The Effect of Supplementary Yeast Culture in Diets for Pigs on the Bioavailability of Dietary Phosphorus

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Summary and Implications

Twenty-four crossbred barrow pigs were used in four replications of six treatments to study the effect of supplementary yeast culture in improving the bioavailability of dietary phosphorus. Pigs were fed corn/soybean diets containing 0.5, 0.4, or 0.3% total phosphorus with or without 0.5% yeast culture. The pigs were fed at 5% of body weight daily in two equal feedings for a seven-day preliminary period followed by a seven-day collection period. The percent apparent dry matter digested, percent apparent absorbed phosphorus, and percent apparent absorbed nitrogen only varied according to the amount of phosphorus in the diet. Yeast culture had no effect on any of these measurements. Serum phosphorus levels in all pigs decreased from beginning to termination of the study with the larger decreases in those pigs receiving less phosphorus in their diet. Supplementing pig diets with yeast culture did not improve bioavailability of dietary phosphorus in this study.

Introduction

Phytate is located in various plant parts, with the greatest concentration being found in the seed (Ward, 1994). Phytate readily binds to certrain minerals including phosphorus. Low digestibility and poor intestinal solubility can lead to decreased biological availability of the phytate-bound compounds (Erdman, 1979).

In grains, phytate phosphorus can often account for 50 to 80% of the total phosphorus content (Ward, 1994). A typical monogastric diet contains approximately 0.2 to 0.25% phytate phosphorus (Ward, 1994). Because monogastric animals lack the enzyme phytase, this phosphorus remains undigested. Due to the large amount of undigested dietary phosphorus, a substantial amount is excreted in the manure. This loss represents an inefficiency in digestive utilization and poses an environmental concern of soil and water pollution (Cromwell and Coffey, 1991).

Yeast, fungi, or bacteria can produce phytase that is needed to hydrolyze phytate into inorganic phosphate (Simons et al., 1990). The purpose of this research was to assess the efficacy of a yeast culture supplement as a means of improving the bioavailability of phosphorus in a corn/soybean meal swine diet.

Materials and Methods

Twenty-four crossbred barrow pigs (Yorkshire x Landrace) x (Hampshire x Duroc) were used in four replications of six treatments in a randomized complete block design. Four litters with six or more barrow pigs were weaned between 21 and 28 days of age. Pigs were fed a starter diet (corn, soybean meal, dried whey) for a three- to four-week nursery period. After the nursery period, six barrows from each litter were selected by weight to provide a uniform initial weight of approximately 40 to 50 pounds. Pigs within litters were randomly allotted to pens within replication. Pigs were housed in metabolism pens which allowed for collection of urine, feces, and wasted feed, and room temperature was maintained at approximately 68°F. The care and use of all animals in this study were evaluated and approved by the Iowa State University Committee on Animal Care.

The following treatments were fed:

		Total phosphorus		
	Treatment	0.5%	0.4%	0.3%
1)	Control	X		
2)	Control		X	
3)	Control			X
4)	Control + yeast culture	X		
5)	Control + yeast culture		X	
6)	Control + yeast culture			X

The experimental diets (table 1) consisted of a corn/soybean meal mixture and contained vitamins and trace minerals in excess of the NRC requirements (NRC, 1988). The calcium level of each diet was held constant at the suggested NRC requirement using calcium carbonate as the supplemental inorganic source. Supplemental inorganic phosphorous levels were met with monosodium phosphate.

Pigs were fed the diets at 5% of body weight in two equal feedings daily. Refused feed was collected and recorded. A preliminary period of seven days was followed by a seven day period with total collection of urine and feces. Aliquots of pooled fecal samples were freeze-dried for chemical analysis. Corn, soybean meal, diet samples, feces, and urine were analyzed for dry matter, nitrogen, calcium, and phosphorus. Blood samples were taken at the beginning and termination of the study for serum phosphorus determination. Apparent absorption of dietary phosphorus by pigs fed each treatment was evaluated to determine the effects of added dietary yeast culture phosphorus bioavailability.

Data were analyzed using the GLM procedures of SAS (1988) for a completely randomized block design experiment with a 2 x 2 factorial arrangement of treatments.

Results and Discussion

A summary of the effects of supplemental yeast culture to the pig diet is presented in table 2. The overall measured responses of pigs receiving yeast culture were nearly identical to those of the control pigs. The apparent absorbed phosphorus averaged 45.92% by the pigs fed yeast culture and 46.06% for the control group. Serum phosphorus levels for the yeast culture and control groups were 2.06 g./dL. and 2.11 g./dL., respectively. These results suggest that the addition of a supplementary yeast culture has little effect on the bioavailability of dietary phosphorus. The averages for percent apparent absorbed nitrogen and percent biological value of the feed protein were also similar.

