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Energy Sources in Starter Diets for Early Weaned Pigs

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Cereal grains constitute the major percentage of swine diets. Although they are used mainly as energy sources, these grains also supply a considerable amount of protein to the diet. With increased feed prices, much interest has been expressed in alternate ingredient sources in swine diets and combinations of ingredients that will be palatable and furnish the nutrients required. Starter diets for young weaned pigs are the most expensive diets because of the higher nutrient requirement at this stage of the life cycle. Therefore, this experiment was conducted to evaluate the performance of young weaned pigs fed different grains, alone and in combination, as the energy source in starter diets and to study the effect of lysine and protein levels of these diets on pig performance.

Experimental Procedure

This experiment consisted of three separate trials. Pigs were removed from their dams when they weighed from 15.5 to 19.5 lb. and were between 3 and 5 weeks of age. They were placed directly on the experimental diets allotted on the basis of ancestry, weight and sex. The trials were continued for 5 weeks. All pigs were housed in concrete floored pens bedded with straw and confined indoors. Feed and water were provided ad libitum.

A total of 60, 72 and 60 crossbred pigs were used in trials 1, 2 and 3, respectively. Each treatment was represented by three replicate lots of four pigs each. The experimental treatments for the three trials were as follows:

- Trial 1 -
1. Normal corn diet - 18% protein
 2. Opaque-2 corn diet - 18% protein
 3. Double mutant corn diet - 18% protein
 4. Opaque-2 corn and oats, equal parts - 18% protein
 5. Opaque-2 corn diet - 14% protein.
- Trial 2 -
1. Normal corn diet - 18% protein
 2. Hulled, rolled oats diet - 18% protein
 3. Hulled, rolled oats diet - 15.5% protein
 4. Diet 3 plus 0.1% L-lysine
 5. Diet 3 plus 0.2% L-lysine
 6. Diet 3 plus 0.3% L-lysine.
- Trial 3 -
1. Normal corn diet - 18% protein
 2. Oats diet - 18% protein
 3. Corn and oats, equal parts - 18% protein
 4. Corn and oats, equal parts, and 5.9% fat - 18% protein
 5. Oats and 11.5% fat - 18% protein.

The compositions of the diets are shown in tables 1, 2 and 3 for trials 1, 2 and 3, respectively. The opaque-2 and double mutant corn used in trial 1 contained 0.40 and 0.37% lysine, respectively, while the normal corn contained 0.28% lysine. Dehulled soybean meal, 48.5% protein, was used in trial 1 and 44% solvent processed soybean meal was used in trials 2 and 3.

Results

Trial 1

The results of this trial are summarized in table 4. There were no significant differences in average daily gain which ranged from 0.72 lb. per day for pigs fed the 18% protein, opaque-2 corn diet to 0.87 lb. per day for pigs fed the diet of equal parts of opaque-2 corn and oats. Pigs fed the 14% protein diet containing opaque-2 corn gained similarly to those fed opaque-2 or normal corn in 18% protein diets. This is surprising since the lower protein diet contained about 0.70% lysine which is less than that considered to be needed by pigs of this size. The somewhat greater feed requirement of pigs fed the 14% protein diet would indicate that it may have been deficient in lysine content to support optimum feed efficiency.

Pigs fed the diet of opaque-2 corn and oats consumed more feed daily and required less feed per unit of gain than those fed the corn diets. Since the diet containing oats would be higher in fiber content, it would not be expected to be as efficient. However, these pigs seemed to adapt to their diet more rapidly and this may account for the faster and more efficient gains observed when pigs received the opaque-2 corn-oats diet.

Trial 2

Table 5 summarizes the results of trial 2. Pigs fed the corn diet gained significantly faster than those pigs fed the lower protein, hulled oats diet with 0, 0.1 or 0.2% lysine and approached significance with the lower protein, hulled oats diet plus 0.3% lysine and the higher protein, hulled oats diet. Gains of pigs fed these latter two diets were also significantly faster than those of pigs fed the lower protein, hulled oats diet. Since the corn diet contained 0.94% lysine compared to 0.44, 0.54, 0.64, 0.74 and 0.66% lysine for the lower protein, hulled oats diets with 0, 0.1%, 0.2% and 0.3% L-lysine and the higher protein, hulled oats diet, respectively, it would appear that all of these diets may have been lacking in lysine for optimum gains. The corn diet was also consumed in greater amounts which may have been due to a better amino acid balance or to other factors affecting palatability.

Significantly more feed per gain was required by pigs fed the lower protein, hulled oats diet than by pigs fed this diet supplemented with 0.2 or 0.3% lysine, the higher protein, hulled oats diet or the corn diet. Pigs fed the corn diet were also more efficient in feed conversion (2.07) than those fed the hulled oats diet supplemented with 0.1% lysine (2.33).

