South Dakota State University

Open PRAIRIE: Open Public Research Access Institutional Repository and Information Exchange

South Dakota Swine Field Day Proceedings and Research Reports, 1978

Animal Science Reports

1978

Effects of Dietary Protein, Calcium, and Phosphorus in Pig Starter Diets

Wayne E. Schiefelbein
South Dakota State University

Richard C. Wahlstrom

George W. Libal

EFFECTS OF DIETARY PROTEIN, CALCIUM, AND PHOSPHORUS IN PIG STARTER DIETS

Wayne E. Schiefelbein, Richard C. Wahlstrom, and George W. Libal

Department of Animal Science
Swine Section

South Dakota State University
A.S. Series 78-14

Genetic selection by the swine industry over the past 20 years has resulted in faster growing, heavier muscled pigs. Previous research has shown that during the first 12 weeks of life in swine, maximum bone formation and muscle development occur. Recent research conducted at Ohio State University indicated that growing swine might respond to increasing dietary protein levels if both calcium and phosphorus are also correspondingly increased but maintained at approximately a 1.3:1 ratio.

The study reported herein was designed to determine the effect of dietary protein levels and varying levels of calcium and phosphorus on performance of early weaned pigs.

Experimental Procedure

Three trials were conducted with 144 pigs in trials 1 and 2 and 96 pigs in trial 3. Pigs were weaned at an average weight of about 18 lb. and allotted to six treatments in each experiment on the basis of ancestry and weight. The animals were housed in the environmentally controlled swine lab of the Animal Science Complex and the experiments conducted for 4 weeks.

Corn-soy diets were ground and mixed at the Central Feed Unit and formulated to contain various levels of protein, calcium and phosphorus as shown in table 1. The protein levels were varied by altering the soybean meal:corn ratio and the various combinations of calcium and phosphorus were obtained using limestone and dicalcium phosphate.

Blood was collected initially and at termination of trials 1 and 2 and analyzed for serum calcium and phosphorus. One pig from each pen in trial 2 was sacrificed and metacarpals from the front feet extracted for bone ash analysis.

Results

Experiment 1. Data on performance and blood analyses from experiment 1 are shown in table 2. There was a significant feed efficiency difference between protein levels, with pigs fed 21% protein diets being more efficient than those fed 18% protein diets. Pigs fed the higher protein diets gained slightly faster than those fed the 18% protein diets, but these differences were not significant.

Analysis of termination serum phosphorus samples showed differences between protein levels among treatments. Pigs on the 18% protein diets had higher serum phosphorus concentrations than those on the higher protein diets. The serum phosphorus concentration from pigs receiving .80/.60% Ca:P in 21% protein diets was lower than those for all other treatments at termination. Also, pigs getting 1.30/1.00% Ca:P at the 18% protein level had lower serum phosphorus concentrations than those on diets containing .80/.60 or 1.05/.80% Ca:P at the same protein level. Although these differences in blood phosphorus were significant, they did not appear to be related to growth performance of the pigs.

Experiment 2. The results of pig performance and blood and bone analyses from experiment 2 are listed in table 3.

Again, pigs fed 21% protein diets gained more efficiently than those fed the 18% protein diets. There were also feed efficiency differences among treatments in this trial. Pigs provided 1.00% dietary phosphorus in 21% protein diets gained more efficiently than all groups of pigs fed the lower protein diet. Those pigs receiving the 21% protein diet treatments at .60 and .80% dietary phosphorus were more efficient in feed/gain than were those pigs fed the diets containing .60 or 1.00% phosphorus at the lower protein level. Among the 18% protein level treatments, pigs fed .60% dietary phosphorus grew more efficiently than those on 1.00% phosphorus.

In this experiment, differences were found in both termination serum calcium and phosphorus concentrations. Averaging over protein levels, pigs receiving diets with .60% dietary phosphorus had higher serum calcium concentrations than did those receiving 1.00% phosphorus. Among the treatments, feeding the diet containing .60% phosphorus at the 21% protein level resulted in pigs with lower serum phosphorus concentrations than all other treatments.

There were differences observed in both bone weight and percent bone ash. The pigs fed 18% protein diets had higher bone weights than did those on the 21% protein diets. However, the higher protein diets resulted in pigs with higher percent bone ash than those fed lower protein diets.

Differences were noted in bone weights and percent bone ash among mineral levels when averaged over protein levels. Pigs receiving .80% phosphorus in their diets had heavier bone weights and higher percent bone ash than those pigs receiving .60% dietary phosphorus. Also, diets containing 1.00% dietary phosphorus resulted in pigs with higher percent bone ash than those pigs receiving diets with .60% phosphorus.

