EFFECTS OF COMMERCIAL ENZYMES IN DIETS CONTAINING DRIED DISTILLERS GRAINS WITH SOLUBLES FOR NURSERY PIGS[1]

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Summary

Two experiments utilizing a total of 530 pigs were conducted to evaluate the effects of commercial enzymes in diets containing dried distillers grains with solubles (DDGS) on nursery pig growth performance. In Exp. 1, 180 pigs (initially 19.9 lb) were used in a 27-d growth trial to compare the effects of Easyzyme, Hemicell-W, and Porzyme in diets containing 30% DDGS on weanling pig performance. The 5 dietary treatments fed were a positive control (corn-soybean meal-based diet), negative control (diet with 30% corn DDGS), and the negative control diet with either 0.05% Easyzyme, 0.05% Hemicell-W, or 0.05% Porzyme added. Overall (d 0 to 27), pigs fed the diet containing Easyzyme had lower ($P < 0.05$) ADG than pigs fed the positive control diet. Pigs fed diets containing Hemicell-W had lower ($P < 0.05$) ADG than pigs fed the control diet with or without 30% DDGS or the diet containing Porzyme. Pigs fed the diet containing Porzyme had ADG similar ($P > 0.10$) to that of pigs fed the control diets with or without 30% DDGS. There were no differences ($P > 0.10$) in ADFI or F/G.

In Exp. 2, 350 pigs (initially 24.3 lb) were used to evaluate the effects of a commercial enzyme in diets containing a variety of levels and sources of DDGS on nursery pig performance. The 10 experimental treatments were (1) corn-soybean meal positive control, (2) 15% corn DDGS, (3) 30% corn DDGS, (4) 30% corn DDGS + 0.05% Easyzyme, (5) 15% milo DDGS from source 1, (6) 30% milo DDGS from source 1, (7) 30% milo DDGS from source 1 + 0.05% Easyzyme, (8) 15% milo DDGS from source 2, (9) 30% milo DDGS from source 2, and (10) 30% milo DDGS from source 2 + 0.05% Easyzyme. Overall (d 0 to 21), there was no ($P > 0.10$) enzyme × DDGS source interaction for any of the measured growth variables. Pigs fed diets with increasing corn DDGS had ADG, ADFI, and F/G similar ($P > 0.10$) to those of pigs fed the control diet. Pigs fed diets with increasing milo DDGS had poorer (linear, $P = 0.002$) F/G than pigs fed the control diet. Also, pigs fed diets containing milo DDGS had poorer ($P = 0.04$) F/G than pigs fed diets containing corn DDGS. However, pigs fed different sources of milo DDGS had similar ($P > 0.10$) ADG, ADFI, and F/G. Adding 0.05% Easyzyme to the diets containing 30% DDGS did not influence ($P > 0.10$) ADG, ADFI, or F/G.

[1] Appreciation is expressed to ADM, Decatur, IL; Danisco, New Century, MO; and Form-A-Feed, Inc., Stewart, MN, for providing the enzymes and Chief Ethanol Fuels, Inc., Hastings, NE; Kansas Ethanol, Lyons, KS; and U.S. Energy Partners, Russell, KS, for providing the various sources of DDGS.

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In summary, feeding diets with milo DDGS resulted in poorer F/G with no change in ADG compared with feeding the control diet or diets containing corn DDGS. Adding enzymes to corn-soybean meal-based diets containing high levels of DDGS did not improve any of the growth performance variables.

Key words: distillers, enzyme, growth, nursery pig

Introduction

Rising feed ingredient costs have prompted the swine industry to utilize products that improve feed efficiency. Enzymes have been used extensively in Europe, where feedstuffs with high fiber concentrations are the primary source of carbohydrates in swine diets. Enzymes are used to improve feed utilization and decrease the cost of gain. Because corn is highly digestible and has a low fiber content, enzymes have not consistently shown economic improvements in growth performance when used in corn-based diets.

Recently, high ingredient costs have led to increasing use of coproduct ingredients in swine diets. Dried distillers grains with solubles (DDGS) are one such coproduct that is widely used. Because the starch fraction is removed, DDGS have a greater fiber fraction than corn. Therefore, enzymes may be more beneficial in diets containing DDGS than in corn-soybean meal-based diets. The objective of these experiments was to evaluate the effects of different commercial enzymes in diets containing a variety of sources of DDGS on weanling pig growth performance.

Procedures

All experimental procedures were approved by the Kansas State University (KSU) Institutional Animal Care and Use Committee.

