine (0, 25, or 50 ppm) from 73.6 lb until slaughter (approximately 240 lb). The basal diet was formulated to contain 1.10% lysine from 73.6 to 164 lb, and 1.00% lysine from 164 lb until the end of the experiment. Dietary Paylean treatments (0, 4.5, or 9 g/ton) were fed for the last 4 weeks of the experiment.

Table 1. Basal Diet Composition (As-Fed Basis)[a]

Ingredient, %	73.6 to 164 lb	164 lb to slaughter
Corn	68.41	74.50
Soybean meal (46.5% CP)	26.63	22.80
Soybean oil	2.00	-
Monocalcium phosphate	1.05	0.90
Limestone	1.00	0.90
Salt	0.35	0.35
Vitamin premix[b]	0.15	0.15
Trace mineral premix[c]	0.15	0.15
L-Lysine HCL	0.15	0.15
Medication[d]	0.05	-
DL-Methionine	0.01	-
Cornstarch[e]	0.05	0.10
Calculated composition		
CP (N × 6.25), %	18.20	16.90
Lysine, %	1.10	1.00
Methionine, %	0.31	0.28
Threonine, %	0.69	0.64
ME, kcal/lb	1,542	1,505
Ca, %	0.69	0.61
P, %	0.60	0.55

[a]Diets were formulated to meet or exceed NRC (1998) requirements.

[b]Provided 44 mg tylosin/kg feed.

[c]L-Carnitine replaced cornstarch to provide either 0, 25, or 50 ppm L-Carnititne. Paylean replaced cornstarch to provide either 0, 4.5, or 9 g/ton ractopamine·HCl during the last 4 weeks of the experiment.

Weights were obtained on all pigs and feed disappearance was recorded every 14 days during the experiment until the last 4 weeks, at which time measurements were recorded weekly to calculate ADG, ADFI, and F/G. One pig (closest to 240 lb) per pen was selected and slaughtered at the Kansas State University Meat Laboratory. Standard carcass measurements, visual analyses of longissimus muscle color, marbling, and firmness, color spectrophotometry (L*, a*, and b*), drip loss, ultimate pH, and temperature were obtained from each pig at 24-h postmortem.

Data were analyzed as a randomized complete block. Pen was the experimental unit for growth performance data, carcass characteristics, and meat quality measurements. Analysis of variance was performed using the GLM procedure of SAS. Hot carcass weight was used as a covariate in the statistical analysis of backfat, carcass length, loin eye area, and percentage lean.

Results and Discussion

Growth Performance. Supplementing finishing pig diets with L-carnitine did not affect (P>0.64) growth performance of pigs between 73.6 and 164 lb (Table 2). Pigs were allotted to treatments at the initiation of feeding carnitine and remained within the same treatment groups for the duration of the experiment. This explains the numeric (P<0.22) differences in initial weight at the beginning of the Paylean feeding period (Table 3). Two pens within the same treatment (50 ppm L-carnitine and 4.5 g/ton Paylean) were removed from the experiment because of clinical ileitis, therefore values reported in the tables are means of seven or five replications. There were no Paylean × carnitine interactions (P>0.12) observed for ADG, ADFI, or F/G during the last 4 weeks of the experiment. Increasing Paylean increased ADG (quadratic, P<0.02) and improved (quadratic, P<0.01) F/G. Average daily gain decreased from 0 to 4.5 g/ton but increased and was highest for pigs fed 9 g/ton Paylean. Feed efficiency

improved with increasing Paylean and was best for pigs fed 9 g/ton Paylean.

Carcass Characteristics. There were no Paylean × carnitine interactions ($P>0.14$) for carcass characteristics (Table 4). Dressing percentage tended to be greater ($P<0.08$) for pigs fed Paylean compared to control pigs. Shrink loss (1-(cold carcass wt/hot carcass wt)×100), average backfat, 10th rib fat depth, carcass length, longissimus muscle area, and percentage lean were not affected ($P>0.12$) by Paylean or dietary L-carnitine.

A Paylean × carnitine interaction was observed ($P<0.02$) for visual color, L*, a*/b* ratio, and Hue angle (Table 5). Carnitine did not improve visual color scores in control pigs, but carnitine improved visual color when 4.5 or 9 g/ton of Paylean was fed. Pigs fed increasing carnitine had lower L* values when fed with 4.5 or 9 g/ ton of Paylean, resulting in a darker colored longissimus muscle measured at the 10th rib. Pigs fed carnitine and 4.5 or 9 g/ton Paylean, but not control pigs, had lower a*/b* and Hue angle values, resulting in more red and less orange color.

