

Dietary Available Phosphorus Needs of Pigs From 13 to 70 Pounds Body Weight

T. S. Stahly, professor, and
D. R. Cook, assistant research scientist
Department of Animal Science

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Summary and Implications

Pigs were self-fed one of six dietary concentrations (.20, .30, .40, .50, .60, .70%) of available phosphorus (AP) from 13 to 70 pounds body weight. Dietary available phosphorus concentrations of at least .50, .40, and .40% were needed for pigs weighing 23, 43, and 63 pounds, respectively, to maximize daily body weight gains and gain:feed ratios.

Based on these data, the dietary AP needs of 13- to 70-pound pigs experiencing a moderate level of antigen exposure are 1.25 to 1.5 times greater than current NRC (1) estimates for similar weight pigs.

Introduction

The rate at which pigs accrue proteinaceous tissues (i.e., muscle) is a critical factor in determining the efficiency of pork production. Phosphorus is needed for proteinaceous tissue growth because of its integral role in energy metabolism (high energy phosphate compounds and energy transfer enzymes, i.e., ATP, CPK), nucleic acid synthesis (sugar-phosphate backbone of DNA and RNA), and membrane structure (phospholipid bilayer of cells). Inadequate intake of dietary phosphorus results in reduced rates of muscle and bone tissue growth in 40- to 240-pound pigs as well as reduced efficiency of feed utilization for growth (2).

The objective of this study was to determine dietary available phosphorus (AP) needs of pigs experiencing a moderate level of chronic antigen exposure in animals fed from 13 to 70 lb body weight.

Materials and Methods

Eight sets of six littermate pigs (barrows only) from a single genetic strain and site of origin were used. The pig's genetic capacity for muscle growth from 40 to 240 lb is estimated to be .75 to .80 lb daily based on previous research at our station with this genetic strain.

Pigs were reared via a management scheme designed to create animals with a moderate to low level of chronic antigen exposure (AE). Pigs were reared via a segregated-early-weaning (SEW) scheme, which consisted of farrowing

the pigs in a sanitized farrowing room, administering antibiotics (Naxcel and Baytril) to each pig at 1, 3, 5, 8, and 11 days of age, weaning pigs at 12±2 days of age, and then placing the pigs into a sanitized nursery room. However, the nursery room was located at the site of origin of the pigs. Pigs were allowed to consume a milk-based diet until they reached a body weight of 13 pounds.

At 13±3 pounds body weight, pigs were randomly allotted within litter to one of six dietary AP concentrations (.20, .30, .40, .50, .60, or .70%) (Table 1). Dietary AP concentrations were achieved by altering the ratio of mono-dicalcium phosphate, limestone, and starch. A single source of mono-dicalcium phosphate and limestone was used throughout the trials. Single sources of corn, soybean meal, whey, and lactose were used within trials one and two, and a second source of these ingredients was used within trials three and four. Diets were formulated to contain 1.8% lysine. Dietary calcium was maintained at 1.15%.

Table 1. Composition of diets (%).^a

Ingredient	Available Phosphorus, %	
	.20	.70
Corn	17.11	17.11
Soybean meal, 48%	50.62	50.62
Whey, dried	20.0	20.0
Lactose	5.0	5.0
Corn oil	2.0	2.0
L-Threonine	.10	.10
D,L-Methionine	.35	.35
Salt	.40	.40
Trace mineral/vit mix ^b	.48	.48
Choline Cl, 60%	.30	.30
Mono-dicalcium phosphate ^c	.10	2.89
Limestone	2.12	.40
Corn starch	1.42	.35

^aDietary available phosphorus concentration achieved by altering the amounts of mono-dicalcium phosphate, limestone, and starch.