Experiment 1. A total of 180 pigs (initially 19.9 lb) were used in a 27-d growth trial to evaluate the effects of 3 different commercial enzymes in diets containing corn DDGS on weanling pig performance. Pigs were blocked by weight and allotted to 1 of 5 dietary treatments. There were 6 pigs per pen and 6 pens per treatment. Each pen contained 1 self-feeder and 1 nipple waterer to provide ad libitum access to feed and water. Pigs were housed in the KSU Swine Teaching and Research Center.

A common pelleted starter diet was fed from weaning until the start of the experiment. The 5 dietary treatments fed were (1) positive control (corn-soybean meal diet), (2) negative control (corn-soybean meal diet with 30% corn DDGS; Chief Ethanol Fuels, Hastings, NE), and the negative control diet with either (3) 0.05% Easyzyme (Archer Daniels Midland Company, Decatur, IL), (4) 0.05% Hemicell-W (Form-A-Feed, Inc., Stewart, MN), or (5) 0.05% Porzyme (Danisco, New Century, MO) added (Table 1). Inclusion levels were based on manufacturers' recommendations and guaranteed analysis (Table 2). Treatment diets were fed for 27 d and were in meal form. Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 7, 14, and 27 of the trial.

Data were analyzed as a randomized complete block design with pen as the experimental unit. Pigs were blocked on the basis of weight at the beginning of the trial, and analysis of variance was performed by using the MIXED procedure of SAS. Contrasts were used to determine the effects of enzyme source compared with the control.

Experiment 2. A total of 350 pigs (initially 24.3 lb) were used in a 21-d growth trial to evaluate the effects of a commercial enzyme in diets containing corn or milo DDGS on nursery pig performance. Pigs were blocked by weight and allotted to 1 of 10 dietary treatments. There were 5 pigs per pen and

7 pens per treatment. Each pen (5 ft × 5 ft) contained a 4-hole dry self-feeder and 1 cup waterer to provide ad libitum access to feed and water. The study was conducted at the KSU Segregated Early Weaning Facility.

Analyzed nutrient values were used in diet formulation (Table 3). The 10 experimental treatments were (1) positive control (corn-soybean meal diet), (2) 15% corn DDGS (Chief Ethanol Fuels, Hastings, NE), (3) 30% corn DDGS, (4) 30% corn DDGS + 0.05% Easyzyme (Archer Daniels Midland Company, Decatur, IL), (5) 15% milo DDGS from source 1 (Kansas Ethanol, Lyons, KS), (6) 30% milo DDGS from source 1, (7) 30% milo DDGS from source 1 + 0.05% Easyzyme,(8) 15% milo DDGS from source 2 (U.S. Energy Partners, Russell, KS), (9) 30% milo DDGS from source 2, and (10) 30% milo DDGS from source 2 + 0.05% Easyzyme (Table 4). Treatment diets were fed for 21 d. All diets were in meal form. Average daily gain, ADFI, and F/G were determined by weighing pigs and measuring feed disappearance on d 7, 14, and 21 of the trial.

Data were analyzed as a completely randomized design with pen as the experimental unit. Data were analyzed with an analysis of variance by using the MIXED procedure of SAS with treatment as a fixed effect. Contrasts were used to determine the effects of DDGS source and enzyme inclusion compared with the control.

Results and Discussion

Experiment 1. Diet analysis was similar to expected levels (Table 5). Overall (d 0 to 27), there were no differences ($P > 0.10$) between pigs fed the corn-soybean meal diet or the corn-soybean meal diet with 30% DDGS (Table 6). Furthermore, pigs fed diets containing Porzyme had ADG, ADFI, and F/G similar ($P > 0.10$) to those of pigs fed the corn-soybean meal diet with or without 30% DDGS. However, pigs fed diets containing Hemicell-W and Easyzyme had poorer ($P < 0.05$) ADG than pigs fed the positive control diet, and pigs fed the diet containing Hemicell-W also had lower ($P < 0.05$) ADG than pigs fed the negative control diet or diet containing Porzyme. There were no differences ($P > 0.10$) in ADFI or F/G.

