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Determining the Effects of Increasing Levels of Xylanase in Nutrient Adequate Diets on Growth Performance, Carcass Characteristics of Growing-Finishing Pigs

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Abstract

A total of 1,944 mixed sex growing-finishing pigs (PIC; 337 × 1050; initial BW of 49.9 ± 1.18 lb) were used in a 131-d growth trial to determine the effects of increasing added xylanase xylanase in adequate diets on grow-finish pig growth performance and carcass characteristics. Pens were assigned to 1 of 6 treatments in a randomized complete block design with BW as a blocking factor. There were 12 replicate pens per treatment and 27 pigs per pen. The experimental diets were corn-soybean meal-based and were fed in 5 phases. The 6 dietary treatments were formulated to: 0, 2.3, 4.5, 9.1, 18.1, and 34.0 of enzymatic activity for xylanase (IU)/lb (0, 5, 10, 20, 40, and 75 IU/kg) of added xylanase (Belfeed B 1100 MP; Jefo Nutrition, Inc., Saint-Hyacinthe, Quebec). From d 0 to 70, there was a tendency (quadratic, $P = 0.068$) for average daily gain (ADG) to decrease and then increase with increasing added xylanase, but there was no evidence ($P > 0.10$) of differences for average daily feed intake (ADFI) and feed efficiency (F/G). From d 70 to 131 and overall, there was no evidence of difference ($P > 0.10$) observed for ADG, ADFI, and F/G. There was no evidence for difference ($P > 0.10$) between treatments for number of pigs receiving injectable treatments or mortalities. For carcass traits, increasing xylanase increased then decreased (quadratic, $P = 0.010$) percentage carcass yield. Also, as xylanase increased, percentage lean decreased (linear, $P = 0.038$) and backfat marginally increased (linear, $P = 0.066$). In conclusion, adding increasing levels of xylanase in nutrient adequate diets did not impact growth performance or mortality but did improve carcass yield at intermediate levels.

Keywords

finishing pig, growth performance, xylanase

Cover Page Footnote

Appreciation is expressed to Jefo (Saint-Hyacinthe, Quebec) for providing technical and partial financial support, and to New Horizon Farms (Pipestone, MN) for providing research facilities.

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Determining the Effects of Increasing Levels of Xylanase in Nutrient Adequate Diets on Growth Performance, Carcass Characteristics of Growing-Finishing Pigs[1]

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Summary

A total of 1,944 mixed sex growing-finishing pigs (PIC; 337 × 1050; initial BW of 49.9 ± 1.18 lb) were used in a 131-d growth trial to determine the effects of increasing added xylanase xylanase in adequate diets on grow-finish pig growth performance and carcass characteristics. Pens were assigned to 1 of 6 treatments in a randomized complete block design with BW as a blocking factor. There were 12 replicate pens per treatment and 27 pigs per pen. The experimental diets were corn-soybean meal-based and were fed in 5 phases. The 6 dietary treatments were formulated to: 0, 2.3, 4.5, 9.1, 18.1, and 34.0 of enzymatic activity for xylanase (IU)/lb (0, 5, 10, 20, 40, and 75 IU/kg) of added xylanase (Belfeed B 1100 MP; Jefo Nutrition, Inc., Saint-Hyacinthe, Quebec). From d 0 to 70, there was a tendency (quadratic, $P = 0.068$) for average daily gain (ADG) to decrease and then increase with increasing added xylanase, but there was no evidence ($P > 0.10$) of differences for average daily feed intake (ADFI) and feed efficiency (F/G). From d 70 to 131 and overall, there was no evidence of difference ($P > 0.10$) observed for ADG, ADFI, and F/G. There was no evidence for difference ($P > 0.10$) between treatments for number of pigs receiving injectable treatments or mortalities. For carcass traits, increasing xylanase increased then decreased (quadratic, $P = 0.010$) percentage carcass yield. Also, as xylanase increased, percentage lean decreased (linear, $P = 0.038$) and backfat marginally increased (linear, $P = 0.066$). In conclusion, adding increasing levels of xylanase in nutrient adequate diets did not impact growth performance or mortality but did improve carcass yield at intermediate levels.

