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Abstract

Homozygous yellow endosperm grain sorghum had no advantage in feeding value over heterozygous yellow endosperm hybrids (P>.05). A heterozygous yellow endosperm hybrid, Funk's 550, had larger kernels (P<.001) and when dry rolled, produced more fine particles (P<.01). This may explain its trend toward improved feed efficiency, higher DM digestibility, and greater in vitro VFA production compared with the other dry processed grain sorghum hybrids tested. Our results do not support the traditional 12 to 16% price discount for grain sorghum relative to corn.

Keywords

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Comparative Feeding Value of Grain Sorghum and Corn in Beef Cattle Diets

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Summary

Homozygous yellow endosperm grain sorghum had no advantage in feeding value over heterozygous yellow endosperm hybrids (P>.05). A heterozygous yellow endosperm hybrid, Funk's 550, had larger kernels (P<.001) and when dry rolled, produced more fine particles (P<.01). This may explain its trend toward improved feed efficiency, higher DM digestibility, and greater in vitro VFA production compared with the other dry processed grain sorghum hybrids tested. Our results do not support the traditional 12 to 16% price discount for grain sorghum relative to corn.

Introduction

The use of yellow endosperm grain sorghum hybrids has increased greatly. Commercial grain sorghum seed companies have claimed superior feeding values for homozygous yellow endosperm hybrids. However, the issue of endosperm type and color has become confused with seedcoat color, since yellow endosperm grain sorghum may be either heterozygous or homozygous for this trait, and may have a variety of seedcoat colors.

Kernel size may explain some of the difference among sorghum hybrids. Larger kernels with more starch and less protein may have higher digestibility and may also process more easily and efficiently than smaller, harder kernels.

We compared the relative feeding value for cattle of representative commercial grain sorghum hybrids commonly grown in Kansas. Furthermore, heterozygous and homozygous yellow endosperm grain sorghums were compared with corn. The influence of kernel size on grain processing and animal performance was also studied.

Experimental Procedures

Cattle feeding trials were conducted at the Kansas State University Beef Research Unit with four grain sorghum hybrids and one corn hybrid during the spring of 1986.

Source and Treatment of Grains. Four hybrid grain sorghums differing in pericarp and endosperm color were grown under similar dryland conditions at Manhattan in 1985. Their characteristics are shown in Table 1.1. The corn hybrid, Pioneer 3377, was obtained in 1985 from one source near Manhattan. Each grain sorghum was harvested at approximately 13% moisture and stored in steel bins until processed. High moisture DK 42Y (HM DK 42Y) was harvested at about

28% moisture and stored whole in an oxygen-limiting structure. Composite grain samples for each of the hybrids were analyzed for crude protein (CP) (Table 1.1). These values were used to formulate the experimental diets (Table 1.2).

Table 1.1. Descriptive Characteristics of Grain Sorghums Studied

Variety	Abbreviation	Crude[a] Protein	Color	
			Pericarp	Endosperm
Funk's 550	F 550	13.4	white	hetero-yellow
Cargill 70	C 70	10.3	red	hetero-yellow
Northrup-King 2778	NK 2778	12.2	red	yellow
DeKalb DK 42Y	DK 42Y	11.6	yellow	yellow

[a]% DM basis

Table 1.2. Composition of Experimental Steer Diets

Ingredient	Diets % DM Basis		
	Grain Sorghum	Corn + Urea	Corn - Urea
Sorghum grain, rolled	78.74	--	--
Corn, rolled	--	78.31	78.74
Sorghum silage	15.00	15.00	15.00
Soybean meal	3.58	3.57	3.58
Urea	--	.44	--
Limestone	1.09	1.09	1.09
Potassium chloride	.20	.20	.20
Salt	.29	.29	.29
Trace mineral premix[a]	.02	.02	.02
Tylan® premix[b]	.06	.06	.06
Rumensin® premix[c]	.02	.02	.02
Animal fat	.99	.99	.99
Vitamin A premix[d]	.01	.01	.01

[a]Contained 11% Ca, 10% Mn, 10% Fe, 10% Zn, 1% Cu, .3% I and .1% Co.
[b]Contained 10 g of tylosin per lb.
[c]Contained 60 g of monensin per lb.
[d]Contained 851,250 IU of Vitamin A per oz.

