EFFECTS OF CELLULASE ENZYME AND A BACTERIAL FEED ADDITIVE ON THE NUTRITIONAL VALUE OF SORGHUM GRAIN FOR FINISHING PIGS

I. H. Kim, J. D. Hancock, R. H. Hines, and C. R. Risley[1]

Summary

One hundred and twenty-eight finishing pigs (113 lb average initial body wt) were used to determine the effects of adding cellulase enzyme and *Bacillus* bacteria to sorghum-based diets on growth performance, carcass merit, and nutrient digestibility in finishing pigs. Treatments were: 1) corn-soybean meal-based positive control; 2) sorghum-soybean meal-based negative control; 3) Diet 2 with cellulase; and 4) Diet 2 with a bacterial feed additive (i.e., a mixture of *Bacillus licheniformis*, *Bacillus subtilis*, and *Bacillus pumilus*). There was a trend for greater average daily gain in pigs fed corn vs the sorghum treatments from d 0 to 28, but there was no effect of treatment on overall average daily gain (i.e., d 0 to 63). Overall feed consumption was not affected by treatment, but pigs fed the corn-based diet had 3% greater efficiency of gain compared to pigs fed the sorghum diets. Dressing percentage was not affected by treatment, but there was a trend for fat thickness at the last rib to be greater for pigs fed corn vs the sorghum treatments. Pigs fed corn had greater apparent digestibilities of dry matter, nitrogen, and gross energy than pigs fed the sorghum treatments. In conclusion, pigs fed the corn-based control diet had greater growth performance but tended to be fatter than pigs fed sorghum. Adding cellulase and the bacterial feed additive did not affect growth performance, carcass merit, or nutrient utilization in finishing pigs.

(Key Words: Bacilli, Enzyme, Performance, Digestibility, Carcass, Finishing.)

Introduction

Corn is the most widely accepted energy source used in livestock feeding. In general, it has a greater concentration of available energy, and, therefore, greater feeding value than other cereal grains. Although the feeding value of sorghum is on average 5% less than that of corn, the hardy nature of sorghum makes it appealing to farmers and livestock producers in the High Plains and Southeastern states of the U.S. and in more arid regions of the world. Thus, a means of improving nutrient utilization from sorghum would be of great benefit. It has been suggested that *Bacillus* organisms improve function of the gastrointestinal tract via reduced numbers of *E. coli* organisms and increased synthesis of volatile fatty acids. As an alternative to use of microbial feed additives, some researchers have suggested that enzyme supplementation can improve nutrient utilization and growth performance. Thus, the objective of the present experiment was to determine if cellulase or bacilli improve the nutritional value of sorghum-based diets for finishing pigs.

Procedures

A total of 128 pigs, with an average initial body wt of 113 lb, was blocked by weight and allotted to four dietary treatments based on sex and ancestry. There

[1]Chr. Hansen's Biosystems, Inc.

were four barrows and four gilts in each pen and four pens per treatment. The pigs were housed in a modified open-front building with 50% solid concrete and 50% concrete slat flooring. Each pen (6 ft × 16 ft) had a three-hole self-feeder and nipple waterer to allow ad libitum consumption of feed and water. Treatments were: 1) corn-soybean meal-based positive control; 2) sorghum-soybean meal-based negative control; 3) Diet 2 with cellulase; and 4) Diet 2 with a bacterial feed additive (i.e., a mixture of *Bacillus licheniformis*, *Bacillus subtilis*, and *Bacillus pumilus*). All diets were formulated to .70% lysine, .65% Ca, and .55% P (Table 1). The diets were fed in meal form.

On d 44 of the experiment, chromic oxide (.25%) was added to the diets, and after a 4-d adjustment period, fecal samples were collected from two barrows and two gilts per pen, pooled within pen, and frozen. The feces were oven-dried at 122°F for 24 h and ground before chemical analyses. The feed and feces were analyzed for dry matter (DM), nitrogen (N), gross energy (GE), and chromium concentrations to allow calculation of apparent digestibilities of DM, N, and GE with chromium as the indigestible marker.

The pigs were slaughtered when those in the heaviest pen in a weight block reached an average body wt of 250 lb. Dressing percentage and last rib backfat thickness for each pig were adjusted to the average final body wt (using regression analysis) before being pooled within pen. Response criteria were average daily gain (ADG); average daily feed intake (ADFI); feed/gain (F/G); dressing percentage; last rib backfat thickness; apparent digestibilities of DM, N, and GE; and excretion of DM and N in feces. Contrasts used to separate treatment means were: 1) corn-based positive control vs sorghum treatments; 2) sorghum-based negative control vs sorghum-based control with cellulase and bacteria; and 3) cellulase vs bacteria.

Results and Discussion

Average daily gain for d 0 to 28 tended to be greater (P<.10) for pigs fed the corn-based positive control compared to the sorghum-based treatments, and pigs fed corn were 4% more efficient (Table 2). Adding the enzyme and bacteria did slightly increase efficiency of gain compared to the sorghum-soybean meal-based negative control (P<.12). For d 28 to 63, ADG and F/G were not affected by treatment, although pigs fed the sorghum diets ate more feed than pigs fed corn (P<.10). Overall (d 0 to 63) ADG and ADFI were not affected by treatment (P>.15), but pigs fed corn were 3% more efficient (P<.01) than pigs fed the sorghum treatments. Adding the cellulase and bacilli did not improve overall growth performance compared to the sorghum-based negative control (P>.15). Also, no differences occurred in growth performance among pigs fed the enzyme vs the bacteria (P>.48).

