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Niacin and Vitamin B_{12} Requirements of Weanling Pigs

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Summary and Implications

An experiment was conducted to assess the responsiveness of weanling pigs to increased dietary concentrations of niacin and vitamin B_{12}. The purpose of the experiment was to determine if the niacin and vitamin B_{12} requirements of nursery pigs are greater than the NRC (1998) recommendations for 11 to 22 lb pigs. Pigs (initial weight 9.4 lb) were fed one of four diets for a total of 35 days: 1) Negative control, common nursery diet with no added niacin or vitamin B_{12}; 2) Niacin, common nursery diet with 22.7 mg/lb added niacin; 3) B_{12}, common nursery diet with 36.3 μg/lb added vitamin B_{12}; and 4) Positive control, common nursery diet with 22.7 mg/lb added niacin and 36.3 μg/lb added vitamin B_{12}. Pigs and feeders were weighed weekly to determine average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (ADG/ADFI). Pigs were visually scored to assess any potential niacin and vitamin B_{12} deficiencies on days 14, 21, 28, and 35. No niacin $\times$ vitamin B_{12} interactions were observed. During Phase I, pigs fed supplemental niacin had a greater ADFI ($P < 0.01$) than pigs fed supplemental vitamin B_{12}. During Phase II, pigs fed supplemental vitamin B_{12} had the greatest ADG ($P < 0.001$) and ADFI ($P < 0.01$). Overall, the pigs fed supplemental vitamin B_{12} had greater ADG ($P < 0.001$), ADFI ($P < 0.01$), and ADG/ADFI ($P < 0.05$) than pigs fed supplemental niacin. There were no differences among groups for visual assessment of B vitamin deficiencies. Based on these results, the niacin requirement of 10 to 40 lb pigs is not greater than 4.5 μg/lb of diet and the vitamin B_{12} requirement is greater than 3.1 μg/lb.

Introduction

The B-vitamins have received little attention since the 1950s and 1960s. In the past 40 to 50 years, leaner pigs have been developed, which may increase their B-vitamin requirements due to increased protein accretion. Vitamins are important to consider when formulating diets, especially the water-soluble vitamins because the body cannot synthesize these vitamins and there is little storage in the body.

Niacin and vitamin B_{12} are the only two B-vitamins that are significantly limiting (below the NRC requirement) in a common nursery diet. There are conflicting data regarding current niacin research. Research at Iowa State University reported that niacin supplementation up to 13.6 mg/lb did not alter average daily gain (ADG), average daily feed intake (ADFI), feed efficiency (ADG/ADFI), protein accretion, or fat accretion of high-lean segregated early weaned pigs. Kansas State reported that adding niacin to nursery diets improved ADG and ADFI day 0 to 8 after weaning with the greatest response observed at 25 mg/lb of diet.

Vitamin B_{12} functions include: purine and pyrimidine synthesis, transfer of methyl groups, formation of proteins from amino acids, and carbohydrate and fat metabolism. The most important function of B_{12} is in the metabolism of nucleic acids and proteins.

The major function of niacin is as a coenzyme, primarily as nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP). Enzymes containing NAD and NADP are important links in a series of reactions associated with carbohydrate, protein, and lipid metabolism.

The objective of this study was to determine the responsiveness of weanling pigs to niacin and vitamin B_{12} supplementation. Our hypothesis was that pigs fed diets containing supplemental niacin or vitamin B_{12} would have greater ADG and improved feed efficiency than pigs fed a negative control diet.

Materials and Methods

Pigs were weighed and allotted, based on initial weight and litter of origin, to one of four treatments using a randomized complete block design. Treatments were arranged in a 2 $\times$ 2 factorial. Ninety-six pigs were allotted to 16 pens. There were four replications per treatment and six pigs per pen. Pigs were weaned at 14 to 16 days of age with an average initial weight of 9.4 lb. The duration of the trial was 35 days (Phase I was from day 0 to 14 and Phase II was from day 15 to 35). The average final weight was 38.2 lb.

