EFFECT OF SORGHUM GRAIN VARIETY ON THE SITE AND EXTENT OF NITROGEN DIGESTION IN HEIFERS

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Story in Brief

Dwarf Redlan, 1133, Darset and millrun sorghum grain varieties were dry rolled and fed in a high grain ration with all supplemental nitrogen coming from urea to determine the effect of variety on site and extent of nitrogen digestion. Dwarf Redlan is a low tannin, waxy endospermed sorghum. 1133 is a waxy high tannin-bird resistant type, while Darset is a normal endosperm, high tannin-bird resistant type. Millrun was purchased commercially through the OSU feedmill. The four sorghum varieties were fed (two percent of body weight) in a 4 x 4 Latin square using four Hereford-Angus heifers (506 lb) equipped with ruminal, duodenal and ileal cannulae. Total tract nitrogen digestion was higher for non-bird resistant types, Dwarf Redlan (69.0 percent) and millrun (63.8 percent) than bird resistant types, 1133 (54.0 percent) and Darset (47.8 percent). Ruminal feed nitrogen disappearance was highest for Dwarf Redlan (51.7 percent) and lowest for 1133 (27.9 percent), with millrun (42.2 percent) and Darset (35.4 percent) being intermediate. For all varieties, nitrogen disappearance was nearly complete by the ileum. Waxy type grains tended to have improved nitrogen digestion post ruminally when compared within bird resistant or non-bird resistant groupings. Sorghum grain variety does appear to alter both site and extent of nitrogen digestion in beef heifers and may result in variation in animal performance.

Introduction

Sorghum grain is an ever increasingly important feed grain in the Great Plains region. Constantly decreasing water supplies in combination with increasing water demands increase the importance of sorghum grain research and utilization for feedlot cattle. Sorghum grain, although less popular than corn due to the increased processing required, is drought resistant. Unlike corn, sorghum varieties vary greatly in physical and chemical composition. Variation between varieties leads to inconsistent and often lower animal performance. Sorghum grain protein degradation is probably of greater importance than is corn protein degradation, because sorghum starch is encapsulated in protein. Digestion of protein has been suggested as a limiting factor in starch availability. Therefore, the following study was conducted to determine the relationship of four sorghum grain varieties to the site and extent of protein digestion in heifers.

Materials and Methods

Three varieties of sorghum grain, Dwarf Redlan (Dwf), 1133 and

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Darset (Dar) were grown under dryland conditions at the Perkins Agronomy Experiment Station. A fourth variety, millrum (MR), was purchased commercially through the OSU feedmill. Origin of MR was unknown, but appeared to be representative of that commonly purchased on a commercial basis. Observable physical characteristics of the varieties are listed in Table 1.

Table 1. Descriptive characteristics of sorghum grains.

			Endosperm		
Sorghum Variety	Abbreviation	Pericarp color	Color	Starch type	Testa Layer[a]
1133	1133	brown	yellow	waxy	present
Darset	Dar	brown	white	normal	present
Dwarf Redlan	Dwf	red	white	waxy	absent
Millrun	MR	mixed	non-descript	normal	absent

[a]Presence of a testa layer indicative of high tannin content and bird resistance.

Each grain variety was dry rolled and incorporated at the same level of dry matter into an 88.8 percent sorghum grain ration (Table 2). Complete mixed diets were stored at room temperature until fed. Rations were fed to four Hereford-Angus heifers (506 lb) fitted with ruminal, duodenal and ileal T-type cannulae to allow determination of the site and extent of protein digestion. Heifers and rations were arranged in a 4 x 4 Latin square design. Heifers were fed equal portions twice daily to total two percent (DM basis) of initial body weight. Experimental periods lasted 10 days with days 1 through 7 serving for diet adaptation and days 8 through 10 for digesta sampling, performed at 1000, 1400 and 1800 hours. Ruminal fluid was collected on day 10 of each period. Digesta and ruminal samples were composited across time and day within each period. Digesta samples were dried using a lyoiphilizer and ground through a 1 mm screen in a Udy mill prior to analysis. Ruminal fluid was acidified by adding 3.3 ml of 36N H_2SO_4 per 1000 ml of fluid and frozen prior to analysis. Ruminal fluid was also collected at 1400 hours during periods two and four and used to determine bacterial nitrogen reaching the small intestine.

