

EFFECT OF L-CARNITINE AND PAYLEAN (RACTOPAMINE·HCl) SUPPLEMENTATION ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS, AND POSTMORTEM pH DECLINE

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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 2 × 3 factorial. Dietary L-carnitine (0, 25, or 50 ppm) and Paylean (0 or 9 g/ton) were fed the last 4 weeks prior to slaughter. Feeding Paylean to pigs improved ($P<0.01$) ADG and F/G. Supplemental L-carnitine did not affect ($P>0.46$) ADG, but there was a trend for improved (quadratic, $P<0.07$) F/G in pigs fed increasing carnitine. A carnitine × Paylean interaction ($P<0.05$) was observed for dressing percentage and visual firmness, percentage transmission (soluble protein), temperature measured 1.5 h postmortem, and percentage drip loss. Dressing percentage was higher for pigs fed 25 ppm carnitine with no Paylean and lower for pigs fed 25 ppm carnitine with Paylean. Visual firmness scores decreased in pigs fed increasing carnitine and no Paylean but increased when adding carnitine to diets containing Paylean. Soluble protein increased (more soluble protein indicates higher quality muscle) and drip loss decreased when pigs were fed increasing L-carnitine with Paylean. A trend ($P<0.07$) was observed for pigs fed increasing carnitine to have lower 10th rib and average backfat. Feeding Paylean to pigs increased ($P<0.01$) percentage lean, L*, and hue angle, and decreased ($P<0.02$) visual color scores and a*/b*

values. Pigs fed Paylean had higher temperature and lower pH measured 3 h postmortem ($P<0.01$) and tended ($P<0.06$) to have lower pH measured 6 h postmortem. These results suggest that Paylean improves growth performance when fed to finishing pigs. Carnitine decreased drip loss and improved meat quality when fed to pigs in combination with Paylean.

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

Introduction

Previous research conducted with L-carnitine and Paylean demonstrated that Paylean, but not carnitine, improved growth performance when fed during the late finishing phase. However, pigs fed L-carnitine had improved visual color, L*, b*, a*/b*, and Hue angle when fed in combination with Paylean. In addition pigs fed L-carnitine had decreased percentage drip loss and saturation index, which was supported by a higher ultimate pH. These results led us to hypothesize that carnitine may be having an affect on the pigs' metabolic parameters either antimortem or postmortem. Carnitine has been shown to increase pyruvate carboxylase and decrease lactate dehydrogenase in pigs. This may explain the increase in pH and decreased drip loss when adding carnitine to the diet. Therefore, the objective of this experiment was to verify

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the affect of L-carnitine and Paylean supplementation on growth performance, carcass characteristics, and postmortem pH decline in finishing pigs.

Procedures

One hundred twenty gilts (initially 192.2 lb, PIC C22 × L326) were allotted by weight and ancestry in a randomized complete block design to each of the six experimental treatments arranged in a 2 × 3 factorial. There were 2 pigs/pen and 10 replicates/treatment. Pigs were fed a corn-soybean meal basal diet (1.00% lysine; 16.9% CP) with added L-carnitine (0, 25, or 50 ppm) and Paylean (0 or 9 g/ton) for the four-week experiment (Table 1).

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

Ingredient, %	
Corn	74.50
Soybean meal (46.5% CP)	22.80
Monocalcium phosphate, 21%P	0.90
Limestone	0.90
Salt	0.35
Vitamin premix	0.15
Trace mineral premix	0.15
L-Lysine HCL	0.15
Cornstarch ^b	0.10
Calculated composition	
CP (N × 6.25), %	16.90
Lysine, %	1.00
Methionine, %	0.28
Threonine, %	0.64
ME, kcal/lb	1,505
Calcium, %	0.61
Phosphorus, %	0.55

^aDiets were formulated to meet or exceed NRC (1998) requirements.

^bL-Carnitine replaced cornstarch to provide either 0, 25, or 50 ppm L-Carnitine and Paylean replaced cornstarch to provide either 0 or 9 g/ton ractopamine·HCl.

