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

M.N. Streeter[1], C.A. Hibberd[2], D.G. Wagner[3] and M.R. Putnam[4]

Story in Brief

Darset, 1133, Dwarf Redlan and millrun sorghum grain varieties were dry rolled and fed in a high grain ration to determine the effect of variety on site and extent of starch digestion. Darset is a normal endosperm, high tannin bird resistant type. 1133 is a waxy bird resistant type and Dwarf Redlan, a low tannin, waxy sorghum. Millrun was purchased commercially through the OSU feed mill, The four sorghum varieties were fed (two percent of body weight) in a 4 x 4 Latin square, using four Hereford-Angus heifers (506 lbs) equipped with ruminal, duodenal and ileal cannulae. Total tract starch digestion was similar for the Dwarf Redlan, 1133 and millrun (90.4 to 91.9 percent) and tended to be greater than the Darset (86.0 percent). Ruminal starch disappearance was 68.7, 74.1, 75.2 and 77.3 percent for the millrun, Dwarf Redlan, Darset and 1133 varieties, respectively. Heifers receiving millrun digested 398 g of starch in the large intestine, compared to only 144 to 206 g for the other types - compensating for lower ruminal starch digestion in this variety. Digestion of starch in the large intestine is less efficient than if digested in the rumen or small intestine, but preferable to excretion. Variety of sorghum appears to alter both the site and extent of starch digestion, in beef heifers, and may influence animal performance.

Introduction

Diminishing water supplies in the Great Plains region in recent years have caused many to reevaluate the use of corn as the main energy source in feedlot rations. Sorghum grain, although much less popular due to the necessity of processing, is drought resistant and therefore a viable option to corn. Sorghum varieties vary greatly in physical and chemical composition. Differences between varieties result in inconsistent and possibly lower animal performance. The following study was conducted to determine the relationship of sorghum grain variety to site and extent of starch digestion in heifers.

Materials and Methods

Three varieties of sorghum grain, Dwarf Redlan (Dwf), 1133 (1133) and Darset (Dar) were grown under dryland conditions at the Perkins Agronomy Experiment Station. A fourth variety, millrun (MR), was purchased commercially through the OSU feed mill. Origin and genetic background of MR were 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.

[1]Graduate Assistant [2]Assistant Professor, Animal Science [3]Professor, Animal Science [4]College of Veterinary Medicine, Auburn University

Table 1. Descriptive characteristics of sorghum grains.

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

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

Each sorghum grain variety was dry rolled and incorporated into an 88.8 percent grain ration (Table 2). Rations were fed to four Hereford-Angus heifers (506 lbs), fitted with ruminal, duodenal and ileal T-type cannulae to permit determination of the site and extent of starch digestion. Heifers and rations were arranged in a 4 x 4 Latin square design. Equal portions of the diet were fed twice daily to total two percent (DM basis) of initial body weight. Each experimental period consisted of seven days of diet adaptation, followed by three consecutive days of sampling, performed at 1000, 1400 and 1800 hours. Digesta samples were composited across time and day within each period. Samples were dried using a lyophilizer and ground through a 1 mm screen in a Udy mill prior to analyses. Grain, feed and digesta were analyzed for dry matter, starch (glucose polymers), crude protein, tannin (catechin equivalents) and ash. Starch digestibility was determined by chromic oxide ratios. The data were subjected to least squares analysis and differences between means were detected by orthogonal contrasts.

Table 2. Ration composition of experimental diets.

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

Results and Discussion

In general, bird resistant varieties of grain (Dar and 1133) were higher (P<.05) in crude protein than non-bird resistant sorghums (Dwf and MR). As expected for brown seed coated, bird resistant types, tannin content of Dar and 1133 was greater (P<.05) than MR and Dwf. Starch content ranged from 72.1 to 78.8 percent, but did not differ significantly between grain varieties (P>.05). Chemical composition of the complete rations were similar and reflected that of the grains.

