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D E. Real

E Alonso

Jim L. Nelssen

See next page for additional authors

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Influence of increasing niacin on growth performance and carcass characteristics of grow-finish pigs reared in a commercial environment

Abstract

There were 1,243 growing pigs used to determine the effects of increasing dietary niacin on growth performance and meat quality of pigs reared in a commercial environment. The dietary treatments consisted of a control diet (no added niacin) or the control diet with 12.5, 25, 50, 100, or 500 g/ton of added niacin. Increasing dietary niacin decreased ADFI and improved F:G for the overall study. Increasing dietary niacin improved carcass shrink, ultimate pH, drip loss percentage, and loin color. Increasing dietary niacin up to 50 ppm improved feed efficiency, but higher concentrations (up to 50 ppm) decreased carcass shrink, and improved muscle quality in grow-finish pigs.; Swine Day, Manhattan, KS, November 15, 2001

Keywords

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Authors

D E. Real, E Alonso, Jim L. Nelssen, John A. Unruh, Michael D. Tokach, Robert D. Goodband, Joel M. DeRouchey, and Steven S. Dritz

INFLUENCE OF INCREASING NIACIN ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF GROW-FINISH PIGS REARED IN A COMMERCIAL ENVIRONMENT [1]

D. E. Real, J. L. Nelssen, J. A. Unruh, M. D. Tokach, R. D. Goodband, S. S. Dritz [2], J. M. DeRouchey, and E. Alonso [3]

Summary

There were 1,243 growing pigs used to determine the effects of increasing dietary niacin on growth performance and meat quality of pigs reared in a commercial environment. The dietary treatments consisted of a control diet (no added niacin) or the control diet with 12.5, 25, 50, 100, or 500 g/ton of added niacin. Increasing dietary niacin decreased ADFI and improved F:G for the overall study. Increasing dietary niacin improved carcass shrink, ultimate pH, drip loss percentage, and loin color. Increasing dietary niacin up to 50 ppm improved feed efficiency, but higher concentrations (up to 50 ppm) decreased carcass shrink, and improved muscle quality in grow-finish pigs.

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

Introduction

Niacin has long been accepted as an essential vitamin for swine diets. However, the optimal dietary inclusion for finishing pigs receives considerable debate. According to a 1997 survey of vitamin inclusion rates, the average inclusion rate for niacin was 21 g/ton. The average of the 25% of the companies with the highest inclusion rate 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 health status, previous nutrition, vitamin levels in other ingredients and level of metabolic precursors in the diet.

Previous research at Kansas State University has shown no difference in growth performance due to added niacin and a minimal impact on pork quality. However, this could have been due to the high feed intakes of these hogs and that the control pigs were eating enough soybean meal to meet their requirement for niacin. Due to the limited information concerning the influence of niacin on meat quality and the wide range in supplementation rates in the commercial industry, we conducted this experiment to determine the effect of added niacin in finishing diets performance and meat quality characteristics of pigs raised on commercial facilities.

Procedures

One thousand two hundred forty-three PIC L337 × C22 barrows and gilts (initially 79.7 lb) were used in this experiment. Pens of approximately 26 pigs were blocked by average initial body weight and then randomly allotted to one of six dietary treatments with 4 pens/treatment/sex. Each pen was equipped with an eight hole stainless steel feeder and one cup waterer to provide ad libitum access to feed and water. Pigs were housed on totally slatted concrete floors in 10 × 18-ft pens. The finishing facility was a double curtain-sided, deep-pit barn that operated on manual ventilation during the

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[1]Authors thank Global Ventures, Pipestone, MN for pig management.
[2]Food Animal Health and Management Center.
[3]Lonza, Inc., Fair Lawn, NJ.

summer and on automatic ventilation during the winter.

Pigs were fed the experimental corn-soybean meal diets in four phases (Table 1). The dietary treatments consisted of a control diet (no added niacin), or the control diet with 12.5, 25, 50, 100, or 500 g/ton additional niacin from niacinamide. The first three phases contained 6% choice white grease and all diets contained 0.15% L-lysine·HCl. All diets were fed in meal form and, vitamins and minerals except niacin were fed according to the KSU Swine Nutrition Guide.