Grain, feed, ruminal and digesta samples were analyzed for all or part of the following: dry mater, ash, tannin (catechin equivalents), ammonia-nitrogen, RNA-nitrogen (total purines) and crude protein-nitrogen. Protein digestibility was determined by RNA and chromic oxide ratios. Differences between means were detected by orthogonal contrasts. Contrast BR compared bird resistant to non-bird resistant varieties. Contrast Dwf compared Dwarf Redland to millrun, and 1133 compared 1133 to Darset.

Results and Discussion

The crude protein content of bird resistant grain varieties tended to be higher than non-bird resistant varieties (Table 3). Varieties with waxy endosperm (Dwf and 1133) were more similar to each other than

Table 2. Ration composition of experimental diets (dry matter basis).

Ingredient	%
Sorghum grain	88.78
Cottonseed hulls	7.22
Supplement	
Urea	1.20
Dicalcium phosphate	.44
Calcium carbonate	.93
Potassium chloride	.57
Sodium sultate	.36
Chromic oxide	.20
Vitamin A	2200 IU/kg

were varieties with normal endosperm (Dar and MR). Millrun was considerably lower in crude protein content (10.3%) than all other varieties. Tannin contents of the grains reflect brown seed coats and the presence of a testa layer. Bird resistent varieties (1133 and Dar) contained more tannin ($P<.05$) than did non-bird resistant varieties (Dwf and MR). Darset (1.44 cat.eq.) also tended to contain greater amounts of tannin than 1133 (1.19). Crude protein and tannin content of the complete mixed feeds tended to reflect differences observed for the grains.

Table 3. Chemical characteristics of sorghum grains and complete feeds (dry matter).

	1133	Darset	Dwarf Redlan	Millrun	SE
Grain					
Crude protein %[abc]	12.0	13.2	12.4	10.3	.1
Tannin (cat eq/g)[a]	1.19	1.44	0.00	0.00	.07
Feed					
Crude protein %[abc]	13.5	14.4	14.3	12.1	.2
Tannin (cat eq/g)[ac]	1.24	1.54	0.02	0.02	.05

[a]Bird resistant varieties vs non-bird resistant varieties ($P<.05$).
[b]Dwarf Redlan vs Millrun ($P<.05$).
[c]1133 vs Darset ($P<.05$).

All differences observed in nitrogen digestion between grain varieties were between bird resistant and non-bird resistant varieties (Table 4). However, within each bird resistant or non-bird resistant group, trends are present that may become increasingly important as feed intake increased. Nitrogen intake was not equal for all diets. Greater nitrogen intakes occurred when heifers were fed Dwarf Redlan (103.5 g/d) and Darset (103.2 g/d) versus 1133 (96.7 g/d) and millrun (87.0 g/d), due primarily to higher protein contents of Dwf and Dar grains. Crude protein intake was below NRC recommemded levels for 500 pound heifers for the MR diet. With all diets there was a net gain in the

amount of nitrogen reaching the duodenum above nitrogen intake levels. A gain in nitrogen through the rumen may be a reflection of inadequate nitrogen intake and increased nitrogen recycling to the rumen. Low rumen ammonia concentrations across all diets may also reflect inadequate nitrogen for maximum microbial growth. The extent of feed nitrogen disappearance in the rumen was greatest for Dwarf Redlan (51.7 percent) and lowest for 1133 (27.9 percent), with millrun (42.2 percent) and Darset (35.4 percent) being intermediate. Bird resistant varieties (1133 and Dar) had lower ruminal nitrogen disappearance than non-bird resistant varieties (Dwf and MR). The rumen was the major site of nitrogen degradation for Dwf (76.4 percent), Dar (75.2 percent) and MR (72.6 percent) and tended to be of less importance for 1133 (54.7 percent). Microbial efficiencies did not vary greatly between varieties.

