Phosphorus Reduction in Swine Manure and Pig Performance by Using Dietary Phytase

Larry K. McMullen, swine field specialist, Iowa State University Extension
Dr. Arlin Karsten, DVM, professor, Swine Center, Kirkwood Community College

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Summary and Implications

Phytase addition to swine diets reduces the phosphorus levels in the swine manure. The addition of the phytase into the swine diets did not increase the cost of the diets, nor was pig performance impacted by the phytase addition to the diets.

However, phosphorus reductions with phytase may vary from farm to farm due to feed ingredient variation and amounts, an incorrect ration formulation for phosphorus, and possibly the amount of manure dilution with wastewater.

Manure management plans on a phosphorus basis will be easier to implement with a phytase diet. Therefore, because swine premixes are commercially available with phytase, swine producers should take advantage of reducing manure phosphorus levels. This management plan will limit the buildup of phosphorus in the soil, reduce the crop acres needed for manure application, reduce water pollution due to runoff and leaching, and comply with Iowa Department of Natural Resources manure management plans.

Introduction

The current Department of Natural Resources manure management plan uses nitrogen as the base for land application rates of manure. However, a proposal has been submitted by the DNR to the Iowa Legislature to convert to a phosphorus base. Therefore, when and if this legislation is passed, the acres needed for manure application would essentially double for continuous yearly application.

Phytase, an enzyme that breaks down the undigestible phytic acid (phytate) portion in grains and oil seeds and releases digestible phosphorus that the pig can use, was used in this study to determine the following criteria: 1) if feeding of dietary phytase in swine finishing rations would economically and effectively reduce the phosphorus content of swine manure from finishing hogs, and 2) the extent of the manure analysis variations and production efficiencies between the phytase and control pigs.

Phytase activity is expressed as phytase units (FTU) per unit of feed (i.e., FTU/kg or FTU/lb) Typically, for corn-soy diets, an inclusion rate for phytase would be approximately 115 to 150 FTU/lb.

Materials and Methods

Four replications of this demonstration were made in room one of the Kirkwood Community College swine-finishing unit, a modern double curtain facility. The finishing room capacity is 100 head and it has two separate manure pits. Therefore, approximately 50 head of pigs were assigned to each a control and phytase diet group. High oil corn/soybean meal diets were designed for each test group to be nutritionally comparable. The phytase inclusion level ranged from 125 to 150 FTU/lb. Groups were split sex fed and rotated within the replications to obtain equal representation within the diet groups. The pigs were placed on the diets at approximately 90 lb and fed four-diet phases. Feed samples for each phase were analyzed to secure a basis for diet component accuracy and phosphorus baselines (Table 1).

Both liquid and solid manure samples were collected every 2 weeks from the two diet groups. Manure samples were analyzed for nitrogen (N), phosphorus (P), and potassium (K). To standardize the water dilution levels in the liquid samples, the initial pit charge was 30 gallons of water per pig density over the manure pit. Both the control and phytase pigs were weighed off test at approximately 240 lb simultaneously.

Results and Discussion

The addition of the phytase to the swine diet significantly reduced the phosphorus (P_2O_5) in the solid manure by approximately 17 and 22% in the liquid manure on an as received basis (Tables 2 and 3). The phytase inclusion levels of 125 to 150 FTU/lb achieved this reduction.

With the four replications combined, a total of 436 pigs was placed on test. The control and phytase groups each started with 218 pigs. The on-test weight was 92.1 lb for the control and 89.4 lb for the phytase group. Both groups were on test for 74 days. Pigs (214) came off-test for the control group and 212 pigs for the phytase group. The off-test weight was 244.2 for the control and 237.6 for the phytase. The average daily gain was 2.03 for the control and 1.97 for the phytase pigs. Feed efficiency was 2.91 for the control and 2.75 for the phytase group (Table 4). The costs of the phytase diets were slightly less ($0.59 to $1.20) per ton than the control diet.

Also, the pH of the liquid manure was monitored for both the control and phytase groups and no difference was noted as both groups averaged 7.4.

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Table 1. Phytase and control diet comparison.