Experiment 2. Diet analysis was similar to expected levels (Table 7). Corn DDGS had lower CP and fiber contents but higher crude fat content than milo DDGS. Milo DDGS from source 1 had higher CP, fat, fiber, and ash contents than milo DDGS from source 2. Overall (d 0 to 21), there were no ($P > 0.10$) enzyme × DDGS source interactions for any of the measured growth variables (Tables 8 and 9). Pigs fed diets with increasing corn DDGS had ADG, ADFI, and F/G similar ($P > 0.10$) to those of pigs fed the control diet. Pigs fed diets with increasing milo DDGS had poorer (linear, $P = 0.002$) F/G than pigs fed the control diet but similar ADG. Also, pigs fed diets containing milo DDGS diets had poorer ($P = 0.04$) F/G than pigs fed diets containing corn DDGS. Pigs fed different sources of milo DDGS had similar ($P > 0.10$) ADG, ADFI, and F/G. However, pigs fed diets containing 30% DDGS had ADG, ADFI, and F/G similar ($P > 0.10$) to those of pigs fed diets including 30% DDGS with 0.05% enzyme.

In summary, adding different enzymes to diets containing 30% DDGS did not improve performance compared with either a corn-soybean meal-based diet or a corn-soybean meal-based diet with 30% added DDGS. Feeding diets including milo DDGS resulted in poorer feed efficiency because of the lower energy content of milo DDGS. Neither source of milo DDGS nor inclusion of an enzyme affected growth performance variables.

Table 1. Composition of diets (Exp. 1, as-fed basis)[1]

Ingredient, %	0 % DDGS[2]	30% Corn DDGS[3,4]
Corn	65.42	41.35
Soybean meal (46.5%)	30.55	25.05
Corn DDGS	---	30.00
Monocalcium P (21% P)	1.65	0.90
Limestone	0.98	1.38
Salt	0.35	0.35
Vitamin premix	0.25	0.25
Trace mineral premix	0.15	0.15
Lysine-HCl	0.37	0.45
DL-methionine	0.15	0.06
L-threonine	0.14	0.06
Total	100.00	100.00
Calculated analysis		
Standardized ileal digestible amino acids, %		
Lysine	1.25	1.25
Isoleucine:lysine	60	68
Leucine:lysine	127	159
Methionine:lysine	35	33
Met & Cys:lysine	59	62
Threonine:lysine	63	63
Tryptophan:lysine	17	17
Valine:lysine	67	75
Total lysine, %	1.38	1.45
CP, %	20.3	23.8
ME, kcal/lb	1,496	1,421
Total lysine:ME ratio, g/Mcal	3.79	3.99
Ca, %	0.80	0.80
P, %	0.74	0.69
Available P, %	0.42	0.41

[1] Pigs were fed experimental diets for 27 d.
[2] Dried distillers grains withsolubles.
[3] Diets were formulated from the same lot of corn DDGS from Chief Ethanol Fuels, Hastings, NE.
[4] Easzyme, Hemicell-W, and Porzyme were added in place of corn.

Table 2. Guaranteed analysis of enzymes (Exp. 1 and 2)

Item	Easyzyme[1,2]	Hemicell-W[3]	Porzyme[4]
β-glucanase, units/g	1,100	---	---
β-mannanase, units/g	110	140,000,000	---
Xylanase, units/g	1,500	70,000,000	40,000

[1] Easyzyme (Archer Daniels Midland Company, Decatur, IL).
[2] One unit is micromoles total reducing sugars (glucose equivalent) released per minute at 30°C and pH 4.0.
[3] Hemicell-W (Form-A-Feed, Inc., Stewart, MN).
[4] Porzyme (Danisco, New Century, MO).

Table 3. Proximate analysis of DDGS[1] (Exp. 2, as-fed basis)[2]

	Corn DDGS[3]	Milo DDGS Source 1[4]	Milo DDGS Source 2[5]
DM, %	88.50	88.34	88.43
CP, %	25.94	30.74	29.67
Crude fat, %	8.93	10.22	8.91
Crude fiber, %	5.72	7.21	6.90
Ash, %	5.13	4.06	3.91
Ca, %	0.37	0.04	0.07
P, %	0.82	0.72	0.69

[1] Dried distillers grains with solubles.
[2] Results of analyzed values on which the diets were formulated.
[3] Chief Ethanol Fuels (Hastings, NE).
[4] Kansas Ethanol (Lyons, KS).
[5] U.S. Energy Partners (Russell, KS).

