Evaluating High Oil Corn and Normal Corn as Energy Sources in Nursery Pig Diets

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Introduction

Due to selection and genetic engineering of corn, specialty hybrids have been developed, such as high oil corn. High oil corn (HOC) is a type of yellow corn that has a higher content of oil, and which therefore has more energy than normal corn. The higher lipid content of HOC could provide an alternative method of increasing the energy density of swine diets. This energy-packed corn could be beneficial to producers due to the limited nutrient intake of the young pig during the nursery phase. In turn, the energy dense diets have the potential to improve feed efficiency, which would be of economic value to the swine producer.

The present study was conducted to evaluate HOC and normal corn as energy sources in nursery diets. One of the challenges in nursery diets is to balance for maximum feed intake and efficiency. This balance has been researched in previous studies conducted in the growing stage of pigs, but has not yet been thoroughly evaluated with HOC in nursery age pigs.

Experimental Procedures

Five diets were formulated using two different strains of corn, normal number 2 yellow corn and a high oil variety; these treatments are shown in Tables 1 and 2. The NC diet was a normal number 2 yellow dent corn diet. The HC diet was formulated using high oil corn on a pound-for-pound substitution for the normal corn in diet NC. The NC+O diet was formulated with added soybean oil to make the diet isocaloric with the HC diet. The next diet was NC+O+AA, which was the normal corn, plus oil and synthetic amino acids, formulated to balance the lipid and lysine to calorie ratio similar to the HC dietary treatment. The last diet, HC+O+AA, was the high oil corn, plus oil and amino acids. This diet was formulated to look at the ability of the young pig to utilize the excess fat, and the amino acids, which were added to balance the lysine to calorie ratio. The diets contained chromic oxide, which was used as an indigestable marker.

The HOC was analyzed for crude protein (CP), oil, and starch after harvest by using near infrared spectrophotometry. The HOC analysis was: CP – 9.4%; Oil – 8.2%; and Starch – 54.7%. The Swine NRC (1988) values were used for the number 2 yellow corn for ration balancing.

Two hundred pigs were weaned at 28 days of age with an initial body weight of 19 lb. The pigs were blocked by sex and initial body weight and were randomly assigned to the five dietary treatments. The pigs were housed eight pigs per pen and there were five pens per diet. A diet complexity change was made on day 14. Pigs and feeders were weighed on days 7, 14, and 25 to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (G:F). Three pigs per pen were bled on days 14 and 25 to determine serum urea nitrogen (SUN) concentration. Fecal samples were

collected on days 13 and 25, from three pigs per pen. The fecal samples were dried and pooled on an equal dry weight basis within pen and were used to determine the apparent digestibility for dry matter (DM), nitrogen (N), and gross energy (GE).

Results and Discussion

There were no differences between dietary treatments in ADG or in body weight at any time during this trial (Table 3). Pigs fed the HC+O+AA had a greater ADFI than pigs fed NC+O+AA during days 0 to 14 and days 0 to 25 ($P<.04$ and $P<.08$, respectively). No differences were seen during the day 14 to 25 time period for this trial. During days 0 to 14 and days 0 to 25, the HOC dietary treatments, HC and HC+O+AA, tended to have greater ADFI compared to the normal corn treatments, NC and NC+O+AA ($P<.09$ and $P<.16$, respectively). The increased feed intake could have been due to the high oil corn diets having a greater palatability. This higher feed intake also resulted in reduced G:F during days 0 to 14, where pigs consuming normal corn diets (NC and NC+O+AA) were more efficient than pigs consuming HOC (HC and HC+O+AA) diets ($P<.03$ and $P<.06$, respectively).

Pigs fed the NC+O+AA had a greater day 14 SUN concentration than those fed the HC+O+AA diet ($P<.01$). Normal corn diets, NC and NC+O+AA, had a greater day 14 SUN concentration than HOC diets, HC and HC+O+AA ($P<.05$). High oil corn (HC and HC+O+AA) had a greater SUN concentration on day 25 than the normal corn diets of NC and NC+O+AA ($P<.01$ and $P<.03$, respectively). The SUN data would indicate that HOC is better utilized by the nursery pig when there are synthetic amino acids added to the diet to balance the lysine to calorie ratio. The nutrient availability of high oil corn and normal corn diets appeared to be equivalent, as shown in Table 4.

