Seed Characteristics of Different Varieties of Grain Sorghum

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Story in Brief

Eight varieties of grain sorghum representing four different seed classes (Waxy, Waxy-BR, Normal, Normal-BR) were wet-milled to study seed composition (percent starch, bran and germ, peripheral endosperm cells-PEC and gluten). Starch recovery was high and similar for all varieties except the Waxy 1126 and Normal-BR ROKY 78. Depression in starch recovery was reflected in the other fractions, particularly the bran and germ.

Protein recovery in each fraction was variable but total protein recovery was fairly constant except for a decreased response in Soft Endo (Normal-BR). *In vitro* dry matter disappearance (DMD) studies performed on the *purified isolated starch* suggested only small differences in ruminal starch digestibility between varieties.

These studies suggest some differences in wet-milling composition, but that the *in vitro* digestibility of purified starch differs little among varieties. Hence, differences in digestibility of finely ground sorghum grains are probably not influenced much by digestibility differences in the starch "per se", but by factors (such as protein content and compostion, tannin content, etc.) which may affect digestive access to the starch in the grain. Gross compositional differences (e.g. percent starch, percent protein, etc.) may also be important, however, in influencing nutritive value.

Introduction

Recent increases in the production and utilization of grain sorghum as a cereal crop in the Southern Great Plains has indicated a need to further investigate differences in feeding quality of sorghums for ruminants. One of the greatest concerns in using grain sorghum in feeding programs is the variability often associated with this grain. Some variability may be caused by environmental factors such as rainfall or soil fertility. A major portion of the variability might also be attributed to variety of the grain sorghum. Varietal effects should be related to one of the major seed components such as starch, protein or tannins, alone or in combination. Therefore, the purpose of this study was to further investigate the seed characteristics of different varieties of grain sorghum grown in Year 3.

Materials and Methods

Eight different varieties of grain sorghum were grown and harvested under dryland conditions for a third consecutive year (Year 3). These varieties included four with Waxy endosperms: Dwarf Redlan, BCT 1122-2, BCT 1126 and BCT 1133-2. The 1133 also had a brown seed coat indicating bird resistance. The other four varieties were of the Normal (Nonwaxy) endosperm: Redlan, Soft Endo, Darset and ROKY 78. All of these varieties were bird resistant except the Redlan. These characteristics are summarized in Table 1.

A laboratory wet-milling procedure as outlined by Ackerson *et al.* (1978) was utilized to separate the sorghum kernels into four components: bran and germ, peripheral endosperm cells, gluten and purified starch. The bran and germ consists of

Table 1. Descriptive characteristics of grain sorghum varieties (Year 3).

Variety	Waxy	Bird resistant	Seed class
Dwarf Redlan	yes	no	Waxy
BCT 1122-2	yes	no	Waxy
BCT 1126	yes	no	Waxy
BCT 1133-2	yes	yes	Waxy-BR
Redlan	no	no	Normal
Soft Endo	no	yes	Normal-BR
Darset	no	yes	Normal-BR
ROKY 78	no	yes	Normal-BR

the outer seed coat surrounding the endosperm and the germ portion of the seed. The peripheral endosperm cells (PEC) originate primarily from the outer portion of the endosperm which is the location of the dense protein matrix. The gluten consists of protein bodies from the floury endosperm plus fragmentary protein from all portions of the seed. The final component is the purified raw starch which has been isolated in its native granular state. After wet-milling, all components were dried and expressed as a percentage of the original sample. Each component was then analyzed for crude protein utilizing the Kjeldahl procedure. Protein content is expressed as a proportion of total protein recovered in each fraction.

A 24-hr *in vitro* dry matter disappearance (DMD) study was run on the purified starch. A 0.2 g sample of each starch was incubated in strained rumen fluid and buffer solution. Twenty mg of urea was added to each tube to simulate crude protein levels in the intact seed. Dry matter disappearance was determined by difference after a 24-hr incubation period. The data was subjected to an analysis of variance and differences were determined using Tukey's HSD test for multiple comparisons as outlined in Steel and Torrie (1960).

Results and Discussion

Wet-milling composition of the Year 3 grain sorghums is presented in Table 2. The starch isolated was similar for all varieties (56.98-61.31 percent) except for the Waxy 1126 (50.46 percent) and the Normal-BR ROKY 78 (54.57 percent). The lower quantities of starch recovered for the 1126 and ROKY 78 are reflected in the highest content ($P<.05$) of bran and germ for these two varieties. Bran and germ recovery was similar for the other varieties (16.68-19.36 percent) although some significant differences were observed. The grains differed significantly in PEC content ranging from 1.75 percent for the 1133 to 4.80 percent for the Redlan. Although these differences are significant, the PEC fraction does not account for a large proportion of the kernel. Nevertheless, the PEC fraction may have an important influence upon starch digestibility in the rumen and/or intestine in that the PEC fraction represents the dense protein matrix surrounding the starch granules. A heavy, dense matrix may make accessibility to the starch granules more difficult, lowering starch digestion. Some significant differences were observed in gluten recovery; however, no predictable patterns were discernable. The wet-milling composition trends were generally small and difficult to define. This data illustrates that differences in wet-milling composition across varieties do occur and may contribute to variability in grain sorghum.