Pig weights and feed disappearance were measured by pen every 14 d to calculate ADG, ADFI, and F/G. Diet phase changes occurred every 28 d. At the end of the growth study, one pig per pen was randomly selected and transported 450 miles to the KSU Meat Laboratory for harvest. The remaining pigs in each pen were tattooed to maintain pen identity and were transported to a commercial packing facility where standard carcass measurements were obtained.

Pigs transported to the KSU Meat Laboratory were harvested similar to that of a commercial facility. At 45 min postmortem, longissimus muscle (LM) pH was recorded at the 10th rib. Twenty-four hours postmortem, carcasses were weighed, ribbed, and one chop was removed (9th rib chop) and allowed to bloom for 30 minutes. A 2-person panel then assigned subjective color, marbling, wetness, and firmness scores to each chop. Immediately thereafter, Minolta color spectrophotometry data (CIE L*, a*, and b*) were measured in triplicate from the same chop. These values were then used to calculate a:b ratio, hue angle, and saturation index. The chops were then measured for loin eye area and dissected to obtain a 15-g center-cut sample. The samples were weighed and suspended on a fishhook in a sealed container for 24 hr to determine percentage drip loss.

All data from this experiment were analyzed using the MIXED procedure of SAS as a split-plot design with sex as the whole plot and dietary niacin as the subplot. The model included contrasts for linear and quadratic effects of unevenly spaced dietary niacin levels.

Results and Discussion

For the overall growth study, barrows had greater ($P<0.01$) ADG and ADFI ($P<0.07$) than gilts as would be expected (Table 2). From d 0 to 28 increasing dietary niacin decreased ADFI (quadratic, $P<0.01$) and improved F/G (quadratic, $P<0.003$) up to 100 g/ton additional niacin. From d 28 to 56, there were no differences in growth performance among treatments. Increasing dietary niacin up to 500 g/ton from d 56 to 84 improved (quadratic, $P<0.03$) F/G. Overall, increasing dietary niacin increased ADG (linear, $P<0.05$) and decreased ADFI (quadratic, $P<0.01$). Additionally, increasing dietary niacin up to 50 g/ton improved F/G (quadratic, $P<0.01$).

Regardless of slaughter facility, gilts were lighter ($P<0.01$) and had higher fat free lean indexes (FFLI) ($P<0.06$) than barrows (Table 3). Of the pigs harvested at the KSU Meat Laboratory, gilts were also leaner at the 10^{th} rib ($P<0.03$) and tended to have a larger loin eye area ($P<0.06$) than barrows. Increasing niacin in the diet increased hot carcass weight (HCW) of gilts, but decreased HCW in barrows resulting in an interaction (sex × trt, $P<0.02$) for this response as well as cold carcass weight (CCW) (sex × trt, $P<0.04$). The interaction was primarily a function of pigs fed 500 g/ton niacin.

Barrows had more marbling ($P<0.02$) and higher a* values on the LM at the 10^{th} rib ($P<0.05$) than gilts (Table 4). Therefore, a:b ratio was increased ($P<0.01$) for barrows, and hue angle was higher ($P<0.01$) for gilts. There were no other main effect differences for sex ($P>0.10$). Increasing niacin increased redness (a*) of LM at the 10th rib for barrows while decreasing a* when niacin was increased in gilts (trt × sex, $P<0.005$). Similarly, increasing niacin increased calculated saturation indexes for barrows, while decreasing these values for gilts (sex × trt, $P<0.03$). Because saturation index is dependent on L*, a*, and b* values, this is expected due to the effects of gender on a* values. Also, there was an interaction (sex × trt, P<0.005) for reflectance values on the 10th rib LM. Increasing niacin increased reflectance values for barrows, while decreasing values for gilts.

