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Effects of Hemicell® Addition to Corn-Soybean Meal Diets on Energy and Nitrogen Balance in Growing Pigs

L.A. Pettey, S.D. Carter and B.W. Senne

Story in Brief

This study was designed to evaluate the effects of Hemicell®[5] addition to corn-SBM diets on energy and nitrogen balance in growing pigs, and to quantify the metabolizable energy (ME) concentration of a corn-SBM diet with Hemicell®. Five groups of four littermate barrows (n=20) were allotted randomly to four dietary treatments. Treatments were: 1) a fortified corn-SBM diet as the control; 2) the control diet with cornstarch added to the daily ration of each pig to increase the ME concentration by 100 kcal/kg; 3) the control diet with cornstarch added to the daily ration to increase ME by 200 kcal/kg; and 4) the control diet with Hemicell® (.05%). Pigs were housed in metabolic chambers to allow for the total but separate collection of feces and urine. Collections were conducted in two 5-d periods. Data were pooled from the two periods. As expected, gross energy of Diets 1, 2, and 3 increased linearly with cornstarch addition, while the diet with added Hemicell® was similar to the control. No differences in fecal energy or urinary energy losses were detected among the four diets. Thus, ME concentrations increased for Diets 1, 2, and 3 as increasing amounts of cornstarch were added to the daily rations of the pigs. The diet with added Hemicell® had a similar ME concentration (kcal/kg) as compared with the control diet. Nitrogen absorption and retention, as a percentage of intake, were not affected by the addition of Hemicell®. Based on these observations, Hemicell® appears to have no effect on the ME concentration of a typical corn-SBM diet.

Key Words: Enzyme, Metabolizable Energy, Pigs

Introduction

Galactomannans are non-starch polysaccharides commonly found in the ungerminated seeds of many legumes. These cell wall components are chemically composed of a chain of repeating mannose molecules connected by beta-1-4 linkages, with galactose molecules attached to the chain. Monogastric animals, such as pigs, lack the essential enzyme to break down the mannan chain.

Soybean meal can contain 1.3 – 1.7% beta-mannans on a dry matter basis according to ChemGen (unpublished data). Although research focused on beta-mannans in soybean meal is limited, the guar seed contains high levels of beta-mannans and has been used to evaluate the effects of these non-starch polysaccharides in animal diets. When added to broiler diets, guar meal (a product of the extraction of gums from guar seeds) decreases growth performance (Vorha and Kratzer, 1964; Verma and McNab, 1981). Guar gums have been found to inhibit glucose absorption in pigs and rats (Rainbird et al., 1984; Blackburn and Johnson, 1981) possibly by preventing smooth muscle contractions from mixing intestinal contents (Edwards et al., 1988).

An enzyme, Hemicell®, can be added to swine and poultry diets to degrade beta-mannans. The addition of Hemicell® to corn-SBM diets can improve the efficiency of pigs in late nursery phases (Pettey et al., 1999) and pigs fed through the growing-finishing phase (Hahn et al., 1995; Pettey et al., 2000).

Research conducted by Radcliffe et al. (1999), suggests increased total tract digestibility of energy in pigs fed diets containing Hemicell®. In previous work using the chromium marker method, we found no differences in energy digestibility when Hemicell® was added to a corn-SBM diet (Pettey et al., 2000). Our objectives were to evaluate the effects of adding Hemicell® to a typical corn-SBM diet on energy and nitrogen balance, and potentially quantify the metabolizable energy Hemicell® adds to the diet.

Materials and Methods

Five sets of four littermate barrows were blocked by weight and allotted randomly to four dietary treatments in a randomized complete block design. Treatments were: 1) a fortified corn-SBM diet as the control; 2) the control diet with cornstarch added to the daily ration of each pig to increase the ME concentration by 100 kcal/kg; 3) the control diet with cornstarch added to increase ME concentration by 200 kcal/kg; and 4) the control diet with Hemicell® (.05%). The composition of the basal diet is shown in Table 1. Pigs were housed individually in metabolic chambers (2.5 ft x 3.3 ft) with galvanized mesh floors and pigs had *ad libitum* access to water.

Pigs were equally fed within litter group to ensure equal consumption of the basal diet and to maintain differences in ME intake. Daily rations of the basal diet were weighed and cornstarch was added and mixed according to the respective treatments. The proper amount of cornstarch required to increase ME by 100 or 200 kcal/kg was determined daily by the following equation:

A = (desired increase in ME / ME of cornstarch) x daily ration

An increase of 100 and 200 kcal/kg ME requires the addition of 2.5 and 5% cornstarch to the daily ration, respectively, assuming the ME concentration of cornstarch equals 3985 kcal/kg (NRC, 1998).

