COMPARISON OF THE SITE AND EXTENT OF NITROGEN DIGESTION BETWEEN CORN AND FOUR DIVERGENT SORGHUM GRAIN HYBRIDS

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Story in Brief

Corn and four divergent sorghum grain hybrids were dry rolled before incorporation into 85% grain diets. Sorghum grain hybrids were grown during the summer of 1986 in a single location to reduce variation caused by the environment. The four sorghum hybrids represented yellow, cream, hetero-yellow and red endosperm types. Diets were fed at 2% of body weight to 5 Angus x Angus - Hereford steers (532 lb) equipped with large ruminal and L - type duodenal and ileal cannulae to determine the site and extent of nitrogen (N) digestion. Total tract non-ammonia N (NAN) digestibility was greater for corn (63.5%) than for yellow (56.9%) and red (54.8%), but not different than cream (60.9%) or hetero-yellow (60.4%). Feed N escape of ruminal digestion was less for corn (49.6%) than for all sorghum hybrids. Red (81.0%) had greater feed N escape of ruminal digestion than cream (65.9%), but did not differ from hetero-yellow (71.6%) or yellow (69.0%). The efficiency of microbial protein production did not differ between grain sources and averaged 20.3 g of microbial crude protein / kg organic matter truly fermented. Digestion of NAN through the ileum was greatest for corn (65.1%), cream (64.1%) and hetero-yellow (63.4%) and least for red (56.6%) with yellow (59.0%) being intermediate. Nitrogen digestion was complete at the ileum (104.2% of total). Non ammonia N disappearance in the small intestine averaged 63.8% of NAN entry. The small intestine appeared to compensate for lower ruminal feed N digestion. The small intestine was the primary site of NAN digestion (116% of total). Differences in feed N escape and similar digestion through the ileum may result in differences in the quality of protein absorbed from the small intestine.

(Key Words: Sorghum Hybrid, Corn and Nitrogen Digestion)

Introduction

The majority of the crude protein requirement of feedlot cattle is fulfilled by the grain component of the diet; therefore, digestion of grain protein is of great importance. Ruminal digestion of grain protein may be of greater benefit to cattle than passage of low quality grain protein to the small intestine for subsequent digestion and absorption. Corn is the preferred grain by the feedlot industry. However, increasing energy costs and water demands for irrigated corn production make sorghum grain a viable alternative. Sorghum grain is generally considered to have a lower feeding value than corn even though the gross composition of the grain types is similar. However, estimates for the feeding value of sorghum are based on sorghum varieties not currently produced. Sorghum grain protein is considered to be less digestible in the rumen and total tract than corn protein. Therefore,

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ruminal escape of low quality sorghum protein is of particular importance. Furthermore, a relationship between the digestibility of sorghum grain protein and starch has been postulated based on the physical and chemical structure of the sorghum berry. Unfortunately, this suggestion has been widely accepted, but little information exists supporting the concept. Therefore, the objectives of this study were to determine differences in chemical composition and the site and extent of nitrogen digestion between corn and currently available sorghum grain hybrids.

Materials and Methods

Five diets were developed (Table 1) using dry rolled corn and four currently available divergent sorghum grain hybrids. The four sorghum grains had either red, cream, hetero-yellow or pure yellow endosperm. All sorghum grain hybrids were grown in a single location during the summer of 1986 to reduce variation due to the environment. Diets were high grain (85%) containing urea as the only supplemental nitrogen (N) source to facilitate estimation of grain protein escape of ruminal digestion.

Diets were fed twice daily, at 2% of individual body weight (DM basis), to 5 Angus x Angus - Hereford steers (532 lb) fitted with large ruminal and L - type duodenal and ileal cannulae. Experimental periods and digesta sampling were conducted as described by Streeter et al. (1988). Ruminal fluid, for bacterial isolation, was collected at 1400 hour on day 14 of each sampling period. Ruminal, digesta and fecal composite samples were sub sampled at the end of each period and frozen. Digesta and fecal samples were managed as described by Streeter et al. (1988). Samples were analyzed for all or part of the following chemical constituents: dry matter (DM), crude protein nitrogen (N), total purine nitrogen, ammonia N, pH and chromium. Ruminal escape of feed N was calculated using determined microbial OM, N and purine N values. The site and extent of N digestion was determined by using total purine N and chromium ratios.