Dressing percentage was not affected by dietary treatment (P>.15). However, last rib backfat thickness was affected by treatment (P<.10), with pigs fed corn having .04, .07, and .11 inches greater fat thickness than pigs fed sorghum, enzyme, and bacteria, respectively.

Pigs fed corn had greater digestibilities of DM (P<.05), N (P<.001), and GE (P<.01) than pigs fed sorghum (Table 3). These greater nutrient digestibilities also resulted in 13% less DM and 21% less N excreted in the feces when pigs were fed corn compared to sorghum. Those greater nutrient digestibilities probably contributed to a surplus of circulating energy substrates that resulted in greater fat thickness for pigs fed the corn-based diet. The enzyme and bacteria did not improve nutrient digestibilities compared to the sorghum-based negative control (P>.15). Also, nutrient digestibilities or excretions were not different among pigs fed the enzyme vs bacteria (P>.15).

In conclusion, our data indicated that pigs fed a corn-soybean meal-based diet had improved F/G and nutrient digestibilities, but tended to have greater fat thickness than pigs fed sorghum-soybean meal-based diets. Cellulase and bacilli had no effect on growth performance or nutrient utilization.

Table 1. Composition of Diets[a]

Ingredient, %	Corn-Soy	Sorghum-Soy
Corn	81.30	—
Sorghum	—	81.28
Soybean meal (48% CP)	14.85	14.85
Enzyme premix[b]	—	—
Bacteria premix[c]	—	—
Soybean oil	1.00	1.00
Monocalcium phosphate (21% P)	1.08	1.08
Limestone	1.02	1.02
Vitamins and minerals[d]	.55	.55
Lysine-HCl	.05	.07
Antibiotic[e]	.15	.15
Total	100	100
Calculated Values		
CP, %	14.1	14.4
DE, Mcal/lb	1.58	1.54

[a]All diets were formulated to .70% lysine, .65% Ca, and .55% P.
[b]Supplied 15 mg of enzyme (4.5 filter paper units of activity) per lb of complete diet. Added as .05% of the diet at the expense of sorghum.
[c]Supplied 500 million spores per lb of complete diet. Added as .05% of the diet at the expense of sorghum.
[d]KSU vitamin mix (.15%), KSU mineral mix (.10%), and salt (.3%).
[e]Supplied 150 g chlortetracycline per ton of complete diet.

Table 2. Effects of Cellulase and Bacilli on Growth Performance of Finishing Pigs[a]

Item	Corn-Soy	Sorghum-Soy	Sorghum-Soy + Enzyme	Sorghum-Soy + Bacteria	SE
d 0 to 28					
ADG, lb[b]	1.94	1.83	1.90	1.90	.04
ADFI, lb	6.26	6.22	6.44	6.28	.15
F/G[b]	3.23	3.40	3.39	3.31	.07
d 28 to 63					
ADG, lb	2.23	2.21	2.27	2.25	.06
ADFI, lb[b]	7.76	7.87	8.17	8.16	.15
F/G	3.48	3.56	3.60	3.63	.08
d 0 to 63					
ADG, lb	2.09	2.05	2.12	2.09	.03
ADFI, lb	7.12	7.19	7.45	7.36	.13
F/G[c]	3.41	3.51	3.51	3.52	.03

[a]A total of 128 finishing pigs (eight pigs/pen and four pens/treatment) were fed from an average initial body wt of 113 lb to an average final body wt of 251 lb.
[bc]Corn vs other treatments (P<.10, P<.01, respectively).

Table 3. Effects of Cellulase and Bacilli on Carcass Characteristics and Apparent Nutrient Digestibilities in Finishing Pigs[a]

Item	Corn-Soy	Sorghum-Soy	Sorghum-Soy + Enzyme	Sorghum-Soy + Bacteria	SE
Dressing percentage	71.9	71.1	71.6	71.7	.3
Last rib BF, in[b]	1.30	1.26	1.23	1.19	.1
Apparent digestibility, %					
DM[c]	83.4	80.3	81.2	80.7	.9
N[e]	76.1	65.1	66.8	67.7	1.4
GE[d]	84.3	80.6	81.3	80.9	.8
DM consumed, g/d[f]	2,690	2,610	2,740	2,690	31
N consumed, g/d[dg]	58	50	55	53	1.2
DE consumed, kcal/d[d]	11,897	10,674	11,326	10,846	248
DM excretion, g/d[d]	447	514	515	519	29
N excretion, g/d[e]	14	18	18	17	1.1

[a]A total of 64 finishing pigs (four pigs/pen and four pens/treatment).
[bcde]Corn vs other treatments (P<.10, P<.05, P<.01, P<.001, respectively).
[fg]Sorghum vs enzyme and bacteria (P<.05, P<.10, respectively).