Pigs were fed their respective treatments for a total of 22 days. The total but separate collection of feces and urine was conducted in two 5-d periods (Period 1, d 4 to 8; Period 2, d 18 to 22). Urine and feces were stored frozen (-20°C) until further analyses. Feces were oven-dried (60°C), ground in a Wiley Mill equipped with a 1 mm screen, and subsampled. A sample (approx. 75 ml) was taken from the total daily urine volume. All samples collected were combined to a 100 ml composite based on the percentage of the daily volume of the total 5-d urine volume. Gross energy determinations were made by bomb calorimetry. For urinary energy analyses, two milliliters of composite urine was added to one-half gram of cellulose (Solka-Floc) and dried 24 hr at 100°C. After bomb analysis, the gross energy of the urine was calculated based on the total energy of combustion and the percentage of dry urine in the combusted pellet.

Data were analyzed as a randomized complete block design using analysis of variance procedures as described by Steel et al. (1997). Pen served as the experimental unit. The interaction of period x treatment was tested. The effects of ME concentration by increasing cornstarch addition were partitioned into linear and quadratic components using orthogonal polynomial contrasts. A pre-planned non-orthogonal contrast was used to compare the Hemicell® treatment with the control.

Results and Discussion

There were no period x treatment interactions; therefore data were pooled across period. The addition of increasing levels of cornstarch to the daily rations linearly ($P<.01$) increased gross energy (GE) intake (Table 2). Pigs fed the diet with Hemicell® were similar in energy intake compared with pigs fed the control diet. There were no differences ($P>.10$) among the four dietary treatments in energy lost as fecal energy (FE) or urinary energy (UE). Thus, when using the equation: $ME = GE – FE – UE$, metabolizable energy (ME) was found to increase linearly ($P<.01$) with increasing levels of cornstarch addition to the pigs' daily rations. The diet containing Hemicell® had a similar ME value compared with the control diet, when expressed on a concentration basis (kcal/kg). Therefore, the addition of Hemicell® had no effect ($P>.10$) on the ME of the diet.

The comparison of ME concentrations of the four diets is shown in Figure 1. By adding increasing levels of cornstarch and feeding the same amount of basal diet to each pig in the litter group, we observed a linear ($P<.01$) increase in the ME concentration of the three dietary treatments. This line, only when linear, can be used as a reference to quantify the ME content of the diet with Hemicell®. As seen in Figure 1, Hemicell® added no ME to a corn-SBM diet, thus no increase could be quantified.

Increasing the level of cornstarch added to the daily rations had no effect on nitrogen balance (Table 3). However, nitrogen intake (g/d) was greater ($P<.04$) for pigs fed the control diet compared with pigs fed the diet with added Hemicell®. This increased intake of nitrogen led to a trend towards greater (P<.10) absorption of nitrogen on a grams/d basis. Yet, when comparing nitrogen absorption and retention as a percentage of intake, no differences (P>.10) were observed between the two treatments.

Although improvements in energy and nitrogen digestibility have been reported in pigs fed diets with Hemicell® (Radcliffe et al., 1999), this experiment failed to reveal similar results. Certainly, differences in beta-mannan content of different soybean meal types could influence detection of inhibiting factors present in those feed ingredients. The improvements in digestibility by adding Hemicell® shown by Radcliffe were observed with diets containing soybean meal with the hull portion added back (44% CP), which increases the beta-mannan content of the diet. Thus, with more substrate available for Hemicell® to degrade, a greater increase in digestibility would be expected. Results of our experiment support earlier data in finishing pigs when diets with dehulled soybean meal (48% CP) were fed and only slight numeric improvements in digestibility by adding Hemicell® were observed (Pettey et al., 2000).

Implications

Although the addition of Hemicell® to corn-SBM diets has been shown to improve efficiency of feed utilization, results of the present experiment suggest that the mechanism of action is not an increase in the metabolizable energy concentration of the diets. Also, the digestibility of nitrogen does not appear to be a contributing factor toward the improvements seen in growth performance. Further research evaluating the effects of a beta-mannanase on gastrointestinal peptide regulation and blood insulin levels may prove beneficial in determining the mode of action of Hemicell® in improving growth performance.

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Table 1. Composition of basal diet[a].