Table 4. Composition of diets (Exp. 2, as-fed basis)[1]

		Corn DDGS[3]			Milo DDG[2] Source 1[4]			Milo DDG[2] Source 2[5]		
	Control	15%	30%	30%	15%	30%	30%	15%	30%	30%
Enzyme[6]	No	No	No	Yes	No	No	Yes	No	No	Yes
Ingredient, %										
Corn	65.73	55.86	44.10	44.04	55.26	43.17	43.11	55.13	42.61	42.56
Soybean meal, 46.5%	30.24	25.38	22.55	22.55	25.88	23.22	23.23	25.97	23.73	23.74
DDGS	---	15.00	30.00	30.00	15.00	30.00	30.00	15.00	30.00	30.00
Monocalcium P, 21% P	1.63	1.25	0.85	0.85	1.30	0.95	0.96	1.30	1.00	1.00
Limestone	1.00	1.08	1.15	1.15	1.18	1.38	1.38	1.18	1.33	1.33
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Lysine-HCl	0.38	0.44	0.44	0.44	0.44	0.45	0.45	0.45	0.46	0.46
DL-methionine	0.14	0.11	0.06	0.06	0.09	0.02	0.02	0.10	0.05	0.05
L-threonine	0.14	0.14	0.11	0.11	0.12	0.07	0.07	0.12	0.08	0.08
Easyzyme	---	---	---	0.05	---	---	0.05	---	---	0.05
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis										
Standardized ileal amino acids, %										
Lysine	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Isoleucine:lysine	59	59	61	61	62	67	67	62	67	67
Leucine:lysine	127	135	147	147	147	171	171	147	171	171
Methionine:lysine	34	33	31	31	32	29	29	32	30	30
Met & Cys:lysine	58	58	58	58	58	58	58	58	58	58
Threonine:lysine	62	62	62	62	62	62	62	62	62	62
Tryptophan:lysine	17	16	16	16	16	16	16	16	16	16
Valine:lysine	66	67	67	67	71	79	79	71	78	78
Total lysine, %	1.38	1.42	1.47	1.47	1.41	1.45	1.45	1.41	1.44	1.44
CP, %	20.2	21.0	22.5	22.5	21.9	24.2	24.2	21.8	24.1	24.1
ME, kcal/lb	1,496	1,502	1,507	1,506	1,494	1,491	1,490	1494	1491	1490
Total lysine:ME ratio, g/Mcal	3.79	3.77	3.76	3.76	3.80	3.80	3.81	3.80	3.80	3.81
Ca, %	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
P, %	0.73	0.72	0.70	0.70	0.71	0.70	0.70	0.71	0.70	0.70
Available P, %	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42

[1] Pigs were fed experimental diets for 21 d. [2] Dried distillers grains with solubles (DDGS). [3] Diets were formulated from the same lot of corn DDGS from Chief Ethanol Fuels, Hastings, NE. [4] Diets were formulated from the same lot of milo DDGS from Kansas Ethanol, Lyons, KS. [5] Diets were formulated from the same lot of milo DDGS from U.S. Energy Partners, Russell, KS. [6] Easyzyme (Archer Daniels Midland Company, Decatur, IL).

Table 5. Analysis of diets (Exp. 1, as-fed basis)

	Corn-soy	30% Corn DDGS[1,2]			
Enzyme	No	No	Easyzyme[3]	Hemicell-W[4]	Porzyme[5]
DM, %	87.07	88.71	88.86	88.42	88.75
CP, %	19.88	22.56	24.06	22.97	24.15
Crude fat, %	2.18	4.54	4.43	4.26	4.64
Crude fiber, %	2.24	3.70	3.73	3.57	3.69
Ash, %	5.67	7.08	7.24	6.80	7.18

[1] Dried distillers grains with solubles.
[2] Diets were formulated from the same lot of corn DDGS from Chief Ethanol Fuels, Hastings, NE.
[3] Easyzyme (Archer Daniels Midland Company, Decatur, IL).
[4] Hemicell-W (Form-A-Feed, Inc., Stewart, MN).
[5] Porzyme (Danisco, New Century, MO).

Table 6. Effects of dried distillers grains with solubles (DDGS) enzymes on nursery pig performance (Exp. 1)[1]

		30% DDGS[2]				
Item	No Enzyme	No Enzyme	Easyzyme[3]	Hemicell-W[4]	Porzyme[5]	SE
d 0 to 27						
ADG, lb	1.17[a]	1.13[ab]	1.10[bc]	1.05[c]	1.15[ab]	0.033
ADFI, lb	1.70	1.70	1.61	1.55	1.74	0.084
F/G	1.45	1.51	1.45	1.47	1.52	0.048

[abc] Within a row, means without a common superscript letter differ ($P < 0.05$).
[1] A total of 180 pigs (6 pigs per pen and 6 pens per treatment) with an initial BW of 19.9 lb. Pigs were fed a common diet from weaning until the start of the trial then fed experimental diets for 27 d.
[2] Diets were formulated from the same lot of corn DDGS from Chief Ethanol Fuels, Hastings, NE.
[3] Easyzyme (Archer Daniels Midland Company, Decatur, IL).
[4] Hemicell-W (Form-A-Feed, Inc., Stewart, MN).
[5] Porzyme (Danisco, New Century, MO).