Pigs and feeders were weighed every seven days to determine ADG, ADFI, and ADG/ADFI. Pigs were scored to determine whether there were any visual B-vitamin deficiencies. Two individuals examined the pigs on days 14, 21, 28, and 35 using a scale of 1 to 5 (1 having extensive deficiency signs and 5 having no deficiency signs). This assessment was based on physical appearances, such as skin and hair coat characteristics.

The four diets (Table 1) were: 1) Negative control, common nursery diet with no added niacin or vitamin B_{12};

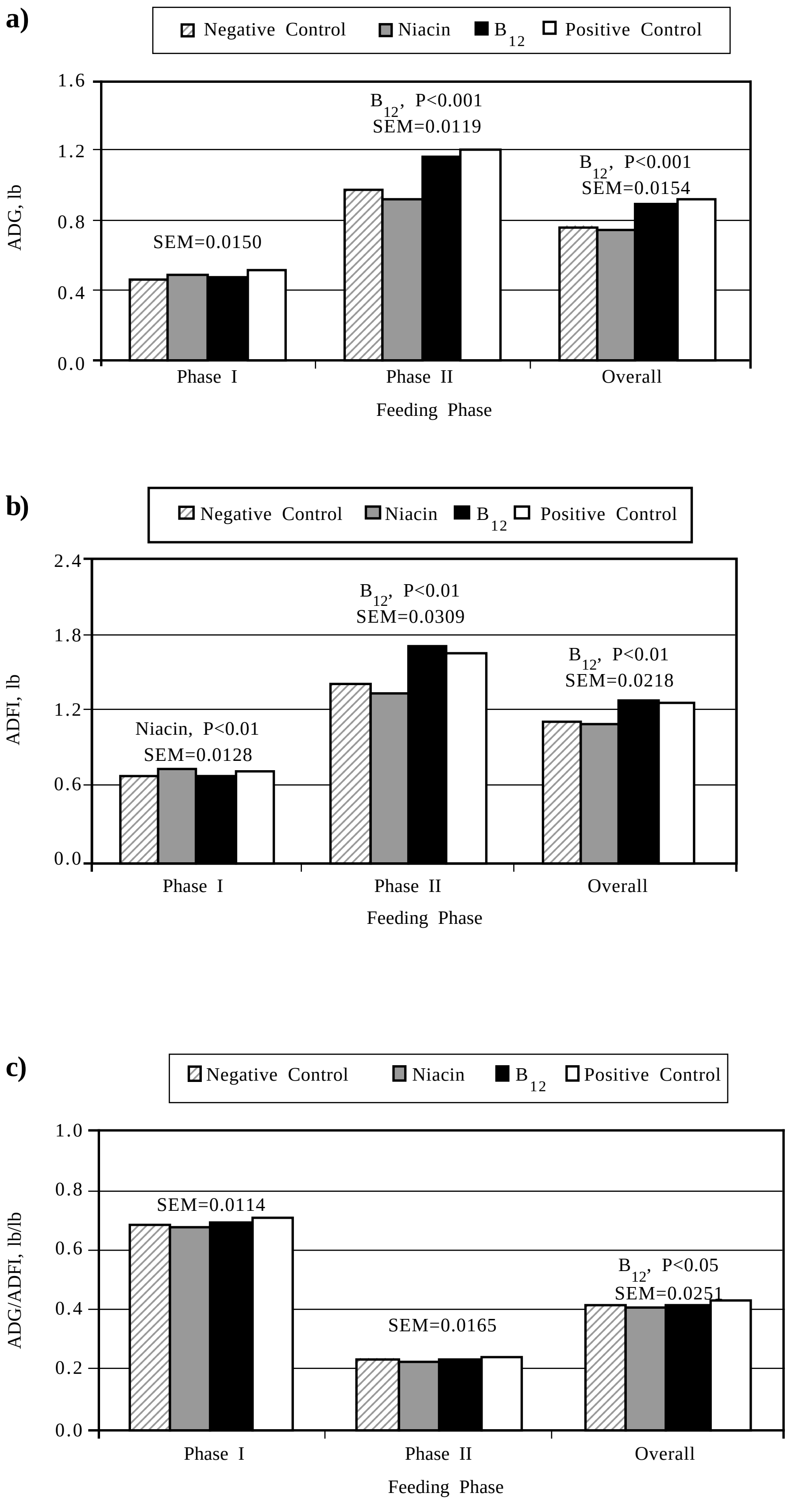

Figure 1. The response of a) average daily gain (ADG), b) average daily feed intake (ADFI), and c) ADG/ADFI in weanling pigs. SEM = standard error of the mean.

