EFFECT OF SORGHUM HYBRID ON SITE AND EXTENT OF NITROGEN DIGESTION IN BEEF STEERS

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Story in Brief

To compare the effect of two yellow, two cream and two hetero-yellow sorghum grain hybrids on site and extent of nitrogen digestion, sorghum grain was dry rolled and fed in 81% sorghum grain diets to Angus-Hereford steers (752 lb) equipped with ruminal, duodenal and ileal cannulae. Diets were fed at 1.85% of body weight (dry matter basis) in a 6 x 6 Latin square. Total tract non-ammonia nitrogen digestibility (%) was greater for hetero-yellow 2 (58.2) and creme 2 (58.1) than for hetero-yellow 1 (48.2), yellow 2 (51.8) and creme 1 (53.5), with yellow 1 (56.2) being intermediate. Ruminal feed nitrogen (excluding urea) digestibility ranged from 31.7 (hetero-yellow 1) to 53.7 (hetero-yellow 2), with other sorghums intermediate. Conversely, escape of feed nitrogen from ruminal degradation varied from 46.2 (hetero-yellow 2) to 68.3% (hetero-yellow 1). Microbial N flow to the duodenum was strongly correlated while feed N flow to the duodenum was weakly correlated to fractional non-ammonia nitrogen digestion in the small intestine. Moreover, ruminal starch digestion was negatively related to feed nitrogen flow to the duodenum. Hybrids differed considerably in site and extent of nitrogen digestion.

(Key Words: Sorghum Grain, Nitrogen, Digestion, Beef Steers.)

Introduction

Cereal grains represent the major sources of energy and protein in feedlot diets. Nationally, corn is the most prominent grain fed, but sorghum grain is extensively used in some regions. Sorghum grain generally is regarded as being more variable in quality and less digestible than corn. Improvements in sorghum grain hybrids should improve the feeding value of sorghum. Endosperm characteristics and digestion may differ among sorghum hybrids, altering efficiency of utilization. The objective of this study was to assess the

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differences which may exist in site and extent of nitrogen (N) digestion among several homozygous and heterozygous yellow endosperm sorghum hybrids.

Materials and Methods

Six sorghum hybrids (Table 1) representing two yellow (Y1 and Y2), two cream (C1 and C2) and two hetero-yellow (HY1 and HY2) grains were grown under dryland conditions. Hybrids within an endosperm type and color were of different genetic background. Rainfall was evenly distributed throughout the growing season and totalled 15 inches.

All grains were dry rolled and fed in 81% sorghum diets (Table 2). Diets were fed at 1.85% (DM basis) of body weight to ensure uniform consumption. Molasses was included in the diet to reduce dust. Urea was used as the source of supplemental nitrogen (N) to enhance the estimation of sorghum feed N digestion in the rumen. Chromic oxide was used as an indigestible marker. Diets were fed three times daily to Angus-Hereford steers surgically fitted with permanent ruminal, duodenal and ileal cannulae in a 6 x 6 Latin square. Experimental periods lasted 10 days, with days 1 through 7 used for diet adaptation and 8 through 10 for feed, digesta and fecal sampling. Digesta samples were collected every 3 h in a 24-h period.

Digesta and fecal samples were composited across time and day within steer for each period, lyophilized and ground through a 1-mm screen. Ruminal fluid for ammonia N (NH_3-N) determination was collected at 3:00 p.m. and 9:00 p.m. on day 9 and at 3:00 a.m. and 9:00 a.m. on day 10. Ruminal fluid also was collected at 2:00 p.m. on day 10 for determination of microbial N characteristics. Grain, feed, duodenal, ileal, fecal and microbial samples were analyzed for DM, ash, crude protein (CP), NH_3-N, purine N (RNA basis) and chromic oxide. Nitrogen digestibility was determined by chromic oxide ratio, while purine-N was utilized to distinguish feed protein from microbial protein escaping the rumen. Data were subjected to least squares analysis with period, animal and treatment included in the model. Least squares means were separated by a protected least significant difference.

Results and Discussion

Sorghum grain hybrids varied in CP content from 9.5 to 10.5% CP ($P<.05$) (Table 3). The proportion of NaCl-N tended to be greater for Y1 (26.7% of N) and lower for HY1 (19.6%). Ruminal NH_3-N levels were not altered by hybrid and averaged 4.39 mg/dl (Table 4). If CP content is multiplied by the percentage of NaCl-N, the corresponding values are 2.5 (Y1), 2.4 (Y2), 2.3 (C1), 2.1 (C2), 1.9 (HY1) and 2.3 (HY2) with the ruminal NH_3-N values being

Table 1. **Characteristics of sorghum grain hybrids.**

Sorghum hybrid[a]	Seed coat color	Endosperm color	Endosperm cross
Y1 and Y2	yellow	homozygous yellow	yellow x yellow
C1 and C2	white	heterozygous yellow	white x yellow
HY1 and HY2	red	heterozygous yellow	white x yellow

[a] Y=yellow; C=cream; HY=hetero-yellow.

Table 2. Ingredient composition of experimental diets (DM basis).

Ingredient	DM, %
Grain	81.2
Cottonseed hulls	12.0
Molasses	3.0
Supplement:	
Urea	1.0
Calcium carbonate	.93
Dicalcium phosphate	.44
Potassium chloride	.57
Sodium sulfate	.36
Trace mineralized salt	.25
Chromic oxide	.20
Vitamin A premix[a]	.05

[a] Vitamin A was included at 1,000 IU/lb DM.

4.9, 6.0, 4.3, 3.9, 3.8 and 3.4 for the same grains, respectively, suggesting that sorghum with more soluble protein results in higher ruminal NH_3-N values.