Trial 3

The performance of the pigs in trial 3 is shown in table 6. Pigs fed the corn diet gained 0.19 lb. per day faster than those fed the oats diet (1.00 vs. 0.81 lb.). It is assumed that this difference in gain is due at least in part to the higher energy content of the corn diet. Pigs fed a mixture of corn and oats gained 0.93 lb. per day and those fed the corn and oats diet with fat added to equalize the caloric content to that of the corn diet gained 0.95 lb. per day. Adding fat to the all oats diet to make it isocaloric to the corn diet resulted in pig gains of 0.87 lb. per day or 0.13 lb. per day less than pigs fed the corn diet. Although these diets were equal in energy, pigs consumed 0.23 lb. per day more of the corn diet resulting in faster gains. Results of this trial were similar to trial 2 in that the best feed consumption and daily gain were obtained by pigs fed diets containing corn as the cereal grain.

Feed per gain ranged from 2.32 for pigs fed the oats diet to 2.07 for pigs fed the corn-oats mixture containing 5.9% fat. Feed per gain for pigs fed corn, corn-oats and oats plus fat diets were 2.11, 2.14 and 2.18, respectively. There were no significant differences among the treatments in feed per gain.

Summary

One hundred ninety-two pigs averaging 17.5 lb. were used in three trials to evaluate 14 different starter diets for weanling pigs. An 18% protein, normal corn diet was used as a control diet in all three trials.

In trial 1, there were no significant differences in average daily gain or feed per pound of gain among the five treatments. Average daily gain ranged from 0.87 lb. for pigs fed the 18% protein, opaque-2 corn-oats diet to 0.72 lb. for pigs fed an 18% protein, opaque-2 corn diet. Feed per pound of gain ranged from 2.00 lb. for pigs fed the 18% protein, opaque-2 corn-oats diet to 2.26 lb. for pigs fed the 14% protein, opaque-2 diet.

In trial 2, pigs fed a hulled, rolled oats diet calculated to contain 15.5% protein had an average daily gain of 0.54 lb., which was significantly ($P < .01$) lower than the gain of pigs fed the corn or hulled oats diets calculated to contain 18% protein. As lysine supplementation increased in the diets, the average daily gain of the pigs increased. The same pattern developed with feed per pound of gain. As lysine supplementation increased from 0.1% to 0.3%, the feed per pound of gain decreased from 2.33 to 2.13 pounds. The data indicate that the low protein, hulled, rolled oats diet supplemented with 0.3% lysine promoted equal pig gains and feed efficiency to an 18% protein, hulled, rolled oats diet.

In trial 3, isocaloric diets of oats and equal parts of corn and oats were compared to an 18% protein corn diet and an 18% protein oats diet. There were no significant differences in average daily gain among the five treatments, although pigs fed the oats diet gained 19% slower than those fed the corn diet. Also, adding 11.5% supplemental fat to the 18% protein oats diet did not significantly improve average daily gain. Feed per pound of gain ranged from 2.32 for pigs fed the oats diet to 2.07 for pigs fed the corn-oats-fat supplemented diet. Again, the differences in feed efficiency were not significant, although pigs fed diets with supplemental fat tended to be slightly more efficient.

The results from this experiment indicate that a 16% protein, hulled, rolled oats diet is deficient in the amino acid lysine. Also, contrary to some reports that oats should not be over one-third of the grain diet, the 18% protein, oats-opaque-2 corn diet promoted the fastest rate of gain and the best feed efficiency in trial 2. Therefore, diets of up to 50% oats appear to merit consideration in starter diets for early weaned pigs.

Table 1. Percentage Composition of Diets, Trial 1

Ingredients	Diets				
	Normal corn	<u>Opaque-2</u> corn (18%)	Double mutant corn	<u>Opaque-2</u> corn and oats	<u>Opaque-2</u> corn (14%)
Normal corn	74.8	--	--	--	--
<u>Opaque-2</u> corn	--	74.8	--	38.5	85.1
Double mutant corn	--	--	74.8	--	--
Ground oats	--	--	--	38.5	--
Soybean meal (48.5%)	21.7	21.7	21.7	19.6	11.3
Trace mineralized salt	0.5	0.5	0.5	0.5	0.5
Dicalcium phosphate	1.5	1.5	1.5	1.6	1.7
Limestone	0.7	0.7	0.7	0.6	0.6
Vitamin-antibiotic premix ^a	0.8	0.8	0.8	0.8	0.8
Crude protein, % (chemical analysis)	17.8	17.1	17.2	17.8	13.6

^aProvided per lb. of diet: Vitamin A, 2200 IU; vitamin D, 240 IU; riboflavin, 1.9 mg.; pantothenic acid, 7.5 mg.; niacin, 15 mg.; choline, 75 mg.; vitamin B₁₂, 11 mcg.; aureomycin, 50 mg.; sulfamethazine, 50 mg.; penicillin, 25 mg.

