Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 10 *Swine Day (1968-2014)*

Article 990

2003

Effects of increasing CA:P ratio in diets containing phytase on finishing pig growth performance

S M. Hanni

M R. Barker

N Z. Frantz

See next page for additional authors

Recommended Citation

Hanni, S M.; Barker, M R.; Frantz, N Z.; Groesbeck, C N.; Keegan, T P.; Hastad, C W.; Tokach, Michael D.; Nelssen, Jim L.; DeRouchey, Joel M.; Goodband, Robert D.; and Dritz, Steven S. (2003) "Effects of increasing CA:P ratio in diets containing phytase on finishing pig growth performance," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 10. https://doi.org/10.4148/2378-5977.6830

Effects of increasing CA:P ratio in diets containing phytase on finishing pig growth performance

Authors

S M. Hanni, M R. Barker, N Z. Frantz, C N. Groesbeck, T P. Keegan, C W. Hastad, Michael D. Tokach, Jim L. Nelssen, Joel M. DeRouchey, Robert D. Goodband, and Steven S. Dritz

EFFECTS OF INCREASING CA:P RATIO IN DIETS CONTAINING PHYTASE ON FINISHING PIG GROWTH PERFORMANCE

S.M. Hanni, M.D. Tokach, J.L. Nelssen, J.M. DeRouchey, R.D. Goodband, S.S. Dritz[1], M.R. Barker, N.Z. Frantz, C.N. Groesbeck, T.P. Keegan, and C.W. Hastad

Summary

A total of 144 finishing pigs (72 barrows and 72 gilts, initially 85 lb) were used to determine the effects of calcium to total phosphorus (Ca:P) ratio in diets containing phytase on growth performance, carcass characteristics, and bone ash percentage. Pigs were housed in an environmentally regulated finishing building with two pigs per pen and six pens per sex per treatment in a randomized complete block design. Pigs were blocked by initial weight and sex, and then allotted to one of six dietary treatments.

The dietary treatments were corn-soybean meal-based diets fed in three phases. In each phase, diets consisted of a 0.75:1; 1:1; 1.25:1; 1.5:1, and 2:1 Ca:P ratio. A sixth treatment group was a diet containing 77% of the total P as the other treatment diets. Diets were formulated to contain 0.44%, 0.39%, and 0.34% total phosphorus and 0.15%, 0.12%, and 0.07% available phosphorus from d 0 to 28, 28 to 57, and 57 to 76, respectively. All diets contained 0.05% phytase, providing 300 FTU/kg in order to achieve equivalent available phosphorus values of 0.23%, 0.19%, and 0.15%. For the overall experiment, increasing Ca:P ratio decreased (linear, $P<0.03$) ADG and F/G. However, the greatest decrease in ADG and F/G was observed when Ca:P ratio increased from 1.5:1 to 2:1. Daily feed intake was not affected by Ca:P ratio. There was no difference in backfat thickness for pigs fed Ca:P ratios between 0.75:1 and 2.0:1 ($P<0.17$). However, pigs fed the negative control diet had reduced backfat thickness ($P<0.05$) compared to the other pigs. Bone ash percentage was not affected ($P<0.23$) by Ca:P ratio. These results suggest that in finishing diets containing 300 FTU/kg phytase, a Ca:P ratio greater then 1.5:1 will decrease ADG and ADFI.

(Key Words: Calcium, Phosphorus, Phytase, Finishing Pigs)

Introduction

Phytase releases phytic phosphorus from plant-based feedstuffs, which increases dietary P absorption and utilization and reduces the need for inorganic phosphorus supplementation. It has been widely demonstrated that dietary supplementation with phytase is effective in making phytate-bound P nutritionally available to growing pigs. Supplemental phytase in swine diets has resulted in improved growth performance and bone mineralization by increasing digestibility and retention of P and Ca. Because phytase use reduces P excretion and the levels of P in the environment, its use has been more widespread.

[1]Food Animal Health and Management Center.

