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Nutrient
Management

DIETARY FIBER LEVEL AND XYLANASE AFFECT NUTRIENT DIGESTIBILITY AND EXCRETA CHARACTERISTICS IN GROWER PIGS

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Summary
An experiment was conducted with twelve grower pigs to determine if lowering dietary fiber, through selection of commonly available feedstuffs or including a commercial xylanase, can provide an effective and practical approach for improving nutrient digestibility and reducing waste production in pigs. Data obtained in this study show that lowering dietary NDF level or dietary inclusion of xylanase to high fiber diets improves the total tract digestibility of most nutrients and as a result reduces waste excretion in pigs.

Introduction
Pig production has changed dramatically over the last fifty years with small, family farms being replaced by large, highly integrated production systems. Currently, large amounts of manure are produced in concentrated areas and given that shipment of this bulky material to crop producing areas of the country is not attractive economically, alternative nutrient management strategies must be employed.

One nutritional strategy, that has received little attention, involves the reduction of indigestible fiber in pig feeds. Fiber has been shown repeatedly to decrease nutrient digestibilities and as a consequence, increase fecal bulk and nutrient excretion (Stanogias and Pearce, 1985; Canh et al., 1998; Davidson and Mcdonald, 1998).

Another novel nutritional strategy, receiving a considerable amount of attention, involves the use of exogenous fiber degrading enzymes to improve the digestibility of nutrients and, therefore, reduce manure production in monogastric species. For the most part, these studies have focused on the effects of ß-glucanase in pig diets containing barley and oats (Baas and Thacker, 1996, Baidoo et al., 1998). Relatively little data have been published regarding the effects of xylan-degrading enzymes (xylanase) in pig diets based on corn and soybean meal.

The objectives of this balance study were to evaluate: 1) the effect of manipulating dietary fiber level and 2) the efficacy of supplementing a high fiber diet with a commercial xylanase on nutrient digestibility, excreta pH, and fecal production in grower pigs.

Materials and Methods
Twelve grower crossbred (Yorkshire X [Duroc X Hampshire]) barrows with an initial body weight of 33 kg were housed in metabolism cages in an environmentally controlled room. Pigs were randomly assigned to one of four experimental diets according to a 4X4 Latin square design. Experimental diets were formulated to contain three levels of dietary fiber: low fiber (5.6% NDF), moderate fiber (10.3% NDF), and high fiber (18.4% NDF). 0.2% xylanase was added to the high fiber diet to make up the fourth dietary treatment (Table 1). The experiment lasted 28 days

with each experimental period consisting of a 4-day dietary adaptation period followed by a 3-day quantitative collection of urine and feces. Pigs were fed experimental diets twice daily at twelve-hour intervals (0700-1900) at a restricted feeding level equal to .29 Mcal ME/kg$^{0.75}$ (90 g/kg$^{0.75}$ for the low and moderate fiber diet, and 101 g/kg$^{0.75}$ for the high fiber diets).

Table 1. Composition of Experimental Diets

Diet	Low fiber	Moderate fiber	High fiber	High fiber + xylanase
NDF, %:	5.6	10.3	18.4	18.4
Corn	-	69.7	57.3	57.1
Degermed, dehulled corn	78.6	-	-	-
Soybean meal	-	27.4	18.9	18.9
Soybean hulls	-	-	20	20
Corn gluten meal	11.6	-	-	-
Meat and bone meal	5	-	-	-
Blood meal	2.5	-	-	-
Xylanase[a]	-	-	-	0.2
Crude Protein	18	18.7	16.4	16.4
ME:dLYS	0.34	0.34	0.34	0.34

Results and Discussion

Lowering dietary fiber from 10.3% NDF to 5.6% NDF resulted in significant improvements in the digestibility of dry matter and energy but had no effect on the nitrogen digestibility. Raising dietary fiber via the addition of soybean hulls resulted in marked reductions in the digestibility of dry matter, energy, and nitrogen (Figure 1). This effect was linear when comparing values from the low fiber, moderate fiber, and high fiber diet with regards to the digestibility of energy and dry matter (r^2 = 0.99). Noblet and Perez (1993) reported similar results with grower pigs (45kg), with each 1% increase in dietary fiber resulting in a reduction in energy digestibility by 1.1%. In our study, the effect of dietary fiber on the digestibility of energy was less pronounced in that a 1% increase in dietary fiber resulted in a reduction in the energy digestibility coefficient by 0.86%.

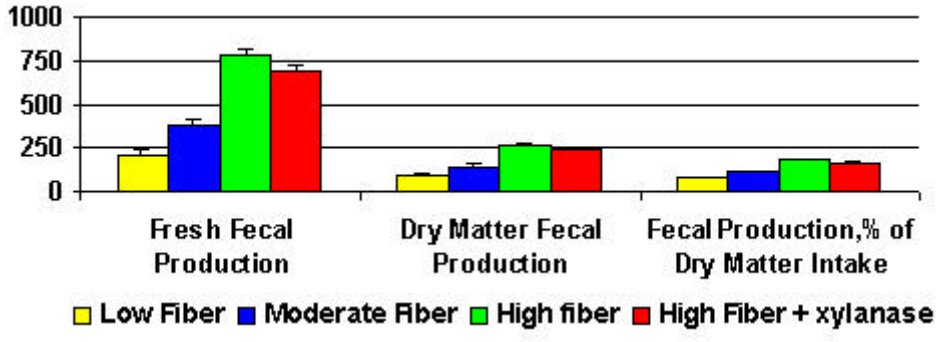

Figure 1. Apparent digestibility of dietary components as affected by fiber level and xylanase.

