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Effects of adding enzymes to diets with corn-and sorghum-based

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EFFECTS OF ADDING ENZYMES TO DIETS WITH CORN- AND SORGHUM-BASED DRIED DISTILLERS GRAINS WITH SOLUBLES ON GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY IN NURSERY AND FINISHING PIGS

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Summary

Two experiments were conducted to determine the effects of added enzymes on the nutritional value of diets with corn- and sorghum-based dried distillers grains with solubles (DDGS). For Exp. 1, 180 weanling pigs (initially 16.6 lb) were fed the same starter diet for 10 d and then used in a 27-d growth assay. There were 6 pigs per pen and 6 pens per treatment. Treatments were a corn-soybean meal-based control and diets with 30% corn-based (Hudson, SD) and sorghum-based (Russell, KS) DDGS with and without enzymes (a cocktail of ß-glucanase, protease, α-amylase, and xylanase to supply 331, 1,102, 2,205, and 8,818 units of activity, respectively, per pound of diet). Pigs fed the control diet had greater ($P < 0.003$) ADG, ADFI, and digestibility of DM, N, and GE than pigs fed the DDGS treatments; sorghum-based DDGS supported worse ($P < 0.04$) F/G and digestibilities of N and GE than corn-based DDGS. Addition of enzymes tended to improve F/G ($P < 0.09$) and did improve digestibility of DM ($P < 0.04$) for pigs fed diets with 30% DDGS, and this response was similar regardless of DDGS source. For Exp. 2, 330 finishing pigs (initially 141 lb) were used in a 65-d growth assay. There were 11 pigs per pen and 6 pens per treatment. Treatments were the same as in Exp. 1, but 40% DDGS was used in diets for the finishing experiment. Pigs fed the control diet had greater ADG, ADFI, and digestibility of DM, N, and GE and lower iodine value than pigs fed the DDGS treatments ($P < 0.008$). Pigs fed the corn-based DDGS treatments had better F/G and digestibility of DM, N, and GE but greater iodine value of jowl fat than pigs fed the sorghum-based DDGS treatments ($P < 0.04$). Enzymes improved digestibility of DM, N, and GE ($P < 0.01$), especially for diets with sorghum-based DDGS (DDGS source × enzyme interaction, $P < 0.10$). In conclusion, growth performance and nutrient digestibility were decreased with addition of DDGS to diets for nursery and finishing pigs, but adding enzymes partially restored the losses in nutrient digestibility.

Key words: digestibility, dried distillers grains with solubles, enzyme supplementation

Introduction

Price and availability make using ethanol industry coproducts in diets for pigs a very attractive option. However, previous studies from this laboratory indicated that inclusion of high levels of dried distillers grains with solubles (DDGS) in diets for nursery and finishing pigs had negative effects on growth performance and nutrient digestibility. Dried distillers grains with solubles have approximately 16% cellulose, 8% xylans, and 5% arabinans and are known to reduce digestibility of

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nutrients. We have reported that enzymes can improve nutrient digestibility in wheat-based diets when their specific substrates are present. Thus, it seems likely that adding enzymes to DDGS-based diets might improve nutrient utilization. Therefore, the objective of these experiments was to determine the effects of enzyme additions on the nutritional value of diets with corn- and sorghum-based DDGS in nursery and finishing pigs.

Procedures

For Exp. 1, 180 weanling pigs (initially 16.6 lb) were fed the same starter diet for 10 d and then used in a 27-d growth assay. The pigs were sorted by sex and ancestry, blocked by weight, and assigned to pens. There were 6 pigs per pen and 6 pens per treatment. The pigs were housed in an environmentally controlled nursery room having 4-ft × 4-ft pens with woven-wire flooring. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water. The diets (Table 1) were offered to the pigs in meal form.

Treatments were arranged as a 2 × 2 factorial plus control with main effects of DDGS source (corn-based DDGS from Sioux River Ethanol, Hudson, SD, and sorghum-based DDGS from U.S. Energy Partners, Russell, KS) and enzyme addition (with and without 331, 1,102, 2,205, and 8,818 units of β-glucanase, protease, α-amylase, and xylanase per pound of diet).

Pigs and feeders were weighed on d 0, 10, and 27 to allow calculation of ADG, ADFI, and F/G. Feces were collected on d 15 and 16 from no less than 3 pigs per pen, and DM, N, GE, and Cr were determined to allow calculation of apparent nutrient digestibility.

Data were analyzed as a randomized complete block design by using the MIXED procedure of SAS with initial weight as the blocking criterion and pen as the experimental unit. Orthogonal contrasts were used to separate treatment means with comparisons of (1) control vs. DDGS treatments, (2) effect of DDGS source, (3) effect of enzyme addition, and (4) interaction among DDGS source and enzyme addition.