When formulating diets with phytase, the reduction in P results in a widening of the Ca:P ratio if the amount of limestone that is generally added is not also adjusted. Other research has shown that high dietary Ca concentrations increase the formation of an insoluble Ca-phytate complex and/or the reduction of phytase activity. Research conducted using weanling pigs showed that narrowing the dietary Ca:tP ratio from 2.0:1 to 1.2:1 led to an approximate 16% increase in phytase efficacy, thus, improving performance, digestibility, bone measurements, and serum Ca levels. It has also been demonstrated that growth performance and P utilization were increased by lowering the Ca:tP ratio from 1.5:1 to 1.0:1 in low-P corn-soybean meal diets supplemented with microbial phytase in grow-finish pigs.

Therefore our objective was to determine the optimum calcium to total phosphorus ratio in diets containing phytase on growth performance, carcass characteristics, and bone ash percentage in finishing pigs.

Procedures

One hundred forty-four pigs (72 barrows and 72 gilts; PIC 327 × C22) averaging 85 lb were used in this study. Pigs were housed in an environmentally regulated finishing building with two pigs per pen and twelve pens (5 × 5ft) per sex per treatment (six pens of barrows and six pens of gilts) in a randomized complete block design. Pigs were blocked by initial weight and sex, and then randomly allotted to one of the six dietary treatments. Feed and water were provided ad libitum.

The six dietary treatments consisted of calcium to total phosphorus ratios of 0.75:1; 1:1; 1.25:1; 1.5:1, and 2:1. A sixth treatment group was formulated to contain 77% of the total P of the other treatment diets and was the negative control in this study. Soybean meal, vitamin premixes, antibiotic, Natuphos 600, monocalcium phosphate, trace mineral premix, and limestone were analyzed for percentage calcium and phosphorus. These values were then used in diet formulation. Diets were fed in meal form in three phases, 28, 28, and 19 days in length, respectively, that corresponded to approximately 70 to 130 lb, 130 to 190 lb, and 190 to 250 lb, respectively. The same Ca:P ratios were used in each phase. Diets were formulated to contain 1.10%, 0.90%, and 0.75% total dietary lysine, and 0.44%, 0.39%, and 0.32% total phosphorus (0.15, 0.11, and 0.07 calculated available P) for phases 1, 2, and 3, respectively. The negative control diet was formulated to contain 0.39%, 0.33%, and 0.30% total P which corresponded to 0.11%, 0.07%, and 0.05% available phosphorus. Natuphos was added to all diets to provide 300 FTU/kg in order to achieve equivalent available phosphorus values of 0.23%, 0.19%, and 0.15% for phases 1, 2, and 3, respectively. Diets were analyzed for dry matter, crude protein, calcium, and phosphorus.

Individual pig weights were taken and feed disappearance were measured every 14 d to calculate ADG, ADFI, and F/G. At the end of the study, pigs were marked with an individual tattoo to allow for individual carcass data to be collected at marketing. All pigs were sent to Downs, Kansas, for individual carcass data collection (i.e., carcass weight and backfat thickness). The experiment was conducted from December to February.

Results and Discussion

From d 0 to 28, increasing Ca:P ratio decreased (linear, $P<0.001$), ADG and F/G, but did not affect ($P>0.82$) ADFI. The greatest decrease in performance was observed when the Ca:P ratio increased from 1.5:1 to 2.0:1. There was no difference between pigs fed the negative control and the mean of all other Ca:P ratio treatments for either ADG, ADFI, and F/G. In addition, barrows had greater ($P<0.001$), ADG, and ADFI compared to gilts, but F/G was not affected ($P>0.91$). From d 28