Measurements of b* decreased (quadratic, $P<0.05$) with increasing carnitine, resulting in less yellow color of the longissimus muscle. The saturation index (vividness or intensity) measured on the longissimus muscle tended to decrease (quadratic, $P<0.07$) with increasing levels of carnitine. Drip loss measured 48 hours postmortem and temperature at 45 minutes postmortem decreased (linear, $P<0.04$) with increasing carnitine. Twenty-four hour pH increased and then decreased (quadratic, $P<0.06$) with increasing Paylean and was highest for pigs fed 4.5 g/ton. Ultimate (24-h) pH also increased (linear, $P<0.07$) with increasing dietary L-carnitine.

The improvements in meat quality of pigs fed L-carnitine in combination with Paylean may be the result of carnitine's affect on the pigs' metabolic parameters either antimortem or postmortem. Carnitine has been shown to increase pyruvate carboxylase and decrease lactate dehydrogenase in pigs. An increase in pyruvate carboxylase may direct pyruvate away from lactate, thus reducing substrate for lactic acid synthesis postmortem. Furthermore, a decrease in lactate dehydrogenase may delay the onset of postmortem glycolysis. In theory, this would result in an increase in pH and therefore better water holding capacity and decreased drip loss. Subsequently, meat color would be darker.

The results of this experiment suggest that L-carnitine improves meat quality in pigs fed Paylean. Further research needs to be conducted to better understand the effects and metabolic action of carnitine on antimortem lactate levels and postmortem glycolysis. If further studies confirm pork quality benefits, such as decreased drip loss, increased pH, and improved meat color, or decreased serum lactate levels, the potential exists for dietary L-carnitine to be used in conjunction with Paylean in the late finishing phase.

Table 2. Effect of Carnitine on Growth Performance of the Finishing Pig Prior to Feeding Paylean[a]

	Carnitine, ppm				Probability ($P<$)		
Item	0	25	50	SEM	Carnitine	Linear	Quad
ADG, lb	1.98	2.02	2.03	0.04	0.64	0.37	0.76
ADFI, lb	4.41	4.44	4.45	0.06	0.90	0.65	0.91
Feed/gain	2.24	2.20	2.21	0.03	0.66	0.49	0.55

[a]Values represent the period from 73.6 to 164.0 lb BW. At 164 lb, pigs were switched to diets containing 0, 4.5, or 9 g/ton Paylean in addition to the carnitine levels. Values are means of 21 replications (pens) and 2 pigs per pen.

Table 3. Effect of Carnitine and Paylean on Finishing Pig Growth Performance[a]

	Paylean, g/ton										Probability (*P*<)						
	0			4.5			9										
	Carnitine, ppm										Paylean ×			Paylean		Carnitine	
Item	0	25	50	0	25	50	0	25	50	SEM	Carnitine	Paylean	Carnitine	Linear	Quad	Linear	Quad
Initial wt	157.7	163.7	163.8	164.8	166.2	166.4	166.8	163.4	164.9	2.98	0.58	0.22	0.72	0.11	0.56	0.43	0.87
ADG, lb	2.14	2.18	2.39	2.32	2.18	2.14	2.48	2.23	2.43	0.10	0.12	0.07	0.13	0.88	0.02	0.73	0.04
ADFI, lb	5.49	5.52	5.89	5.48	5.29	5.31	5.87	5.25	5.50	0.20	0.17	0.21	0.16	0.08	0.77	0.84	0.06
Feed/gain	2.60	2.54	2.47	2.39	2.44	2.48	2.38	2.37	2.28	0.08	0.53	0.01	0.55	0.05	0.01	0.32	0.64
Final wt	217.5	224.6	230.8	229.6	227.1	226.4	236.1	225.7	232.9	4.50	0.10	0.09	0.39	0.26	0.06	0.42	0.25

[a]Values are means of seven or five replications (pens) and two pigs per pen for 28 d.

Table 4. Carcass Characteristics of Finishing Pigs Fed Carnitine and Paylean[a,b]

