THE EFFECTS OF DIETARY FIBER COMPONENTS ON DIGESTIBILITY IN SWINE

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Story in Brief

A digestion trial with ten ileally cannulated barrows (150 lb) was conducted to determine the effects of the addition of semi-purified fiber components on site of digestion and apparent dry matter and protein digestibility. Treatments consisted of a basal corn-soy diet with 10 percent of either cornstarch (control), mucilose flakes (hemicellulose), solka floc (cellulose), lignin or guar gum (a source of gum and mucilages), added by weight to the basal diet. Pre-ileal digestibility of dry matter was reduced in pigs fed all fiber sources when compared to those fed the control diet. The magnitude of reduction, however, was much greater when guar gum or mucilose flakes were added to the diet. Similarly, protein apparent digestibility was decreased preileally and increase postileally in pigs fed guar gum and mucilose flakes when compared to pigs fed either the control diet or a diet containing either solka floc or lignin as the fiber source. Fecal digestibility of dry matter was decreased in pigs fed mucilose flakes, solka floc or lignin but not guar gum as the source of fiber. Apparent fecal crude protein digestibility was reduced by the addition of mucilose flakes and lignin. This study suggests that fiber components composed of noncellulosic polysaccharides may shift the site of digestion to the cecum and large intestines and may decrease overall digestibility.

Introduction

Swine producers have traditionally utilized forages and by-products as a means of reducing feed cost and supplying protein, vitamins and minerals in swine rations. Least cost ration formulation programs could provide for additional incorporation of fibrous feedstuffs in swine rations if such feedstuffs do not interfere with utilization of other dietary nutrients. While earlier studies have demonstrated the efficacy of feeding many of these fibrous feedstuffs to swine, little is known about the digestibility of specific fiber components and their effect on the digestibility of other nutrients. This study was conducted to determine the effect of semi-purified dietary fiber components on site of digestion and apparent digestibility.

Methods and Materials

Ten ileally cannulated Yorkshire barrows (150 lb) fitted with simple T-cannulas were randomly allotted to one of five treatments in a replicated 5 x 5 latin square designed experiment. A basal corn-soy ration was formulated to contain .62 percent lysine and ten percent cornstarch (control) or one of four fiber sources was added by weight to the basal ration (Table 1). The four semipurified fiber sources selected to represent different fiber components were: (1) mucilose

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Table 1. Composition of experimental diets

Ingredient	%
Ground shell corn	71.50
Soybean meal (44%)	15.30
Fiber source[a]	10.00
Dicalcium phosphate	1.60
Calcium carbonate	.75
Salt	.35
Vitamin premix	.25
Chromic oxide	.25
Total	100.00

[a] 1) cornstarch, 2) mucilose flakes (Winthrop Lab, New York, N.Y.), 3) Guar gum (Colony Import Export Corp. New York, N.Y.) 4) Lignin (West Vaco, Charleston, S.C.) 5) Solka floc (James Rivers Co., Berlin, N.H.)

flakes, a fiber composed primarily of hemicellulose; (2) solka floc, a purified form of wood cellulose; (3) indulin, a purified source of lignin; (4) guar gum to represent the gums and mucilages. Each pig was maintained in an individual metabolism crate and fed 4.4 lb/day in two equal feedings at 0800 and 1600 hrs. Each period consisted of ten days with days 1-5 serving as an adjustment period. On days 6, 7 and 8 ileal samples were collected in a 3 ounce plastic bag attached to the cannula starting 4 hours after the 0800 feeding. A subsample was obtained to measure ileal pH and dry matter. Grab fecal samples were collected at 1200 hr on days 7, 8 and 9. Samples were frozen and stored at 0 F. Lyophilized ileal and fecal samples from each individual pig for each period were composited based on an equal dry matter weight per day and analyzed for Kjeldahl nitrogen and chromic oxide.