Table 4. Site and extent of nitrogen digestion of sorghum varieties.

Item	1133	Darset	Dwarf Redlan	Millrun
N-Intake g/day	96.7	103.2	103.5	87.0
Non-Urea-N Intake g/day	71.7	78.2	78.2	61.8
Ruminal N disappearance:				
Ruminal NH_3 g/dl	3.42	4.47	3.74	4.55
Nitrogen appearing at duodenum, g/day[a]	118.6	119.8	105.5	98.7
Nitrogen disappearance in rumen:				
Feed-N g/day	26.9	36.6	53.6	40.2
Feed-N, % of intake	27.9	35.4	51.7	46.2
Feed N, % of total tract	54.7	75.2	76.4	72.6
Microbial efficiency g Microbial N/kgOM fermented	20.5	21.7	21.1	20.3
Non-NH_3 nitrogen disappearance in small intestine				
g/day	69.8	57.6	62.8	62.6
%	61.6	49.8	62.7	66.8
Non-NH_3 nitrogen disappearance through ileum[a]				
% of Intake[a]	55.0	46.2	64.4	63.8
% of total tract	103.1	97.1	93.6	100.2
Total tract N digestibility %[a]	54.0	47.8	69.0	63.8

[a]Bird resistants vs non-bird resistants ($P<.05$).

Non-ammonia nitrogen disappearance in the small intestine tended to be higher for non-bird resistant than bird resistant varieties. Within bird resistant varieties, the extent of non-ammonia nitrogen disappearance in the small intestine tended to be greater in heifers fed 1133 than Dar (61.6 percent vs 49.8 percent). Non-ammonia nitrogen disappearance through the ileum (percent of intake) suggests that greater amounts of nitrogen disappear with non-bird resistant versus bird resistant sorghum grain varieties. Within each group, waxy varieties (Dwf and 1133) tended to have greater disappearance through the ileum than normal varieties (MR and Dar). Non-ammonia nitrogen disappearance through the ileum (percent of total tract) was nearly

equal to or in two cases greater than total tract digestibility, indicating that nitrogen digestion was almost complete at the ileum. Total tract non-ammonia nitrogen digestion was greatest for MR (69.8 percent) and Dwf (69.0 percent), the non-bird resistant varieties, and lowest for 1133 (54.0 percent) and Dar (42.8 percent), the bird resistant varieties. As was the case in the small intestine, varieties within each group with waxy endosperm, Dwf (69.0 percent) and 1133 (54.0 percent), tended to have greater non-ammonia nitrogen digestibilities than normal endosperm varieties, MR (63.8 percent) and Dar (47.8 percent).

Differences observed between bird resistant and non-bird resistant varieties may be caused by tannin, present in bird resistant varieties, binding to feed and endogenous protein making the feed nitrogen less available and possibly making proteinatious enzymes less active. The bird resistant characteristic may also result in decreased protein solubility. Waxy varieties may have greater nitrogen digestibility due to increased protein solubility. Bird resistant varieties may have reduced ruminal feed nitrogen disappearance due to tannin binding of feed protein or through inhibition of ruminal microbes by tannin. Rates of passage may differ between varieties resulting in depressed nitrogen digestibility for bird resistant types. However, passage measurements were not made in this study and statements about passage rates are speculative.

The site and extent of nitrogen digestibility of the four sorghum grain varieties tested are different. These differences would be expected to result in animal performance differences at these levels of feed intake. At higher levels of feed intake (more typical in feedlot situations) larger differences in digestibility and animal performance would be expected. Further research is needed to determine more clearly the effects of the bird resistant characteristic and of condensed tannins on nitrogen digestion in feedlot cattle.