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Summary and Implications

Increasing concentrations of vitamin B_{12} were fed to 144 weanling pigs (weaned 13-14 days) in two, five-week trials. Pigs were fed one of six diets: NC, negative control, basal diet without supplemented vitamin B_{12}; or the basal diet with the inclusion of 100% (1X, 7.94 µg/lb), 200% (2X, 15.87 µg/lb), 400% (4X, 31.75 µg/lb), 800% (8X, 63.49 µg/lb), or 1,600% (16X, 126.98 µg/lb) of NRC requirements for the 11- to 22-lb pig. Each trial was divided into two phases: phase 1, day 0 - day 14 and phase 2, day 14 - day 35. Throughout phase 1, there were no differences among treatments, although ADG (average daily gain) and ADFI (average daily feed intake) increased linearly ($P< 0.1$). During phase 2, the inclusion of B_{12} resulted in a linear increase ($P< 0.05$) in ADG with pigs receiving the 16X treatment (126.98 µg/lb) having the greatest gains (ADG = 1.24 lb) in contrast with pigs receiving the control diet (ADG = 1.08 lb). Average daily feed intake increased linearly ($P< 0.05$) with pigs receiving the control diet consuming less ($P< 0.1$) than the 2X, 4X, 8X, and 16X treatments during phase 2. Overall (phase 1 and phase 2), ADG increased ($P< 0.01$) as much as 0.13 lb (16X treatment, 126.98 µg/lb) over the negative control with the inclusion of vitamin B_{12}. Increased concentrations of B_{12} resulted in a linear increase ($P< 0.05$) in ADG and ADFI overall. This study suggests that feeding levels of vitamin B_{12} above the NRC recommendation may improve weight gain and feed intakes of weanling pigs.

Introduction

Vitamin B_{12}, also known as cobalamin, is a water soluble vitamin that plays a role in two pathways. These pathways are central to energy and amino acid metabolism in animal cells. The pathways in which vitamin B_{12} acts as a coenzyme are: 1) methylmalonyl-CoA synthase, involving the breakdown and utilization of fatty acids and 2) methionine synthase, a reaction in the metabolism of amino acids. Vitamin B_{12} is necessary for the breakdown of odd-chain fatty acids which occur in plant feedstuffs. Vitamin B_{12} plays a major role in amino acid metabolism through DNA methylation and the formation of DNA building blocks, purines and pyrimidines. In previous studies conducted at the University of Nebraska–Lincoln, feeding vitamin B_{12} at concentrations above the 1998 NRC recommendation for the 11- to 22-lb pig resulted in increased average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (ADG/ADFI). This study was conducted to validate previous research and to study the pathways affected by increased supplementation of vitamin B_{12}. Serum homocysteine, vitamin B_{12}, and folate concentrations are being analyzed to determine the role of vitamin B_{12} in the observed growth response.

Materials and Methods

Experimental design

The experiment protocol was reviewed and approved by the Institute for Animal Care and Use Committee of the University of Nebraska–Lincoln. One hundred forty-four pigs were weaned (13 - 14 days), allotted based on initial weaning weight and litter-of-origin, and randomly assigned to one of six dietary treatments. There were four pigs per pen (two gilts/two barrows) and six replications per treatment. Average initial weight was 10.1 lb. The study consisted of two, five-week trials, each divided into phase 1 (day 0 – day 14) and phase 2 (day 14 – day 35).

The six dietary treatments included (Table 1): NC, negative control, basal diet without supplemented vitamin B_{12}; or the basal diet with the inclusion of 100% (1X, 7.94 µg/lb), 200% (2X, 15.87 µg/lb), 400% (4X, 31.75 µg/lb), 800% (8X, 63.49 µg/lb), or 1,600% (16X, 126.98 µg/lb) of NRC requirements for the 11- to 22-lb pig.

Live animal care and measurements

Pigs and feeders were weighed weekly for determination of ADG, ADFI, and ADG/ADFI. Blood was collected each week for analysis of serum (still in progress) vitamin B_{12}, folate, and homocysteine. Mats and heat lamps were placed in pens for phase 1 and removed for the remainder of the trial.

Statistical analysis

Data were analyzed as a completely randomized block design using the MIXED procedure of SAS. The main effect of the statistical model was dietary treatment. Pen was the experimental unit used for analyses. Pairwise comparisons were made to observe differences among treatments for ADG, ADFI, and ADG/ADFI.

