Whole-Plant Forage, Grain, or Nonheading Sorghum Silages for Growing Cattle

Russell Smith, Keith Bolsen, Harvey Ilg, Jim Hoover, and John Dickerson

Summary

Three sorghum hybrid types were used to make six silages in the fall of 1983. Eight silage rations were compared using 160 steer calves in an 84-day growing trial. Using forage sorghum silage as a base (100), grain sorghum silage had a feeding value of 133, and nonheading sorghum silage 89, when evaluated for comparative rates and efficiencies of gain. Silages from concrete stave silos produced faster and more efficient steer gains than silages from Silopress® bags. Rolling the grain sorghum silages at feeding time to break 95% of the grain significantly improved steer performance. The feeding value of corn silage was not enhanced by processing.

Introduction

Unlike corn, sorghums have a wide range of grain yield, plant height, and forage dry matter content. Therefore, large variations in feeding value often occur among sorghum varieties. A producer must choose a variety (or type) that will best fit the needs of his livestock and return the greatest economic benefit.

One objective of this trial was to further substantiate previous results concerning the feeding values of grain-type, grain producing forage-type, and nonheading forage-type sorghum silages. Another objective was to determine the effect of storage structure, concrete stave silo VS. Silopress® bag, on the feeding value of the forage and nonheading sorghums. Previous research has shown that processing (rolling) whole-plant sorghum silages is not cost effective (Reports of Progress 427 and 448). This trial measured the response to processing grain sorghum silages harvested at two stages of maturity.

Experimental Procedures

Six silages were made from three sorghum hybrids in the fall of 1983. The crops were: 1) DeKalb FS 25A+ forage sorghum; 2) Funk's G 1990 nonheading sorghum and 3) DeKalb 42Y grain sorghum. The forage sorghum (late-dough stage of maturity) and nonheading sorghums were harvested in concrete stave silos (10 x 50 ft) and Silopress® bags. The grain sorghum was harvested at two stages of maturity and ensiled in a 12 x 60) ft concrete stave silo (late-dough) or a 14 x 40 ft Harvestore® (hard-grain). The harvest dates, dry matter (DM) contents, and type of structure are shown in Table 22.1.

Table 22.1. Crops, Harvest Dates, Dry Matter Contents, and Storage Structures

Sorghum	1983 Harvest Dates	% DM at Harvest	Type of Structure
Forage	Sept. 28	27.9	Silopress bag
	Sept. 30	29.2	Concrete stave
Nonheading	Sept. 28	26.9	Silopress bag
	Sept. 29	27.1	Concrete stave
Grain	Aug. 28-30	42.1	Concrete stave
	Sept. 15-16	50.8	Harvestore

All crops were direct-cut using a Field Queen forage harvester. About 80 to 85% of the sorghum grain was whole when ensiled.

Growth Trial. Eight silage rations were compared: each of the six silages fed without further processing, and the two grain sorghum silages fed after processing through a Roskamp® roller mill to break 95% of the grain. Each silage ration was fed to 20 crossbred steers (four pens of five steers per ration). The silages were full-fed with 2 lb of supplement per steer daily (as-fed basis). Rations were formulated to provide 12.0% crude protein (DM basis), 200 mg of Rumensin® per calf daily, equal amounts of calcium and phosphorus, and vitamin A. The steers received hormonal implants at the start of the trial. The growing trial lasted 84 days, December 15, 1983 to March 9, 1984.

To minimize fill effects, all steers were fed forage sorghum silage to provide a DM intake of 1.75% of body weight for one week before the trial began. Then the steers were weighed individually on two consecutive days after 16 hr without feed or water at the start and end of the trial. The average initial weight was 571 pounds.

Samples of each silage were taken twice weekly. Feed intake was recorded daily for each pen and the quantity of silage fed adjusted daily to assure that fresh feed was always in the bunks. Feed not consumed was removed, weighed, and discarded as necessary.

Digestion Trial. Thirty-six steers similar to those in the growth trial were individually fed six silage rations. The two grain sorghum silages fed in the growth trial and a whole-plant corn silage (40% DM) were each fed unprocessed or rolled. The corn silage is described on page 60 of this report. Chromic oxide was used as a marker to determine digestibility.

The trial consisted of a 14-day adaptation period followed by a 7-day fecal collection period. Fecal samples were taken twice daily according to an advancing 2 hr schedule designed to minimize diurna1 variations in digestion.