to 57, increasing the Ca:P ratio decreased (quadratic, $P<0.04$) ADG and F/G, but did not affect ADFI ($P>0.14$). Again, like d 0 to 28, the greatest change in performance was observed when Ca:P ratio increased from 1.5:1 to 2.0:1. Barrows had greater ($P<0.0001$), ADG and ADFI then gilts, with no difference ($P>0.15$) in feed efficiency. There were no differences between pigs fed the negative control and the other diets for ADG, ADFI, and F/G. From d 57 to 76 increasing the Ca:P ratio decreased ADFI (quadratic, $P<0.02$) but, did not affect ($P>0.13$), ADG and F/G. As in d 0 to 28 and 28 to 57 there were no differences between pigs fed the negative control and the mean of the other Ca:P ratios for either ADG, ADFI, and F/G. Barrows had greater ($P<0.05$), ADG and ADFI than gilts, while gilts had improved F/G ($P<0.01$) compared to barrows.

For the overall study, increasing the Ca:P ratio decreased (linear, $P<0.003$), ADG and F/G, with no affect on ADFI ($P>0.42$). Similar to the response in both phase 1 and 2, the greatest changes in ADG and F/G occurred when the Ca:P ratio increased from 1.5:1 to 2.0:1. As in each of the growth periods there were no differences between pigs fed the negative control and the mean of the other Ca:P ratio treatments for ADG, ADFI, or F/G. Furthermore, barrows had a greater ($P<0.001$), ADG and ADFI than the gilts, while the gilts had an improved F/G ($P<0.03$) compared to the barrows.

Increasing the Ca:P ratio decreased the final live animal weight (linear, $P<0.003$) but, did not affect carcass weight ($P<0.11$). Also, barrows had higher ($P<0.05$) carcass weight and backfat thickness compared to gilts. There was no difference in backfat thickness for pigs fed Ca:P ratios between 0.75:1 and 2.0:1 ($P<0.17$). However, pigs fed the negative control had reduced backfat thickness ($P<0.05$) compared to the other pigs. In addition bone ash percentage was not affected ($P<0.23$) by Ca:P ratio or gender.

When comparing pigs fed the negative control to the mean of the other Ca:P ratio treatments, there are no differences, due mostly to the low values of pigs fed the 2:1 Ca:P ratio. However, throughout the study, ADG and F/G of pigs fed the negative control diets are numerically poorer than pigs fed the optimal Ca:P ratios (1.25:1 and below). The negative control treatment was included in the experiment to ensure our dietary phosphorus levels were not above the pig’s requirement. If we were well above the pigs requirement for phosphorus in our diets this would affect our interpretation.

In conclusion, these results suggest that increasing the calcium to total phosphorus ratio above a 1.5:1 ratio in a corn-soybean meal-based diet containing 300 FTU/kg phytase for growing finishing pigs can have a negative effect on growth performance, carcass traits, and bone ash percentage.

Table 1. Diet Composition (As-fed Basis)

Ingredient, %	Day 0 to 28	Day 28 to 56	Day 56 to 73
Corn	69.99	77.80	83.67
Soybean meal, 46.5% CP	26.51	19.18	13.72
Monocalcium phosphate, 21% P	0.40	0.25	0.10
Limestone	0.38 – 1.99	0.36 – 1.74	0.35 – 1.53
Salt	0.35	0.35	0.35
Vitamin premix	0.15	0.15	0.15
Trace mineral premix	0.15	0.15	0.15
Medication[a]	0.05	0.05	0.05
Sand	1.71 – 0.21	1.39 – 0.31`	1.08 – 0.08
Lysine HCL	0.15	0.15	0.15
Phytase[b]	0.05	0.05	0.05
Calculated analysis			
Lysine, %	1.10	0.90	0.75
Protein, %	18.30	15.50	13.50
ME, Kcal/lb	1,492	1,501	1,509
Ca, %	0.33 – 0.88	0.28 – 0.75	0.24 – 0.64
P, %	0.44	0.38	0.32
Available P, %	0.15	0.11	0.07

[a]Provided 44 mg/kg of Tylosin.
[b]Provided 300 FTU/kg of feed (Natuphos® 600).

