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EXPANDER PROCESSING AND ENZYMES FOR A WHEAT-BASED DIET FOR FINISHING PIGS [1]

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Summary

Overall ADG and ADFI were not affected, but feed efficiency was improved with pelleting and further improvements resulted from expander processing. In a second experiment, enzyme supplementation to mash, but not pelleted, diets improved feed efficiency. Indeed, F/G for pigs fed mash with enzyme was similar to that for pigs fed pelleted diets.

(Key Words: Expander, Wheat, Enzyme, Finishing Pigs.)

Introduction

Recent experiments demonstrated enhanced nutrient utilization and improved growth performance when barley-based diets supplemented with β-glucanase were fed to poultry. Furthermore, phytase and β-glucanase have been used in swine diets to improve digestibilities of phosphorus and complex carbohydartes. In a previous Swine Day Report, we demonstrated that wheat has a feeding value approximately 92% that of corn. Thus, a means of improving nutrient utilization from wheat would be of great benefit. The objective of the experiments reported herein was to determine the effects of pelleting and expanding a wheat-based diet and of wheat-specific enzymes on growth performance and nutrient digestibility.

Procedures

In Exp. 1, 60 crossbred gilts (PIC line 326 sires × C22 dams; average initial BW of 109 lb) were used in a 70-d growth assay. The pigs were blocked by weight and allotted to treatments based on ancestry. There were two pigs per pen (5-ft × 5-ft with slatted concrete floors) and 10 pens/treatment in an environmentally controlled building. Each pen had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water. Treatments were: 1) mash; 2) standard pellet; and 3) expanded pellet. The diets (Table 1) were formulated to .9% lysine for Phase 1 (d 0 to 33) and .7% lysine for Phase 2 (d 33 to 70).

At approximately midexperiment (d 33), chromic oxide (.25%) was added to the diets as an indigestible marker. After a 4-d adjustment period, fecal samples were collected from two pigs per pen, pooled within pen, and frozen. Later, the feces were oven-dried at 122°F for 72 h and ground. Feed and feces were analyzed for concentrations of DM, N, and Cr to allow calculation of apparent digestibilities of DM and N.

The pigs were slaughtered when those in the heaviest pen in a weight block reached an average BW of 250 lb. Dressing percentage (hot carcass weight/final live weight × 100) and last rib backfat thickness (measured on the midline of the split carcass) for each pig were adjusted (using regression analysis) to

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the average final BW before being pooled within pen. Also, fat-free lean index for each pen was calculated using the equation proposed by the National Pork Producers Council (1994). Response criteria were ADG, ADFI, F/G, apparent digestibilities of DM and N, dressing percentage, backfat thickness, fat-free lean index, and scores for stomach keratosis and ulceration.

Table 1. Basal Diets

Ingredient, %	Period 1[a]	Period 2[b]
Wheat (hard red winter)	85.96	90.95
Soybean meal (46.5% CP)	9.51	4.72
Soybean oil	1.00	1.00
Lysine-HCL	.38	.41
DL-methionine	.03	.02
Monocalcium phosphate	1.55	1.20
Limestone	.66	.60
Salt	.30	.30
Enzyme[c]	-	-
Vitamins, trace minerals, and antibiotic[d]	.61	.80
Total	100.00	100.00

[a]Formulated to .90% lysine, .65% Ca, and .55% P and fed from d 0 to 33 and d 0 to 34 in Exps. 1 and 2, respectively.
[b]Formulated to .70% lysine, .55% Ca, and .45% P and fed from d 33 to 55 and d 34 to 70 in Exps. 1 and 2, respectively.
[c]Porzyme™ 9300 (Finnfeed Interational, Schaumburg, IL) powder was added as .1% of the finished diets and Porzyme™ 9310 liquid was sprayed on as .05% of finished diets after pelleting.
[d]Supplied 100g/ton tylosin.

In Exp. 2, 80 crossbred gilts (PIC line326 sires × C-22 dams; average initial BW of 123 lb) were used in a 55-d growth assay. The pigs were blocked by weight and allotted to treatments based on ancestry. There were two pigs per pen (5-ft by 5-ft with slatted concrete floors) and five pens/treatment. Pig and feeder managements were the same as in Exp. 1. Treatments were : 1) mash; 2) mash with xylanase (from *Trichoderma longibrachiatium)* with 4,000 xylanase units/g of product; 3) pellets; 4) pellets with xylanase added at the mixer; 5) pellets with xylanase sprayed on after pelleting; 6) expanded pellets; 7) expanded pellets with xylanase added at the mixer; and 8) expanded pellet with xylanase sprayed on after pelleting. The diets (Table 1) were formulated to .9% lysine for Phase 1 (d 0 to 34) and .7% lysine for Phase 2 (d 34 to 55).