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Introduction

It is a common practice in today's commercial swine production to add distillers dried grains with solubles (DDGS) and other by-product ingredients to reduce feed cost. These ingredients can increase non-starch polysaccharides such as arabinoxylan, cellulose, and hemi-cellulose. Non-starch polysaccharides are poorly utilized and have low digestibility in pigs. Xylanase is a naturally occurring enzyme derived from bacteria and fungi that can degrade the linear polysaccharide beta-1, 4-xylan; thus, breaking down the non-starch polysaccharides and improving nutrient utilization. Weiland et al.[5] observed that dietary inclusion of xylanase increased dry matter digestibility and digestible energy in pigs weighing approximately 154 lb, but did not show a difference for pigs weighing approximately 101 and 119 lb. Zier-Rush et al.[6] observed a reduction in mortality of finishing pigs with increasing added dietary xylanase. Therefore, the objective of this study was to determine the effects of xylanase on growth performance, carcass characteristics, and economics of growing-finishing pigs raised in a commercial environment.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in this experiment. The study was conducted at a commercial research-finishing site in southwest Minnesota. The barn was naturally ventilated and double-curtain-sided. Each pen was equipped with a 5-hole stainless steel dry self-feeder and a bowl waterer for *ad libitum* access to feed and water.

Two groups of approximately 972 pigs (1,944 total pigs; PIC; 337 × 1050; initial BW of 49.8 ± 1.18 lb) were used in a 131-d growth trial. Pigs were housed in mixed gender pens with 27 pigs per pen and 12 pens per treatment (6 replications per group). Daily feed additions to each pen were accomplished using a robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) able to record feed amounts for individual pens. Pens were assigned to 1 of 6 dietary treatments in a randomized complete block design with BW as a blocking factor. Experimental diets were corn-soybean meal-DDGS-based with dietary treatments formulated to include xylanase (Belfeed B 1100 MP; Jefo Nutrition, Inc., Saint-Hyacinthe, Quebec) at levels of: 0, 2.3, 4.5, 9.1, 18.1, and 34.0 SXU/lb (0, 5, 10, 20, 40, and 75 SXU/kg). Belfeed B 1100 MP contained 44,448 SXU/lb and therefore, 0, 0.1, 0.2, 0.4, 0.8, and 1.5 lb were added per ton of complete feed to form the experimental treatments. The unit SXU refers to the measurement of enzymatic activity of xylanase.

Experimental diets were fed in 5 phases (Table 1.) All diets consisted of the same basal formulation and were fed in meal form. Phase 1 was fed from 50 to 80 lb, phase 2 from 80 to 140 lb, phase 3 from 140 to 195 lb, phase 4 from 195 to 240 lb, and phase 5 from 240 lb to market.

Pigs were weighed approximately every 14 days to determine ADG, ADFI, and F/G. On d 102, the 2 heaviest pigs in each pen were selected and marketed, but not included

[5] Weiland S., J. F. Patience, 2016. 232 Xylanase effects on apparent total tract digestibility of energy and dry matter with or without DDGS at 46, 54, 70 kg bodyweight. J. Anim. Sci. 94 (Suppl 2):109 (Abstr.).
[6] Zier-Rush, C. E., C. Groom, M. Tillman, J. Remus, R. D. Boyd, 244. 2016. The feed enzyme xylanase improves finish pig viability and carcass efficiency. J. Anim. Sci. 94 (Suppl 2):115 (Abstr.).

in the final pen carcass data. On the last day of the trial, final pen weights were obtained and the remaining pigs were tattooed with a pen identification number and transported to a U.S. Department of Agriculture-inspected packing plant (JBS Swift, Worthington, MN) for carcass data collection. Carcass measurements included hot carcass weight (HCW), loin depth, backfat, and percentage lean. Percentage lean was calculated from a plant proprietary equation. Carcass yield was calculated by dividing the pen average HCW by the pen average final live weight obtained at the farm.

Data were analyzed as a randomized complete block design for one-way ANOVA using the lmer function from the lme4 package in R (version 3.5.1 (2018-07-02), R Foundation for Statistical Computing, Vienna, Austria) with pen considered as the experimental unit, body weight as blocking factor, and treatment as a fixed effect.

Results and Discussion

Analyzed DM, CP, and NDF content of the experimental diets (Table 1) were consistent with the formulated estimates. Also, the xylanase activity followed the intended increasing dose curve (Table 2).

From d 0 to 70, there was a marginal response (quadratic, $P = 0.064$) for ADG, with growth decreasing and then increasing with increasing xylanase. This change in ADG was responsible for an increase (linear, $P = 0.007$) in d 70 BW. However, there was no evidence ($P > 0.10$) of differences for ADFI and F/G.