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. Weights were obtained on all pigs and feed disappearance was recorded every 14 d during the experiment to calculate ADG, ADFI, and F/G. One pig (closest to 240 lb) per pen was randomly selected and slaughtered at the Kansas State University Meats Laboratory. Blood was collected as soon as possible after exsanguination and pH, glucose, and lactate were measured from whole blood. Longissimus pH and temperature were measured as soon as possible after exsanguination and at 15 min, 45 min, 1.5 h, 3 h, and 6 h postmortem. Standard carcass measurements; visual analyses of longissimus muscle color, marbling, and firmness; color spectrophotometry (L*, a*, and b*); drip loss; and ultimate pH were obtained from each pig at 24-h postmortem. A 10-g tissue sample was obtained from the longissimus muscle at the 11th rib to measure transmission value. The sample was thoroughly mixed with 20 ml of distilled water and stored at 3 °C for 24 h. It was then centrifuged at 500 × g for 20 min and the supernatant was filtered through #1 Whatman filter paper. The filtrate (1 ml) was mixed with citric acid-phosphate buffer (5 ml), stored for 30 min at 24°C, and percentage turbidity measured at 600 nm. High transmission values indicate less soluble protein and lower quality muscle.

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. There were no Paylean \times carnitine interactions ($P>0.87$) observed for ADG, ADFI, or F/G (Table 2). Feeding pigs Paylean improved ($P<0.01$) ADG and feed efficiency. There was no effect ($P>0.46$) of feeding L-carnitine on ADG. However, pigs fed carnitine tended (quadratic, $P<0.07$) to have improved F/G, which was best for pigs fed 25 ppm carnitine. The major differences between this experiment and our previous experiment are: 1) only two levels of Paylean (0 and 9 g/ton) were fed compared to three (0, 4.5, and 9 g/ton) levels fed in the previous experiment; and 2) L-carnitine was only fed for four weeks compared to approximately six or seven weeks. Paylean improved both ADG and F/G in both experiments.

Carcass Characteristics. A Paylean \times carnitine interaction was observed ($P>0.01$) for dressing percentage (Table 3). Dressing percentage was higher for pigs fed 25 ppm carnitine and no Paylean and was lower for pigs fed 25 ppm carnitine and 9 g/ton Paylean.

Shrink loss (1-(cold carcass wt/hot carcass wt) $\times 100$), carcass length, and longissimus muscle area were not affected ($P>0.37$) by feeding either Paylean or L-carnitine. Tenth rib fat depth and average backfat were not affected ($P>0.30$) by feeding Paylean; however, there was a trend (linear, $P<0.07$) for pigs fed increasing L-carnitine to have lower 10th rib and average backfat. Feeding Paylean to pigs increased ($P<0.01$) percentage lean.

A Paylean \times carnitine interaction ($P<0.04$) was observed for visual firmness, percentage drip loss, percentage transmission, and temperature measured 1.5 h postmortem (Table 4). Visual firmness scores decreased when pigs were fed increasing carnitine and no Paylean but increased with increasing carnitine when Paylean was in the diet. Percent-

age drip loss and percentage transmission value decreased with increasing carnitine when fed with Paylean. A high transmission value indicates less soluble protein and higher quality muscle. Therefore, feeding carnitine improves meat quality when fed in combination with Paylean. In addition, longissimus muscle temperature was lower for pigs fed increasing levels of carnitine when Paylean was fed. Feeding carnitine to pigs did not affect ($P>0.07$) any of the other measured carcass characteristics. Visual color scores and a^*/b^* decreased ($P<0.02$) and L^* and hue angle increased ($P<0.01$) when pigs were fed Paylean, resulting in a lighter colored longissimus muscle. Pigs fed Paylean also had higher temperature and lower pH measured 3 h postmortem ($P<0.01$) and tended ($P<0.06$) to have lower pH measured 6 h postmortem.

The results of this experiment suggest that L-carnitine improves meat quality in pigs fed Paylean. The postmortem pH was not as greatly affected as previously hypothesized. However, improvements in other meat quality indicators, such as transmission value (more soluble protein indicating higher muscle quality) and decreased drip loss, were observed, which support the findings of our initial research. Because postmortem pH was not significantly affected by feeding carnitine, the mode of action for the improved meat quality is likely occurring prior to slaughter. The duration of carnitine supplementation was shorter in this experiment and may contribute to some of the variation from the results of other experiments. The affect of carnitine may be different at a commercial finishing facility where pigs have lower feed intake and different metabolic stressors compared to these that were reared at a university research facility. These factors support the need for further research to better understand the affects of carnitine under different situations.