(Continued on next page)

Table 1. Composition of phase 1 and phase 2 dietary treatments (as-fed basis)

	Phase 1[1,2]						Phase 2[1,3]					
Ingredients, %	NC	1X	2X	4X	8X	16X	NC	1X	2X	4X	8X	16X
Corn	31.81	31.81	31.81	31.81	31.81	31.81	45.09	45.09	45.09	45.09	45.09	5.09
Soybean meal, 46.5% CP	10.63	10.63	10.63	10.63	10.63	10.63	30.59	30.59	30.59	30.59	30.59	0.59
Soy protein concentrate	6.25	6.25	6.25	6.25	6.25	6.25	0.00	0.00	0.00	0.00	0.00	0.00
Whey, dried	30.00	30.00	30.00	30.00	30.00	30.00	14.99	14.99	14.99	14.99	14.99	4.99
Animal plasma	8.00	8.00	8.00	8.00	8.00	8.00	2.00	2.00	2.00	2.00	2.00	2.00
Blood cells	0.00	0.00	0.00	0.00	0.00	0.00	3.00	3.00	3.00	3.00	3.00	3.00
Lactose	4.00	4.00	4.00	4.00	4.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00
Dicalcium phosphate	1.28	1.28	1.28	1.28	1.28	1.28	1.60	1.60	1.60	1.60	1.60	1.60
Limestone	0.69	0.69	0.69	0.69	0.69	0.69	0.53	0.53	0.53	0.53	0.53	0.53
Sodium chloride	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Corn oil	5.00	5.00	5.00	5.00	5.00	5.00	3.00	3.00	3.00	3.00	3.00	3.00
Mecadox®	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
UNL mineral mix[4]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
UNL vitamin mix[5]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Zinc oxide	0.40	0.40	0.40	0.40	0.40	0.40	0.30	0.30	0.30	0.30	0.30	0.30
L-lysine • HCl	0.15	0.15	0.15	0.15	0.15	0.15	0.10	0.10	0.10	0.10	0.10	0.10
DL-methionine	0.11	0.11	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin B_{12}, µg/lb	0.00	7.94	15.87	31.75	63.49	126.98	0.00	7.94	15.87	31.75	63.49	6.98

[1] NC = negative control, 1X = 100% of NRC requirement (7.94 µg/lb), 2X = 200% of NRC requirement (15.87 µg/lb), 4X = 400% of NRC requirement (31.75 µg/lb), 8X = 800% of NRC requirement (63.49 µg/lb), 16X = 1,600% of NRC requirement (126.98 µg/lb).
[2]Phase 1 diets formulated to contain: lysine, 1.60%; Ca, 0.91%; P, 0.80%; available P, 0.57%.
[3]Phase 2 diets formulated to contain: lysine, 1.42%; Ca, 0.85%; P, 0.75%; available P, 0.45%.
[4]Supplied per kilogram of diet: Zn (as ZnO), 128 mg; Fe (as $FeSO_4 \bullet H_2O$), 128 mg; Mn (as MnO), 30 mg; Cu (as $CuSO_4 \bullet 5\ H_2O$), 11 mg; I (as $Ca(IO_3) \bullet H_2O$), 0.26 mg; Se (as Na_2SeO_3), 0.3 mg.
[5]UNL vitamin mix excluding vitamin B_{12}. Supplied per kilogram of diet: retinyl acetate, 4,400 IU; cholecalciferol, 440 IU; α-tocopheryl acetate, 24 IU; menadione sodium bisulfite, 3.5 mg; riboflavin, 8.8 mg; d-pantothenic acid, 17.6 mg; niacin, 26.4 mg.

Results and Discussion

Figures 1a-c show the growth criteria responses to dietary treatments. There were no treatment effects on ADG (0.50 lb), ADFI (0.73 lb), or ADG/ADFI (1.52 lb/lb) during phase 1, although there were linear effects of B_{12} addition on ADG and ADFI ($P < 0.1$). During phase 2, pigs receiving the negative control, NC, (ADG = 1.08 lb) had lower ($P< 0.05$) ADG than all other treatments with the pigs receiving the 16X treatment having the greatest ADG (1.24 lb). There was a linear response ($P< 0.05$) of ADG to B_{12} addition during phase 2. Pigs receiving the negative control consumed less feed ($P < 0.05$; ADFI = 1.59 lb) than the 2X, 8X, and 16X treatments during phase 2. Pigs receiving the 4X treatment had numerically greater ADFI ($P< 0.10$; ADFI = 1.69 lb) than pigs not receiving vitamin B_{12} supplementation. Pigs receiving the 1X treatment had greater ($P< 0.05$) feed efficiency (ADG/ADFI = 1.58 lb/lb) than pigs receiving the NC (ADG/ADFI = 1.50 lb/lb) during phase 2. Pigs receiving the 2X and 16X diets had numerically greater ($P< 0.1$) ADG/ADFI than the NC. The addition of B_{12} resulted in increased ($P< 0.01$) ADG and increased ($P< 0.10$) ADFI and ADG/ADFI, overall. Pigs receiving the NC had lower ADG, ADFI, and ADG/ADFI than those receiving other treatments.

Pigs supplemented with vitamin B_{12} had greater ADG, ADFI, and feed efficiency than those not supplemented with vitamin B_{12} in this study, and in research previously conducted at the University of Nebraska–Lincoln. Similar to other studies, no treatment effects for ADG, ADFI, or ADG/ADFI were observed in phase 1. This was likely due to storage of vitamin B_{12} in pigs. The pigs receiving the 4X treatment did not perform as well as other pigs receiving supplemental vitamin B_{12}. Overall, pigs with the greatest gains (ADG = 0.96 lb) and greatest intakes (ADFI = 1.35 lb) were on the 16X dietary treatment, while the 1X treatment had the greatest ADG/ADFI (1.57 lb/lb).

