INFLUENCE OF DIETARY NIACIN ON FINISHING PIG PERFORMANCE AND MEAT QUALITY

D. E. Real, J. L. Nelssen, M. D. Tokach,
R. D. Goodband, S. S. Dritz[1], J. A. Unruh,
J. M. DeRouchey, J. C. Woodworth,
M. J. Webster, B. W. James, and E. Alonso[2]

Summary

One hundred forty-four finishing pigs were used to determine the influence of added dietary niacin on their growth performance and meat quality. Gilts grew slower, ate less, and were more efficient than barrows for the entire growth performance period. Increasing dietary niacin levels to 25 g/ton increased ADG in gilts for the first 25 days, but decreased ADG for barrows. No other interactions occurred. From d 25 to 62, ADFI tended to increase for pigs fed up to 100 g/ton niacin, whereas pigs fed 500 g/ton niacin ate less. Dietary niacin level did not significantly affect carcass yield or quality characteristics.

(Key Words: Niacin, Finishing Pigs, Meat Quality.)

Introduction

Niacin has long been accepted as an essential vitamin for swine diets. However, the optimal level of inclusion for finishing pigs has been the subject of considerable debate. According to a 1997 survey of vitamin inclusion rates, the overall average inclusion rate for niacin was 21 g/ton. The average for the 25% of the companies with the highest inclusion rates was 32 g/ton. The average of the lowest 25% of the companies was only 12 g/ton. Vitamin requirements of pigs are influenced by many factors, including the health status, previous nutrition, vitamin levels in other ingredients in the diet, and level of metabolic precursors in the diet. We are unaware of any research to determine the influence of niacin on meat quality of finishing pigs. An effect of niacin on serotonin levels would indicate a potential calming influence, which could improve meat quality of finishing pigs fed higher dietary levels of niacin. Modern lean genetics have lead to a particular problem with aggression in the growing-finishing phase and on the packer floor. Because of the lack of information concerning the influence of niacin on meat quality and the wide range of supplementation rates in the commercial industry, we conducted an experiment to determine the influence of niacin level in finishing diets on pig performance and meat quality characteristics.

Procedures

One hundred forty-four crossbred barrows and gilts, initially 112.8 lb, were used in this experiment. Niacin was added to a control diet (no added niacin) at rates of 12.5, 25, 50, 100, or 500 g/ton. Pigs were blocked by weight and fed one of the six dietary treatments.

Diets (Table 1) were fed in two phases. Phase I was fed from d 0 to 25 and formulated to contain 1.0% lysine; phase II was fed from d 25 to 62 and was formulated to contain 0.75% lysine. The diets were corn-soybean meal based and fed in meal form. The pigs were housed with two pigs per pen in an environmentally controlled finishing barn with 4-ft × 4-ft slatted-floor pens. Each treatment included two pigs per pen and 12 pigs per treatment (six pens of gilts and six pens of barrows). Pigs were provided ad libitum access to feed and water. Pigs and feeders were weighed to determine ADG, ADFI, and F/G. Pen served as the experimental unit for all statistical analysis.

[1]Food Animal Health and Management Center.
[2]Lonza, Inc., Fair Lawn, NJ.

One pig from each pen (closest to 240 lb) was slaughtered at the Kansas State University Meats Laboratory when the mean weight of all pigs was 240 lb. An entire block was removed from the experiment at the same time. At 45 min and 1 h postmortem, longissimus muscle (LM) pH and temperature were recorded. At 24 h postmortem, carcasses were ribbed, and one chop was removed (9th rib chop) and allowed to bloom for 30 minutes. Ultimate pH and temperature of the LM were measured at the tenth rib. Then, a two-person panel assigned visual color, marbling, and firmness scores for tenth rib LM. Longissimus muscle color was evaluated on a scale of 1 to 5 with 1 representing a muscle that was pale pinkish-gray and 5 representing a dark-purplish red color. Marbling was evaluated on a scale of 1 to 5 with 1 being practically devoid and 5 being moderately abundant or greater. Longissimus muscle firmness was evaluated on a scale of 1 to 3 with 1 being soft and exudative and 3 being firm and moist.

Immediately thereafter, Minolta color spectrophotometry data (CIE L*, a*, and b* values) were obtained in duplicate from the same chop. These values then were used to calculate A:B ratio, hue angle, and saturation index. The Minolta L* value represents the lightness of the sample. Longissimus muscles with a higher L* value would be lighter in color. Minolta a* values are chromatic coordinates representing a change from green to red color. A higher a* value indicates a sample with more red color. Minolta b* values are also chromatic coordinates, representing a change in color from blue to yellow. The higher the b* value, the more yellow the sample is in color. The A:B ratio indicates a change in redness. The higher the ratio, the redder the color. The hue angle represents the change from red to an orange color; therefore, a larger hue angle corresponds to less red color in the sample. The chroma or the total color, of the sample is expressed as the saturation index. The greater the value of the saturation index, the more intense the color of the sample.