2) Niacin, common nursery diet with 22.7 mg/lb added niacin; 3) B_{12}, common nursery diet with 36.3 µg/lb added vitamin B_{12}; and 4) Positive control, common nursery diet with 22.7 mg/lb added niacin and 36.3 µg/lb added vitamin B_{12}. All phase-I diets were formulated to contain 22% CP, 1.5% total lysine, 0.31% total tryptophan, 0.9% Ca, and 0.78% P. Phase-II diets were similar to diets used in Phase I, except diets were formulated to contain 21% CP, 1.4% total lysine, 0.29% total tryptophan, 0.86% Ca, and 0.74% P.

Pigs were housed in pens 6.3 ft × 3.4 ft that had plastic-coated wire flooring, one nipple waterer, and one four-hole stainless steel feeder. Pigs had ad libitum access to feed and water throughout the experiment. Heat lamps and comfort boards were provided during Phase I of the trial. The relative humidity (ranging between 50% and 60%) and room temperature (maintained at 78°F) were monitored continuously using a temperature and humidity recorder.

Results and Discussion

Average daily gain, ADFI, ADG/ADFI are shown in Figures 1a, b, and c, respectively. No niacin × vitamin B_{12} interactions were observed. Average daily gain was greater ($P < 0.001$) during Phase II and overall ($P < 0.001$) for the pigs fed supplemental vitamin B_{12}. During Phase I, pigs receiving the niacin diet had a greater ($P < 0.01$) ADFI than pigs fed the vitamin B_{12} diet. However, pigs fed the vitamin B_{12} diet had a greater ADFI during Phase II ($P < 0.01$) and overall ($P < 0.01$). There were no differences in feed efficiency except during the overall experimental period, when the pigs fed vitamin B_{12} had a greater ADG/ADFI ($P < 0.05$).

Scores for each group are shown in Figure 2. Essentially no B-vitamin deficiencies were observed throughout the five-week study, and there were no differences among treatment groups.

The vitamin B_{12} content of the negative control and vitamin B_{12} supplemented diets were calculated to be 3.1 and 39.4 µg/lb, respectively, and the

(Continued on next page)

Table 1. Composition of experimental diets, as fed basis.

Ingredient, %	Phase I				Phase II			
	NC[a]	Niacin	Vitamin B_{12}	PC[a]	NC[a]	Niacin	Vitamin B_{12}	PC[a]
Corn	31.81	31.81	31.81	31.81	43.07	43.07	43.07	43.07
SBM, 46.5% CP	10.62	10.62	10.62	10.62	32.75	32.75	32.75	32.75
Soy protein concentrate	6.25	6.25	6.25	6.25	——-	——	——	——
Whey	30.00	30.00	30.00	30.00	15.00	15.00	15.00	15.00
Blood cells	——	——	——	——	2.00	2.00	2.00	2.00
Animal plasma	8.00	8.00	8.00	8.00	——	——	——	——
Lactose	4.00	4.00	4.00	4.00	——	——	——	——
Corn oil	5.00	5.00	5.00	5.00	3.00	3.00	3.00	3.00
Limestone	0.69	0.69	0.69	0.69	0.30	0.30	0.30	0.30
Dicalcium phosphate	1.28	1.28	1.28	1.28	1.60	1.60	1.60	1.60
Salt	0.30	0.30	0.30	0.30	0.53	0.53	0.53	0.53
Vitamin mix[b]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral[c]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
L-Lysine•HCl	0.15	0.15	0.15	0.15	——	——	——	——
DL-Methionine	0.11	0.11	0.11	0.11	0.06	0.06	0.06	0.06
Mecadox	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ZnO	0.40	0.40	0.40	0.40	0.30	0.30	0.30	0.30
Vitamin B_{12}, µg/lb	——	——	36.30	36.30	——	——	36.30	36.30
Niacin, mg/lb	——	22.70	——	22.70	——	22.70	——	22.70