Table 2. Influence of Calcium to Total Phosphorus Ratio on Growth Performance and Bone Ash in Finishing Pigs[a]

	Calcium:Phosphorus ratio							Probability (P<)			Sex		
Item	Neg control	0.75:1	1:1	1.25:1	1.5:1	2:1	SED	Linear	Quad	Neg vs others	Barrows	Gilts	P< Value
Day 0 to 28													
ADG, lb	2.17^{b}	2.31^{c}	2.25^{bc}	2.23^{bc}	2.14^{bd}	2.03^{d}	0.06	0.001	0.69	0.66	2.31	2.07	0.001
ADFI, lb	5.24	5.22	5.15	5.17	5.05	5.20	0.14	0.82	0.28	0.47	5.45	4.89	0.001
F/G	2.41^{b}	2.26^{c}	2.30^{bc}	2.33^{bc}	2.36^{bc}	2.58	0.07	0.001	0.16	0.41	2.37	2.38	0.77
Day 28 to 57													
ADG, lb	2.32^{bc}	2.56^{bc}	2.42^{b}	2.37^{bc}	2.35^{bc}	21.8^{c}	0.10	0.19	0.04	0.98	2.44	2.19	0.001
ADFI, lb	7.03	6.76	6.46	6.66	6.55	7.00	0.29	0.26	0.14	0.13	7.20	6.28	0.001
F/G	3.05^{bc}	3.00^{bc}	2.68^{a}	2.83^{ab}	2.80^{ab}	3.22^{c}	0.13	0.01	0.001	0.16	2.97	2.89	0.29
Day 57 to 76													
ADG, lb	1.79	1.86	1.98	1.92	1.96	1.79	0.12	0.41	0.15	0.21	1.95	1.82	0.053
ADFI, lb	7.05^{b}	6.99^{bc}	7.52^{bc}	7.65^{d}	7.42^{bcd}	7.24^{bcd}	0.26	0.70	0.02	0.13	7.82	6.80	0.001
F/G	3.98	3.83	3.86	4.07	3.82	4.11	0.21	0.24	0.86	0.78	4.08	3.81	0.03
Overall													
ADG, lb	2.14^{bc}	2.19^{c}	2.25^{c}	2.21^{c}	2.18^{c}	2.03^{b}	0.06	0.003	0.04	0.45	2.28	2.06	0.001
ADFI, lb	6.35	6.22	6.20	6.31	6.17	6.37	0.15	0.42	0.66	0.50	6.67	5.87	0.001
F/G	2.97^{b}	2.84^{bc}	2.75^{c}	2.85^{bc}	2.83^{c}	3.15^{d}	0.07	0.001	0.001	0.10	2.94	2.86	0.05
Live wt.	241.0^{bc}	2.44.0^{c}	249.5^{c}	246.5^{c}	244.1^{c}	233.3^{b}	4.46	0.003	0.03	0.48	251.8	234.3	0.001
Packing Plant Data													
Carcass wt., lb	188.6	190.7	188.8	187.2	188.7	183.7	4.09	0.11	0.82	0.81	190.33	185.57	0.05
Backfat, in.	0.74^{b}	0.83^{bc}	0.83^{bc}	0.89^{bc}	0.90^{bc}	0.93^{c}	0.06	0.17	0.81	0.05	0.92	0.79	0.01
Bone ash, %													
3rd Metacarpal	43.30	43.22	41.19	43.33	42.77	42.96	0.008	0.64	0.95	0.75	43.19	43.06	0.79
4th Metacarpal	43.84	44.48	44.66	45.15	43.75	43.66	0.01	0.22	0.56	0.50	44.29	44.22	0.90
Average bone ash	43.57	43.85	43.93	44.24	43.26	43.31	0.007	0.23	0.71	0.77	43.74	43.64	0.79

[a]Values are means of 144 pigs (initially 85 lb) with 2 pigs per pen and 12 replicate pens per treatment.
[b,c,d]Means on the same row with different superscript differ (P<0.05).