Effects of Extrusion Processing on the Nutritional Value of Dried Distillers Grains with Solubles in Diets for Nursery Pigs

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Summary

A total of 224 pigs (PIC TR4 × 1050, initially 18.7 lb avg BW) were used in a 21-d experiment to determine the effects of extrusion processing on the nutritional value of dried distillers grains with solubles (DDGS) in diets for nursery pigs. The pigs were weaned at 21 d of age, sorted by sex and ancestry, and blocked by BW. All pigs were fed a common diet for 11 d postweaning and the experimental treatments for the next 21 d. Treatments were a corn-soybean meal-based control and 3 diets formulated with 30% DDGS. The 3 DDGS treatments were either (1) not treated, (2) dry-extruded with the barrel configured for processing cereal grain (to generate less shear and temperature rise), or (3) dry-extruded with the barrel configured for processing soybeans (to generate more shear and temperature rise). Overall, ADG and ADFI both improved ($P < 0.02$) while F/G became poorer ($P < 0.05$) for pigs fed the corn-soy control compared to those fed the DDGS treatments. Extruding the DDGS did not affect ADG or F/G ($P > 0.11$) but did reduce ADFI ($P < 0.02$). There were no differences in growth performance among pigs fed the DDGS extruded with low vs. high shear ($P > 0.20$). Pigs fed the corn-soy control diet had greater digestibility of DM, N, and GE ($P < 0.02$) compared to pigs fed the diets with DDGS. Among the DDGS treatments, extrusion improved digestibility of DM and GE ($P < 0.04$), but digestibility of N was only improved with high-shear conditions ($P < 0.05$).

Key words: DDGS, dried distillers grains with solubles, feed processing, extrusion

Introduction

Because of high corn prices, the inclusion of dried distillers grains with solubles (DDGS) in swine diets has become a common practice. However, negative effects on performance have sometimes been reported with high dietary inclusion (> 30%) of DDGS. Previous research conducted at Kansas State University (K-State) suggested that thermal processing (expanding) diets containing high levels of DDGS improved both efficiency of growth and nutrient digestibility in nursery and finishing pigs. Because of the improved nutrient utilization with these thermally processed diets, we designed an experiment to investigate the effect of an even more extreme technology, extrusion, on growth performance and nutrient digestibility in nursery pigs fed diets with high inclusion of DDGS.

Procedures

The K-State Institutional Animal Care and Use Committee approved the protocol used in this experiment. The experiment was completed at the K-State Swine Teaching and Research Center.

A total of 224 pigs (PIC TR4 × 1050, initially 18.7 lb average initial body weight) were used in a 21-d growth assay. The pigs were weaned at 21 d of age, sorted by sex and ancestry, blocked by weight, and assigned to pens. The pigs were fed a common commercial starter diet for the first 11 d after weaning and the experimental treatments for the next 21 d. Each pen had a self-feeder and nipple water to allow ad libitum consumption of feed and water.

Treatments (Table 1) were a corn-soybean meal-based control and 3 diets formulated with 30% DDGS. The DDGS treatments were either no additional processing, dry-extruding with the barrel configured for processing cereal grain (to generate less shear and temperature rise), or dry-extruding with the barrel configured for processing soybeans (to generate more shear and temperature rise). To create the low-shear conditions, an Insta-pro 2000 dry extruder (Des Moines, IA) was fitted with a #6 steam lock, single flight screw, #6 steam lock, single flight screw, 11-R steam lock, and 15.9 mm cone opening sequence. For the high-shear conditions an 11-R steam lock, single flight screw, a blank spacer, single flight screw, 11-R steam lock, and 15.9 mm cone opening were used. Extruder barrel temperatures were collected by probes located 20 cm from the end of the extruder. The low-shear DDGS had a final temperature of 228°F and a production rate of 1,320 lbs/h while the high-shear DDGS had a final temperature of 234°F and a production rate of 1,320 lbs/h.

Pigs and feeders were weighed at d 11 and 32 postweaning to allow calculation of ADG, ADFI, and F/G. Feces were collected on d 32 postweaning from no less than 4 randomly selected pigs per pen. The fecal samples were combined within pen and stored frozen at 5°F until dried at 122°F. Feed and feces were analyzed for concentrations of DM, N, and GE. Chromium concentrations in the feed and feces were determined to allow calculation of apparent digestibility using the indirect ratio method.

