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Effects of Hemicell® Addition to Corn-Soybean Meal Diets on Growth Performance, Carcass Traits, and Apparent Nutrient Digestibility in Growing-Finishing Pigs

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Story in Brief

Two experiments were conducted to examine the effects of adding Hemicell®[5] to corn-SBM diets on growth performance, carcass traits, and apparent nutrient digestibility of growing-finishing pigs. In Exp. 1, 60 pigs (49.6 lb) were allotted randomly by weight, sex, and genotype to three dietary treatments. Diets were: 1) a fortified corn-SBM diet as the control; 2) the control diet with soybean oil (SBO) added to increase the metabolizable energy (ME) of the diet by approximately 100 kcal/kg; and 3) the control diet with Hemicell® (.05%). Overall, Hemicell® addition increased ADG compared with pigs fed the control diet. Also, pigs fed the diet with soybean oil were more efficient than pigs fed the control diet. Feed efficiency was similar for pigs fed diets with Hemicell® or soybean oil. At 240 lb, all pigs were slaughtered and carcass measurements were taken. Hemicell® addition increased HCW compared with pigs fed the control or SBO diets. Also, pigs fed the diet with SBO were leaner than pigs fed the control diet. Addition of Hemicell® increased lean gain and carcass lean tissue compared with pigs fed the control or SBO diets. In Exp. 2, 12 barrows were allotted randomly to the three dietary treatments used in Exp. 1. Pigs were penned individually and the chromium marker method was used to determine nutrient digestibility. There were no differences in the digestibility of energy, nitrogen, phosphorus, or dry matter among diets. Based on these results, Hemicell® appears to improve the rate and efficiency of gain of finishing pigs, but it has no effect on the apparent digestibility of energy or nitrogen.

Key Words: Enzyme, Growth Performance, Nutrient Digestibility

Introduction

A variety of non-starch polysaccharides (NSP) are present in the cell wall structure of leguminous seeds. These components, commonly known as hemicelluloses, are found in many ungerminated seeds used as ingredients in swine diets. These feedstuffs, including soybean meal, can contain up to 22.7% NSP on a dry matter basis (Chesson, 1987). Hemicelluloses in soybean meal, specifically galactomannans, are chemically composed of a d-mannose backbone with attached d-galactose molecules.

Monogastrics, including pigs, lack the essential enzyme needed to degrade galactomannans. This enzyme, beta-d-mannanase, degrades galactomannans, and is commercially available as the patented feed additive Hemicell®. Studies have shown decreased F:G and improved energy digestibility when broilers are fed corn-SBM based diets with added Hemicell® (McNaughton et al., 1998). An unpublished study conducted by the Taiwan Sugar Corp. found that pigs fed a diet with less digestible energy (≈100 kcal/kg with 4% crude fiber) but containing Hemicell® had similar ADG and F:G compared with pigs fed a higher energy diet (3% crude fiber) with no added enzyme. This suggests that Hemicell® may provide ≈100 kcal/kg ME to a swine diet. Pettey et al. (1999) found that weanling pigs fed corn-SBM diets with Hemicell® had similar ADG and F:G compared with pigs fed a diet with 2% added soybean oil. The objectives of these studies were: 1) to determine the effects of adding Hemicell® to corn-SBM diets for growing-finishing pigs compared with pigs fed diets with an added fat source, and 2) to determine the effects of Hemicell® on nutrient digestibility in finishing pigs.

Materials and Methods

Experiment 1. Sixty pigs were allotted randomly by weight, sex, and genotype to three dietary treatments. The experimental design was a randomized complete block design with five pen replicates per treatment. Yorkshires and Hampshire x Yorkshire crosses were used and equally distributed across treatments. Pigs were penned with four pigs per pen (two barrows, two gilts) and allowed *ad libitum* access to feed and water. Dietary treatments were: 1) a fortified corn-SBM (48% CP) diet to serve as the control; 2) the control diet with soybean oil added (2%) to increase ME by approximately 100 kcal/kg; and 3) the control diet with added Hemicell® (.05%) (Table 1). All feed was fed in meal form. Pigs were fed in three dietary phases. Diets in Phase 1 (50 to 115 lb), Phase 2 (115 to 180 lb), and Phase 3 (180 to 240 lb) were formulated to contain .95, .80, and .65% lysine, respectively. Pigs and feeders were weighed every 2 wk for determination of rate and efficiency of gain. When a replicate of the three treatments reached an average body weight of 240 lb, pigs were slaughtered, split along the dorsal midline, and chilled overnight. Backfat depth and loin muscle area (LMA) were measured from the left side of the carcass. Equations developed by the National Pork Producers Council (NPPC, 1991) were used to calculate total carcass lean tissue, percentage of carcass lean, and lean gain.