Results and Discussion

Chemical analyses and dry matter recoveries of the six silages are shown in Table 22.2. The DM contents ranged from 24.9% for the nonheading sorghum from the concrete stave silo to 50.9% for the late harvested grain sorghum silage. There was little difference in the DM content of the forage and nonheading sorghums. In previous trials (Report of Progress 448), the nonheading silage was wetter.

In spite of the fact that the drier grain sorghum silages underwent less extensive fermentations than the other four silages, as is indicated by their higher pH values and lower acid contents, they were adequately preserved. As a result of their more limited fermentations, DM recoveries were higher. DM recoveries from Silopress bags were slightly higher than those from the concrete stave silos.

Growth Trial. Performance by steers fed the three whole-plant silages made in concrete stave silos is shown in Table 22.3. Grain sorghum produced the fastest gains and highest intakes, nonheading sorghum the slowest gains, and forage sorghum the lowest intakes. Relative feeding values were assigned to each sorghum type based on comparative rates and efficiencies of gain. Performance by steers fed forage sorghum silage was given a value of 100. Grain sorghum had a relative feeding value of 133, reflecting its higher grain content. Nonheading sorghum silage had a relative feeding value of 89, which was likely the result of its higher fiber content.

Data on steer performance from the silo-type comparison are shown in Table 22.4. Silages from the concrete stave silos produced faster gains ($P<.05$) than the silages from the Silopress bags. Intake was higher ($P<.05$) for the nonheading silage from the concrete stave silo than for that made in the bag, however, intakes were numerically lower for the forage sorghum silage from the stave silo when compared to its respective bag silage. Feed efficiencies were better for the stave silo silages.

Performance by steers fed the grain sorghum silages is shown in Table 22.5. Processing the silages prior to feeding significantly improved steer performance. For the earlier harvested silage, processing increased ($P<.05$) gain by 11% and improved ($P<.10$) feed efficiency by 12%, but did not affect DM intake. The responses to processing the grain sorghum silages in this trial were much greater than those observed in our two previous trials (Reports of Progress 427 and 448). However, both grain sorghum silages fed in this trial were harvested at a more mature stage and both contained much higher estimated grain to forage ratios than those fed in previous years.

Digestion Trial. Apparent digestibility coefficients of the six silage rations are shown in Table 22.6. There was no difference between DM digestibility and organic matter (OM) digestibility within any of the silages. For the earlier harvested grain sorghum silage, processing increased DM digestibility by 15% and starch digestibility by 22 percent ($P<.05$). For the later harvested silage, DM digestibility was increased only 5% but starch digestibility was improved 22 percent ($P<.05$). Digestibilities of acid detergent fiber (ADF), cellulose, and crude fiber were not affected by processing the grain sorghum silages. However, ADF, cellulose, and crude fiber digestibilities were decreased when the corn silage was processed. A possible explanation for this lower fiber digestibility is that processing the corn silages reduced the particle size of the corn cob and increased the intake of that portion of the silage. There was a greater refusal of the cobs in the unprocessed corn silage. Corn silage also showed a slightly negative response in DM and OM digestibilities due to processing. Starch digestibility was increased by 8% when the corn silage was processed.

These results suggest that the benefits from processing grain sorghum silage are influenced by grain maturity and grain content. The higher intake of the more mature grain sorghum silage compared with the dough stage silage (Table 22.5) is likely related to differences in DM content (Table 22.2).

When comparing the two unprocessed grain sorghum silages, the lower starch digestibility of the more mature silage (51 vs 65%) accounts for much of the difference in feed efficiency (8.68 vs. 7.75). Even though the processed late-dough grain sorghum silage was numerically more digestible (DM, OM, and starch) than the more mature sorghum silage, the higher intake of the hard-grain silage appeared to compensate for the improvement in digestibility. This was evident in the nearly identical average daily gains of steers fed these two silages (Table 22.5).

