Identifying Dietary Fiber Components that Best Predict the Digestible and Metabolizable Energy Content in Nine Corn Co-Products Fed to Growing Pigs

A.S. Leaflet R2926

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Summary and Implications

An experiment was conducted to determine the best dietary fiber (DF) assay to estimate the effect of DF concentration on energy digestibility, and to predict the digestible (DE) and metabolizable (ME) energy of 9 corn co-products: conventional corn bran, corn bran with solubles, corn distillers dried grains with solubles (DDGS) conventionally produced, reduced oil DDGS, uncooked DDGS, high protein distillers dried grains, dehulled degermed corn, corn germ meal, and corn gluten meal. The apparent total tract digestibility (ATTD) of gross energy (GE), and the DE and ME of the 9 feed ingredients were determined in 20 growing pigs (BW = 25.9 ± 2.5 kg). Feed ingredients were analyzed for the concentration of dietary fiber: NDF, TDF, total non-starch polysaccharides (NSP), and 5 constituent monosaccharides of NSP, namely arabinose (Ara), xylose (Xyl), mannose (Man), glucose (Glc), and galactose (Gal). The concentration of xylose in NSP was the DF assay that best explained variation due to DF concentration in digestibility of energy, DE, and ME values, and can be used to predict the DE and ME values in corn co-products.

Introduction

Corn co-products are typically rich in dietary fiber (DF) with widely variable concentrations of starch, amino acids, and fat. Knowledge of the concentration and composition of DF of feed ingredients is of critical importance, because DF may reduce amino acid and energy digestibility. The DF in corn and co-products is highly resistant to fermentation, and is largely constituted of insoluble non-starch polysaccharides, such as cellulose, arabinoxylans, and lignin. These polysaccharides are mainly polymers of hexoses (D-glucose, D-galactose, D-mannose) and pentoses (L-arabinose, D-xylose) joined through glycosidic linkages. Common assays to determine the DF concentration of a feed ingredient include acid detergent fiber (ADF), neutral detergent fiber (NDF), and total dietary fiber (TDF). Classification by differences in detergent solubility lacks precision with respect to chemical structures and biological function. Therefore, the nutritional relevance of values obtained using these methods in monogastric nutrition is questionable. The analysis for total NSP and constituent monosaccharides may be a tool to understand the effect of the DF concentration on the nutritional value of corn co-products.

Advances in the ethanol industry increase the efficiency of starch and oil extraction from the corn grain, resulting in continuous changes in chemical composition of corn co-products, which present a challenge to estimate their nutritional value. The ADF alone accounted for 85% of the total variation in energy content of barley, but a comprehensive analysis of the effects of DF concentration and selection of a best DF assay, on the DE and ME of corn co-products is unavailable.

In the present study, 9 corn co-products were selected to cover a wide range in DF concentration. The objective was to measure the effect of the DF assay that best explain variation on digestibility of energy, and on DE and ME in corn co-products.

Materials and Methods

A total of 20 growing pigs (initial BW: 25.9 ± 2.5 kg) were allotted to 10 dietary treatment groups in a 4-period incomplete block design with 8 observations per treatment. Treatments included a corn-soybean meal based basal diet and 9 diets obtained by mixing 70% of the basal diet with 30% of the test ingredient. Diets were formulated with titanium dioxide (0.4%), a non-digestible marker used in digestion studies, for estimation of energy digestibility. The 9 ingredients were analyzed for the concentration of NDF, TDF, total non-starch polysaccharides (NSP), and 5 constituent monosaccharides of NSP, namely arabinose (Ara), xylose (Xyl), mannose (Man), glucose (Glc), and galactose (Gal). The ATTD of GE was determined for the 9 feed ingredients, and used for DE calculations. The ME value was estimated using regression equations, using the DE and DF content as inputs. A single best fitting DF assay was assessed and ranked for each trait, and the effect of DF concentration on the variation in ATTD of GE, DE, and ME values was determined.

Results and Discussion

The ATTD of GE, and DE and ME values differed ($P < 0.01$) among the 9 corn co-products (Table 1). A single best fitting DF assay was assessed and ranked for each trait, showing that total the xylose concentration in NSP best explained variance in ATTD of GE (R^2=0.80; cubic, $P<0.01$), DE (R^2=0.66; linear, P=0.02) and ME (R^2=0.71; cubic, P=0.01) values (Table 2). In conclusion, the xylose in

NSP was the DF assay that best explained variation due to DF concentration, and can be used to predict the digestibility of energy, and DE and ME values in corn co-products.

Acknowledgments

We gratefully acknowledge the work of the farm staff at the Iowa State University Swine Nutrition Research Farm, Poet Nutrition (Sioux Falls, SD), and the National Pork Board (Des Moines, IA)

Table 1. Apparent total tract digestibility of energy and digestible and metabolizable energy value of ingredients[1,2]

	Ingredient										
Item	CBS	CB-NS	DDGS-CV	DDGS-RO	DDGS-BPX	HP-DDG	DDC	CGmM	CGnM	Pooled SEM	*P*-value
ATTD, %											
GE	53.4^{d}	40.3^{e}	72.1^{b}	64.8^{bc}	67.6^{bc}	70.7^{bc}	99.6^{a}	63.2^{c}	91.6^{a}	1.99	<0.01
Energy concentration, Mcal/kg (as-fed basis)											
DE	2.45^{e}	1.48^{f}	3.58^{bc}	3.19^{d}	3.34^{cd}	3.59^{bc}	3.84^{b}	2.74^{e}	4.64^{a}	0.09	<0.01
ME	2.39^{d}	1.46^{e}	3.40^{b}	3,03^{c}	3,17^{bc}	3.33^{bc}	3.79^{a}	2,63^{d}	4.07^{a}	0.08	<0.01

[a,b] Means within a row lacking a common superscript letter are different ($P < 0.05$).

[1]Least squares means of 8 pigs per ingredient.

[2]CBS = corn bran with solubles; CB-NS = corn bran; DDGS-CV = conventional DDGS; DDGS-RO = reduced oil DDGS; DDGS-BPX = uncooked DDGS; HP-DDG = high protein distillers dried grains; DDC = dehulled-degermed corn; CGmM = corn germ meal; CGnM = corn gluten meal.

Table 2. Regression coefficients and model fit of the best fitting dietary fiber across traits.

		Regression components					
Trait	DF[2]	Intercept	Linear	Quadratic	Cubic	R^2_{fiber}	*P*-value[1]
ATTD, %							
GE	Xyl	106.5	-18.3	2.6	-0.1	0.80	<0.01
Energy concentration, Mcal/kg (as-fed basis)							
DE	Xyl	4.46	-0.46	-	-	0.66	0.02
ME	Xyl	4.22	-0.52	0.08	-0.004	0.71	0.01

[1]*P*-value of the highest order regression component.

[2]Concentration of DF in feed ingredients. Xyl = xylose concentration in total NSP.