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B J. Healy

P J. Bramel-Cox

B T. Richert

See next page for additional authors

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Selection for increased in vitro digestibility improves feeding value of sorghum grain

Abstract

Six cannulated barrows and two hundred eighty-eight chicks were used in an experiment to determine the value of an in vitro protein digestibility assay (pepsin digest) for identification of sorghum parent lines with improved nutritional value. The barrows were used to determine digestibility of the experimental sorghums at the terminal ileum and for the total digestive tract. Due to a limited supply of the sorghums, broiler chicks were used as a model to predict the value of the experimental sorghums for growth performance. Four sorghum parent lines were selected from 100 SI families grown at several locations in Kansas. Two of the sorghums were consistently low and two were consistently high for in vitro digestibility. Treatments were: 1) corn-soybean meal control; 2) and 3) low digestibility sorghums (LDI and LD2); 4) and 5) high digestibility sorghums (HDI and HD2); and 6) pearl millet (PM). The sorghums that had consistently high in vitro digestibility were of greater nutritional value to pigs and growing chicks than sorghums with low in vitro digestibility. In the pig experiment, digestibility of N at the terminal ileum ranged from 69.6% for LDI to 79.0% for HDl, compared to 81.6% for the corn-based control. Similar responses were noted for digestibility of gross energy, with values of 71.8% and 77.0% for LDI and HDl, compared to 80.2% for the corn-based control. The HD lines were equal or nearly equal to corn in the chick growth assay, with efficiencies of gain that were 98 and 100% that of corn for HD1 and HD2, respectively. Pearl millet was of greater feeding value than sorghums for chicks but less digestible than sorghums in pigs. These data suggest that in vitro pepsin digestibility can be a valuable tool for sorghum breeders to select parent lines with improved feeding value.; Swine Day, Manhattan, KS, November 21, 1991

Keywords

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Authors

B J. Healy, P J. Bramel-Cox, B T. Richert, C F. Klopfenstein, Merle D. Witt, and Joe D. Hancock

SELECTION FOR INCREASED IN VITRO DIGESTIBILITY IMPROVES FEEDING VALUE OF SORGHUM GRAIN

B. J. Healy, J. D. Hancock, P. J. Bramel-Cox[1], B. T. Richert, C. F. Klopfenstein[2], and M. D. Witt[3]

Summary

Six cannulated barrows and two hundred eighty-eight chicks were used in an experiment to determine the value of an in vitro protein digestibility assay (pepsin digest) for identification of sorghum parent lines with improved nutritional value. The barrows were used to determine digestibility of the experimental sorghums at the terminal ileum and for the total digestive tract. Due to a limited supply of the sorghums, broiler chicks were used as a model to predict the value of the experimental sorghums for growth performance. Four sorghum parent lines were selected from 100 S_1 families grown at several locations in Kansas. Two of the sorghums were consistently low and two were consistently high for in vitro digestibility. Treatments were: 1) corn-soybean meal control; 2) and 3) low digestibility sorghums (LD1 and LD2); 4) and 5) high digestibility sorghums (HD1 and HD2); and 6) pearl millet (PM). The sorghums that had consistently high in vitro digestibility were of greater nutritional value to pigs and growing chicks than sorghums with low in vitro digestibility. In the pig experiment, digestibility of N at the terminal ileum ranged from 69.6% for LD1 to 79.0% for HD1, compared to 81.6% for the corn-based control. Similar responses were noted for digestibility of gross energy, with values of 71.8% and 77.0% for LD1 and HD1, compared to 80.2% for the corn-based control. The HD lines were equal or nearly equal to corn in the chick growth assay, with efficiencies of gain that were 98 and 100% that of corn for HD1 and HD2, respectively. Pearl millet was of greater feeding value than sorghums for chicks but less digestible than sorghums in pigs. These data suggest that in vitro pepsin digestibility can be a valuable tool for sorghum breeders to select parent lines with improved feeding value.

(Key words: Performance, GF, Ileal, Digestibility, Sorghum, Millet, Corn.)

Introduction

Sorghum grain is often viewed as a substitute for corn, with somewhat lower feeding value. That image is due largely to variation in nutrient content and quality. An ongoing research project, by plant breeders in the KSU Department of Agronomy, has identified parent lines of sorghum with high in vitro digestibility. However, the true merit of these sorghums, selected by using the in vitro assay, must be determined in animal feeding experiments. Two experiments were conducted to determine the nutritional value of sorghums that were selected for high digestibility by using an in vitro pepsin digestibility procedure.

Procedures

Four sorghums that had different in vitro protein digestibilities were selected from 100 S_1 families grown for 2 yr at several locations in Kansas. Two of the sorghums consistently had

[1]Department of Agronomy.
[2]Department of Grain Science and Industry.
[3]Southwest Kansas Research and Extension Center.

low in vitro digestibility and two consistently had high in vitro digestibility. Treatments were: 1) corn-soybean meal control; 2) and 3) low digestibility sorghums (LD1 and LD2); 4) and 5) high digestibility sorghums (HD1 and HD2); and 6) pearl millet (PM). LD1 had high tannin and LD2 had corneous (hard) endosperm. The grains were grown during 1988 and 1989, and fed during 1989 and 1990, respectively. Grain produced in both years was used in the chick growth assay, but quantities of the grains were sufficient only from the 1989 crop to allow the pig feeding experiment in 1990.