Experiment 2. Twelve crossbred barrows were allotted randomly by weight to the three dietary treatments used in Exp. 1. Pigs were penned individually in a randomized complete block design with four pen replicates and were fed their respective diets for 14 d. All diets were fed in meal form and pigs were given *ad libitum* access to feed and water. On d 10, chromic oxide (Cr_2O_3) was added to the diets to serve as an indigestible marker. Fresh fecal samples were collected from each pig on d 13 and d 14 and frozen for analyses. Feed and freeze-dried feces were analyzed for energy by bomb calorimetry. Nitrogen was determined using Kjeldahl methodology. Phosphorus and chromium concentrations were measured by inductively coupled plasma spectrometry.

Data in Exp. 1 and 2 were analyzed as a randomized complete block design using analysis of variance procedures as described by Steel et al. (1997). In both experiments, pen served as the experimental unit. Pre-planned non-orthogonal contrasts were used to compare treatment means.

Results and Discussion

Experiment 1. Throughout the experiment, pigs fed a diet with a high-energy source (ie. soybean oil) performed as expected compared with pigs fed the control diet (Table 2). Overall, soybean oil addition decreased (P<.02) feed intake and improved (P<.06) feed efficiency compared with the control diet, while pigs fed the diet with Hemicell® gained faster (P<.02) than pigs fed the control diet. Pigs fed a diet with soybean oil or Hemicell® were similar (P>.53) in their conversion of feed to gain.

There were no differences among the three treatment groups in LMA. However, soybean oil addition decreased (P<.03) 10th rib fat compared with pigs fed the control diet. Pigs fed the diet with Hemicell® had heavier (P<.04) carcasses compared with the controls. Also, Hemicell® addition numerically decreased 10th rib fat and increased LMA. Using NPPC equations, total lean gain, carcass lean tissue, and percentage of lean were calculated for all pigs. All calculations are expressed on a fat-free basis (Table 3). The addition of Hemicell® increased (P<.03) lean gain and carcass lean tissue compared with pigs fed the control diet or the diet with soybean oil.

Results of Exp. 1 concur with similar studies conducted in growing-finishing pigs. Hahn et al. (1995) determined that Hemicell® improved F:G in finishing pigs and observed a trend for an improvement in lean gain. Also, these results support previous studies where weanling pigs fed diets with Hemicell® during the late nursery phase had improved feed efficiency, similar to pigs fed a diet with 2% soybean oil (Pettey et al., 1999). From these results, we conclude that Hemicell® addition to corn-SBM diets improves the rate and efficiency of gain in finishing pigs, and increases carcass lean tissue and lean gain.

Experiment 2. During the 14-d feeding period, barrows fed the diet with soybean oil consumed less (P<.09) feed as compared with barrows fed the diet with Hemicell®. There were no differences in the apparent digestibility of energy, nitrogen, phosphorus, or dry matter. However, pigs fed a diet with Hemicell® did show slight numeric improvements in digestibility of each nutrient tested when compared to the control diet (Table 4).

Data from a recent study (Radcliffe et al., 1999) showed that the addition of Hemicell® increased ($P < .05$) the apparent ileal digestibility of dry matter and the apparent total tract digestibility of energy. This study was conducted in cannulated pigs fed a corn-SBM (44% CP) based diet with .5% Hemicell®. Our observations in Exp. 2 agree with data from the previous study, however, differences in nutrient digestibility were not significant. Yet, realistically, the small content of beta-mannan in dehulled soybean meal is likely to cause difficulties in the detection of differences in digestibility. Further research using total collection of feces and urine may be needed to determine any differences in energy digestibility of a diet containing dehulled soybean meal and added Hemicell®.

Implications

The addition of Hemicell® to a typical corn-SBM diet for growing-finishing pigs resulted in an improvement in ADG and feed efficiency, indicating that time spent on feed can be reduced in a commercial setting. Also, pigs consuming a diet with Hemicell® appear to have greater lean gain and carcasses with more total lean tissue.

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Table 1. Composition of diets in Exp. 1 and Exp. 2[a].