^bProvided the following per pound of diet: Cu, 8.0 mg; Fe, 79.5 mg; Mn, 27.3 mg; Se, .11 mg; Zn, 68.2 mg; biotin, .06 mg; folacin, .52 mg; niacin, 31.2 mg; pantothenic acid, 21.2 mg; riboflavin, 7.8 mg; pyridoxine, 2.1 mg; vit E, 34.5 IU; vit A, 5200 IU; vit D, 600 IU; vit K, 1.1 mg; vit B₁₂, 40 µg.

^cDynaphos provided courtesy of Mallinckrodt Feed Ingredients, Mundelein, IL.

Table 2. Impact of dietary available phosphorus (AP) concentration on pig growth.

Criteria	Dietary available phosphorus (AP), %					
	.20	.30	.40	.50	.60	.70
Body weight, lb						
Initial	12.8	12.8	13.4	12.8	13.2	13.2
Final	71.5	71.3	72.6	70.8	73.3	70.6
Growth and feed utilization						
Daily feed, lb	1.99	1.98	2.09	2.22	2.07	2.04
Daily gain, lb ^a	1.28	1.31	1.39	1.40	1.40	1.36
Gain/feed	.653	.671	.671	.636	.686	.666

^aQuadratic dietary AP effect, $P < .04$.

Pigs were penned individually in 2 x 4 ft pens and given *ad libitum* access to feed and water from 13 to 70 lb. Ambient temperature was maintained at 85, 82, and 78°F for pigs whose weight averaged 23, 43, and 63 lb, respectively.

Pig weights and feed consumption were measured at four-day intervals. Pigs were bled via the orbital sinus at body weights of 13 and 70 lb to determine the presence of serum antibody titers for prevalent antigens in the herd of origin, and the serum concentration of the acute-phase protein alpha-1 acid glycoprotein (AGP).

Data were analyzed as a randomized complete block design. The pig was considered the experimental unit. Pig gains and feed utilization responses at different pig body weights were analyzed as a repeated measure.

Results and Discussion

Dietary available phosphorus effect. Over the duration of the study, dietary AP did not affect voluntary feed intake (Table 2). Body weight gain increased quadratically as dietary AP concentrations increased and was maximized numerically at a dietary AP concentration of 0.5. Gain:feed ratios were optimized at 0.6 AP, but a statistical response was not observed.

Current estimates (1) of dietary AP needs for pigs are 0.4, 0.32, and 0.23% for pigs weighing 11 to 22, 22 to 44, and 44 to 100 lb, respectively. Extrapolating these NRC (1) estimates to pigs fed from 13 to 70 pounds results in an estimated dietary AP need of .27%. Based on the results of the present study, dietary AP needs of moderately antigen-exposed pigs from a moderate lean growth genotype are 1.3 times current NRC (1) values for 13 to 70 lb pigs.

The specific dietary AP needs of pigs are dependent on the pigs' stage of growth. As the pig matures, daily feed intake increases and the optimum concentration of AP declines. The daily feed intake, body weight gain, and gain:feed responses of pigs to the varying dietary AP concentration at each of three stages of growth (13 to 33, 33 to 53, and 53 to 73 lb) are shown in Figure 1a, 1b, and 2, respectively. Dietary AP concentrations of .50, .60, and .50 optimized body weight gain in the three stages of growth. Dietary AP concentrations of 0.7, 0.3, and 0.4% optimized gain:feed at three stages of growth.

Based on these data, the dietary concentration of available phosphorus needed by moderately antigen-exposed

pigs fed from 13 to 70 lb body weight is 1.25 to 1.5 times greater than current NRC (1) estimates for similar weight pigs. Inadequate intakes of dietary available phosphorus result in lower rates and efficiencies of body growth.

Table 3. Pig performance on current trial vs previous trial with moderate and high AE pigs.