Conclusion

This study suggests that by feeding weanling pigs vitamin B_{12} above the NRC recommendation for the 11- to 22-lb pig may increase weight gain and feed intakes. The results of this study are similar to those of previous studies from our research group. Subsequently, we plan to measure vitamin B_{12}, folate, and homocysteine in serum and re-evaluate the growth performance data in the context of the serum analyses.

[1]Laura R. Albrecht is a graduate student, Robert L. Fischer is a former graduate student and research technologist, and Philip S. Miller is a professor in the Animal Science Department.

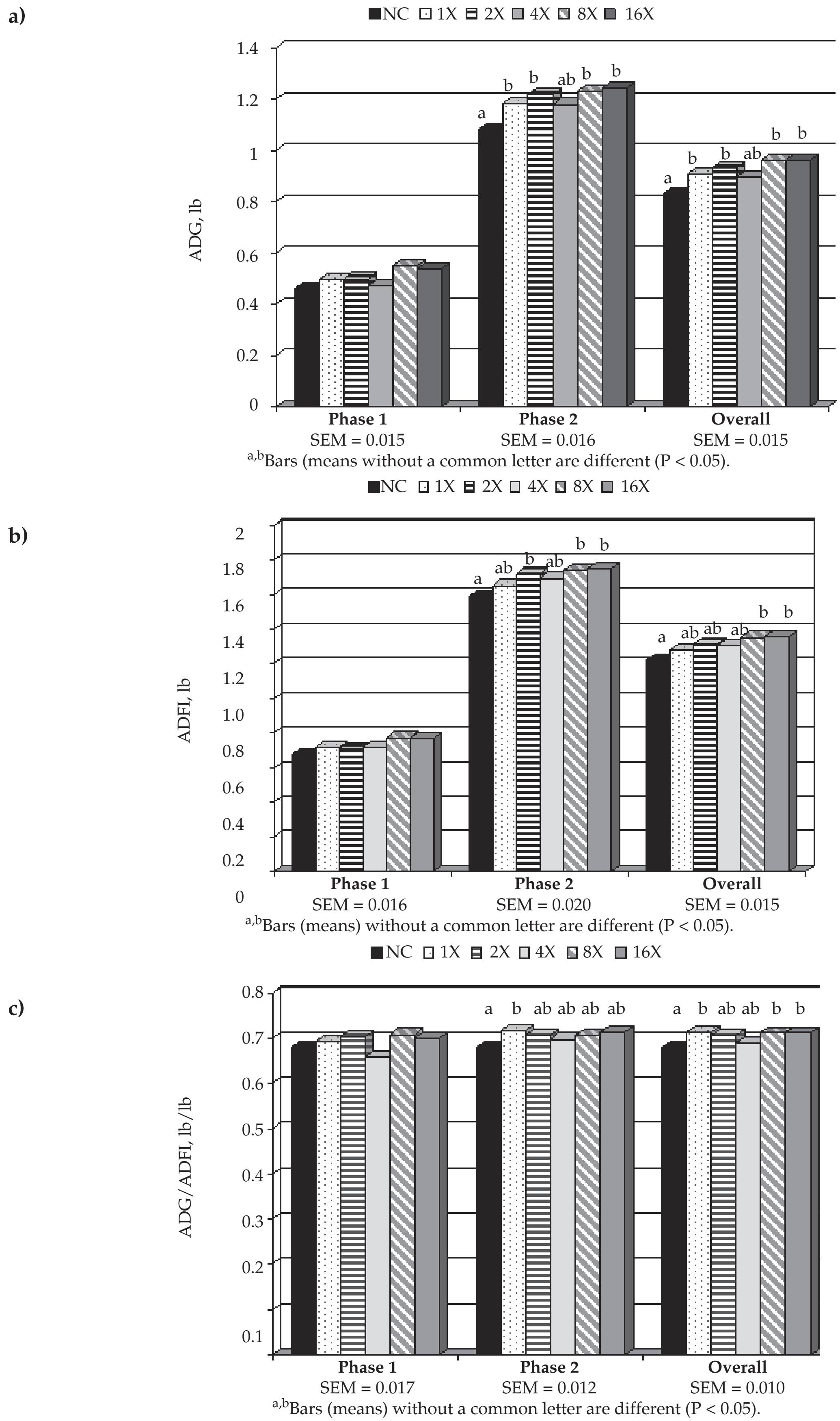

Figure 1. Phase 1, phase 2, and overall growth responses of 10- to 45-lb pigs. a) ADG (average daily gain), b) ADFI (average daily feed intake, c) ADG/ADFI. NC = negative control, 1X = 100% (7.94 µg/lb), 2X = 200% (15.87 µg/lb), 4X = 400% (31.75 µg/lb), 8X = 800% (63.49 µg/lb), and 16X = 1,600% (126.98 µg/lb) of NCR requirements for the 11- to 22-lb pig. SEM = standard error of the mean.