	Treatment		
Ingredient, %	Control	Soybean oil	Hemicell®
Corn, dent grain	71.68	69.48	71.68
Soybean meal,	25.28	25.47	25.28

dehulled			
Cornstarch	.05	.05	
Dicalcium phosphate	1.49	1.51	1.49
Limestone	.75	.74	.75
Salt	.25	.25	.25
Soybean oil		2.00	
Trace Min/Vit premix	.25	.25	.25
Antibiotic	.25	.25	.25
Hemicell®[b]			.05
Calculated analysis			
ME, kcal/kg	3308	3407	3306
Lysine, %	.95	.95	.95
Ca, %	.75	.75	.75
P, %	.65	.65	.65

[a]Dietary treatments were fed in three phases (Phase 1 diets shown).

[b]Hemicell® provided 109 million IU/ton and was added at the expense of cornstarch.

Table 2. Effects of soybean oil and Hemicell® on growth performance of growing-finishing pigs (Exp. 1)[a].

	Treatment[b]			
Item	Control	Soybean oil	Hemicell®	SE
Number of pigs	20	20	20	
Initial weight, lb	50.1[c]	48.7[c]	49.9[c]	
Final weight, lb	240.0[c]	234.2[d]	246.7[e]	.97
Phase 1				
ADG, lb	1.90[cd]	1.84[c]	1.91[d]	.01
ADF, lb	4.17[c]	3.86[d]	4.29[c]	.04
F:G	2.20[cd]	2.10[c]	2.25[d]	.01
Phase 2				
ADG, lb	1.91[c]	1.98[cd]	2.03[d]	.02
ADF, lb	5.63[c]	5.31[d]	5.89[e]	.02
F:G	2.96[c]	2.69[d]	2.90[c]	.01
Phase 3				
ADG, lb	1.77[c]	1.68[d]	1.84[e]	.01
ADF, lb	6.91[c]	6.41[d]	6.41[d]	.08
F:G	3.98[c]	3.86[c]	3.51[d]	.01
Overall				
ADG, lb	1.86[c]	1.83[c]	1.92[d]	.01
ADF, lb	5.51[c]	5.11[d]	5.47[c]	.04
F:G	2.98[c]	2.80[d]	2.85[cd]	.01

[a]Least squares means for 5 pens/treatment with 4 pigs/pen.

[b]Control = fortified corn-SBM diet; Soybean oil = control + 2% soybean oil; Hemicell® = control + Hemicell® (.05%).

[c,d,e]Means within a row with different superscripts differ (P<.10).

Table 3. Carcass characteristics of pigs fed diets with soybean oil or Hemicell® (Exp. 1) [a].

Item	Treatment[b]			SE
	Control	Soybean oil	Hemicell®	
Number of pigs	20	19	20	
Hot carcass wt, lb	182.8[c]	179.4[c]	188.5[d]	1.70
10^{th} rib fat, in.	.88[c]	.81[d]	.84[cd]	.05
LMA, in^2.	6.33[c]	6.29[c]	6.70[c]	1.21
Fat-free lean				
Carcass lean, lb	90.42[c]	90.37[c]	94.86[d]	.54
Lean, %	49.46[c]	50.36[c]	50.40[c]	.43
Lean gain, lb/d	.71[c]	.72[c]	.75[d]	.01

[a]Least squares means for 5 pens/treatment with 4 pigs/pen.

[b]Control = fortified corn-SBM diet; Soybean oil = control + 2% soybean oil; Hemicell® = control + Hemicell® (.05%).

[c,d]Means within a row with different superscripts differ (P<.10).

Table 4. Daily intakes and apparent digestibility coefficients for finishing pigs fed corn-SBM diets with soybean oil or Hemicell®[a].

Item	Treatment[b]			SE
	Control	Soybean oil	Hemicell®	
ADFI, lb	6.70[cd]	6.26[c]	7.34[d]	.38
Energy, %	85.9[c]	86.9[c]	86.5[c]	.42
Nitrogen, %	80.8[c]	81.9[c]	80.7[c]	.88
Phosphorus, %	45.7[c]	48.5[c]	50.4[c]	3.5
Dry matter, %	91.7[c]	92.3[c]	92.1[c]	.34

[a]Least squares means for 4 pens/treatment with 1 pig/pen.

[b]Control = fortified corn-SBM diet; Soybean oil = control + 2% soybean oil; Hemicell® = control + Hemicell® (.05%).

[c,d]Means within a row with different superscripts differ (P<.10).