Increasing niacin increased (linear, P<0.01) 10th rib LM subjective color and wetness scores, while decreasing (linear, P<0.04) percentage drip loss of LM and L* values (linear, P<0.001). Increasing niacin also decreased (linear, P<0.10) redness (a*) and yellowness (b*, linear, P<0.04) of LM at the 10th rib. Saturation index was decreased (linear, P<0.04) as niacin increased, but this significance is only evident when looking at pigs fed 500 g/ton niacin. Increasing niacin in the diet increased (linear, P<0.02) carcass temperatures 45 min postmortem, which would indicate a slower temperature decline postmortem. In contrast, increasing niacin increased (linear, P<0.02) ultimate pH, which would normally suggest a more rapid decline in carcass temperature.

In conclusion, increasing niacin improved feed efficiency in this experiment contrary to a study where pigs were housed with four per pen in a research facility (2000 KSU Swine Day Report). Increasing niacin improved carcass shrink, and drip loss percentage in pigs, although it did not affect loin eye area or FFLI. Furthermore, increasing niacin improved subjective color, L* values (lightness), and ultimate pH of LM at the 10th rib, which would all indicate an improvement in pork quality.

The maximum response in feed efficiency was seen at 50 g/ton additional niacin; however, muscle quality indicators would suggest adding up to 500 g/ton additional niacin through the finishing phase to improve drip loss, color, and ultimate pH. More research is needed to determine the correct amount of niacin to add to maximize profitability from the growth performance and meat quality benefits found when adding niacin to grow-finish pig diets.

Table 1. Basal Diet Compositions

	Phases			
Item	D 0 to 28	D 28 to 56	D 56 to 84	D 84 to 117
Ingredient, %				
Corn	58.61	64.26	71.97	87.76
Soybean meal (46.5%)	32.44	26.99	19.70	10.06
Choice white grease	6.00	6.00	6.00	0.00
Monocalcium phosphate (21% P)	1.25	1.10	0.70	0.60
Limestone	0.90	0.90	0.90	0.85
Salt	0.35	0.35	0.35	0.35
Vitamin premix[a]	0.15	0.15	0.13	0.13
Trace mineral premix[b]	0.15	0.10	0.10	0.10
Lysine HCl	0.15	0.15	0.15	0.15
Chemical composition				
Lysine, %c	1.25	1.10	0.85	0.60
Tryptophan, %[c]	0.25	0.21	0.16	0.11
Calcium, %[c]	0.70	0.66	0.56	0.49
Phosphorus, %[c]	0.65	0.60	0.48	0.44
Total niacin, mg/kg[d]	24.9	24.8	24.5	24.6
Available niacin, mg/kg[e]	11.0	9.2	6.7	3.4

[a]Provided dietary treatments of 0, 13, 28, 55, 110, or 550 mg/kg niacin. Also provided 6,600 USP vitamin A, 990 USP vitamin D_3, 26 IU vitamin E, 2.64 mg B_{12}, 6 mg riboflavin, and 20 mg pantothenic acid per kg of diet from d 0 to 56, and 83% of these levels from d 56 to 117. [b]Provided 165 mg zinc, 165 mg iron, 40 mg manganese, 17 mg copper, 0.30 mg iodine, 0.30 mg selenium per kg of diet from d 0 to 28, and 67% of these levels from d 28 to 117. [c]Calculated content, NRC (1998). [d]Analyzed content. [e]Calculated by subtracting niacin in corn (NRC, 1998) from total analyzed content.

Table 2. Effects of Niacin on Growth Performance in Grow-Finish Pigs[a]