Table 7. Analysis of diets (Exp. 2, as-fed basis)

		Corn DDGS[2]			Milo DDGS[1] Source 1[3]			Milo DDGS[1] Source 2[4]		
	Control	15%	30%	30%	15%	30%	30%	15%	30%	30%
Enzyme[5]	No	No	No	Yes	No	No	Yes	No	No	Yes
DM, %	86.98	87.60	88.28	88.48	87.64	88.62	87.48	87.08	87.81	87.50
CP, %	21.08	20.51	23.07	22.94	20.82	23.57	24.10	20.90	23.00	23.10
Crude fat, %	3.15	4.39	5.21	4.75	3.60	4.68	4.36	3.14	4.14	4.10
Crude fiber, %	2.37	2.84	3.27	3.40	3.10	3.90	3.55	2.71	3.76	3.45
Ash, %	5.49	5.44	5.81	5.66	5.55	5.40	5.71	5.32	5.29	5.10

[1] Dried distillers grains with solubles.
[2] Diets were formulated from the same lot of corn DDGS from Chief Ethanol Fuels, Hastings, NE.
[3] Diets were formulated from the same lot of milo DDGS from Kansas Ethanol, Lyons, KS.
[4] Diets were formulated from the same lot of milo DDGS from U.S. Energy Partners, Russell, KS.
[5] Easyzyme (Archer Daniels Midland Company, Decatur, IL).

Table 8. Effects of dried distillers grains with solubles (DDGS) with enzymes on nursery pig performance (Exp. 2)[1]

		Corn DDGS[2]			Milo DDGS Source 1[3]			Milo DDGS Source 2[4]		
	Control	15%	30%	30%	15%	30%	30%	15%	30%	30%
Enzyme[5]	No	No	No	Yes	No	No	Yes	No	No	Yes
d 0 to 21										
ADG, lb	1.05	1.02	1.03	1.03	1.07	1.01	0.98	1.05	1.02	1.04
ADFI, lb	1.60	1.60	1.60	1.62	1.68	1.65	1.57	1.68	1.68	1.69
F/G	1.53	1.57	1.55	1.57	1.57	1.63	1.60	1.59	1.65	1.63

[1] Pigs were fed experimental diets for 21 d.
[2] Diets were formulated from the same lot of corn DDGS from Chief Ethanol Fuels, Hastings, NE.
[3] Diets were formulated from the same lot of milo DDGS from Kansas Ethanol, Lyons, KS.
[4] Diets were formulated from the same lot of milo DDGS from U.S. Energy Partners, Russell, KS.
[5] Easyzyme (Archer Daniels Midland Company, Decatur, IL).

Table 9. Probability effects of dried distillers grains with solubles (DDGS) enzymes on nursery pig performance (Exp. 2)[1]

	Probability, $P <$								
	Corn DDGS[2]		Milo DDGS		Corn DDGS	Source 1 Milo DDGS[3]	Enzyme[4]	30% DDGS	
Item;	Linear	Quadratic	Linear	Quadratic	vs. Milo DDGS	vs. Source 2 Milo DDGS[5]	vs. DDGS Source	vs. 30% DDGS + Enzyme	SEM
D 0 to 21									
ADG, lb	0.53	0.37	0.19	0.12	0.76	0.40	0.91	0.87	0.022
ADFI, lb	0.98	0.94	0.19	0.20	0.06	0.12	0.35	0.58	0.038
F/G	0.52	0.36	0.002	0.82	0.04	0.34	0.29	0.62	0.030

[1] Pigs were fed experimental diets for 21 d.
[2] Diets were formulated from the same lot of corn DDGS from Chief Ethanol Fuels, Hastings, NE.
[3] Diets were formulated from the same lot of milo DDGS from Kansas Ethanol, Lyons, KS.
[4] Easyzyme (Archer Daniels Midland Company, Decatur, IL).
[5] Diets were formulated from the same lot of milo DDGS from U.S. Energy Partners, Russell, KS.