The chops then were dissected, a 1-cu in. sample was taken to determine drip loss, and a .5 g sample was taken to determine water holding capacity (WHC). Samples were weighed and suspended on a fishhook inside a sealed container at 6°C for 24 hours. Then they were removed from the sealed containers and weighed again to determine percent drip loss. Water holding capacity was determined by the Carver press analysis and is expressed as a percent of meat:water ratio.

The data from this experiment were analyzed by the proc mixed procedure of SAS as a split-plot design with dietary niacin level as whole plot and sex as the subplot. The model included contrasts for linear and quadratic effects of increasing dietary niacin.

Results and Discussion

For the entire growth portion of the study, barrows had greater ADG, ADFI, and F/G than gilts (P<.01;Table 2). From d 0 to 25, a sex × treatment interaction affected ADG (P<.04;Table 2). Increasing dietary niacin to 25 g/ton increased ADG of gilts, but decreased ADG of barrows. Average daily feed intake and F/G decreased linearly (P<.03; P<.05, respectively) during this period. This response was caused by the lower intake for pigs fed 500 g/ton, because no differences in ADFI and F/G were apparent for pigs fed 0 to 100 g/ton niacin. From d 25 to 62, pigs fed up to 100 g/ton niacin tended to have higher ADFI (P<.09), but poorer F/G (P<.11) than pigs fed lower levels of niacin. However, pigs fed 500 g/ton niacin had lower ADFI (quadratic, P<.005) and lower ADG (quadratic, P<.03) similar to that of control pigs. Overall, ADFI tended to increase (P<.08;quadratic P<.007) along with feed efficiencies (P<.11; quadratic P<.007) for pigs fed up to 100 g/ton niacin, but then pigs fed 500 g/ton niacin had similar feed intakes and F/G as control pigs.

No differences (P<.10) in live wt or dressing percent occurred among niacin rates or between sexes (Table 3). Hot and cold carcass weights both decreased linearly (P<.05, P<.06, respectively). However, this can be attributed to the lower weights for pigs fed 500 g/ton. Essentially, pigs fed niacin up to 100 g/ton had similar carcass weights as control pigs. Niacin had no other effects on any of these carcass parameters. Sex had a significant effect on shrink loss (P<.001), because percent of cooler shrink was higher for gilts than for barrows. Gilts also had lower average and tenth rib backfat measurements (P<.001), shorter carcasses (P<.001), larger loin eyes (P<.001), and a higher percent lean (P<.001).

Subjective quality measurements on the LM showed no differences, only trends among treatments (Table 4). Even so, LMs from pigs fed niacin tended to have more reddish-pink color (P<.14) than those from pigs fed no added niacin. However, sex differences were observed. Carcasses of gilts had a more reddish pink color (P<.01), less marbling (P<.001), and a less firm and more exudative LM (P<.001) than carcasses of barrows. Gilt carcasses also had a lower b* value (P<.01) and saturation index (P<.02) than barrow carcasses, indicating that lean from barrows had a more yellowish, intense color. Carcasses of barrows also tended to be colder at 45 min postmortem than those of gilts (P<.07), and carcasses of pigs fed increasing levels of niacin were colder at 45 min postmortem (P<.08; linear P<.06).

In conclusion, this experiment showed that niacin had minimal effects on growth performance of pigs from 110 to 250 lb, regardless of sex. This could have been because pigs were eating an average of 6.47 lb of feed, and, therefore, had sufficient niacin from soybean meal and corn to meet their requirement. However, ADFI appeared to be increased with up to 100 g/ton niacin and then was similar to controls when niacin was included at 500 g/ton.

Although carcasses from pigs fed niacin tended to have a more reddish-pink color and a firmer lean, from a muscle quality perspective, niacin had minimal effects on carcass parameters and meat quality measurements.

Further research under field conditions needs to be conducted to determine the optimal amount of niacin for pigs with a lower level of feed intake.