Cattle Feeding Trial. Thirty five crossbred steers averaging 905 lb. were allotted by weight in a randomized complete block design to seven treatments: 1) dry rolled (DR) F550, 2) DR C70, 3) DR NK 2778, 4) DR DK 42Y, 5) HM DK 42Y, 6) corn + urea, and 7) corn. Diet compositions are presented in Table 1.2. All diets except corn without urea were formulated to provide a minimum of 11% CP on a

DM basis (actual range was 11.2 to 13.8% CP). The corn without urea diet contained 10% CP. The grain mix in each diet contained 17 mg/lb of Rumensin® and 6 mg/lb of Tylin®, which provided 250 to 300 mg/hd/d of Rumensin and 90 to 104 mg/hd/d of Tylan. Steers were housed in individual pens with solid concrete floors. Initial and final weights were determined by the average of two weights taken on consecutive days prior to the AM feeding.

Digestibility Trial. Starting on day 22 of the feeding trial, chromic oxide, an inert marker, was fed to determine apparent digestibility. A 7-day adaption period preceded a 7-day fecal collection period. Fecal grab samples were collected twice daily, then composited and dried in a forced draft oven at 55 C, prior to being ground for chromic oxide analysis.

In Vitro Trials. Two in vitro experiments were conducted to compare the four dry grain sorghum hybrids and the HM DK 42Y. In the first experiment, we measured two-stage in vitro dry matter disappearance (IVDMD). In the second experiment, a modified continuous culture fermentation system was used to measure volatile fatty acid (VFA) production. Ten 500 ml flasks were filled to the overflow port with rumen fluid strained through one layer of cheesecloth. Fermentation flasks were infused continuously with a buffer. The five grain sorghum diets were randomly assigned in duplicate to the 10 flasks. A mixture of 6.9 g of each grain-supplement mixture and 1.7 g of sorghum silage (DM basis) was introduced into the flasks at 12-hour intervals. Effluent was removed daily, with samples taken for VFA analyses on days 5, 6, and 7 of the fermentation.

Results and Discussion

Cattle Feeding Trial. The performance of finishing steers fed the various grains is shown in Table 1.3. Dry matter intakes did not differ significantly among diets; however, consumption of the F 550 diet tended to be lowest (18 lb/d). Average daily gains were statistically similar and ranged from 3.1 to 3.5 lb. However, dry grain sorghum tended to produce lower cattle gains than HM DK 42Y or corn. Feed efficiencies ranged from 5.41 to 6.39. Although means were statistically similar, cattle fed the dry grain sorghum diets tended to have the poorest feed efficiencies, averaging 8.5% poorer (range 13.5 to 3.7%) than those on the corn diets. Efficiency on on the HM DK 42Y diet was 3.6% better than the corn diets. Steers fed dry grain sorghum diets had more difficulty switching from high moisture grain growing diets, as indicated by lower gains for the first 28 days.

During the finishing trial, we observed that steers fed the F 550 hybrid were sorting the diet; therefore, the grain portions of the dry grain sorghum diets were compared for differences in particle size (Table 1.4). In addition, a composite sample of the refused portion of the F 550 diet was compared with the original (as-fed) diet. The F 550, NK 2778, and the refused F 550 had fewer ($P<.01$) large particles (>2380 microns) than the other hybrids. The C 70 and DK 42Y sorghums had similar percentages of large particles. The refused F 550 had over twice the percentage of small particles (<1190 microns) as the original grain portion. That hybrid, as fed, had a greater ($P<.01$) percentage of fine particles than the other hybrids, and may explain why the cattle sorted that ration and tended to have lower feed intakes.