Table 2. Percentage Composition of Diets, Trial 2

Ingredients	Diets					
	Corn 18% C.P.	Hulled oats 18% C.P.	Hulled oats 15.5% C.P.	Hulled oats + 0.1% lysine	Hulled oats + 0.2% lysine	Hulled oats + 0.3% lysine
Ground yellow corn	70.0	--	--	--	--	--
Hulled oats	--	87.7	96.7	96.6	96.5	96.4
Soybean meal (44%)	26.6	9.0	--	--	--	--
Trace mineralized salt	0.5	0.5	0.5	0.5	0.5	0.5
Dicalcium phosphate	1.4	1.1	1.2	1.2	1.2	1.2
Limestone	0.7	0.8	0.8	0.8	0.8	0.8
L-lysine	--	--	--	0.1	0.2	0.3
Vitamin-antibiotic premix ^a	0.8	0.8	0.8	0.8	0.8	0.8
Crude protein, % (Chemical analysis)	16.8	15.9	13.7	14.0	14.3	13.6

^aSee footnote a, table 1.

Table 3. Percentage Composition of Diets, Trial 3

Ingredients	Diets				
	Corn 18% C.P.	Ground oats 18% C.P.	Corn-oats 18% C.P.	Corn-oats + fat	Oats + fat
Ground yellow corn	70.0	--	36.6	32.8	--
Ground oats	--	76.8	36.6	32.8	61.0
Soybean meal (44%)	26.6	19.8	23.4	25.1	24.1
Trace mineralized salt	0.5	0.5	0.5	0.5	0.5
Dicalcium phosphate	1.4	1.6	1.5	1.6	1.7
Limestone	0.7	0.5	0.6	0.5	0.4
Vitamin-antibiotic premix ^a	0.8	0.8	0.8	0.8	0.8
Fat	--	--	--	5.9	11.5
<u>Chemical Analysis</u>					
Crude protein, %	17.5	17.5	17.3	18.2	18.9
Ether extract, %	2.8	2.4	2.8	9.1	14.4

^aSee footnote a, table 1.

Table 4. Results of Feeding Opaque-2 and Double Mutant Corn to Young Pigs

	Normal corn	<u>Opaque-2</u> corn (18%)	Double mutant corn	<u>Opaque-2</u> corn and oats	<u>Opaque-2</u> corn (14%)
Number of pigs	12	12	12	12	12
Avg. initial wt., lb.	17.4	17.5	17.4	17.4	17.5
Avg. final wt., lb.	44.0	42.6	45.2	47.9	43.2
Avg. daily gain, lb.	0.76	0.72	0.80	0.87	0.74
Avg. daily feed, lb.	1.58	1.53	1.65	1.74	1.66
Avg. feed/gain	2.08	2.14	2.08	2.00	2.26

Table 5. Effects of Lysine Supplementation in Hulled Rolled Oats Diets

	Corn 18% C.P.	Hulled oats 18% C.P.	Hulled oats 15.5% C.P.	Hulled oats + 0.1% lysine	Hulled oats + 0.2% lysine	Hulled oats + 0.3% lysine
Number of pigs ^a	12	11	12	12	12	12
Avg. initial wt., lb.	17.5	17.6	17.6	17.6	17.6	17.5
Avg. final wt., lb.	48.5	44.1	36.6 ^{b,d}	40.4 ^c	41.2 ^c	43.5
Avg. daily gain, lb.	0.89	0.75	0.54 ^{b,d}	0.65 ^c	0.68 ^c	0.74
Avg. daily feed, lb.	1.83	1.61	1.38 ^{b,e}	1.52 ^c	1.51	1.59
Avg. feed/gain	2.07	2.13	2.54 ^{b,e}	2.33 ^c	2.18	2.13

^aOne pig died, data not included.

^bSignificantly different from the corn diet (P<.01).

^cSignificantly different from the corn diet (P<.05).

^dSignificantly different from the 18% hulled oats and 15.5% hulled oats + 0.3% lysine diets (P<.01).

^eSignificantly different from the 18% hulled oats, 15.5% hulled oats + 0.2% lysine and 15.5% hulled oats + 0.3% lysine diets (P<.01).

Table 6. Effect of Adding Supplemental Fat to Oats Diets

	Corn 18% C.P.	Ground oats 18% C.P.	Corn-oats 18% C.P.	Corn-oats + fat	Oats + fat
Number of pigs	12	12	12	12	12
Avg. initial wt., lb.	17.1	17.0	17.1	17.1	17.0
Avg. final wt., lb.	52.2	45.5	49.5	50.4	47.5
Avg. daily gain, lb.	1.00	0.81	0.93	0.95	0.87
Avg. daily feed, lb.	2.11	1.89	1.97	1.97	1.88
Avg. feed/gain	2.11	2.32	2.14	2.07	2.18