From d 70 to 131 and overall, there was no evidence of differences ($P > 0.10$) for ADG, ADFI, and F/G among treatments. Also, there was no evidence for differences ($P > 0.10$) found among treatments for the percentage of pigs receiving injectable treatments and overall mortality.

When evaluating carcass characteristics, there was a quadratic response ($P < 0.010$) for carcass yield, as added xylanase increased, carcass yield increased and then decreased. Also, as xylanase increased, percentage lean decreased (linear, $P = 0.038$), backfat tended (linear, $P = 0.066$) to increase. Xylanase had no evidence of impact ($P = 0.10$) on HCW and loin depth.

Economically, increasing xylanase increased (linear, $P < 0.05$) feed cost and feed cost/lb of gain and decreased (linear, $P = 0.002$) income over feed cost.

In conclusion, this study provided no evidence that feeding xylanase had an impact on growth performance, mortality, or the percentage of pigs that required health-related treatments, but did increase carcass yield when intermediate levels were fed.

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Table 1. Diet composition (as-fed basis)[1]

Item	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Ingredients, %					
Corn	50.82	58.29	64.10	64.10	84.33
Soybean meal (46.5% CP)	20.54	13.27	7.46	7.64	12.44
DDGS[2]	25.00	25.00	25.00	25.00	0.00
Beef tallow	1.00	1.00	1.00	1.00	1.00
Calcium carbonate	1.10	1.10	1.10	1.10	0.85
Calcium phosphate (monocalcium)	0.15	0.00	0.00	0.00	0.25
Salt	0.50	0.50	0.50	0.50	0.50
L-Lysine-HCl	0.53	0.54	0.53	0.41	0.30
DL-Methionine	0.04	0.00	0.00	0.00	0.04
L-Threonine	0.11	0.09	0.09	0.04	0.09
L-Tryptophan	0.03	0.04	0.04	0.03	0.02
Phytase[3]	0.04	0.04	0.04	0.04	0.04
Mineral-vitamin premix[4]	0.15	0.15	0.15	0.15	0.15
Xylanase [5]	+/-	+/-	+/-	+/-	+/-
Calculated analysis					
Standardized ileal digestible (SID) amino acids, %					
Lysine	1.17	1.00	0.85	0.76	0.72
Isoleucine:lysine	60	59	58	65	60
Leucine:lysine	150	159	171	192	153
Methionine:lysine	30	28	30	34	33
Methionine and cysteine:lysine	55	54	58	65	61
Threonine:lysine	61	60	61	63	65
Tryptophan:lysine	18.0	18.0	18.0	19.0	19.0
Valine:lysine	70	70	71	80	70
SID Lysine:net energy, g/Mcal	4.73	3.96	3.33	2.98	2.77
Net energy, kcal/lb	1,123	1,144	1,159	1,158	1,178
Calcium, %	0.54	0.50	0.48	0.48	0.44
Standard digestible P, %	0.40	0.35	0.34	0.34	0.28
Chemical analysis, %					
Dry matter, %	88.89	88.68	87.87	87.86	86.46
Crude protein, %	21.45	20.78	16.28	16.30	13.57
Neutral detergent fiber, %	11.53	11.85	12.42	12.33	8.67

[1]Phases 1, 2, 3, 4, and 5 were fed from 50 to 80 lb, 80 to 140 lb, 140 to 195 lb, 195 to 240 lb, and 240 lb to market, respectively.
[2]DDGS = dried distillers grains with solubles.
[3]Optiphos 2000 (Huvepharma Inc. Peachtree City, GA) provided 389.6 units of phytase FTY/lb of diet with an assumed release of 0.12 available P.
[4]Provided per lb of diet: 111 ppm Zn, 111 ppm Fe, 33 ppm Mn, 17 ppm Cu, 0.33 ppm I, 0.30 ppm Se, 2400 IU vitamin A, 600 IU vitamin D, 12 IU vitamin E, 1.2 mg vitamin K, 22.5 mg niacin, 7.5 mg pantothenic acid, 2.25 mg riboflavin, and 10.5 mg vitamin B12.
[5]Belfeed B 1100 MP (Jefo Nutrition, Inc., Saint-Hyacinthe, Quebec) replaced corn in the diet.