Ingredient, %	
Ground corn	66.65
Soybean meal, dehulled	30.68
Dicalcium Phosphate	1.09
Limestone	.83
Salt	.25
Trace Vit/Min premix	.25
Antibiotic	.20
Cornstarch[b]	.05

[a]Cornstarch was added to the daily rations to provide 100 or 200 kcal/kg ME in Diets 2 and 3.

[b]Hemicell® replaced cornstarch in Diet 4 and provided 89 million IU/ton.

Table 2. Energy balance of pigs fed corn-SBM diets with increasing levels of cornstarch or Hemicell®[ab].

	Treatment[c]				
Item	Control	+100	+200	Hemicell®	SE
ADFI, g/d[d]	1397	1482	1510	1417	16.3
GE, kcal/kg	4455	4547	4651	4443	
GE intake, kcal/d[d]	6222	6735	7025	6297	73.5
FE, kcal/d	740.9	730.8	763.8	738.3	32.3
UE, kcal/d	114.7	108.4	110.6	111.5	3.3
DE, kcal/d[d]	5481	6004	6261	5559	73.5
DE, kcal/kg[d]	3921	4053	4144	3914	21.1
ME, kcal/d[d]	5366	5896	6151	5448	72.8
ME, kcal/kg[d]	3840	3980	4071	3836	20.6
ME:DE, %[d]	97.9	98.2	98.2	98.0	.06
ME:GE, %[e]	86.2	87.5	87.5	86.3	.46

[a]Least squares means for 5 pigs/treatment; pooled data from two 5-d periods.

[b]All values are expressed on a dry matter basis.

[c]Control = fortified corn-SBM diet; +100 = control + 100 kcal/kg ME from cornstarch; +200 = control + 200 kcal/kg ME from cornstarch; Hemicell® = control + Hemicell® (.05%).

[d]Linear (P<.01) for control, +100, and +200.

[e]Linear (P<.07) for control, +100, and +200.

Table 3. Nitrogen balance of pigs fed corn-SBM diets with increasing levels of cornstarch or Hemicell®[ab].

	Treatment[c]				
Item	Control	+ 100	+ 200	Hemicell®	SE
N intake, g/d[d]	47.5	47.1	48.1	45.8	.53
Fecal N, g/d	7.2	7.4	7.6	7.2	.46
Urinary N, g/d	14.9	13.7	13.9	14.4	.66
N absorption, g/d	40.3	39.7	40.6	38.5	.69
N retention, g/d	25.3	26.0	26.7	24.2	.80
N absorption, % intake	84.7	84.2	84.2	84.0	.99
N retention, % intake	53.4	55.1	55.4	52.8	1.4

[a]Least squares means for 5 pigs/treatment.

[b]All values are expressed on a dry matter basis.

[c]Control = fortified corn-SBM diet; +100 = control + 100 kcal/kg ME from cornstarch; +200 = control + 200 kcal/kg ME from cornstarch; Hemicell® = control + Hemicell® (.05%).

[d]Hemicell® vs control (P<.05).

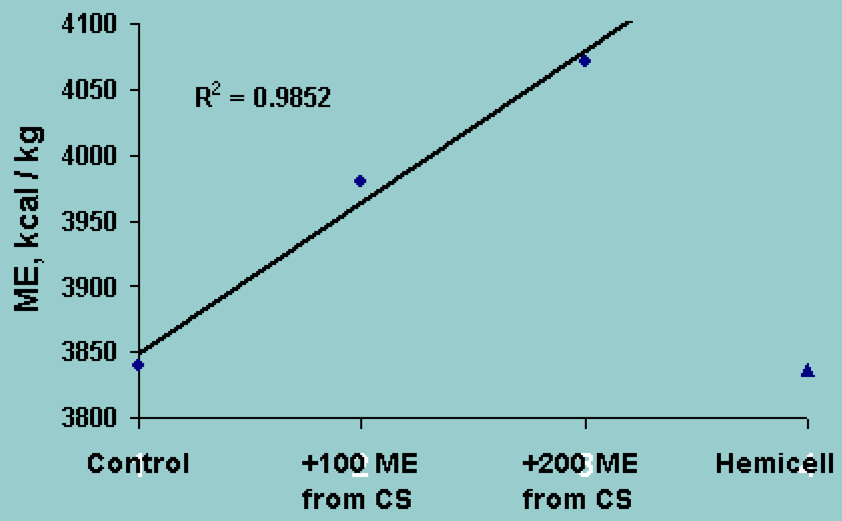

Figure 1. The metabolizable energy concentrations of three diets with increasing levels of cornstarch (CS) addition compared with the ME concentration of a diet with Hemicell®.

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