It remains unclear why lowering dietary fiber level from 18.4% to 10.3% improved nitrogen digestibility but lowering dietary fiber from 10.3% to 5.6% had no effect. In the literature, dietary fiber has been shown to exert consistently negative, linear effects on the digestibility of nitrogen at both the ileal and fecal level. Schulze et al. (1995) showed the levels of endogenously excreted nitrogen to be linearly related to the levels of dietary NDF intake. Failure to observe improvements in nitrogen digestibility at the lowest fiber level may well be related to the variability and(or) overestimation of the quality of the major protein sources used in the low fiber diet. Meat and bone meal and corn gluten meal are by-products originating from the animal rendering processes and corn milling processes, respectively, and their quality, i.e., amino acid digestibility, has been shown to be variable. For example, meat and bone meal has an ileal lysine digestibility coefficient of 80% and ileal cysteine digestibility of 63%(NRC, 1998). However, Parsons et al. (1997) showed that ileal digestibility coefficients of meat and bone meal can range between 69 to 88% for lysine and 37 to 72% for cysteine.

Dietary addition of 0.2% xylanaseto the high fiber diet in our study improved the digestibility of dry matter and energy by 2 and 3%, respectively. Xylanase supplementationalso resulted in a trend for improved digestibility of nitrogen.

Lowering dietary fiber from 10.3% NDF to 5.6% NDF resulted in a 35% reduction in the excretion of dry feces. This equated to a 9% reduction in fecal excretion for each 1% decrease in dietary NDF content. On the other hand, increasing the dietary fiber from 10.3% to 18.4% NDF resulted in 57% more dry fecal excretion. Addition of xylanase to the high fiber diet reduced fecal excretion by 10% ($P < 0.01$).

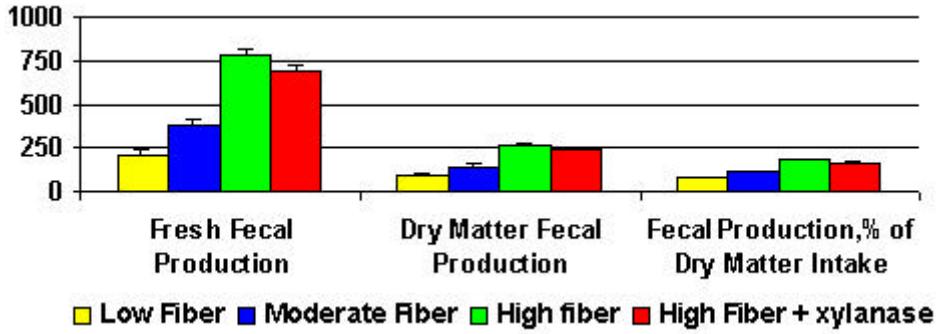

Figure 2. The impact of dietary fiber level and xylanase on fecal excretion and characteristics of manure.

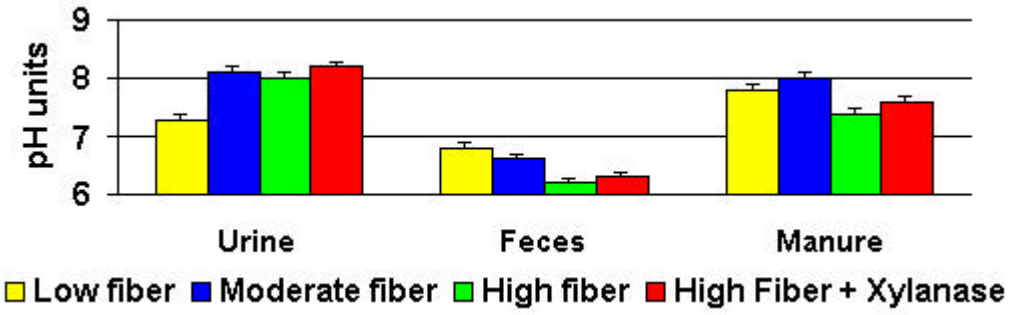

Figure 3. Dietary fiber level and xylanase influence excreta pH.

Supplementing swine diets with fermentable fiber sources has been proposed as a means to

alter excreta pH and as a result, reduce ammonia emissions from swine manure (Canh et al., 1998, Aarnink et al., 1996). Undigested fiber entering the large intestine supplies a considerable amount of microbial substrate for fermentative processes in the large intestine. As a result, short chain fatty acids are yielded as a major end product, effectively decreasing the luminal pH.

Raising dietary fiber via the addition of 20% soybean hulls in this study resulted in significantly lower pH values of feces and manure. Our results are in agreement with several studies that describe the acidifying effects of dietary fiber on feces and manure. Canh et al. (1998) reported a positive linear effect of increasing dietary levels of fermentable fiber on short chain fatty acid concentrations in feces from pigs. Aarnink (1996) supplemented pig diets with soybean hulls and found that pig feces had increased short chain fatty acid concentrations.

Although fiber supplementation to pig diets has been shown to be beneficial to the environment through its effect on reducing ammonia emissions, this type of feeding may give rise to other environmental problems. As shown in this study and many others, increasing dietary fiber results in a decrease in the digestibility of dietary nutrients and increases waste production in pigs. Also, given that fiber supplementation reduces digestibility, this may increase odor production as more substrate is available for microbes in the large intestine to convert to malodorous compounds that are subsequently excreted in swine waste (Mackie et al., 1998).

Implications

This study illustrates the negative impact of dietary fiber on nutrient digestibility and fecal production when fed to pigs. This study also provides evidence that lowering dietary fiber level through ingredient selection or including xylanase in pig diets may provide an effective strategy to reduce the amount of waste generated.

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