Data were analyzed using least squares procedures. Least squares means were separated using least significant difference protected by an initial F test.

Table 1. Diet Composition Dry Matter Basis

Ingredient	% DM
Dry Rolled Grain	85.0
Cottonseed Hulls	8.0
Molasses	3.0
Urea	1.2
Supplement	
Dicalcium phosphate	0.44
Calcium carbonate	0.93
Potassium chloride	0.57
Sodium sulfate	0.36
Trace mineralized salt	0.25
Chromic oxide	0.20
Vitamin A (IU/Kg)	2200

Results and Discussion

Crude protein content (Table 2) of feed was greater (P<.05) for red (13.5%) than for corn (12.1%), cream (12.5%), yellow (12.6%) and hetero-yellow (12.6%). Corn feed contained less (P<.05) crude protein than cream, hetero-yellow or yellow. Corn grain (72.6%) contained less (P<.05) starch than red (79.6%), yellow (78.7%), and cream (78.28%), but was not different from hetero-yellow (72.9%). Within sorghum hybrids, red contained more (P<.05) starch than hetero-yellow but was not different from yellow or cream. Cream and yellow were also not different (P>.05) from hetero-yellow. Starch content of the diets was not different between grain sources and averaged 64.6%.

Nitrogen intake (Table 3) was low for corn compared to the sorghum grain diets. The red sorghum diet resulted in greater N intake than the other sorghum diets. Nitrogen intake was adequate to meet animal requirements with all diets.

Total tract non ammonia N (NAN) digestibility was greatest for corn (63.5%) and least for red (54.8%). Digestibility of cream (60.9%) and hetero-yellow (60.4%) did not differ (P>.05) from corn. Yellow (56.9%) had a lower NAN digestibility than corn (P<.05), but was not different from cream or hetero-yellow (P>.05). Red NAN digestibility was less (P<.05) than corn and cream, but not different from yellow or hetero-yellow (P>.05). Red is a traditional sorghum hybrid typical of sorghum grain compared to corn in the past. Therefore, it was expected that red would have a lower total tract NAN digestibility than corn. Based on limited animal performance research, yellow was expected to differ very little from corn. However, cream and hetero-yellow were the only sorghum hybrids not different from corn. Differences between sorghum hybrids and corn were presumably the result of differences in protein solubility and particle size.

The ruminal environment was not different between diets. Ruminal pH averaged 5.90 across all diets. Ruminal ammonia N level was 8.65 mg/dl averaged across all diets. Total feed N digestion in the rumen was greatest for corn (64.6%) and lowest for red (39.7%). Corn had greater (P<.05) ruminal feed N disappearance than all sorghum hybrids. Within sorghum hybrid, cream (52.4%) had greater (P<.05) ruminal feed N disappearance than red, but not greater than (P>.05) yellow (49.8%) or hetero-yellow (48.0%). Ruminal feed N disappearance was not different (P>.05) between red, hetero-yellow and yellow. Feed N escape of ruminal digestion was greatest for red (81.0%) and lowest for corn (49.6%). Corn escape of ruminal digestion was less than (P<.05) all sorghum hybrids. Cream (65.9%) feed N escape was less than (P<.05) red, but not

Table 2. Chemical Composition (%) of Grains and Diets.

Item		Corn	Cream	Hetero	Red	Yellow
Grain						
	Crude Protein	10.0^{ab}	9.7^{bc}	9.6^{bc}	10.4^{a}	9.5^{c}
	Starch	72.2^{c}	78.3^{ab}	72.9^{bc}	79.6^{a}	78.7^{ab}
Feed						
	Crude Protein	12.1^{a}	12.5^{b}	12.6^{b}	13.5^{c}	12.6^{b}
	Starch	64.7	62.6	65.2	65.2	65.1

^{abc} Means in the same row with different superscripts differ (P<.05).

Table 3. Influence of corn and four sorghum grain hybrids on nitrogen digestion.