For Exp. 2, a total of 330 finishing pigs (initially 141 lb) were used in a 65-d growth assay. The pigs were sorted by sex and ancestry, blocked by weight, and assigned to pens. There were 11 pigs per pen and 5 pens per treatment. The pigs were housed in an environmentally controlled finishing facility having 6-ft × 16-ft pens with half solid and half slatted concrete flooring. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water. Treatments were arranged as a 2 × 2 factorial plus control as in Exp. 1, but 40% DDGS was used in diets for the finishing experiment (Table 2).

Pigs and feeders were weighed on d 0, 35, and 65 to allow calculation of ADG, ADFI, and F/G. Feces were collected mid-experiment from no less than 6 pigs per pen, and DM, N, GE, and Cr were determined to allow calculation of apparent nutrient digestibility. Half of the pigs were slaughtered (average BW of 270 lb) to allow collection of carcass data and samples of jowl fat. Fatty acid profile of jowl fat was determined and iodine value was calculated following AOCS (1998) procedures.

Growth performance, nutrient digestibility, and carcass data were analyzed as a randomized complete block design by using the MIXED procedure of SAS with initial weight as the blocking criterion and pen as the experimental unit. Orthogonal contrasts were used to separate treatment means with comparisons of (1) control vs. DDGS treatments, (2) effect of DDGS source, (3) effect of enzyme addition, and (4) interaction among DDGS source and enzyme addition.

Results and Discussion

In the nursery experiment (Table 3), pigs fed the control diet had greater overall ADG, ADFI, and digestibility of DM, N, and GE than pigs fed the DDGS treatments ($P < 0.003$). Pigs fed diets with corn-based DDGS had greater ($P < 0.04$) digestibility of N and GE than pigs fed diets with sorghum-based DDGS. Addition of enzymes improved ADG for pigs fed corn-based DDGS but decreased ADG for pigs fed sorghum-based DDGS (DDGS source × enzyme interaction, $P < 0.04$). Additionally, enzyme addition tended to improve ($P < 0.09$) F/G and did improve ($P < 0.04$) digestibility of DM regardless of DDGS source.

In the finishing experiment (Table 4), pigs fed the control diet had greater ($P < 0.008$) overall ADG and ADFI and digestibility of DM, N, and GE than pigs fed the DDGS diets. Furthermore, pigs fed the corn-based DDGS treatments had better ($P < 0.04$) overall F/G and digestibility of DM, N, and GE than pigs fed the sorghum-based DDGS treatments. Enzymes had no effect on growth performance ($P > 0.14$) but improved ($P < 0.01$) digestibility of DM, N, and GE, especially for diets with sorghum-based DDGS (DDGS source × enzyme interaction, $P < 0.10$). As for carcass data, the effects of DDGS on ADG were reflected in the lower ($P < 0.002$) HCW for pigs fed diets with DDGS. Percentage carcass lean, backfat thickness, and loin depth were not affected ($P > 0.11$) by treatment, but addition of 40% DDGS increased ($P < 0.001$) iodine value of jowl fat. Diets with corn-based DDGS resulted in greater ($P < 0.001$) iodine value of jowl fat than diets with sorghum-based DDGS.

In conclusion, rate of gain and nutrient digestibility were decreased with addition of DDGS to diets for nursery and finishing pigs, and adding enzymes partially restored those losses in nutrient digestibility.

Table 1. Composition of nursery diets

	d 0 to 10		d 10 to 27	
Ingredient, %	Control	DDGS[1]	Control	DDGS
Corn	47.60	27.58	62.86	42.97
DDGS	---	30.00	---	30.00
Soybean meal (47.5% CP)	28.70	19.00	32.60	22.85
Whey	15.00	15.00	---	---
Fish meal	3.00	3.00	---	---
Spray-dried plasma	2.50	2.50	---	---
Limestone	0.87	1.06	1.11	1.36
Monocalcium phosphate (21% P)	0.62	0.11	1.30	0.67
Salt	0.30	0.30	0.36	0.35
L-lysine HCl	0.21	0.41	0.32	0.53
DL-methionine	0.13	0.03	0.12	0.02
L-threonine	0.02	-	0.09	0.05
Vitamin premix	0.08	0.08	0.11	0.11
Mineral premix	0.07	0.03	0.08	0.05
Antibiotic[2]	0.70	0.70	0.70	0.70
Chromic oxide[3]	---	---	0.25	0.25
Zinc oxide	0.20	0.20	---	---
Copper sulfate	---	---	0.10	0.09
Calculated analysis, %				
Lysine	1.60	1.60	1.40	1.40
Ca	0.80	0.80	0.75	0.75
Total P	0.70	0.70	0.65	0.65

[1] Dried distillers grains with solubles.
[2] To supply 140 g/ton oxytetracycline and 140 g/ton neomycin.
[3] Used as an indigestible marker.