Crude protein recovery in each wet-milling fraction is presented in Table 3. Crude protein recovery in each fraction differed by variety, but, differences were not easily characterized. Total protein recovery, however, was similar for all varieties except the Soft Endo. The depressed protein recovery for Soft Endo may be associated with the weakened matrix of the kernel resulting in a higher amount of soluble protein.

Table 2. Wet-milling compositional characteristics (Year 3).

	% Starch	% Bran & Germ	% PEC	% Gluten
Waxy				
Dwarf Redlan	61.31[a]	16.68[d]	2.50[b,c,d]	12.12[b,c]
BCT 1122-2	58.41[a,b]	19.36[c]	2.32[c,d]	11.04[c]
BCT 1126	50.46[d]	24.85[a]	2.14[c,d]	13.14[a,b]
Waxy BR				
BCT 1133-2	58.34[a,b]	17.16[d]	1.75[d]	14.72[a]
Normal				
Redlan	56.98[b,c]	18.08[c,d]	4.80[a]	13.20[a,b]
Normal BR				
Soft Endo	58.58[a,b]	18.66[c,d]	2.05[d]	10.53[c]
Darset	60.57[a]	17.87[c,d]	3.40[b]	13.32[a,b]
ROKY 78	54.57[c]	22.12[b]	3.14[b,c]	14.28[a]

[a,b,c,d]Means in a column with different superscripts are significantly different ($P<.05$).

Table 3. Protein recovery in various wet-milling fractions.[a]

	Bran and germ	PEC[b]	Gluten	% of total recovered[c]
Waxy				
Dwarf Redlan	24.87	6.09	44.26	75.22
73 BCT 1122-2	29.02	6.11	40.44	75.57
73 BCT 1126	30.86	6.07	41.23	78.16
Waxy-BR				
73 BCT 1133-2	23.79	3.66	50.00	77.45
Normal				
Redlan	22.42	9.07	42.96	74.45
Normal BR				
Soft Endo	20.93	5.23	38.44	64.60
Darset	27.19	8.24	45.96	81.39
ROKY 78	29.76	6.60	42.37	78.73

[a]Presented as grams recover ÷ total grain protein (grams) × 100.
[b]Peripheral endosperm cells.
[c]Percent of total recovered in Bran and germ, PEC and Gluten fractions. Remainder would be in the steeps due to soluble protein components present in the grains or solubilization of protein during the steeping process. One of the purposes of steeping is to loosen the protein matrix for ease of starch granule recovery during the wet-milling process.

Figure 1 illustrates the DMD response of the various *purified, raw isolated* starches. All starches were statistically ($P>.05$) similar with an overall average of 53.5 percent. No trends favoring the high amylopectin Waxy starches were apparent. The DMD response suggests that rumen microorganisms may not show a marked preference for the type of sorghum starch presented to them once access to the starch granules has been achieved. More difficulty may exist, however, in acquiring access to the starch granules in some types of sorghum. If this premise is correct, then differences in the feeding value of different sorghum varieties may also be associated with other factors, such as protein or tannin effects.

In conclusion, wet-milling data suggests that wet-milling composition differs across varieties, but these differences do not appear to be the only ones which contrib-

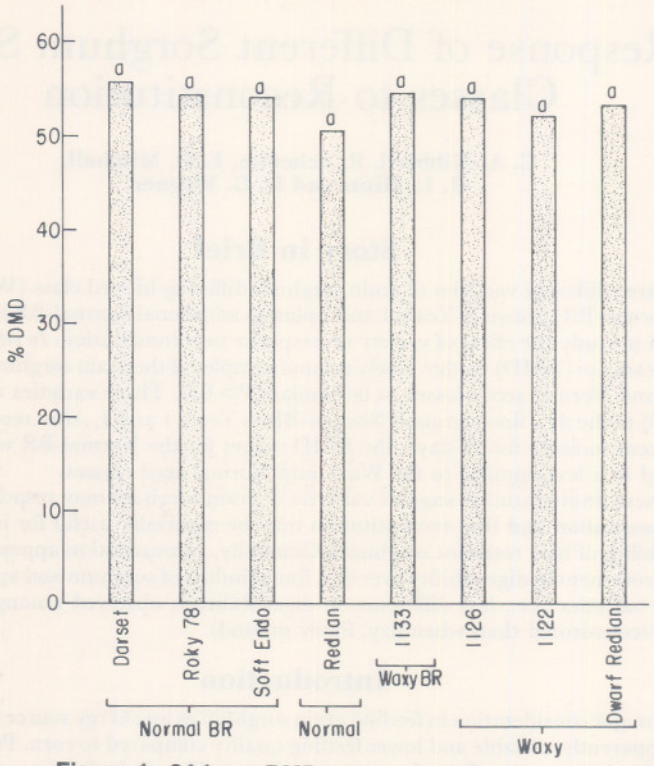

Figure 1. 24-hour DMD of raw, isolated starch (Year 3).

ute to total variability. Finally, differences in DMD of *isolated, raw starch* were not observed, suggesting that starch type (once access to the starch granules is obtained) may not have a large effect on ruminal digestibility.

Literature Cited

Ackerson, B., R. Schemm and D. G. Wagner. 1978. Seed characteristics of different sorghum endosperm types. Okla. Agr. Exp. Sta. MP-103:82.