Application

Based on these results, high oil corn is a viable alternative cereal grain for nursery pig diets. High oil corn can be used as an alternative source of fat to decrease the amount supplemented in normal corn diets without a decrease in nutrient availability. The producer needs to evaluate the economics of high oil corn before using it as alternative cereal grain. The producer should analyze the increase in price to raise or purchase high oil corn, versus the cost of on-farm fat storage and the mixing needs of the supplemental fat added to normal corn diets.

Table 1. Phase 1 nursery pig diets, days 0 to 14 post-weaning.

	Dietary Treatment[a]				
Ingredients, %	NC	NC+O	NC+O+AA	HC	HC+O+AA
Corn	55.63	52.72	52.655	--	--
High Oil Corn	--	--	--	55.63	52.655
Soybean Meal, 48% CP	26.88	27.12	27.12	26.88	27.12
Dicalcium phosphate	1.55	1.58	1.58	1.55	1.58
Limestone	0.34	.32	.32	0.34	.32
Salt	0.25	0.25	0.25	0.25	0.25
Soybean oil	--	2.66	2.66	--	2.66
L-Lysine-HCl	0.15	.15	.20	0.15	.20
DL-Methionine	0.05	0.05	0.065	0.05	0.065
Vitamin premix[b]	0.25	0.25	0.25	0.25	0.25
Trace mineral premix[c]	0.125	0.125	0.125	0.125	0.125
Selenium 600 premix	0.05	0.05	0.05	0.05	0.05
Dried whey	10.00	10.00	10.00	10.00	10.00
Select menhaden fish meal	4.00	4.00	4.00	4.00	4.00
Zinc Oxide (72%)	0.375	0.375	0.375	0.375	0.375
Carbadox (10 g/lb)	0.25	0.25	0.25	0.25	0.25
Chromic oxide	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Crude Protein, %	21.17	21.02	21.03	21.56	21.40
Lysine	1.35	1.35	1.39	1.38	1.41
Crude Fat	2.9	5.4	5.4	5.3	7.7

[a] Dietary Treatments:
NC = normal corn;
NC+O = normal corn with added oil;
NC+O+AA = normal corn with added oil and synthetic amino acids;
HC = high oil corn on lb:lb substitution for NC diet;
HC+O+AA = high oil corn with added oil and synthetic amino acids.

[b] Provides per lb of diet: 2750 IU Vitamin A, 275 IU D3, 20 IU Vitamin E, .91 mg Menadione, .016 mg B12, 3.2 mg Riboflavin, 10 mg Pantothentic Acid, 15 mg Niacin.

[c] Provides per lb of diet: 121 ppm Zn, 121 ppm Fe, 15 ppm Manganese, 11.3 ppm Cu, .42 ppm I.

Table 2. Phase 2 nursery pig diets, days 14 to 25 post-weaning.

	Dietary Treatment[a]				
Ingredients, %	NC	NC+O	NC+O+AA	HC	HC+O+AA
Corn	68.88	65.19	65.11	--	--
High Oil Corn	--	--	--	68.88	65.11
Soybean Meal, 48% CP	26.90	27.26	27.26	26.90	27.26
Dicalcium Phosphate	2.12	2.17	2.17	2.12	2.17
Limestone	0.65	.63	.63	0.65	.63
Salt	0.35	0.35	0.35	0.35	0.35
Soybean oil	--	3.30	3.30	--	3.30
L-Lysine-HCl	0.15	.15	.20	0.15	.20
DL-Methionine	--	--	0.03	--	0.03
Vitamin premix[b]	0.25	0.25	0.25	0.25	0.25
Trace mineral premix[c]	0.125	0.125	0.125	0.125	0.125
Selenium 600 premix	0.05	0.05	0.05	0.05	0.05
Copper Sulfate	0.075	0.075	0.075	0.075	0.075
Carbadox (10 g/lb)	0.25	0.25	0.25	0.25	0.25
Chromic oxide	0.10	0.10	0.10	0.10	0.10
Banmith (48 g/lb)	0.10	0.10	0.10	0.10	0.10
Total	100	100	100	100	100
Crude Protein, %	18.50	18.35	18.37	19.00	18.83
Lysine	1.10	1.10	1.14	1.13	1.18
Crude Fat	2.9	6.1	6.1	5.9	8.9