[a]NC = Negative control and PC = Positive control

[b]Supplied per kilogram of diet: retinyl acetate, 3,088 IU; cholecalciferol, 386 IU; alpha-tocopherol acetate, 15 IU; menadione sodium bisulfite, 2.3 mg; riboflavin, 3.9 mg; d-pantothenic acid, 15.4 mg; choline, 77.2 mg.

[c]Supplied per kilogram of diet: Zn (as ZnO), 110 mg; Fe (as FeSO4•H2O), 110 mg; Mn (as MnO), 22 mg; Cu (as CuSO4•5 H2O), 11 mg; I (as Ca(IO3)•H2O), 0.22 mg; Se (as Na2SeO3), 0.3 mg.

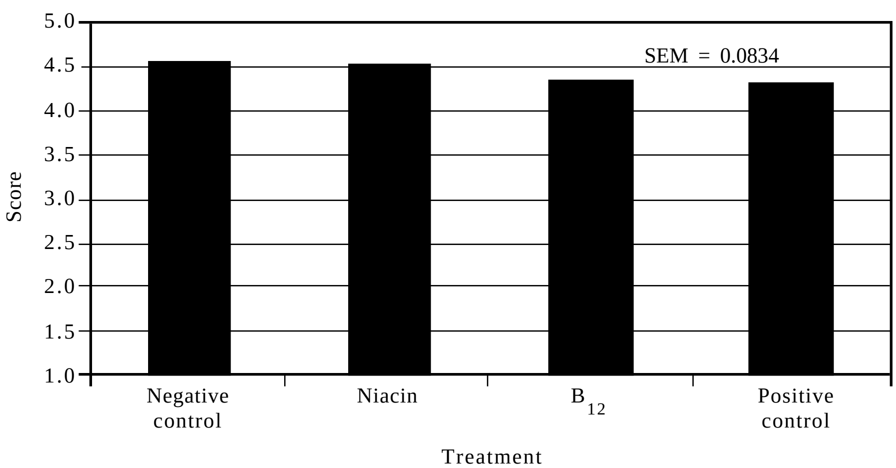

Figure 2. Visual assessment of deficiency signs. Data based on a scale of 1 to 5, with 1 having extensive deficiency signs and 5 having no deficiency signs. SEM = standard error of the mean.

NRC requirement is 7.9µg/lb. Thus, as expected, supplementation with vitamin B_{12} improved growth performance. Almost all of the growth response was observed in Phase II with no response in Phase I. Sows' milk has a high content of vitamin B_{12} and perhaps the pigs had sufficient stores of vitamin B_{12} at weaning to carry them through the first two weeks post weaning without additional supplementation.

The niacin content of the negative control and niacin-supplemented diets were calculated to be 4.5 and 27.2 mg/lb, respectively. This compares to the NRC requirement of 6.8 mg/lb for pigs with an initial weight similar to those used in this experiment. Therefore, we anticipated an improvement in growth performance when niacin was supplemented.

Several factors may have affected niacin intake and contributed to a lack (except for ADFI in Phase I) of response to added niacin. Coprophagy may have contributed to the available niacin intakes because the negative control pigs had access to feces of positive control or niacin-fed pigs in adjoining pens. The amount of available niacin in corn was assumed negligible; however, true niacin availability may be greater and the total niacin contributed by corn could be significantly greater than anticipated. Additionally, tryptophan can be converted to niacin (35 mg tryptophan to 1 mg niacin).

Conclusion

Based on these results, the niacin requirement of 10 to 40 lb pigs is not greater than 4.5 mg/lb of diet and the vitamin B_{12} requirement is greater than 3.1 mg/lb. Further research is needed to define more precisely and to describe the factors controlling the vitamin B_{12} requirement of young pigs.

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