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

Grain	Dwarf Redlan	1133	Darset	Millrun	SE
Crude protein %[abc]	12.4	12.0	13.2	10.3	.1
Starch %	72.1	76.4	77.1	78.8	2.8
Tannin (cat. eq/g)[a]	0.00	5.95	7.21	0.00	.4
Feed					
Crude protein %[abc]	14.3	13.5	14.4	12.1	.2
Starch %[b]	68.2	63.3	64.0	62.3	1.6
Tannin (cat. eq/g)[acd]	.13	6.19	7.73	.08	.3

[a]High tannin vs. low tannin (P<.05).

[b]Dwarf Redlan vs. Millrun (P<.05).

[c]1133 vs. Darset (P<.05).

[d]Possibly some tannin was contributed from cottonseed hulls.

The small differences in starch content of the rations, in combination with equalized dry matter intakes, resulted in approximately equal starch intakes. Varietal differences in site and extent of starch digestion were largely overshadowed by large standard errors. However, observed trends followed a pattern based on tannin content of the grains. Total tract starch digestibility ranged from 86.0 percent for the Dar to 91.9 percent for the 1133, with Dwf (91.4 percent) and MR (90.4 percent) being intermediate. The waxy starch characteristic of the tannin containing 1133 variety appeared to be advantageous for total starch digestion. Ruminal starch disappearance was relatively high regardless of whether expressed as a percent of total starch intake (68.7 to 77.3 percent) or as a percent of the total starch digested (75.3 to 87.6 percent). Tannin did not appear to produce much, if any, inhibition of ruminal starch digestion for the Dar. Perhaps the rumen is capable of overcoming the effects of tannin, while the small and large intestine lack such ability. Waxy endosperm appears to increase small intestinal starch digestibility in the presence or absence of tannin. Nevertheless, starch digestibility, expressed as a percent of the total starch entering the small intestine, appeared rather low for all sorghum types (24.5 to 41.5 percent starch disappearance, Dar being the lowest). Disappearance of starch in the large intestine was low as well, ranging from 26.5 percent (Dar) to 57.4 percent (MR). Starch disappearance in the large intestine was nearly twice as great for the MR compared to the other three sorghum types. The large intestine is capable of fermenting large quantities of starch, thereby compensating for low foregut starch disappear-

Table 4. Site and extent of starch digestion of dry rolled sorghum varieties.

	Dwarf Redlan	1133	Darset	Millrun	SE
Starch intake, g/day	3044	2825	2865	2796	
Ruminal starch disappearance:					
g/day[a]	2256	2185	2153	1920	82
% of intake	74.1	77.3	75.2	68.7	2.7
% of total tract disappearance	81.4	84.0	87.6	75.3	4.3
Starch disappearance in small intestine:					
g/day	332	216	168	210	80
%[c]	41.5	36.6	24.5	32.2	8.3
Starch digestibility through ileum:					
% of intake[b]	84.7	85.0	81.0	76.2	2.8
% of total tract	93.1	92.4	94.6	83.6	3.8
Starch disappearance in large intestine:					
g/day	206	195	144	398	93
%[d]	53.2	51.1	26.5	57.4	16.2
Total tract starch digestibility:					
%	91.4	91.9	86.0	90.4	3.3

[a]Dwarf Redlan vs. millrun ($P<.05$).

[b]Dwarf Redlan vs. millrun ($P<.10$).

[c]Percent of that entering small intestine.

[d]Percent of that entering large intestine.

ance. Fermentation in the large intestine, however, is generally regarded as being less efficient than ruminal fermentation.

In brief, variety of sorghum grain appeared to affect the site and extent of starch digestion. Larger differences might be noted with higher levels of feed intake similar to those usually observed under feedlot conditions. The degree to which any detrimental differences in variety can be minimized or eliminated and total starch excretion further decreased by processing would be of interest. The trends noted in this study may be of economical importance under commercial feedlot conditions.