	Niacin, g/ton							Probabilities, P<			
Item	0	12.5	25	50	100	500	SEM	Trt	Sex × Trt	Linear	Quadratic
D 0 to 28											
ADG, lb	1.82	1.88	1.86	1.85	1.85	1.85	0.030	0.82	0.20	0.98	0.83
ADFI, lb[c]	3.37	3.64	3.58	3.46	3.43	3.57	0.065	0.12	0.82	0.86	0.01
F/G[c f]	2.00	1.94	1.92	1.88	1.85	1.93	0.035	0.06	0.72	0.81	0.003
D 29 to 56											
ADG, lb	1.96	1.94	1.89	2.00	1.85	1.88	0.036	0.05	0.18	0.15	0.20
ADFI, lb[be]	4.86	4.74	4.64	4.57	4.61	4.57	0.095	0.24	0.38	0.17	0.11
F/G	2.49	2.45	2.47	2.29	2.49	2.44	0.075	0.44	0.65	0.97	0.78
D 57 to 84											
ADG, lb	1.45	1.53	1.44	1.49	1.51	1.51	0.038	0.47	0.28	0.37	0.54
ADFI, lb[be]	5.14	5.06	4.94	4.80	4.91	4.82	0.110	0.21	0.05	0.13	0.14
F/G[ce]	3.57	3.30	3.44	3.23	3.25	3.18	0.074	0.01	0.39	0.01	0.03
D 85 to 117											
ADG, lb	1.50	1.51	1.54	1.52	1.46	1.43	0.038	0.43	0.97	0.07	0.59
ADFI, lb[d]	5.38	5.44	5.60	5.32	5.16	5.21	0.109	0.08	0.35	0.08	0.08
F/G	3.58	3.61	3.66	3.51	3.52	3.64	0.079	0.73	0.52	0.61	0.29
D 0 to 117											
ADG, lb[d]	1.67	1.71	1.68	1.71	1.66	1.66	0.013	0.05	0.69	0.05	0.50
ADFI, lb[ce]	4.77	4.75	4.72	4.56	4.55	4.57	0.060	0.03	0.24	0.05	0.01
F/G[ce]	2.85	2.78	2.81	2.67	2.73	2.75	0.030	0.01	0.37	0.32	0.01
Initial wt, lb	79.7	79.8	79.7	79.4	79.7	79.8	0.58	0.99	0.45	0.85	0.87
Final wt, lb	278.3	283.9	276.6	282.9	276.5	277.1	1.90	0.02	0.92	0.17	0.42

[a]Values are representative of initially 1243 pigs (79.7 lb). [b]Niacin linear 0 to 100 g/ton ($P<0.05$). [c]Niacin linear 0 to 100 g/ton ($P<0.01$). [d]Niacin quadratic 0 to 100 g/ton ($P<0.06$). [e]Control vs. 500 g/ton ($P<0.05$). [f]100 niacin vs. 500 g/ton ($P<0.08$).

Table 3. Effects of Niacin on Carcass Characteristics in Grow-Finish Pigs

	Niacin, g/ton							Probabilities, P<			
Item	0	12.5	25	50	100	500	SEM	Trt	Sex × Trt	Linear	Quadratic
Values from pigs harvested at KSU Meat Laboratory											
HCW, lb	188.4	194.6	193.4	190.7	190.4	193.1	3.05	0.71	0.04	0.68	0.76
Dress, %	75.2	75.2	76.1	74.6	74.8	75.7	0.57	0.48	0.54	0.55	0.27
CCW, lb	186.2	193.5	191.8	188.9	189.1	191.1	3.01	0.60	0.03	0.73	0.86
Shrink, %	1.20	0.58	0.86	0.97	0.68	1.01	0.145	0.06	0.34	0.51	0.14
FFL, %	53.54	54.42	53.10	52.65	51.85	53.05	1.194	0.76	0.76	0.76	0.18
BF											
First, in[a]	1.47	1.49	1.58	1.47	1.54	1.40	0.073	0.58	0.54	0.23	0.45
Last, in[a]	0.96	0.85	0.97	0.92	1.00	0.93	0.048	0.31	0.85	0.95	0.20
LLV, in[a]	0.60	0.56	0.64	0.58	0.65	0.59	0.054	0.84	0.95	0.88	0.49
Tenth, in[a]	0.74	0.69	0.80	0.77	0.80	0.76	0.062	0.81	0.96	0.83	0.35
Avg., in[a]	1.01	0.97	1.06	0.99	1.06	0.97	0.055	0.65	0.88	0.55	0.33
Length, in[a]	34.2	34.3	33.5	34.1	34.0	33.8	0.32	0.42	0.12	0.45	0.88
LEA, in^2[a]	7.00	7.16	7.21	6.73	6.35	6.85	0.433	0.74	0.54	0.72	0.16
Values from pens of pigs harvested at commercial facilities											
HCW, lb	212.0	213.5	212.1	211.8	209.9	210.4	1.36	0.48	0.33	0.21	0.18
Dress, %	0.77	0.77	0.77	0.77	0.77	0.76	0.004	0.20	0.09	0.64	0.21
FFLP	52.62	52.36	52.43	52.43	52.51	52.22	0.256	0.92	0.29	0.39	0.92
Avg. BF, in[b]	0.66	0.67	0.68	0.67	0.68	0.69	0.015	0.76	0.70	0.19	0.56
Loin depth, in[b]	2.32	2.32	2.37	2.30	2.35	2.31	0.024	0.40	0.01	0.55	0.61