Total tract non-NH_3-N (NAN) digestibility (%) was greater (P<.05) for HY2 (58.2) and C2 (58.1) than for C1 (53.5), Y2 (51.8) and HY1 (48.2), with HY1 (56.2) intermediate (Table 4). Differences in total tract NAN digestibility may affect total tract organic matter and starch digestibility. With all diets, there was a net gain in the amount of N reaching the duodenum above that consumed. A gain in N through the rumen reflects N recycling to the rumen. Non-urea feed N digestibility in the rumen was highest (P<.10) for HY2 (53.7%) and lowest for HY1 (31.7%), with values for other sorghum ranging from 40.4% (Y2) to 49.9% (C2). Conversely, ruminal escape of feed N ranged from 46.2 to 68.3% (P<.10). Feed N digestibility within the rumen and escape of N from ruminal degradation reflected differences in feed N flow to the duodenum. Although differences in feed N flow to the small intestine tended to reflect NAN flow, NAN flow was correlated more strongly to microbial N flow (r=.79; P<.001) than to feed N flow (r=.45; P<.01). Although starch data are not reported herein, ruminal starch digestion was negatively correlated (r=.46; P<.08) to feed N flow to the duodenum.

Flow (g/day) of NAN to the cecum ranged from 48.8 (C2) to 58.2 (C1), averaging 54.0. Pre-cecal digestibility of NAN was greater (P<.10) for C2 (57.8%) than for HY1 (50.2%) and C1 (49.8%) with others intermediate. Feed N flow to the duodenum was positively correlated (r=.72, P<.01) to NAN flow to the cecum and negatively correlated (r=-.66; P<.01) to pre-cecal NAN

Table 3. Chemical composition of sorghum grain hybrids and diets (DM basis).

Item	Sorghum hybrid[a]						
	Y1	Y2	C1	C2	HY1	HY2	SE
Grain							
CP,%	9.5	10.5	9.7	9.7	9.6	10.3	.15
Starch, %	79.9	76.1	78.4	77.4	74.4	76.8	.69
NaCl soluble N, % of total N	26.7	23.2	23.6	22.0	19.6	22.3	1.57
Pepsin insoluble N, % of total N	11.1	12.5	12.5	10.8	12.2	11.5	.57
Feed							
CP, %	11.3	11.5	11.5	11.4	11.4	11.6	.15
Starch, %	59.5	59.8	60.2	59.4	59.8	55.2	.98

[a] Y=yellow; C=Cream; HY=Hetero-yellow.

Table 4. Comparison of site and extent of nitrogen digestion of sorghum grain hybrids.

Item	Sorghum hybrid[a]						
	Y1	Y2	C1	C2	HY1	HY2	SE
Ruminal NH_3-N, mg/dl	4.9	6.0	4.3	3.9	3.8	3.4	.88
Nitrogen intake, g/day							
Total feed N	115.0	115.6	115.6	115.9	115.7	115.7	.21
Feed N (excluding urea N)	85.8	86.8	86.8	86.7	86.6	87.2	.16
Entering the duodenum, g/day							
Non-NH_3-N	120.0^{xy}	124.8^{xy}	125.4^{xy}	116.2^{y}	132.3^{x}	100.4^{z}	6.79
Microbial N	71.3	73.0	75.8	72.9	77.3	68.3	6.05
Feed N	48.7^{y}	51.8^{xy}	49.6^{xy}	43.3^{yz}	58.3^{x}	39.0^{z}	4.14
Pre-cecal non-NH_3, g/day	52.8	54.6	58.2	48.8	58.0	51.9	2.70
Fecal non-NH_3-N, g/day	50.3^{de}	55.9^{bc}	53.8^{cd}	48.5^{de}	60.4^{b}	48.2^{e}	1.98
Nitrogen digestibility, % of intake:							
Ruminal feed N (excluding urea)	42.1^{xy}	40.4^{yz}	42.0^{xy}	49.9^{wx}	31.7^{z}	53.7^{w}	4.32
Ruminal escape of feed N	57.9^{xy}	59.6^{yz}	58.0^{xy}	50.1^{wx}	68.3^{z}	46.2^{w}	4.32

Table 4. (Continued).

Item	Sorghum hybrid[a]						SE
	Y1	Y2	C1	C2	HY1	HY2	
Pre-cecal non-NH_3-N	54.2^{xyz}	53.0^{xyz}	49.8^{z}	57.8^{x}	50.2^{yz}	55.2^{xy}	2.13
Total tract non-NH_3-N	56.2^{bc}	51.8^{de}	53.5^{cd}	58.1^{b}	48.2^{e}	58.2^{b}	1.54
Non-NH_3-N digestibility in the small intestine:							
disappearance, g/day	67.2	70.2	67.2	67.4	76.0	52.2	5.89
% of entry	54.9	55.8	53.5	57.6	57.2	52.0	2.49
% of intake	59.5	60.3	58.0	58.4	66.6	45.8	5.33

a Y = yellow; C = cream; HY = hetero-yellow

b,c,d,e Means in the same row with different superscripts differ ($P<.05$).

w,x,y,z Means in the same row with different superscripts differ ($P<.10$).

digestibility, indicating perhaps that feed N originating primarily from sorghum is less digestible in the small intestine than microbial N. Moreover, microbial N flow to the duodenum was strongly correlated (r=.88; P<.001) and feed N flow to the duodenum was poorly correlated (r=.17; P=.52) to NAN disappearance from the small intestine.

In summary, sorghum grain hybrids differed considerably in site and extent of N digestion. Moreover, there appeared to be considerable variation both within and among hybrids. Additionally, although not reported herein, starch digestibility was generally positively correlated to N digestibility. Since starch granules may be embedded in less soluble or more poorly digestible protein, even larger diferences in N and starch digestibility among hybrids may be observed with greater dry matter feed intakes than used in this study.