	Paylean, g/ton										Probability (*P*<)						
	0			4.5			9										
	Carnitine, ppm										Paylean ×			Paylean		Carnitine	
Item	0	25	50	0	25	50	0	25	50	SEM	Carnitine	Paylean	Carnitine	Linear	Quad	Linear	Quad
Dressing, %	72.99	73.39	73.40	74.19	74.26	73.68	75.18	73.40	73.63	0.57	0.14	0.08	0.40	0.06	0.25	0.21	0.64
Shrink loss[c], %	2.15	2.12	2.13	2.15	2.64	2.08	1.32	2.01	1.96	0.40	0.69	0.13	0.37	0.53	0.05	0.45	0.24
Backfat, in																	
First rib	1.56	1.43	1.50	1.45	1.45	1.47	1.42	1.44	1.38	0.10	0.87	0.51	0.82	0.55	0.32	0.65	0.68
Tenth rib	0.66	0.57	0.60	0.57	0.55	0.53	0.58	0.57	0.46	0.06	0.64	0.13	0.19	0.10	0.22	0.07	0.96
Last rib	1.00	0.96	0.94	0.91	0.98	0.95	1.03	0.96	0.89	0.07	0.60	0.86	0.46	0.61	0.85	0.23	0.70
Last lumbar	0.69	0.64	0.67	0.60	0.56	0.67	0.60	0.57	0.60	0.06	0.94	0.20	0.43	0.16	0.27	0.77	0.21
Average	1.08	1.01	1.04	0.99	0.99	1.03	1.02	0.99	0.96	0.07	0.86	0.48	0.74	0.34	0.45	0.55	0.63
Carcass length, in	31.51	31.56	31.34	31.75	31.32	31.43	31.14	31.30	31.46	0.28	0.53	0.56	0.93	0.85	0.29	0.80	0.77
Loin eye area, in^2	6.81	7.10	6.60	6.89	6.94	7.14	7.27	7.28	7.28	0.38	0.88	0.23	0.85	0.62	0.10	0.99	0.57
Lean, %	56.17	58.04	56.56	57.47	57.96	58.50	58.30	59.72	59.72	1.31	0.78	0.12	0.52	0.26	0.09	0.31	0.64

[a]Hot carcass weight was used as a covariate in the statistical analysis except for dressing (%) and shrink loss (%).

[b]Values are means of seven or five replications (pig closest to 240 lb in each pen).

[c]Shrink loss was calculated as 1-(cold carcass wt/hot carcass wt) × 100.

Table 5. Carcass Quality Measures of Finishing Pigs Fed Carnitine and Paylean[a]

	Paylean, g/ton										Probability ($P<$)						
	0			4.5			9				Paylean ×			Paylean		Carnitine	
	Carnitine, ppm																
Item	0	25	50	0	25	50	0	25	50	SEM	Carnitine	Paylean	Carnitine	Linear	Quad	Linear	Quad
Visual color[b]	3.35	2.78	31.4	2.57	3.28	3.49	2.57	3.00	2.85	0.25	0.02	0.15	0.18	0.99	0.08	0.11	0.82
Firmness[b]	1.93	1.65	1.93	1.79	1.93	2.05	1.79	2.15	1.79	0.24	0.43	0.88	0.88	0.66	0.81	0.66	0.81
Marbling[b]	2.00	1.71	1.85	1.35	2.07	1.82	1.64	2.00	1.71	0.21	0.08	0.76	0.22	0.46	0.91	0.42	0.13
L*[c]	55.37	58.01	56.80	60.78	56.39	55.06	61.53	58.46	57.88	1.25	0.01	0.01	0.02	0.42	0.01	0.01	0.68
a*[c]	7.61	6.17	6.45	5.78	6.22	7.00	6.30	6.71	6.51	0.53	0.08	0.49	0.81	0.23	0.99	0.94	0.52
b*[c]	15.25	14.61	15.10	15.69	14.09	14.19	15.90	14.98	15.04	0.53	0.67	0.25	0.01	0.42	0.14	0.03	0.05
a*b*[c]	0.50	0.42	0.43	0.37	0.44	0.50	0.39	0.45	0.43	0.03	0.01	0.52	0.33	0.42	0.49	0.27	0.90
Hue angle	63.60	67.38	67.05	69.95	66.31	63.71	68.65	65.91	66.69	1.44	0.01	0.55	0.31	0.44	0.52	0.25	0.84
Saturation index[c]	17.06	15.89	16.44	16.79	15.42	15.84	17.12	16.43	16.41	0.64	0.97	0.32	0.04	0.30	0.26	0.09	0.07
Drip loss	2.68	2,80	2.07	3.13	31.48	1.49	3.68	2.29	2.94	0.66	0.47	0.16	0.06	0.33	0.09	0.04	0.22
Temperature, °C	34.72	34.83	32.98	34.39	34.38	33.80	35.72	34.15	33.76	0.83	0.60	0.74	0.04	0.97	0.44	0.01	0.62
pH																	
45 m postmortem	6.22	6.55	6.46	6.41	6.44	6.34	6.33	6.23	6.39	0.10	0.10	0.38	0.39	0.99	0.17	0.24	0.49
24 h postmortem	5.75	5.79	5.76	5.79	5.86	5.86	5.71	5.79	5.78	0.04	0.91	0.01	0.04	0.01	0.06	0.07	0.08

[a]Values are means of seven or five replications (pig closest to 240 lb in each pen).

[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 2 sample readings per loin. Measures of dark to light (L*), redness (a*), yellowness (b*), red to orange (hue angle), or vividness or intensity (saturation index).