[a]HCW used as covariate (191.8 lb).
[b]HCW used as covariate (211.6 lb).

Table 4. Effects of Niacin on Meat Quality in Grow-Finish Pigs

	Niacin, mg/kg							Probabilities, P<			
Item	0	12.5	25	50	100	500	SEM	Niacin	Sex × Trt	Lin.	Quadratic
Marbling[a]	1.1	1.2	1.2	1.4	1.3	1.6	0.21	0.39	0.86	0.15	0.73
Color[ahi]	3.9	3.8	3.9	3.3	4.2	4.4	0.19	0.86	0.25	0.01	0.89
Wetness[bj]	2.4	2.6	2.4	2.4	2.7	2.9	0.13	0.15	0.53	0.01	0.45
Firmness[c]	2.4	2.4	2.5	2.3	2.4	2.6	0.18	0.75	0.97	0.42	0.82
Drip loss, %[i]	2.00	1.90	1.93	1.90	1.23	0.80	0.469	0.39	0.29	0.04	0.41
L*[dhj]	53.12	53.60	53.14	53.95	51.43	49.77	0.733	0.36	0.08	0.01	0.35
a*[di]	8.22	7.57	8.00	8.15	8.07	7.27	0.374	0.33	0.02	0.10	0.54
b*[di]	13.33	13.15	12.90	14.24	12.89	12.35	0.404	0.61	0.06	0.04	0.76
a:b	0.62	0.58	0.62	0.57	0.62	0.59	0.022	0.42	0.09	0.82	0.77
Hue angle[e]	58.35	60.07	58.21	60.59	58.21	59.40	0.917	0.35	0.07	0.80	0.80
Sat. Index[f]	15.67	15.19	15.20	16.44	15.24	14.35	0.496	0.48	0.03	0.04	0.63
630/580[dh]	2.59	2.47	2.49	2.54	2.60	2.54	0.061	0.37	0.005	0.83	0.38
45 min pH	6.42	6.42	6.32	6.28	6.29	6.32	0.127	0.51	0.93	0.76	0.38
45 min temp[gj]	32.9	34.4	34.2	34.3	35.5	36.2	0.79	0.03	0.45	0.02	0.13
24 hr pH[gj]	5.67	5.73	5.77	5.76	5.85	5.94	0.049	0.01	0.10	0.001	0.06
24 hr temp	0.1	0.2	-0.3	-0.1	0.2	-0.3	0.25	0.64	0.98	0.37	0.64

[a]NPPC reference cards. [b]Scale of 1 to 3; 1-cut surface distorts easily (visibly soft), 2-cut surface tends to hold shape, 3- cut surface very smooth (no distortion of shape). [c]Scale of 1 to 3; 1-excessive fluid pooling on cut surface, 2-cut surface moist - little or no free water, 3-cut surface exhibits no free water. [d]Measure of lightness (L*), redness (a*), or yellowness (b*); reflectance values (%R630/%R580). [e]Measure of color angle (higher value is redder). [f]Measure of color intensity. [g]Niacin linear 0 – 100 g/ton (P<.06). [h]Niacin quadratic 0 – 100 g/ton (P<.10). [i]Control vs. 500 g/ton niacin (P<.10). [j]Control vs. 500 g/ton niacin (P<.01).