Item	Corn	Cream	Hetero	Red	Yellow
Intake (g/d)					
Total N	93.8[a]	97.3[b]	98.0[b]	103.9[c]	97.7[b]
Non-Urea N	67.1[a]	70.5[b]	71.3[b]	77.3[c]	71.1[b]
Total tract N digestibility based on:					
Fecal NAN	63.5[a]	60.9[ab]	60.4[abc]	54.8[c]	56.9[bc]
Ruminal Environment					
pH	5.97	5.83	5.94	5.92	5.86
Ammonia N (mg/dl)	7.60	7.81	9.45	8.36	10.02
Duodenal N Appearance					
Feed N (g/d)	33.1[a]	46.1[b]	51.0[b]	62.6[c]	49.0[b]
Total Feed N (%)	64.6[a]	52.4[b]	48.0[bc]	39.7[c]	49.8[bc]
Feed N Escape	49.6[a]	65.9[b]	71.6[bc]	81.0[c]	69.0[bc]
Microbial Efficiency					
g MCP/kg OMF	16.6	18.0	22.0	21.2	23.0
Ileal N Appearance					
NAN (g/d)	32.6[a]	34.8[ab]	35.7[ab]	45.1[c]	40.3[bc]
NAN Digestibility					
% intake	65.1[a]	64.1[ab]	63.4[ab]	56.6[c]	59.0[bc]
% total tract	102.9	105.6	105.3	103.2	103.9
NAN Disappearance in the Small Intestine					
g/d	63.3	65.6	70.2	71.0	64.7
% entry	65.9	64.3	66.1	61.1	61.4
% intake	67.5	67.0	68.3	71.5	66.1
% total	106.7	110.2	119.5	125.4	118.2

[abc] Means in the same row with different superscripts differ (P<.05).

different (P>.05) from hetero-yellow (71.6%) or yellow (69.0%). Hetero-yellow and yellow feed N escape was not different (P>.05) from red. Escape of low quality grain protein to the small intestine may not be beneficial to animal performance. Sorghum grain protein escape of ruminal digestion has been proposed as a factor limiting post ruminal starch digestion and animal performance. Therefore, cream may have some ruminal advantage when compared to other sorghum hybrids. True microbial efficiency (g microbial crude protein/kg organic matter truly fermented) was not different between grain sources and averaged 20.3.

The amount (g/d) of NAN appearing at the ileum was least for corn (32.6 g/d) and greatest for red (45.1 g/d). Corn had less (P<.05) NAN appearing at the ileum than yellow (40.3 g/d) or red. Cream (34.8 g/d) and hetero-yellow (35.7%) ileal NAN appearance was greater than (P<.05) red, but not different from (P>.05) corn or yellow. Differences in grams NAN appearing at the ileum translated into identical difference in digestibility through the ileum. Corn (65.1%) had a greater (P<.05) NAN

digestibility through the ileum than red (56.6%) and yellow (59.0%), but not different from (P>.05) cream (64.1%) and hetero-yellow (63.4%). Red was less than (P<.05) cream and hetero-yellow, but not different (P>.05) from yellow. Ileal NAN digestibility as a percent of total digestion was not different (P>.05) between diets and averaged 104.2%. Ileal NAN digestibility greater than 100% indicates microbial fermentation in the large intestine and excretion of microbial N in the feces.

Non ammonia N disappearance in the small intestine did not differ (P>.05) between grain sources. The average NAN disappearance was 67.0 g/d. Disappearance of NAN as a percent of NAN entry into the small intestine averaged 63.8 across all diets. NAN disappearance (% entry) appeared to be greater for hetero-yellow (66.1%), corn (65.9%), and cream (64.3%) than red (61.1%) and yellow (61.4%). Disappearance of NAN expressed as a percent of N intake did not differ (P>.05) between diets and averaged 68.1%. Disappearance of NAN in the small intestine expressed as a percent of total NAN disappearance did not differ (P>.05) between treatments and averaged 116.0%. Disappearance as a percent of total digestion suggests that all NAN absorption occurred in the small intestine in this experiment.

The rumen appears to be the major site resulting in differences between true digestibility of corn and sorghum hybrid N. Hybrids similar to the cream and hetero-yellow were close to the N digestibility of corn in the total tract and through the rumen and ileum. Equal NAN digestibility through the ileum and in the small intestine, combined with unequal ruminal escape of feed protein, suggests that the quality of protein absorbed from the small intestine may not be equal among treatments. Protein solubility and particle size differences may be the cause of differences between sorghum grain hybrids and corn. The pure yellow sorghum grain hybrid tested does not appear to be equal to corn with regard to N digestibility. Moreover, yellow did not have the greatest N digestibility in the rumen or total tract of the sorghum hybrids tested.

Literature Cited

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