Some bone weight and percent bone ash differences were also observed among treatments. Pigs provided .80% dietary phosphorus in the 21% protein diet and 1.00% phosphorus in the 18% protein diet had heavier bones than those receiving .60 or 1.00% phosphorus in the 21% protein diet and more bone ash than pigs fed either .80% phosphorus in the 18% protein diet or 1.00% phosphorus in the 21% protein diet.

Experiment 3. A summary of performance data from experiment 3 is presented in table 4. As in trials 1 and 2, pigs fed the higher protein diets grew more efficiently than those on the lower protein diets. Pigs fed the 22% protein diet required an average 1.47 lb. of feed/gain compared to 1.65 lb. for pigs fed 18% dietary protein. Dietary Ca:P levels of 1.00/.80 and 1.25/1.00% resulted in pigs having more efficient gains than pigs fed diets with .75/.60% Ca:P.

Also, the pigs receiving 22% protein diets gained approximately 10% faster ($P<.05$) and consumed less feed daily than those pigs fed 18% protein diets.

Summary

Three trials were conducted using a total of 384 crossbred pigs to evaluate the effects of dietary protein, calcium and phosphorus in starter diets.

Essentially no real differences in average daily gain or average daily feed consumption were observed among treatments. However, pigs fed the higher protein and mineral treatment did gain slightly faster than those on the other treatments in all three experiments. In experiment 3, pigs fed the 22% protein diets gained significantly ($P<.05$) faster than pigs fed 18% protein diets.

In all three experiments, pigs fed the higher protein diets required significantly less feed/gain than those fed lower protein diets.

The lower serum phosphorus values for the higher protein diet with lower mineral levels in both trials 1 and 2 suggest an increased dietary mineral requirement with increased protein levels.

Table 1. Composition of Diets (Percent)

Ingredients	Dietary treatments 1	2	3	4	5	6
	Experiment 1					
Corn	72.91	71.42	70.04	65.45	63.96	62.47
SBOM (48%)	24.00	24.30	24.50	31.60	31.90	32.20
Dicalcium phosphate	1.15	2.25	3.34	1.00	2.10	3.19
Limestone	1.24	1.33	1.42	1.25	1.34	1.44
Trace mineral salt	.4	.4	.4	.4	.4	.4
Premix[a]	.3	.3	.3	.3	.3	.3
Percent protein	18	18	18	21	21	21
Percent calcium	.8	1.05	1.30	.8	1.05	1.30
Percent phosphorus	.6	.8	1.0	.6	.8	1.0
	Experiment 2					
Corn	71.07	70.44	69.79	62.91	62.26	61.52
SBOM (44%)	25.80	25.90	26.00	34.10	34.20	34.40
Dicalcium phosphate	1.18	2.26	3.35	1.03	2.12	3.20
Limestone	1.25	.7	.16	1.26	.72	.18
Trace mineral salt	.4	.4	.4	.4	.4	.4
Premix	.3	.3	.3	.3	.3	.3
Percent protein	18	18	18	21	21	21
Percent calcium	.8	.8	.8	.8	.8	.8
Percent phosphorus	.6	.8	1.0	.6	.8	1.0
	Experiment 3					
Corn	70.54	69.06	67.59	59.31	57.83	56.41
SBOM (44%)	26.50	26.80	27.10	37.90	38.20	38.45
Dicalcium phosphate	1.16	2.26	3.35	.96	2.06	3.15
Limestone	1.10	1.18	1.26	1.13	1.21	1.29
Trace mineral salt	.4	.4	.4	.4	.4	.4
Premix	.3	.3	.3	.3	.3	.3
Percent protein	18	18	18	22	22	22
Percent calcium	.75	1.0	1.25	.75	1.0	1.25
Percent phosphorus	.6	.8	1.0	.6	.8	1.0

[a] Supplied per lb. of diet: vitamin A, 2000 IU; vitamin D, 200 IU; vitamin E, 3 mg; vitamin K, 1.2 mg; pantothenic acid, 6 mg; niacin, 9.6 mg; choline, 30 mg; vitamin B_{12}, 6 mcg; aureomycin, 50 mg; penicillin, 25 mg and sulfamethazine, 50 milligrams.