Table 2. Xylanase relative activity by phase[1,2,3,4]

	Dietary phase				
Xylanase, SXU/lb	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
2.3	-0.6	-0.8	1.0	1.4	0.7
4.5	0.2	3.9	2.3	5.0	3.4
9.1	7.4	7.7	7.3	11.2	6.3
18.1	14.7	22.4	12.9	16.3	14.3
34.0	28.3	31.2	26.6	30.0	33.4

[1]Phases 1, 2, 3, 4, and 5 were fed from 50 to 80 lb, 80 to 140 lb, 140 to 195 lb, 195 to 240 lb, and 240 lb to market, respectively.
[2]SXU is the measurement of enzymatic activity for xylanase.
[3]The dietary treatments with no added xylanase was analyzed and used as a baseline to identify the relative xylanase activity in other diets.
[4]Diets with less than 4.5 SXU/lb activity are difficult to analyze due to low activity.

Table 3. Effects of added xylanase on growth performance and carcass characteristics of growing-finishing pigs[1,2]

	Xylanase, SXU/lb							Probability, P =	
Item[3]	0	2.3	4.5	9.1	18.1	34.0	SEM	Linear	Quadratic
Initial BW, lb	49.2	49.7	49.7	49.1	49.9	50.0	1.18	0.023	0.821
d 70 BW, lb	173.5	176.8	173.5	174.1	175.3	178.2	2.50	0.007	0.249
Final BW, lb	295.8	296.4	292.0	293.7	293.3	296.6	3.20	0.679	0.158
d 0 to 70									
ADG, lb	1.74	1.76	1.71	1.70	1.73	1.75	0.030	0.458	0.064
ADFI, lb	3.55	3.47	3.42	3.41	3.51	3.54	0.064	0.279	0.146
F/G	2.04	1.97	2.01	2.00	2.03	2.02	0.021	0.474	0.884
d 70 to 131									
ADG, lb	2.03	1.97	1.98	2.03	1.99	1.99	0.021	0.620	0.929
ADFI, lb	5.88	5.74	5.93	5.94	5.85	5.89	0.072	0.607	0.687
F/G	2.90	2.91	2.99	2.91	2.94	2.96	0.031	0.184	0.687
Overall (d 0 to 131)									
ADG, lb	1.90	1.88	1.86	1.88	1.87	1.88	0.167	0.909	0.236
ADFI, lb	4.82	4.72	4.81	4.80	4.80	4.83	0.066	0.376	0.929
F/G	2.54	2.51	2.59	2.55	2.57	2.56	0.019	0.172	0.270
Treatments, %[4]	2.02	3.09	4.71	2.16	3.70	3.70	1.230	0.361	0.742
Mortality, %	3.70	3.70	3.36	3.08	3.40	5.56	1.272	0.188	0.277
Carcass traits									
HCW	215.3	213.9	214.4	215.4	213.8	213.6	2.46	0.573	0.966
Yield, %	72.78	72.18	73.48	73.31	73.35	72.02	0.434	0.220	0.010
Backfat, in[5]	0.65	0.64	0.62	0.67	0.66	0.67	0.013	0.066	0.703
Lean, %[5]	57.22	57.23	57.57	56.98	56.99	56.83	0.210	0.038	0.782
Loin depth, in[5]	2.74	2.72	2.74	2.75	2.72	2.72	0.036	0.683	0.828
Economics, $/pig marketed									
Feed cost	55.25	54.17	55.23	55.28	55.72	56.85	0.781	0.002	0.717
Feed cost/lb gain[6]	0.222	0.220	0.227	0.224	0.227	0.230	0.0018	< 0.001	0.536
Revenue[7]	116.00	114.74	115.11	116.15	114.65	114.40	1.332	0.372	0.930
IOFC[8]	60.78	60.52	59.89	60.98	59.07	57.47	0.864	0.002	0.584

[1]A total of 1,944 pigs in two groups were used in a 131-d study with 27 pigs per pen and 12 replicates per treatment.
[2]SXU is the measurement of enzymatic activity for xylanase.
[3]BW = body weight. ADG = average daily gain. ADFI = average daily feed intake. F/G = feed-to-gain ratio. HCW = hot carcass weight.
[4]Treatments = total injectable medication treatments divided by total pigs within dietary treatment.
[5]Adjusted using HCW as covariate.
[6]Feed cost/lb gain = total feed cost per pig divided by total gain per pig.
[7] Revenue = (HCW × $0.65) – (d 0 BW × 0.75 × $0.65).
[8] Income over feed cost = revenue – feed cost.