Table 1. Compositions of Basal Diets

	Phases	
Ingredient, %	D 0 to 25	D 25 to 62
Corn	74.31	83.53
Soybean meal (46.5%)	22.79	13.72
Limestone	0.90	0.85
Monocalcium P (21% P)	0.90	0.80
Salt	0.35	0.35
Cornstarch[a]	0.35	0.35
Vitamin premix[b]	0.15	0.15
Lysine HCl	0.15	0.15
Trace mineral premix	0.10	0.10
Total	100.00	100.00

[a]Cornstarch was replaced by niacin from nicotinic acid (Lonza) to provide 12.5, 25, 50, 100, and 500 g/ton.
[b]Vitamin premix provided 6,000,000 USP units vitamin A, 900,000 USP units vitamin D_3, 24,000 IU vitamin E, 2400 mg B_{12}, 5400 mg riboflavin, and 18,000 mg pantothenic acid.

Table 2. Growth Performance of Finishing Pigs Fed Niacin[a]

	Niacin, g/ton							Sex			Contrasts (P<)				
Item	0	12.5	25	50	100	500	SEM	F	M	SEM	Trt	Sex	Int.	Lin.	Quad.
D 0 to 25															
ADG, lb	2.48	2.49	2.48	2.54	2.49	2.49	.051	2.37	2.61	.037	.89	.001	.04	.91	.68
ADFI, lb	6.08	6.10	6.12	6.18	6.10	5.89	.116	5.60	6.56	.089	.33	.001	.25	.03	.51
F:G	2.45	2.45	2.47	2.43	2.45	2.36	.041	2.36	2.51	.025	.44	.001	.12	.05	.84
D 25 to 62															
ADG, lb	2.22	2.09	2.16	2.28	2.29	2.15	.056	2.13	2.27	.034	.10	.003	.48	.50	.03
ADFI, lb	6.42	6.72	6.74	6.90	7.14	6.56	.201	6.33	7.16	.142	.09	.001	.63	.45	.005
F:G	2.89	3.22	3.12	3.02	3.12	3.05	.102	2.98	3.16	.079	.11	.01	.94	.91	.39
D 0 to 62															
ADG, lb	2.33	2.25	2.29	2.39	2.37	2.29	.042	2.23	2.41	.027	.17	.001	.12	.56	.06
ADFI, lb	6.28	6.47	6.49	6.61	6.72	6.27	.146	6.03	6.92	.110	.08	.001	.49	.18	.007
F:G	2.70	2.87	2.84	2.77	2.83	2.74	.061	2.71	2.87	.047	.11	.001	.84	.33	.29
Trt × sex interaction[b]															
D 0 to 25															
Gilts	2.37	2.30	2.46	2.41	2.35	2.33	.067								
Barrows	2.59	2.68	2.49	2.68	2.62	2.62	.067								

[a]Values are means of 144 pigs (initially 112.8 lb) with 2 pigs/pen and 6 replicate pens per treatment.

[b]Interaction significant (P<.04); no other interactions significant (P>.05).

Table 3. Carcass Yield Characteristics of Finishing Pigs Fed Niacin

	Niacin, g/ton							Sex			Contrasts (P<)				
Item	0	12.5	25	50	100	500	SEM	F	M	SEM	Trt	Sex	Int.	Lin.	Quad.
Live wt., lb	253.7	252.0	251.3	258.5	252.8	248.5	3.08	253.4	252.2	1.72	.34	.58	.51	.15	.52
Dressing %	75.05	75.58	75.35	75.71	74.96	74.73	.417	75.10	75.36	.213	.54	.32	.23	.18	.92
Hot wt., lb	190.4	190.4	189.3	195.7	189.5	185.7	2.48	190.3	190.1	1.58	.11	.91	.16	.05	.54
Cold wt., lb	187.6	187.8	186.5	193.2	187.0	183.4	2.52	186.9	188.3	1.63	.11	.36	.16	.06	.48
Shrink loss, %	1.51	1.38	1.47	1.26	1.31	1.23	.170	1.78	.95	.118	.73	.001	.42	.27	.41
Backfat															
Tenth rib, in	.95	.89	.90	.99	.97	.90	.044	.77	1.10	.026	.46	.001	.26	.51	.25
Average, in	1.20	1.17	1.12	1.26	1.19	1.11	.040	1.09	1.27	.023	.14	.001	.85	.11	.37
Carcass length, in	32.7	32.3	32.4	32.7	32.4	32.3	.217	31.9	33.0	.145	.44	.001	.64	.47	.85
LEA, sq in.[b]	6.27	6.66	6.77	6.68	6.23	6.29	.215	7.05	5.91	.124	.28	.001	.20	.28	.63
% Lean	50.89	52.34	52.46	51.10	50.58	51.69	.763	54.36	48.66	.440	.41	.001	.20	.97	.25
Data with hot carcass weight as a covariate[a]															
Shrink loss, %	1.51	1.38	1.48	1.21	1.32	1.27	.174	.95	.95	.125	.69	.001	.49	.45	.36
Backfat															
Tenth rib, in	.95	.89	.90	.99	.97	.90	.046	.77	1.10	.026	.49	.001	.26	.51	.25
Average, in	1.20	1.17	1.12	1.26	1.19	1.16	.041	1.09	1.27	.024	.24	.001	.85	.15	.39
Carcass length, in	32.7	32.2	32.4	32.6	32.4	32.4	.230	31.9	33.0	.151	.62	.001	.66	.77	.75
LEA,sq in.[b]	6.26	6.65	6.79	6.59	6.23	6.36	.224	7.05	5.91	.124	.37	.001	.21	.47	.55
% Lean	50.88	52.34	52.46	51.10	50.58	51.69	.808	54.36	48.66	.444	.43	.001	.21	.97	.26