Although the yeast averages were similar, performance differences were observed between the three levels of dietary phosphorus. In pigs fed the control diet (no yeast), body weight gain improved with an increase in the amount of dietary phosphorus. However, pigs fed the supplemental yeast culture gained similarly regardless of the level of dietary phosphorus. Feed consumption remained constant across phosphorus levels for the yeast-fed group but increased with higher phosphorus levels fed to the control group. This response explains the differences observed in body weight gain between those fed yeast and the control group.

The percent apparent absorbed phosphorus decreased with reduced dietary phosphorus levels. Supplemental yeast culture made little difference, as the figures for both the yeast-fed and control groups were similar and decreased at approximately the same rate with decreasing levels of dietary phosphorus. The percent apparent absorbed nitrogen seemed unaffected by either the yeast culture or phosphorus levels in the diet. Percent biological value of the feed protein seemed to be maximized at .4% phosphorus in both the yeast-fed and control groups. In all cases, serum phosphorus decreased linearly with decreased in phosphorus level in the diet.

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Table 1. Composition of experimental diets.

	Treatments					
Treatment no.	1	2	3	4	5	6
Phosphorus, %	0.5	0.4	0.3	0.5	0.4	0.3
Yeast, %	0	0	0	0.5	0.5	0.5
Ingredient						
Corn	72.55	73.22	73.82	72.60	73.24	73.82
Soybean meal	23.75	23.60	23.50	23.20	23.10	23.00
Calcium carbonate	1.60	1.60	1.60	1.60	1.60	1.60
Monosodium phosphate	1.02	0.50	0.00	1.02	0.48	0.00
L-Lysine HCl	0.08	0.08	0.08	0.08	0.08	0.08
Soy oil	0.50	0.50	0.50	0.50	0.50	0.50
Salt, plain	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix[a]	0.05	0.05	0.05	0.05	0.05	0.05
Vitamin premix[b]	0.20	0.20	0.20	0.20	0.20	0.20
Yeast culture	0.00	0.00	0.00	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated composition:						
Crude protein, %	17.00	17.00	17.00	17.00	17.00	17.00
Lysine, %	0.90	0.90	0.90	0.90	0.90	0.90
Calcium, %	0.70	0.70	0.70	0.70	0.70	0.70
Phosphorus, %	0.60	0.48	0.37	0.60	0.48	0.38
Analyzed composition:						
Crude protein, %	15.93	16.75	16.24	16.45	16.63	16.02
Phosphorus, %	0.52	0.40	0.32	0.50	0.43	0.33

[a]Contributed in ppm of diet: Zn, 75.0; Fe, 87.5; Mn, 30.0; Cu, 8.8; I, 1.0.

[b]Contributed the following per kilogram of diet: vitamin A, 2,200 IU; vitamin D_3, 550 IU; vitamin E, 22 IU; riboflavin, 3.3 mg.; pantothenic acid, 8.8 mg.; niacin, 16.5 mg.; and vitamin B_{12}, 11.0 mcg.

Table 2. The effect of supplementary yeast in pig diets on the bioavailability of dietary phosphorus.

	Treatments						
Treatment no.	1	2	3	4	5	6	
Phosphorus, %	0.5	0.4	0.3	0.5	0.4	0.3	
Item Yeast, %	0	0	0	0.5	0.5	0.5	C.V.
Net feed consumed, g. (as-fed)	7,617.75	6,967.25	6,375.1	7,018.75	7,088.75	6,895.5	19.96
Apparent feed d.m. digested, %	87.25	87.34	86.42	85.44	86.66	86.82	1.26
Feed P consumed, g.[a]	39.64	27.70	20.41	35.22	30.22	22.80	22.1
Apparent absorbed P, %[a]	57.22	46.53	34.44	54.23	50.39	33.13	13.19
Feed N consumed, g.	194.10	186.75	165.63	184.70	188.67	176.70	19.87
Apparent absorbed N, %	82.40	83.08	82.56	81.16	82.56	81.66	2.59
Urine N excreted, g.	54.57	29.94	31.36	45.60	35.25	38.97	25.67
Biological Value of feed N, %	65.85	80.71	76.96	69.60	77.37	73.00	14.35
Initial serum phosphorus, g./dL.	8.69	8.21	8.50	8.54	8.88	8.74	7.53
Final serum phosphorus, g./dL.[a]	7.38	6.92	4.77	7.95	6.28	5.77	13.45
Serum phosphorus change, g./dL.[a]	-1.31	-1.29	-3.73	-0.60	-2.61	-2.97	57.46

[a]Phosphorus effect, P<.01; linear phosphorus level effect, P<.01.