Table 2. Effect of Carnitine and Paylean on Growth Performance of the Finishing Pig^a

Item	Paylean, g/ton						SEM	Probability (<i>P</i> <)				
	0			9				Paylean × Carnitine	Paylean	Carnitine	Carnitine	
	Carnitine, ppm										Linear	Quadratic
	0	25	50	0	25	50						
Day 0 to 14												
ADG, lb	2.22	2.26	2.21	2.76	2.72	2.60	0.13	0.82	0.01	0.72	0.48	0.70
ADFI, lb	6.04	5.76	5.53	6.04	6.00	5.74	0.20	0.65	0.91	0.09	0.05	0.36
Feed/gain	2.76	2.58	2.52	2.19	2.06	2.30	0.12	0.36	0.01	0.43	0.50	0.27
Day 14 to 28												
ADG, lb	2.37	2.35	2.24	2.15	2.40	2.29	0.15	0.55	0.73	0.68	0.97	0.39
ADFI, lb	7.33	7.00	6.98	7.14	6.89	6.73	0.25	0.96	0.37	0.28	0.13	0.65
Feed/gain	3.18	3.09	3.15	3.43	2.93	3.03	0.20	0.54	0.95	0.33	0.29	0.29
Day 0 to 28												
ADG, lb	2.30	2.31	2.23	2.47	2.55	2.45	0.07	0.90	0.01	0.46	0.50	0.30
ADFI, lb	6.69	6.38	6.25	6.53	6.22	6.24	0.18	0.90	0.44	0.10	0.05	0.41
Feed/gain	2.92	2.77	2.82	2.66	2.43	2.55	0.09	0.87	0.01	0.10	0.23	0.07

^aAverage initial BW, 192.2 lb.^bValues are means of 10 replications (pens) and one or two pigs per pen.**Table 3. Carcass Characteristics of Finishing Pigs fed Carnitine and Paylean^{a,b}**

Item	Paylean, g/ton						SEM	Probability (<i>P</i> <)				
	0			9				Paylean × Carnitine	Paylean	Carnitine	Carnitine	
	Carnitine, ppm										Linear	Quadratic
	0	25	50	0	25	50						
Dressing, %	72.30	74.48	72.71	74.90	73.56	74.25	0.39	0.01	0.35	0.01	0.79	0.23
Shrink loss, %	2.27	1.72	1.73	1.76	1.79	1.74	0.24	0.41	0.46	0.42	0.24	0.56
Backfat, in												
First rib	1.41	1.41	1.25	1.42	1.48	1.35	0.07	0.83	0.25	0.08	0.09	0.14
Tenth rib	0.68	0.65	0.63	0.67	0.63	0.56	0.04	0.77	0.30	0.18	0.06	0.86
Last rib	0.81	0.83	0.79	0.89	0.78	0.79	0.05	0.47	0.84	0.46	0.24	0.70
Last lumbar	0.73	0.66	0.68	0.71	0.65	0.59	0.05	0.85	0.35	0.26	0.11	0.63
Average	0.98	0.96	0.91	1.01	0.97	0.91	0.05	0.96	0.76	0.19	0.07	0.73
Carcass length, in	32.65	32.83	32.55	32.63	32.68	32.65	0.26	0.89	0.90	0.83	0.88	0.55
Loin eye area, in ²	6.60	7.09	6.73	7.81	7.21	7.90	0.23	0.94	0.76	0.37	0.65	0.60
Lean, %	54.85	55.50	55.80	56.71	56.19	58.09	0.71	0.50	0.01	0.19	0.10	0.40

^aHot carcass weight was used as a covariate in the statistical analysis except for dressing (%) and shrink loss (%).^bValues are means of 10 replications (one pig selected randomly from each pen).