[a]Hot carcass weight average 190.2 lb.

[b]LEA = loin eye area.

Table 4. Carcass Quality Characteristics of Finishing Pigs Fed Niacin

	Niacin, g/ton							Sex			Contrasts (P<)				
Item	0	12.5	25	50	100	500	SEM	F	M	SEM	Trt	Sex	Int.	Lin.	Quad.
Visual color[a]	2.21	2.42	2.33	1.71	2.42	2.50	.274	2.51	2.03	.211	.14	.01	.84	.24	.74
Marbling[b]	2.21	2.71	2.79	2.67	2.58	2.58	.273	1.90	3.28	.204	.54	.001	.54	.95	.54
Firmness[c]	1.88	2.13	2.33	1.71	2.00	2.08	.169	1.82	2.22	.088	.19	.001	.36	.76	.60
Drip loss [d], %	4.49	3.85	4.26	5.91	4.64	4.78	.925	4.58	4.73	.579	.73	.84	.34	.80	.52
WHC [e], %	29.82	31.69	32.02	29.88	33.06	32.03	1.59	32.25	30.57	1.06	.56	.17	.21	.51	.33
L*[f]	54.49	54.68	53.47	53.85	54.42	53.81	.849	53.62	54.62	.490	.90	.16	.94	.69	.96
a*[f]	7.98	7.86	8.36	8.71	8.15	8.18	.344	8.11	8.30	.248	.40	.43	.13	.97	.37
b*[f]	16.67	16.75	16.90	17.16	16.87	16.91	.414	16.54	17.21	.331	.91	.01	.31	.82	.56
a*/b*[f]	.478	.468	.496	.508	.483	.483	.016	.490	.481	.009	.55	.45	.40	.95	.47
Hue angle[f]	64.51	65.01	63.72	63.14	64.28	64.23	.727	63.95	64.351	.400	.56	.46	.36	.99	.49
Saturation index[f]	18.49	18.52	18.87	19.26	18.74	18.79	.489	18.43	9.12	.394	.69	.02	.15	.87	.45
%R630/%R580[f]	2.66	2.66	2.72	2.72	2.68	2.77	.066	2.66	2.74	.038	.82	.16	.86	.26	.95
Temperature, °C															
45 min	38.18	37.58	37.98	38.00	38.37	37.12	.367	38.14	37.60	.229	.18	.07	.93	.04	.19
1 hour	36.89	36.65	37.19	37.04	37.37	36.35	.442	37.00	36.83	.255	.63	.39	.40	.24	.24
24 hour	-.03	-.26	.03	.03	.11	.01	.116	-.09	.06	.082	.20	.08	.06	.55	.10
pH															
45 min	6.40	6.36	6.39	6.31	6.29	6.41	.081	6.37	6.35	.046	.87	.87	.37	.67	.25
1 hour	6.24	6.15	6.15	6.19	6.21	6.24	.081	6.22	6.17	.044	.93	.39	.48	.56	.98
24 hour	5.44	5.49	5.49	5.46	5.49	5.48	.027	5.48	5.48	.082	.60	.87	.57	.62	.36

[a]Scoring system of 1 to 5: 2 = grayish pink;3 = reddish pink; and 4 = purplish red.

[b]Scoring system of 1 to 5: 2 = traces to slight; 3 = small to modest; and 4 = moderate to slightly abundant.

[c]Scoring system of 1 to 3: 1 = soft and exudative; 2 = slightly firm and moist; and 3 = firm and unexudative.

[d]Calculated using fishhook method.

[e]Water holding capacity calculated by the Carver press analysis.

[f]Means were derived from two sample readings per chop. Measures of dark to light (L*), redness (a*), yellowness (b*), red to orange (hue angle), vividness or intensity (saturation index), or reflectance values (%R630/%R580).