At approximately midexperiment (d 34), chromic oxide (.25%) was added to the diets as an indigestible marker. After a 4-d adjustment period, fecal samples were collected from two pigs per pen, pooled within pen, and frozen. Later, the feces were oven-dried at 122°F for 72 h and ground. Slaughter procedure and collecting of carcass data were the same as in Exp. 1.

All data were analyzed as a randomized complete block design (with BW as the blocking criterion) using the GLM procedure of SAS. Orthogonal contrasts were used to separate treatment means with pen as the experimental unit.

Results and Discussion

For Exp. 1, overall F/G ($P<.02$) and digestibility of DM ($P<.01$) and N ($P<.02$) were improved by pelleting the diet. Also, for overall period, expander processing improved F/G ($P<.02$) and digestibility of DM ($P<.04$) compared to standard steam conditioning. These results are similar to previous reports from our laboratory, in which pelleting of cereal-based diets increased nutritional value. However, studies with poultry indicate that expander processing of wheat-based diets causes increased viscosity of digesta that reduces nutrient utilization. Our data do not suggest similar effects (i.e., reduced nutritional value) when wheat-based diets are expanded and fed to pigs.

Dressing percentage was not affected by treatments ($P>.3$), but fat-free lean index was lower for pigs fed pelleted diets ($P<.03$). This likely was caused by the greater energy value (e.g., greater digestibility of DM) when the diet was pelletized. Stomach ulceration ($P<.003$) and keratinization ($P<.002$) were

increased by pelleting. However, the mean score for the various treatments ranged from .05 to 1.08 (i.e., from essentially low to mild keratosis and ulceration), suggesting that no treatment caused severe stomach lesions.

For Exp. 2, pelleting decreased F/G from d 0 to 36 (P<.02) and overall (P<.05) and tended (P<.11) to increase digestibility of DM. However, expander processing did not improve F/G or digestibility of nutrients compared to standard steam conditioning (P>.27). Adding the xylanase enzyme to the mash diet improved overall efficiency of growth (P<.01) and digestibility of DM (P<.05). However, the effects of pelleting and enzyme supplementation were not additive (e.g., neither blending the powdered enzyme supplement into the diet before pelleting nor spraying the liquid enzyme on the pellets at the cooler was beneficial).

Pelleting trended to increase scores for ulceration (P<.06), but as in Exp. 1, the means for all treatments were low (ranging from normal to mild). Enzyme supplementation decreased keratinization scores for pigs fed the standard pellets (P< .01) but increased scores for pigs fed expanded pellets (standard vs expander pellets × enzyme addition interaction, P<.01). Scores for ulceration were not affected by enzyme supplementation.

In conclusion, our results demonstrated that pelleting improved feed efficiency and nutrient digestibility. In addition, expander processing resulted in further improvements in F/G. Also, enzyme supplementation to a wheat-based, mash diet improved feed efficiency and nutrient digestibility to a level approaching that with the pelletized diet. However, enzyme addition did not further improve the nutritional value of pelletized, wheat-based diets for finishing pigs.

Table 2. Growth Performance of Finishing Pigs (Exp. 1)[a]