For the digestibility experiment, six barrows (avg initial wt of 87.8 lb) were surgically fitted with T-cannulas at the terminal ileum. These cannulated pigs were used in an experiment to determine apparent digestibilities of DM, N, and GE. A diet was formulated to contain 15% crude protein, .65% Ca, and .55% P with the corn treatment (Table 1). The other grain sources replaced corn on a lb for lb basis. Feed allotments were determined as .05 $\times$ $BW^{.9}$, with BW in kg. Feed was offered at 7 a.m. and 7 p.m. as a wet mash. Water was consumed ad libitum. The experimental design was a six by six Latin square, where each grain source was fed to each pig in one of the six feeding periods. The feeding periods lasted 7 d, with a 4-d adaptation period, 36-h of fecal collection, and 11-h collections of ileal digesta on d 6 and 7. Digesta was collected into containers immersed in an ice-water bath. Digesta and fecal samples were homogenized, subsampled, frozen, and subsequently freeze-dried and analyzed for DM, N, and GE.

For the growth assay, 288 chicks (7 d of age) were used in a 14-d experiment. The chicks were housed with four birds/cage and 12 cages/treatment. The diets were formulated to contain 24% CP, 1.1% Ca and .9% P. Feed and water were consumed ad libitum. Chicks were weighed at the end of the experiment and feed consumption was recorded. Response criteria were gain, feed intake and F/G.

Results and Discussion

Results from the experiment with pigs (Table 2) indicated that ileal and total tract digestibilities of DM, N, and GE were greater for corn than the other grains. Ileal and total tract digestibilities of DM, N, and GE were greater for the HD sorghums than LD sorghums. Digestibilities of DM, N, and GE were greater for LD2 than LD1, suggesting that the tannin content of LD1 had a greater negative effect than the hard endosperm of LD2. Ileal N digestibilities for LD1, LD2, HD1, HD2, and PM were 85, 94, 97, 96, and 95% that of corn, respectively. Ileal GE digestibilities for LD1, LD2, HD1, HD2, and PM were 90, 94, 96, 95, and 91% that of corn, respectively.

From the growth assay, chicks fed the HD sorghums gained more weight than chicks fed LD sorghums (Table 2). Weight gains for chicks fed LD1, LD2, HD1, HD2 and PM were 95, 96, 98, 100, and 99% of weight gains for chicks fed the corn-based diet. Feed intake was not affected by treatment. Efficiency of gain was greater for chicks fed HD sorghums than chicks fed LD sorghums. Feeding values (i.e., efficiencies of gain) for LD1, LD2, HD1, HD2 and PM were 95, 97, 98, 100 and 100% of the corn-based control diet.

In conclusion, these data suggest that an in vitro pepsin assay was effective as a predictor of feeding value for sorghum grain. In pigs, ileal and total tract digestibilities of the HD sorghums were improved compared to LD sorghums, but were still of lower digestibility than corn. Broiler chicks were able to utilize nutrients from the HD sorghums and millet essentially as well as nutrients from corn.

Table 1. Composition of Experimental Diets, %[a]

Ingredient	Pig digestibility	Chick growth
Grain source	77.58	51.14
Soybean meal (48% CP)	19.46	40.42
Soybean oil	—	3.50
DL-methionine	—	.23
Vit/Min/Antibiotic mix[b]	2.96	4.71

[a]Pig diets were formulated to have 15% CP, .65% Ca, and .55% P. Chick diets were formulated to have 24% CP, 1.1% Ca, and .9% P.
[b]Antibiotic was amprolium (.05%) and chlortetracycline (100 g/ton) for chick diets.

Table 2. Apparent Digestibilities in Growing Pigs and Chick Growth Performance

Item	Corn	LD1	LD2	HD1	HD2	Millet	CV
Ileal digestibility in pigs, %[a]							
DM[cfh]	79.3	71.6	74.8	76.4	75.9	73.1	4.3
N[cgj]	81.6	69.6	77.1	79.0	78.6	77.7	4.1
GE[cfi]	80.2	71.8	75.4	77.0	76.5	73.3	4.2
Total tract digestibility in pigs, %[a]							
DM[dgjl]	90.2	85.0	88.9	88.6	89.1	86.0	1.0
N[dgjk]	87.3	71.7	82.1	83.0	82.6	84.1	3.5
GE[dgjl]	89.5	83.3	87.7	87.5	87.9	84.4	1.1
Chick performance[b]							
Gain, lb[e]	1.06	1.00	1.02	1.04	1.06	1.05	7.8
F/G[e]	1.53	1.61	1.57	1.56	1.53	1.52	5.5

[a]Six cannulated barrows in a six by six Latin square (six observations per treatment).
[b]288 chicks, 5 chicks/cage, 12 cages/treatment.
[cd]Corn vs others ($P<.01$, $P<.001$, respectively).
[efg]LD1 and LD2 vs HD1 and HD2 ($P<.11$, $P<.05$, $P<.001$, respectively).
[hij]LD1 vs LD2 ($P<.11$, $P<.07$, $P<.001$, respectively).
[kl]Sorghums vs millet ($P<.01$, $P<.001$, respectively).