Criteria	Current ^a	Mod AE ^b	High AE ^b
Pig wt, lb			
Initial	13.0	13.9	14.3
Final	71.7	59.6	60.5
Growth and feed utilization			
Daily feed, lb	2.07	1.83	1.48
Daily gain, lb	1.36	1.25	.94
Gain:feed	.664	.682	.635
Serum AGP, µg/mL			
Initial	865	833	671
Final	469	472	479

References

1. National Research Council (NRC). 1988. Swine Nutrient Requirements. National Academy of Sciences, Washington, D.C.
2. Bertram, M. J., T. S. Stahly, and R. C. Ewan. 1994. Impact of available dietary phosphorus regimen on growth of pigs with a moderate and low genetic capacity for lean tissue growth. ASL-R1163:26-29. Iowa State University Swine Research Report, Ames.

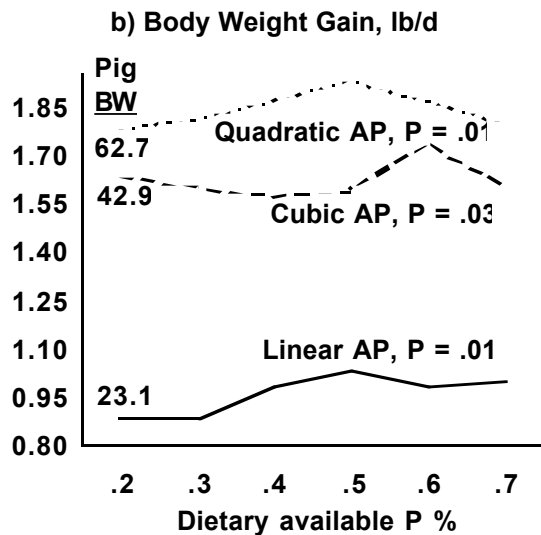
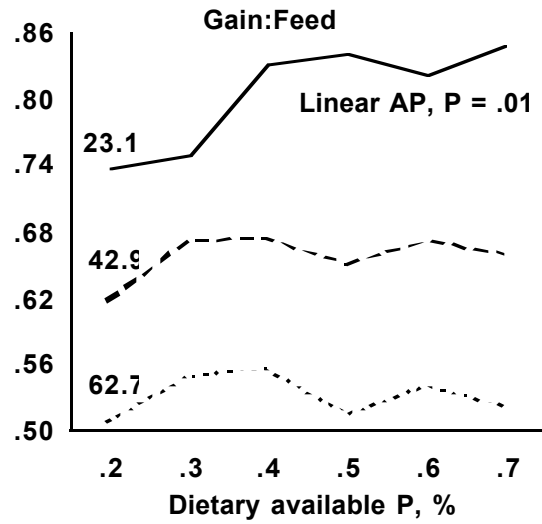
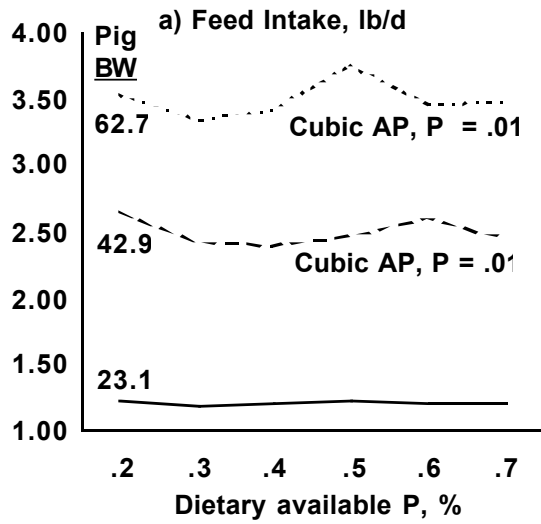


Figure 2. Body gain:feed responses of pigs to dietary available phosphorus (AP) concentration during stages of growth when the pigs' mean body weights (BW) were 23.1, 42.9, and 62.7 pounds.

Figure 1. Feed intake (a) and body weight gain (b) responses of pigs to dietary available phosphorus (AP) concentration during stages of growth in which pigs' mean body weights (BW) were 23.1, 42.9, and 62.7 pounds.