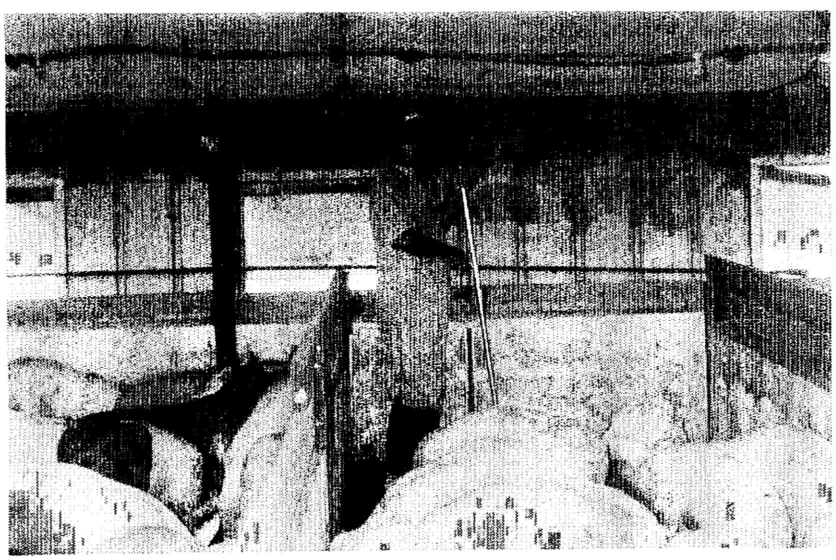
	Treatments				Contrast	
Item	Mash	Standard pellet	Expanded pellet	SE	1	2
Day 0 to 33						
ADG, lb	1.83	1.89	1.88	.08	-	-
ADFI, lb	4.86	4.83	4.68	.19	-	-
F/G	2.63	2.57	2.50	.09	-	-
Day 33 to 70						
ADG, lb	2.01	2.02	2.17	.19	-	-
ADFI, lb	5.96	5.92	5.97	.20	-	-
F/G	2.98	2.95	2.76	.12	-	.06
Overall						
ADG, lb	1.93	1.95	2.03	.07	-	-
ADFI, lb	5.45	5.41	5.36	.16	-	-
F/G	2.83	2.77	2.64	.66	.02	.03
Digestibility (d 37), %						
DM	85.4	86.9	87.6	.4	.01	.04
N	80.0	82.2	82.9	1.6	.02	-
Carcass measurements [c]						
DP, %	74.9	74.9	74.9	.5	-	-
BF, in	.96	1.02	1.04	.04	.04	-
FFLI, %	46.3	45.4	45.4	.5	.03	-

[a]A total of 60 finishing pigs was fed from an average initial BW of 109 lb to an average final BW of 246 lb.
[b]Contrasts were: 1) mash vs pellets and 2) standard pellet vs expanded pellets.
[c]DP = dressing percentage, BF = tenth rib backfat thickness, and FFLI = fat-free lean index (NPPC, 1994).
[d]Dash indicates P>.15.

Table 3. Stomach Morphology of Finishing Pigs (Exp. 1)[a]

	Treatments				Contrast	
Item	Mash	Standard pellet	Expanded pellet	SE	1	2
Keratinization[c]						
Total observations	20	20	17			
Normal	13	2	3			
Mild	6	13	11			
Moderate	1	4	3			
Severe	0	1	0			
Mean score[d]	.22	1.08	.73	.38	.002	.09
Ulceration[e]						
Total observations	20	20	20			
Normal	19	11	10			
Mild	1	5	4			
Moderate	0	1	1			
Severe	0	3	5			
Mean score[f]	.05	.70	1.00	.54	.003	.32

[a]A total of 60 finishing pigs was fed from an average initial BW of 109 lb to an average final BW of 246 lb.
[b]Contrasts were: 1) mash vs pellets; and 2) standard pellets vs expanded pellets.
[c]Scoring system was: 0 = normal; 1 = mild kerosis; 2 = moderate kerosis; and 3 = severe kerosis.
[d]Cochran-Mantel-Haenszel statistic, row mean scores differ test was P<.001.
[e]Scoring system was: 0 = normal; 1 = mild ulceration ; 2 = moderate ulceration; and 3 = severe ulceration.
[f]Cochran-Mantel-Haenszel statistic, row mean scores differ test was P<.01.



Lyle Figge, Finishing Barn Manager.

Table 4. Growth Performance of Finishing Pigs (Exp. 2)[a]