[a] Dietary Treatments:
NC = normal corn;
NC+O = normal corn with added oil;
NC+O+AA = normal corn with added oil and synthetic amino acids;
HC = high oil corn on lb:lb substitution for NC diet;
HC+O+AA = high oil corn with added oil and synthetic amino acids.

[b] Provides per lb of diet: 2750 IU Vitamin A, 275 IU D3, 20 IU Vitamin E, .91 mg Menadione, .016 mg B12, 3.2 mg Riboflavin, 10 mg Pantothentic Acid, 15 mg Niacin.

[c] Provides per lb of diet: 121 ppm Zn, 121 ppm Fe, 15 ppm Manganese, 11.3 ppm Cu, .42 ppm I.

Table 3. Growth performance.

	Dietary Treatment[a]						Contrast[b]				
	NC	NC+O	NC+O +AA	HC	HC+O +AA	SE	A	B	C	D	E
BW, lb											
d 0	19.28	19.33	19.19	19.21	19.14	.108	-	-	-	-	-
d 14	28.53	28.78	28.25	27.72	29.10	.631	-	-	-	-	-
d 25	42.01	43.18	41.46	41.37	42.78	.834	-	-	-	-	-
ADG, lb											
d 0-14	.661	.675	.647	.607	.711	.041	-	-	-	-	-
d 14-25	1.23	1.31	1.20	1.24	1.24	.052	-	-	-	-	-
d 0-25	.910	.954	.891	.886	.946	.032	-	-	-	-	-
ADFI, lb											
d 0-14	.805	.857	.753	.825	.898	.046	-	-	-	.04	.09
d 14-25	1.55	1.71	1.55	1.56	1.65	.069	-	-	-	-	-
d 0-25	1.13	1.23	1.11	1.15	1.23	.047	-	-	-	.08	.16
G:F											
d 0-14	.818	.786	.866	.737	.797	.038	-	-	.03	-	.06
d 14-25	.790	.781	.790	.818	.768	.038	-	-	-	-	-
d0-25	.801	.781	.816	.782	.775	.025	-	-	-	-	-
SUN, mg/dL											
d 0-14	15.62	15.11	17.44	16.41	12.53	.948	-	-	-	.01	.05
d 14-25	16.07	17.41	16.43	18.75	15.55	.666	.01	.17	.03	-	-

[a] Dietary Treatments:
NC = normal corn;
NC+O = normal corn with added oil;
NC+O+AA = normal corn with added oil and synthetic amino acids;
HC = high oil corn on lb:lb substitution for NC diet;
HC+O+AA = high oil corn with added oil and amino acids.

[b] Contrasts:
A = NC vs. HC;
B = HC vs. NC+O;
C = HC vs. NC+O+AA;
D = NC+O+AA vs. HC+O+AA;
E = NC,NC+O+AA vs. HC,HC+O+AA.

Table 4. Digestibility.

	Dietary Treatment[a]					
	NC	NC+O	NC+O+AA	HC	HC+O+AA	SE
Phase 1[b]						
DM	72.69	74.92	73.46	73.16	77.04	2.53
N	67.30	73.03	72.18	70.60	77.24	3.69
GE	69.15	72.70	70.72	70.78	74.10	3.10
Phase 2[b]						
DM	81.55	78.45	82.41	80.25	78.77	2.02
N	78.23	73.81	79.88	77.49	75.98	2.53
GE	80.95	77.31	81.66	79.53	77.32	2.26

[a] Dietary Treatments:
NC = normal corn;
NC+O = normal corn with added oil;
NC+O+AA = normal corn with added oil and synthetic amino acids;
HC = high oil corn on lb:lb substitution for NC diet;
HC+O+AA = high oil corn with added oil and amino acids.

[b] Phase 1 and 2: There were no differences in nutrient availability between the dietary treatments.