Table 4. Carcass Characteristics of Finishing Pigs fed Carnitine and Paylean^a

Item	Paylean, g/ton						SEM	Probability (<i>P</i> <)				
	0			9				Paylean ×		Carnitine		
	Carnitine, ppm							Carnitine	Paylean	Carnitine	Linear	Quadratic
	0	25	50	0	25	50						
Visual color ^b	3.20	3.10	2.90	2.75	2.75	2.80	0.16	0.52	0.02	0.72	0.93	0.43
Firmness ^b	2.59	2.44	2.34	1.99	2.59	2.34	0.15	0.04	0.25	0.33	0.75	0.15
Marbling ^b	1.65	1.75	1.55	1.85	1.75	1.60	0.18	0.85	0.57	0.53	0.33	0.57
L* ^c	57.18	57.23	58.00	59.72	59.63	58.44	0.83	0.37	0.01	0.95	0.78	0.89
a* ^c	7.54	7.58	7.93	7.94	6.73	6.61	0.38	0.07	0.07	0.29	0.24	0.30
b* ^c	15.81	15.86	16.27	16.97	15.75	15.29	0.47	0.08	0.95	0.37	0.22	0.51
a*/b* ^c	0.48	0.48	0.49	0.46	0.43	0.43	0.02	0.40	0.01	0.44	0.46	0.30
Hue angle ^c	64.49	64.61	64.07	65.14	66.99	66.70	0.78	0.39	0.01	0.45	0.47	0.30
Saturation index ^c	17.52	17.59	18.11	18.74	17.13	16.67	0.56	0.06	0.64	0.321	0.20	0.42
Drip loss, %	2.04	3.07	2.73	4.85	2.47	2.82	0.64	0.02	0.48	0.15	0.32	0.56
Transmission, %	50.40	53.09	60.00	66.69	49.85	58.27	3.52	0.01	0.19	0.06	0.87	0.02
Temperature, °C												
5 min postmortem	38.59	39.79	39.17	39.60	39.74	39.68	0.56	0.60	0.24	0.40	0.51	0.25
15 min postmortem	40.20	39.92	39.56	40.42	40.18	40.06	0.31	0.88	0.16	0.23	0.09	0.97
45 min postmortem	37.72	39.03	38.73	39.43	38.35	38.76	0.69	0.18	0.16	0.23	0.73	0.93
1.5 h postmortem	32.91	32.87	33.17	35.99	33.51	32.65	0.72	0.04	0.06	0.07	0.05	0.46
3 h postmortem	21.38	22.12	20.89	24.38	22.37	22.76	0.63	0.10	0.01	0.26	0.11	0.85
6 h postmortem	10.74	11.28	11.22	12.04	11.09	10.97	0.48	0.20	0.47	0.82	0.55	0.89
Blood												
Glucose	109.73	107.07	108.44	109.21	103.82	108.89	3.74	0.88	0.71	0.51	0.83	0.26
Lactate	12.46	11.78	10.41	11.71	9.93	10.36	1.51	0.84	0.47	0.50	0.26	0.77
pH	7.14	7.13	7.21	7.16	7.16	7.21	0.05	0.94	0.76	0.37	0.23	0.47
Longissimus pH												
5 min postmortem	6.93	6.84	6.82	6.79	6.80	6.94	0.07	0.17	0.76	0.66	0.74	0.40
15 min postmortem	6.55	6.60	6.58	6.59	6.47	6.49	0.07	0.48	0.35	0.84	0.62	0.76
45 min postmortem	6.16	6.16	6.02	6.14	6.21	6.13	0.10	0.82	0.57	0.54	0.44	0.43
1.5 h postmortem	5.95	5.91	5.97	5.89	5.95	5.92	0.10	0.87	0.74	0.96	0.77	0.94
3 h postmortem	5.77	5.76	5.88	5.59	5.67	5.69	0.08	0.77	0.01	0.33	0.15	0.73
6 h postmortem	5.76	5.70	5.70	5.61	5.66	5.68	0.04	0.23	0.06	0.98	0.90	0.89
24 h postmortem	5.64	5.61	5.60	5.58	5.64	5.59	0.02	0.19	0.57	0.46	0.60	0.26

^aValues are means of 10 replications (one pig selected randomly from each pen).

^bScoring 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.

^cMeans were derived from two 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).