Table 1.3. Performance of Finishing Steers Fed Diets of Grain Sorghum or Corn

Item	Grain sorghum					Corn		SE[2]
	Dry				HM[1]	(+)	(-)	
	F 550	C 70	NK 2778	DK 42Y	DK 42Y	Urea	Urea	
No. steers	5	4	5	5	5	5	5	
Av. Daily Gain, lb	3.13	3.13	3.24	3.20	3.46	3.46	3.51	.19
Daily Intake[3],lb.	18.0	19.6	19.3	20.4	18.8	20.2	18.8	1.04
Feed/gain[3]	5.83	6.15	5.98	6.39	5.42	5.83	5.41	.30

[1]High moisture.

[2]Standard error of mean.

[3]DM basis.

Table 1.4. Whole Kernel Size and Dry Rolled Particle Size of Grain Sorghums Fed to Finishing Steers

Item	Grain Sorghum				Refused	SE[1]
	F 550	C 70	NK 2778	DK 42Y	F 550	
g per 100 kernels	3.39[a]	2.71[b]	2.85[b]	2.09[c]	--	.06
>2380 microns % of wt	4.31[e]	8.73[g]	5.73[f]	9.18[g]	3.12[d]	.18
<1190 microns % of wt	17.81[f]	14.56[e]	11.28[d]	12.62[d]	36.04[g]	.42

[1]Standard error of mean.

[abc]Means in the same row with different superscripts differ (P<.001).

[defg]Means in the same row with different superscripts differ (P<.01).

Table 1.4 shows the weights of 100 kernels of each hybrid. The F 550 hybrid was heaviest (3.39 g/100 kernels) and DK 42Y was lightest (2.09 g/100 kernels) (P<.001). The larger size of F 550 kernels appears to be the reason for the lower proportion of particles >2380 microns and the greater proportion of particles <1190 microns in size compared with the other grain sorghum hybrids examined.

Digestibility Trial. Apparent dry matter digestibilities were different (P<.10) among the experimental diets (Table 1.5). F 550 sorghum grain had the highest digestibility of the dry sorghum grain diets. This is consistent with the trend for improved feed efficiency on that diet (Table 1.3). Steers consuming HM DK 42Y had a 2.5% greater DM digestibility than those fed the most highly digestible dry grain sorghum (74.5 vs. 72.0%), supporting the feed efficiencies of these diets (Table 1.5). The mean digestibilities of the four dry grain sorghums, the

HM grain sorghum, and the corn diets were significantly different and were consistent with the feed efficiencies.

In Vitro Trials. Volatile fatty acid production measured with the continuous culture fermenter was not significantly different among diets (Table 1.6). The HM DK 42Y had a mean VFA production rate of 92.3 mM/ml/d compared with the dry grain sorghum diets, which ranged from 83.1 to 85.7 mM/ml/d. That trend parallels the feed efficiency and digestibility data. The IVDMD values of F 550, C 70, NK 2778, DK 42Y, and HM DK 42Y grain sorghums were 75.2, 78.1, 78.7, 82.0, and 74.4%, respectively, and are inconsistent with in vitro VFA production rates, apparent dry matter digestibilities, and feed efficiencies. This lack of correlation between the IVDMD values and the other cattle performance indexes may be due to the extra fine grinding of samples required for the procedure.

Table 1.5. Apparent Dry Matter Digestibilities (DMD) of Grain Sorghum and Corn Diets Fed to Finishing Steers

	Grain sorghum					Corn		
	Dry				HM[1]	(+)	(-)	
Item	F 550	C 70	NK 2778	DK 42Y	DK 42Y	Urea	Urea	SE[2]
DMD, %	72.0[a]	67.7[c]	69.4[bc]	69.7[bc]	74.5[a]	70.7[bc]	71.7[ab]	1.5

[1]High moisture.

[2]Standard error of mean.

[abc]Means with different superscripts differ, (P<.10).

Table 1.6. In Vitro Continuous Culture Daily VFA Production Rate of Grain Sorghum Diets Fed to Finishing Steers

	Dry Grain				High Moisture	
Item	F 550	C 70	NK 2778	DK 42Y	DK 42Y	SE[1]
VFA, mM/ml/d	85.7	83.1	83.9	83.8	92.3	4.1

[1]Standard error of mean.