Table 2. Composition of finishing diets

	d 0 to 35		d 35 to 65	
Ingredient, %	Control	DDGS [1]	Control	DDGS
Corn	79.72	52.75	81.56	54.67
DDGS	---	40.00	---	40.00
Soybean meal (47.5% CP)	17.80	4.95	16.20	3.25
Limestone	1.09	1.34	1.06	1.24
Monocalcium phosphate (21% P)	0.73	0.05	0.54	---
Salt	0.30	0.30	0.38	0.30
L-lysine HCl	0.20	0.47	0.13	0.40
L-threonine	0.03	---	---	---
Vitamin premix	0.04	0.04	0.04	0.04
Mineral premix	0.04	0.05	0.04	0.05
Antibiotic [2]	0.05	0.05	0.05	0.05
Calculated analysis, %				
Lysine	0.90	0.90	0.80	0.80
Ca	0.60	0.60	0.55	0.55
Total P	0.50	0.50	0.45	0.45

[1] Dried distillers grains with solubles.
[2] To provide 40 g/ton tylosin.

Table 3. Effects of adding enzymes to diets with corn- and sorghum-based dried distillers grains with solubles (DDGS) on growth performance and nutrient digestibility in nursery pigs[1]

		Corn-DDGS		Sorghum-DDGS			*P* value			
Item	Control	no enzyme	with enzyme	no enzyme	with enzyme	SE	Cont. vs. DDGS	DDGS source effect	Enzyme effect	DDGS × Enzyme
d 0 to 10										
ADG, lb	1.10	0.94	0.99	1.09	1.02	0.05	0.003	0.002	---[2]	0.02
ADFI, lb	1.34	1.15	1.16	1.32	1.23	0.06	0.001	0.001	---	0.07
F/G	1.22	1.22	1.17	1.21	1.21	0.01	---	---	---	0.08
d 0 to 27										
ADG, lb	1.27	1.16	1.19	1.20	1.15	0.04	0.001	---	---	0.04
ADFI, lb	1.82	1.64	1.65	1.80	1.70	0.06	0.001	0.001	0.15	0.08
F/G	1.43	1.41	1.39	1.50	1.48	0.01	---	0.001	0.09	---
Digestibility of DM, %[3]	80.4	75.0	76.7	75.6	76.3	0.5	0.001	---	0.04	---
Digestibility of N, %	75.9	75.5	76.4	68.5	68.2	1.0	0.003	0.001	---	---
Digestibility of GE, %	78.4	73.6	75.0	72.6	72.9	0.7	0.001	0.04	---	---

[1]A total of 180 nursery pigs (31 d old, initially 16.6 lb) with 6 pigs per pen and 6 pens per treatment.
[2]Dashes indicate $P > 0.15$.
[3]Fecal samples were collected on d 15 and 16 with chromic oxide used as an indigestible marker.

Table 4. Effects of adding enzymes to diets with corn- and sorghum-based dried distillers grains with solubles (DDGS) on growth performance, nutrient digestibility, and carcass characteristics in finishing pigs[1]

		Corn-DDGS		Sorghum-DDGS			*P* value			
Item	Control	no enzyme	with enzyme	no enzyme	with enzyme	SE	Cont. vs DDGS	DDGS source effect	Enzyme effect	DDGS × Enzyme
d 0 to 35										
ADG, lb	2.23	1.89	1.92	1.97	2.00	0.08	0.001	0.06	---[2]	---
ADFI, lb	6.50	5.58	5.60	5.98	6.13	0.19	0.001	0.001	---	---
F/G	2.91	2.95	2.92	3.04	3.07	0.09	0.12	0.02	---	---
d 0 to 65										
ADG, lb	2.14	1.91	1.90	1.96	1.96	0.07	0.001	0.13	---	---
ADFI, lb	6.71	6.00	6.12	6.43	6.55	0.25	0.008	0.004	---	---
F/G	3.14	3.14	3.22	3.28	3.34	0.07	0.08	0.02	0.15	---
Digestibility of DM, %[3]	84.5	77.5	79.1	73.0	78.5	1.1	0.001	0.04	0.004	0.10
Digestibility of N, %	78.0	76.1	77.5	62.3	70.0	1.3	0.001	0.001	0.002	0.02
Digestibility of GE, %	82.9	76.7	77.9	70.3	75.6	1.1	0.001	0.001	0.01	0.09
HCW, lb	200.0	189.0	184.0	187.5	188.1	6.8	0.002	---	---	---
Dress, %[4]	73.0	72.7	72.7	72.1	72.3	0.2	0.11	0.06	---	---
Carcass lean, %[4]	54.2	53.9	54.0	54.3	54.2	0.6	---	---	---	---
Backfat thickness, in.[4]	0.65	0.64	0.64	0.62	0.60	0.05	---	---	---	---
Loin depth, in.[4]	2.34	2.25	2.25	2.29	2.24	0.04	0.12	---	---	---
Iodine value[4,5]	70.3	80.4	80.1	74.6	74.3	0.7	0.001	0.001	---	---

[1] A total of 330 finishing pigs (initially 141 lb) with 11 pigs per pen and 6 pens per treatment.
[2] Dashes indicate $P > 0.15$.
[3] Fecal samples were collected mid-experiment with chromic oxide used as an indigestible marker.
[4] HCW used as a covariate.
[5] As calculated from fatty acid profile of jowls.