Results and Discussion

The addition of fiber reduced ($P<.05$) preileal apparent dry matter digestibility (Table 2). Preileal digestion was reduced from 79 percent in pigs fed the control diet to 55 percent and 50 percent in pigs fed diets containing guar gum and mucilose, respectively. This reduction in apparent dry matter digestibility in pigs fed guar gum and mucilose flakes was greater than could be accounted for by the addition of a 10 percent nondigestible fraction and suggests that these fiber sources were not only poorly digested in the small intestines but substantially reduced preileal apparent digestibility of other dietary components. Apparent preileal dry matter digestibility was reduced to 65 percent and 67 percent in pigs fed solka floc and lignin, respectively ($P<.05$), an amount which could be accounted for by the addition of a 10 percent nondigestable fraction.

Postileal apparent dry matter digestibility increased ($P<.05$) in pigs fed guar gum and mucilose flakes when compared to those fed the non-fiber control diet or diets containing solka floc or lignin as the fiber source. This suggest that guar gum and mucilose flakes cause a shift in digestion of the nonfiber dietary components from preileal to

Table 2. The effect of fiber source on apparent dry matter digestibility

Item	Treatment				
	Control	Guar Gum	Mucilose Flakes	Solka Floc	Lignin
Intake, lb/d	3.84	3.82	3.82	3.84	3.84
Digestion, %					
Preileal	79.00[a]	55.00[cd]	50.00[d]	65.00[bc]	67.00[b]
Postileal	8.00[b]	30.00[a]	28.00[a]	13.00[b]	9.00[b]
Fecal	87.00[a]	85.00[a]	78.00[b]	78.00[b]	76.00[b]

[a,b,c,d]Means in a row with different superscripts differ (P<.05).

postileal digestion or that dietary fiber sources are digested postileally or a combination of these effects. Fecal dry matter digestibility was reduced (P<.05) in pigs fed mucilose flakes, solka floc or lignin but not guar gum when compared to pigs fed the nonfiber control diet.

Apparent crude protein digestibility followed a pattern similiar to that observed for dry matter (Table 3). Guar gum and mucilose flakes addition reduced (P<.05) apparent preileal crude protein digestibility from 76 percent (control) to 48 percent while solka floc and lignin addition had little effect on apparent crude protein digestibility. Postileal apparent crude protein digestibility increased with the addition of guar gum and mucilose flakes. Fecal apparent crude protein digestibility was reduced (P<.05) with the addition of mucilose flakes and lignin, but not guar gum and solka floc when compare to the control diet.

Table 3. The effect of fiber source on apparent crude protein digestibility in swine

Item	Treatment				
	Control	Guar Gum	Mucilose Flakes	Solka Floc	Lignin
Intake, lb/d	.44	.48	.48	.49	.49
Digestion, %					
Preileal	76.00[a]	48.00[b]	48.00[b]	72.00[a]	71.00[a]
Postileal	5.00[a]	30.00[b]	23.00[b]	7.00[a]	1.00[a]
Fecal	80.00[a]	78.00[a]	71.00[b]	79.00[a]	73.00[b]

[a,b]Means in a row with different superscripts differ (P<.05).

Dietary fiber source had an effect on dry matter of ileal chyme ($P<.05$; Table 4). Dry matter of ileal chyme ranged from a 13.2 percent in pigs fed lignin to 8.6 percent in pigs fed mucilose flakes. In addition, a noticable increase in viscosity occurred when both guar gum and mucilose flakes were included in the diet. The pH of chyme was similar across all dietary treatments. The effect of specific fiber sources upon digestibility may be related to the physical effects of digesta contents.

This study suggests that, at the 10 percent level, noncellulosic fiber components (hemicellulose, gum and mucilages) may move the site of digestion of nonfiber dietary components from preileal to postileal and reduce overall digestibility. Cellulose and lignin components when added at levels used in this experiment appear to have little effect on apparent digestibility of dry matter and crude protein in swine rations.

Table 4. Effect of dietary fiber source on swine ileal contents

	Treatment				
Item	Control	Guar Gum	Mucilose Flakes	Solka Floc	Lignin
Dry Matter, %	10.50^{ab}	11.80^{ab}	8.60^{b}	12.40^{a}	13.20^{a}
PH	6.48	6.23	5.99	6.67	6.36

^{a,b}Treatments with different superscripts are significantly different ($P<.10$).