Table 22.2. Chemical Analyses and Dry Matter Recoveries for the Six Silages

	Forage Sorghum		Nonheading Sorghum		Grain Sorghum	
Item	Concrete Stave Silo	Silopress Bag	Concrete Stave Silo	Silopress Bag	Late-Dough	Hard-Grain
Silage DM, %	25.1	25.8	24.9	25.8	42.3	50.9
DM Recovery, % of the DM Ensiled	86.5	90.2	86.4	89.8	96.7	97.9
pH	3.82	3.78	3.75	3.69	4.19	4.34
	% of the Silage DM					
Lactic Acid	8.78	9.45	9.61	9.26	5.92	4.56
Acetic Acid	2.43	1.96	3.01	2.26	1.54	1.22
Butyric acid	trace	trace	none	none	trace	trace
Total Fermentation Acids	11.26	11.42	12.62	11.52	7.48	5.81
Acid Detergent Fiber	38.8	39.8	40.3	42.0	23.3	23.1
Neutral Detergent Fiber	63.9	64.3	64.9	65.8	40.1	45.2
Lignin	6.6	7.4	6.8	7.5	3.8	4.0
Cellulose	28.5	28.8	30.3	30.9	17.3	16.6
Hemicellulose	24.3	24.0	23.9	23.5	17.1	22.2
Crude Protein	6.2	6.0	6.1	6.2	10.9	10.1
	% of the Total N					
Ammonia-N	4.2	4.8	5.2	4.8	6.5	5.0
Hot Water Insoluble-N	55.2	51.7	47.1	44.1	46.7	56.3
Acid Detergent-N	14.0	14.5	15.8	10.6	11.1	13.3

Table 22.3. Performance by Steers Fed the Three Whole-plant Silages Made in Concrete Stave Silos

Item	Nonheading Sorghum	Forage Sorghum	Grain Sorghum[1]
No. of Calves	20	20	20
Initial Wt., lb	572	572	573
Final Wt., lb	677	687	762
Avg. Daily Gain, lb	1.25	1.37	2.25
Avg. Daily Feed, lb[2]	12.62	11.94	19.41
Feed/lb of Gain, lb[2]	10.12	8.87	8.68
Relative Feeding Value[3]	89	100	133

[1] Late-dough stage of maturity, unprocessed.
[2] 100% dry matter basis.
[3] Based on comparative rates and efficiencies of gain, with performance of steers fed forage sorghum silage assigned a value of 100.

Table 22.4. Performance by Steers Fed the Forage Sorghum and Nonheading Sorghum Silages

Item	Forage		Nonheading	
	Concrete Stave Silo	Silopress Bag	Concrete Stave Silo	Silopress Bag
No. of Calves	20	20	20	20
Initial Wt., lb	572	570	572	571
Final Wt., lb	687	669	677	647
Avg. Daily Gain, lb	1.37[a]	1.18[b]	1.25[ab]	.91[c]
Avg. Daily Feed, lb[1]	11.94[ab]	12.46[ab]	12.62[a]	11.84[b]
Feed/lb Gain, lb[1]	8.87[a]	10.60[a]	10.12[a]	13.42[b]

[abc] Means with different superscripts differ significantly (P<.05).
[1] 100% dry matter basis.

Table 22.5. Performance by Steers Fed the Grain Sorghum Silages

Item	Late-Dough		Hard-Grain	
	Unprocessed	Processed	Unprocessed	Processed
No. of Calves	20	20	20	20
Initial Wt., lb	573	570	569	570
Final Wt., lb	762	780	746	776
Avg. Daily Gain, lb	2.25[b]	2.50[a]	2.11[b]	2.45[a]
Avg. Daily Feed, lb[1]	19.41[d]	19.37[d]	19.86[c d]	20.82[c]
Feed/lb Gain, lb[1]	8.68[d]	7.75[c]	9.44[e]	8.53[d]

[ab] Means with different superscripts differ significantly (P<.05).
[c d e] Means with different superscripts differ significantly (P<.10).
[1] 100% dry matter basis.

Table 22.6. Apparent Digestibilities of the Six Grain Sorghum and Corn Silage Rations

Item	Grain Sorghum Silage				Corn Silage		SE
	Late-Dough		Hard-Grain				
	Unproc.	Proc.	Unproc.	Proc.	Unproc.	Proc.	
Apparent Digestibility:	%						
Dry Matter	53.7[b]	61.9[a b]	55.0[b]	57.8[b]	63.1[a]	60.9[b]	2.86
Starch	65.0[c]	79.0[b]	50.7[d]	65.4[c]	86.2[a b]	93.4[a]	3.16
Organic Matter	53.7[b]	61.9[a b]	55.1[b]	57.8[b]	63.2[a]	61.0[b]	2.86
ADF	49.5[a b]	49.9[a b]	55.8[a]	56.1[a]	50.7[a b]	42.8[b]	3.60
Cellulose	60.1[a b]	58.9[a b]	62.4[a]	62.9[a]	59.4[a b]	52.4[b]	3.25
Crude Fiber	58.8[a b]	58.5[a b]	65.3[a]	64.3[a]	59.4[a b]	54.0[b]	3.01
Crude Protein	42.7[a b]	51.5[a]	38.2[b]	42.5[a b]	37.9[b]	32.6[b]	4.49

[a b c d] Means with different superscripts differ significantly (P<.05).