	Phase 4		Phase 5		Phase 6		Phase 7	
	80-130 lb		130-175 lb		175-210 lb		210-250 lb	
Item	Phytase	Control	Phytase	Control	Phytase	Control	Phytase	Control
High Oil Corn	1435	1420	1560	1545	1627	1607	1707	1695
Soybean Meal - 48%	515	520	390	395	325	335	251	255
G/F Premix - Added Phytase	50	0	50	0	48	0	42	0
G/F Premix - No Phytase	0	60	0	60	0	58	0	50
Total Pounds	2000	2000	2000	2000	2000	2000	2000	2000
High Oil Corn	$2.00/Bu	$2.00/Bu	$2.00/Bu	$2.00/Bu	$2.00/Bu	$2.00/Bu	$2.00/Bu	$2.00/Bu
Soybean Meal - 48%	$176/Ton	$176/Ton	$176/Ton	$176/Ton	$176/Ton	$176/Ton	$176/Ton	$176/Ton
G/F Premix - Added Phytase	$35.68/Cwt		$35.68/Cwt		$35.68/Cwt		$35.68/Cwt	
G/F Premix - No Phytase		$31.30/Cwt		$31.30/Cwt		$31.30/Cwt		$31.30/Cwt
Cost per Ton, (grind/mix/deliver)	$123.91	$124.75	$117.37	$118.22	$113.33	$114.53	$107.54	$108.13
Calculated Analysis								
Phytase Units/ pound (lb)	150	0	150	0	144	0	125	0
Crude Protein, %	18.00	18.10	15.50	15.60	14.20	14.30	12.60	12.70
Lysine - total, %	1.09	1.09	0.91	0.92	0.82	0.83	0.70	0.70
Crude Fat, %	5.24	5.18	5.63	5.57	5.83	5.77	6.09	6.04
Metabolizable Energy - kcal/lb	1505.00	1493.00	1515.00	1502.00	1525.00	1509.00	1530.00	1520.00
Salt, %	0.42	0.42	0.42	0.42	0.40	0.40	0.35	0.35
Calcium, %	0.62	0.70	0.60	0.68	0.57	0.65	0.49	0.56
Phosphorus - total, %	0.50	0.61	0.47	0.58	0.46	0.56	0.43	0.52
Analyzed Analysis								
Moisture, %	12.20	12.15	12.20	12.23	12.60	12.98	12.43	12.82
Crude Protein, %	18.01	18.51	15.71	15.40	14.04	15.23	13.46	13.54
Calcium, %	0.69	0.79	0.58	0.70	0.55	0.82	0.51	0.61
Phosphorus, %	0.56	0.67	0.50	0.65	0.49	0.64	0.49	0.60

Table 2. Phosphorus (P_2O_5) values from solids using phytase.

P_2O_5 from Solids	Control Group Average	Phytase Group Average	P-Value	P_2O_5 Reduction from Control Group (%)
As Received Basis (%)	1.63	1.34	0.0006	17.79
Dry Matter Basis (%)	5.90	4.92	0.0001	16.61
Lb/1000 Gallons	135.00	110.80	0.0006	17.90

Table 3. Phosphorus (P_2O_5) values from liquids using phytase.

P_2O_5 from Liquids	Control Group Average	Phytase Group Average	P-Value	P_2O_5 Reduction from Control Group (%)
As Received Basis (%)	0.208	0.162	0.05	22.11
Dry Matter Basis (%)	7.29	6.07	0.004	16.74
Lb/1000 Gallons	17.29	13.42	0.05	22.38

Table 4. Pig performance on phytase and control diets.

	Trial 1		Trial 2		Trial 3		Trial 4		Combined	
Item	Control	Phytase	Control	Phytase	Control	Phytase	Control	Phytase	Control	Phytase
Days on test	74	74	83	83	56	56	83	83	74	74
Sex of pigs	Gilts	Barrows	Barrows	Gilts	Gilts	Barrows	Barrows	Gilts	Mixed	Mixed
Number of pigs on test	53	48	55	57	53	57	57	56	218	218
On test weight - average	115.0	118.3	64.1	64.3	114.2	104.3	77.1	75.1	92.1	89.4
Number of pigs off test	53	46	51	53	53	57	57	56	214	212
Off test weight - average	258.6	269.8	224.4	218.5	220.2	218.8	270.8	248.6	244.2	237.6
Feed efficiency (F/E)	3.00	3.33	2.98	2.59	2.97	2.65	2.75	2.55	2.91	2.75
Average daily gain (ADG)	1.95	2.01	1.87	1.80	1.89	2.04	2.33	2.09	2.03	1.97