Table 2. Effect of Varying Dietary Protein, Calcium and Phosphorus on Performance and Blood Analysis of Young Weaned Pigs in Experiment 1

	Dietary treatments					
Percent protein	18	18	18	21	21	21
Ca:P, %	.80/.60	1.05/.80	1.3/1.0	.80/.60	1.05/.80	1.3/1.0
Avg final wt., lb.	45.0	45.7	44.7	44.8	45.7	49.1
Avg daily gain, lb.	.90	.92	.89	.89	.93	1.04
Avg daily feed consumption, lb.	1.65	1.76	1.65	1.55	1.56	1.77
Feed/gain, lb.[a]	1.84	1.90	1.87	1.74	1.68	1.70
Init. serum calcium, mg/100 ml	10.47	10.58	10.70	10.61	10.64	10.45
Termination serum calcium, mg/100 ml	10.38	10.50	10.51	10.61	10.57	10.37
Init. serum phosphorus, mg/100 ml	9.72	9.63	9.71	9.58	9.47	9.64
Termination serum phosphorus, mg/100 ml[b]	10.53[c]	10.35[c]	9.64[d]	9.05[e]	10.13[cd]	10.16[cd]

[a] Significant (P<.01) protein effect (1.71 lb. for 21% vs. 1.87 lb. for 18% protein).

[b] Significant (P<.02) protein effect (10.17 mg/100 ml for 18% vs. 9.75 mg/100 ml for 21% protein).

[c,d,e] Means with different superscripts are significantly different (P<.01).

Table 3. Effect of Varying Dietary Protein, Calcium and Phosphorus on Performance and Blood and Bone Analysis of Young Weaned Pigs in Experiment 2

	Dietary treatments					
Percent protein	18	18	18	21	21	21
Ca:P, %	.80/.60	.80/.80	.80/1.00	.80/.60	.80/.80	.80/1.00
Avg final wt., lb.	44.8	46.7	45.4	45.3	46.5	47.8
Avg daily gain, lb.	.88	.95	.91	.90	.95	.98
Avg daily feed consumption, lb.	1.63	1.71	1.71	1.56	1.62	1.57
Feed/gain, lb.[a]	1.85[bc]	1.80[bd]	1.89[bc]	1.72[de]	1.72[de]	1.66[e]
Init. serum calcium, mg/100 ml	10.03	10.16	10.10	10.07	9.87	9.98
Termination serum calcium, mg/100 ml[f]	10.26	9.96	9.71	10.06	9.94	9.77
Init. serum phosphorus, mg/100 ml	9.72	9.94	9.54	9.81	9.86	9.91
Termination serum phosphorus, mg/100 ml	10.93	10.55	10.73	9.80[g]	10.57	10.95
Bone weight, g[hi]	4.04[bc]	4.02[bc]	4.26[c]	3.76[b]	4.28[c]	3.81[b]
Percent bone ash[jk]	51.1	52.6	53.7	51.8	54.0	52.7

[a] Significant (P<.01) protein effect (1.70 lb. for 21% protein vs. 1.85 lb. for 18% protein).

[b,c,d,e] Means with different superscripts are significantly different (P<.05).

[f] Significant (P<.05) mineral effect, averaged over protein levels (.80/.60% Ca:P at 10.16% vs. .80/1.00% Ca:P levels at 9.74%).

[g] Significantly less (P<.02) than other treatments.

[h] Significant (P<.01) protein effect (4.11 grams for 18% protein vs. 3.95 grams for 21% protein level).

[i] Significant (P<.02) mineral effect, averaged over protein levels (.80/.80% Ca:P levels yielding 4.15 grams vs. .80/.60% Ca:P levels at 3.90 grams).

[j] Significant (P<.05) protein effect (52.8% for 21% protein vs. 52.5% for 18% protein).

[k] Significant (P<.01) mineral effect averaged over protein levels, both .80/.80% and .80/1.00% Ca:P values at 53.3 and 53.2%, respectively, vs. .80/.60% Ca:P mineral level.

Table 4. Effect of Varying Dietary Protein, Calcium and Phosphorus on Performance of Young Weaned Pigs in Experiment 3

	Dietary treatments					
Percent protein	18	18	18	22	22	22
Ca:P, %	.75/.60	1.00/.80	1.25/1.00	.75/.60	1.00/.80	1.25/1.00
Avg final wt., lb.	40.7	41.8	43.1	44.0	44.0	45.0
Avg daily gain, lb.[a]	.78	.82	.87	.90	.90	.93
Avg daily feed consumed, lb.	1.79	1.46	1.70	1.51	1.45	1.44
Feed/gain, lb.[b,c]	2.29	1.79	1.96	1.71	1.61	1.55

[a] Significant ($P<.05$) protein effect (.91 lb. per day for 22% protein vs. .82 lb. per day for 18% protein).

[b] Significant ($P<.01$) protein effect (1.62 lb. for 22% vs. 2.01 lb. for 18% protein).

[c] Significant ($P<.05$) mineral effect (more feed/gain required for .75/.60% Ca:P than 1.0/.80% and 1.25/1.0% Ca:P levels, 2.00 lb. vs. 1.70 and 1.76 lb., respectively).