	Mash		Standard Pellet			Expanded Pellet				Contrasts[c]						
Item	None	Mixer[b]	None	Mixer[b]	Pellets	None	Mixer[b]	Pellets	SE	1	2	3	4	5	6	7
Day 0 to 36																
ADG, lb	2.39	2.33	2.35	2.31	2.32	2.25	2.40	2.21	.06	-[e]	-	-	-	-	-	-
ADFI, lb	6.04	5.91	5.53	5.57	5.46	5.54	5.53	5.30	.21	-	-	-	.12	-	-	-
F/G	2.53	2.54	2.35	2.41	2.35	2.47	2.31	2.40	.01	.02	-	-	-	-	-	-
Day 36 to 71																
ADG, lb	2.34	2.58	2.67	2.31	2.33	2.66	2.52	2.53	.09	-	-	-	-	-	-	-
ADFI, lb	6.63	6.37	6.98	6.55	6.98	7.00	6.99	6.90	.21	.09	-	-	-	-	-	-
F/G	2.84	2.55	2.62	2.84	2.99	2.62	2.77	2.72	.02	-	.11	-	.07	-	-	-
Overall																
ADG, lb	2.37	2.42	2.47	2.32	2.33	2.41	2.44	2.33	.05	-	-	-	.12	-	-	-
ADFI, lb	6.48	6.09	6.08	5.95	6.04	6.09	6.08	5.92	.17	-	-	-	-	-	-	-
F/G	2.74	2.52	2.46	2.57	2.59	2.53	2.49	2.53	.01	.05	.01	-	-	-	-	-
Digestibility (d 39), %																
DM	85.5	86.8	86.7	86.7	86.7	87.4	85.9	87.0	1.2	.11	.05	-	-	-	-	-
N	86.1	87.5	85.8	86.8	87.0	86.8	85.6	86.6	2.2	-	-	-	-	-	-	-
Carcass measurement[d]																
DP, %	76.8	75.9	77.2	77.1	77.1	76.9	76.7	76.0	1.7	-	-	-	-	-	-	-
BF, in	1.13	1.16	1.14	1.05	1.06	1.12	1.15	1.12	.03	-	-	-	-	-	-	-
FFLI, %	44.4	44.3	44.7	45.5	45.6	44.7	44.5	44.7	3.0	-	-	-	-	-	-	-

[a]A total of 80 finishing pigs was fed from an average initial BW of 119 lb to an average final BW of 255 lb.
[b]'Mixer' means the enzyme was added at the mixer, in powdered form. 'Pellets' means the enzyme was sprayed onto the pellets in liquid form at the cooler.
[c]Contrasts were: 1) mash vs pellets; 2) mash vs mash+xylanase; 3) standard pellets vs expanded pellets; 4) pellets vs pellets + xylanase; 5) standard pellets vs expanded pellets × pellets vs pellets + xylanase; 6) before vs after; and 7) standard pellets vs expanded pellets × before vs after.
[d]DP = dressing percentage, BF = tenth rib backfat thickness, and FFLI = fat-free lean index (NPPC, 1994).
[e]Dash indicates P>.15.

Table 5. Stomach Morphology of Finishing Pigs (Exp. 2)[a]

	Mash		Standard Pellet			Expanded Pellet			Contrasts[c]							
Item	None	Mixer[b]	None	Mixer[b]	Pellets	None	Mixer[b]	Pellets	SE	1	2	3	4	5	6	7
Keratinization[d]																
Total observations	9	9	10	10	9	9	9	10								
Normal	7	1	1	1	3	3	1	1								
Mild	1	2	1	5	4	5	4	7								
Moderate	1	6	8	3	1	1	4	2								
Severe	0	0	0	1	1	0	0	0								
Mean score[e]	.94	1.44	1.55	1.10	.83	.67	1.22	1.05	.26	-[h]	-	-	-	.01	-	-
Ulceration[f]																
Total observations	9	9	10	10	9	9	9	10								
Normal	8	8	8	7	5	8	6	6								
Mild	1	1	0	1	3	1	3	3								
Moderate	0	0	1	1	0	0	0	1								
Severe	0	0	1	1	1	0	0	0								
Mean score[g]	.05	.05	.45	.55	.61	.05	.33	.5	.25	.06	-	-	-	-	-	-

[a]A total of 80 finishing pigs was fed from an average initial BW of 119 lb to an average final BW of 255 lb.
[b]'Mixer' means the enzyme was added at the mixer, in powdered form. 'Pellets' means the enzyme was sprayed onto the pellets in liquid form at the cooler.
[c]Contrasts were: 1) mash vs pellets; 2) mash vs mash+xylanas; 3) standard pellets vs expanded pellets; 4) pellets vs pellets + xylanase; 5) standard pellets vs expanded pellets × pellets vs pellets + xylanase; 6) before pelleting vs after pelleting; and 7) standard pellets vs expanded pellets × before pelleting vs after pelleting.
[d]Scoring system was: 0 = normal; 1 = mild kerosis; 2 = moderate kerosis; 3 = severe kerosis.
[e]Cochran-Mantel-Haenszel statistic, row mean scores differ test was P>.21.
[f]Scoring system was: 0 = normal; 1 = mild ulceration; 2 = moderate ulceration; 3 = severe ulceration.
[g]Cochran-Mantel-Haenszel statistic, row mean scores differ test was P>.39.
[h]Dash indicates P>.15.