Data were analyzed as a randomized complete block design using the MIXED procedure of SAS (SAS Institute, Inc., Cary NC). Orthogonal contrasts were used to separate treatment means with comparisons of: 1) the control diet vs DDGS treatments; 2) untreated vs extruded DDGS; and 3) low-shear vs high-shear extrusion.

Results and Discussion

With extrusion processing (Table 2), CP, GE, and ether extract (EE) increased as the degree of processing was increased. However, when calculated on a DM basis, only CP and EE were increased. Both NDF and ADF were decreased with extrusion processing, and extruding DDGS with high-shear conditions led to a greater reduction in NDF and ADF compared to the low-shear settings.

Overall, ADG and ADFI (Table 3) were greater for pigs fed the corn-soy control diet compared to the DDGS treatments ($P < 0.02$). However, F/G was improved when DDGS was added to the diet ($P < 0.05$). Extruding the DDGS had no effect on ADG ($P > 0.11$) or F/G ($P > 0.60$) while ADFI for pigs fed the extruded diets was less ($P < 0.02$) than for pigs fed the untreated DDGS.

Pigs fed the corn-soy control diet had greater ($P < 0.02$) digestibility of DM, N, and GE compared to pigs fed the diets with DDGS. Both DM and GE digestibility were

improved ($P < 0.04$) by extrusion of the DDGS but N digestibility was improved ($P < 0.05$) only with the high-shear conditions.

Our results indicate that feeding nursery pigs diets with 30% DDGS decreased ADG and ADFI but improved F/G. Digestibility results showed that extruding DDGS can improve DM, N, and GE digestibility, but extrusion did not ameliorate the loss in growth performance.

Table 1. Composition of diets

Ingredient, %	Corn-soy control	30% DDGS
Corn	47.30	27.30
Corn DDGS[1]	—	30.00
Soybean meal (47.5% CP)	31.35	21.65
Spray dried whey	15.00	15.00
Menhaden fish meal	3.00	3.00
Monocalcium P (21% P)	0.72	0.21
Limestone	0.80	0.99
L-lysine HCl	0.26	0.46
DL- methionine	0.13	0.03
L-threonine	0.09	0.04
Salt	0.30	0.30
Vitamin premix	0.09	0.09
Mineral premix	0.07	0.03
Zinc oxide	0.19	0.20
Antibiotic[2]	0.70	0.70
Total	100.00	100.00
Calculated analysis, %		
Crude protein	22.9	25.0
SID lysine[3]	1.40	1.40
Ca	0.80	0.80
Total P	0.70	0.70

[1] Dried distillers grains with solubles.
[2] To provide 154 g/ton oxytetracycline and 154 g/ton neomycin.
[3] Standardized ileal digestible.

Table 2. Chemical characteristics of dried distillers grains with solubles (DDGS)

Treatment	DM, %	CP, %	GE, Mcal/lb	Ether extract, %	NDF, %	ADF, %
As-fed basis						
DDGS	87.1	24.3	2.18	9.0	26.5	11.1
Low-shear DDGS	91.8	28.2	2.27	11.5	25.1	10.3
High-shear DDGS	91.8	27.5	2.27	10.4	23.7	8.1
Dry matter basis						
DDGS		27.9	2.49	10.3	30.4	12.7
Low-shear DDGS		30.7	2.45	12.5	27.3	11.2
High-shear DDGS		30.0	2.45	11.3	25.8	8.8

Table 3. Effects of extrusion processing on the nutritional value of dried distillers grains with solubles (DDGS) in diets for nursery pigs[1]

	Treatments					*P* value		
Item	Corn-soy control	DDGS	DDGS low-shear	DDGS high-shear	SE	Control vs DDGS	Treated vs untreated DDGS	Low- vs high- shear
ADG, lb	1.16	1.12	1.04	1.09	.04	0.02	0.11	—[2]
ADFI, lb	1.73	1.63	1.50	1.56	.07	0.001	0.02	—
F/G	1.49	1.46	1.44	1.43	.02	0.05	—	—
Apparent digestibility, %[3]								
DM	78.6	72.8	74.2	75.2	0.8	0.001	0.04	—
N	75.6	72.2	71.9	74.3	1.0	0.02	—	0.05
GE	77.9	71.9	73.9	75.1	0.9	0.001	0.02	—

[1] A total of 224 pigs (avg. initial BW of 18.7 lb) with 7 pigs per pen and 8 pens per treatment.
[2] Dashes indicate P > 0.15.
[3] Fecal samples for digestibility determinations were collected on d 32 postweaning, with chromic oxide used as an indigestible marker.