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Effects of sorghum hybrid and grain supplementation on the utilization of silage-based rations for growing cattle

Abstract

Three whole-plant sorghum silages, each with or without 25% added rolled grain sorghum were fed to six medium-framed, ruminally cannulated steers in a 6 x 6 Latin square design. The grain sorghum silage rations (DeKalb 42Y) had the highest DM, OM, and ADF digestibilities; the late-season forage sorghum silage rations (DeKalb FS 25E), the lowest. Digestibility of NDF tended to be highest for the grain sorghum silage, but starch digestibilities were not affected by sorghum hybrid. Ruminal ammonia, acetate, propionate, butyrate, and total VFA concentrations were highest for the grain sorghum silage rations. Grain supplementation increased DM and OM digestibilities but had no effect on NDF, ADF, or starch digestibilities. Ruminal pH was decreased, whereas VFA concentrations were not affected by grain supplementation. The grain sorghum silage had the highest nutritive value, and the middle-season forage sorghum silage (DeKalb FS 5) was superior to the late-season forage sorghum. These results are consistent with several of our previous trials, which compared grain and forage sorghum silages for growing (backgrounding) cattle.

Keywords

Cattlemen's Day, 1994; Kansas Agricultural Experiment Station contribution; no. 94-373-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 704; Beef; Silage; Forage sorghum; Grain sorghum; Hybrid

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EFFECTS OF SORGHUM HYBRID AND GRAIN SUPPLEMENTATION ON THE UTILIZATION OF SILAGE-BASED RATIONS FOR GROWING CATTLE [1]

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Summary

Three whole-plant sorghum silages, each with or without 25% added rolled grain sorghum were fed to six medium-framed, ruminally cannulated steers in a 6 × 6 Latin square design. The grain sorghum silage rations (DeKalb 42Y) had the highest DM, OM, and ADF digestibilities; the late-season forage sorghum silage rations (DeKalb FS 25E), the lowest. Digestibility of NDF tended to be highest for the grain sorghum silage, but starch digestibilities were not affected by sorghum hybrid. Ruminal ammonia, acetate, propionate, butyrate, and total VFA concentrations were highest for the grain sorghum silage rations. Grain supplementation increased DM and OM digestibilities but had no effect on NDF, ADF, or starch digestibilities. Ruminal pH was decreased, whereas VFA concentrations were not affected by grain supplementation. The grain sorghum silage had the highest nutritive value, and the middle-season forage sorghum silage (DeKalb FS 5) was superior to the late-season forage sorghum. These results are consistent with several of our previous trials, which compared grain and forage sorghum silages for growing (backgrounding) cattle.

(Key Words: Silage, Forage Sorghum, Grain Sorghum, Hybrid.)

Introduction

The wide ranges of plant height, season length, DM content, and whole-plant DM and grain yields contribute to the large variations in nutritive values observed between forage sorghum hybrids and varieties (KAES Reports of Progress 539, pages 167, 172, and 177; 623, page 65; and 678, page 13).

We have reported previously that adding 25% grain (DM basis) to sorghum silage-based rations improved both rate and efficiency of gain, particularly the middle-season, moderate grain-content and late-season, low grain-content forage sorghum hybrids. The present study continued to document the effects of sorghum hybrid and grain supplementation on nutrient digestibilities and passage rates and ruminal metabolism of silage-based rations fed to growing cattle.

Experimental Procedures

Six medium-framed steers, fitted with ruminal cannula and averaging 680 lb, were utilized in a 6 × 6 Latin square design with a 3 × 2 arrangement of treatments. We fed three whole-plant silages (DeKalb 42Y grain sorghum and DeKalb FS 5 and FS 25E forage sorghums), each with or without 25% added rolled grain

[1]The steers used in this trial and partial financial assistance were provided by Mr. Richard Porter, Porter Farms, Reading, KS.

sorghum. DeKalb FS 5 is a middle-season, moderate grain-content hybrid; and DeKalb FS 25E is a late-season, low grain-content hybrid. On day 1 of each experimental period, the steers were allocated randomly to one of the six rations. The rations were formulated to be isonitrogenous and were fed ad libitum twice daily (8 am and 3 pm). Each 16-day experimental period consisted of 8 days for adaptation, 4 days for total fecal collection, and 4 days for rumen collection.

On day 12 of each experimental period, samples of ruminal digesta were collected before the first feeding (0 hour) and at 2, 4, 6, and 10 hours after the first feeding. The samples consisted of subsamples from the dorsal blind sac, mid-dorsal region, mid-ventral region, and the reticulum. On day 2 of the ruminal collection period, 1.0 kg of ytterbium-labeled silage and 250 ml of sodium cobalt EDTA were pulse-dosed ruminally before the first feeding (0 hour). Ruminal fluid and particulate samples were collected at 4, 8, 12, and 24 hours after dosing. Liquid and particulate dilution rates were determined by regressing the natural logarithm of the Yb and Co concentrations against time after dosing.

Data were analyzed using the SAS GLM procedure. Fermentation profile data were analyzed as a split-plot in time 6 × 6 Latin square design using a t-test for mean separations. Terms in the fixed effects model included the main effects of period, steer, time, sorghum hybrid, and grain supplementation and their interactions. Sorghum hybrid, grain supplementation, and sorghum hybrid by grain supplementation (whole-plot) effects were tested for significance by using the whole-plot residual sums of squares (sorghum hybrid by grain supplementation by period by steer). Time, time by sorghum hybrid, time by grain supplementation, and time by sorghum hybrid by grain supplementation (subplot) effects were tested for significance by the subplot residual sums of squares.

Digestibility, intake, and passage rate data were analyzed as a 6 × 6 Latin square using a t-test for mean separations. Terms in the fixed effects model included period, steer, sorghum hybrid, and grain supplementation and their interactions.

Results and Discussion

The nutrient composition and agronomic data for the three silages are presented in Table 1.

Table 1. Composition of the Sorghum Silages

Item	DeKalb 42Y	DeKalb FS 5	DeKalb FS 25E
DM, %	34.5	28.9	27.3
	——% on a DM basis——		
CP	8.8	7.7	6.3
NDF	47.8	55.5	54.5
ADF	27.9	36.5	39.8
Starch	45.3	39.7	30.5
Plant height, in	53	115	125
Grain, bu/acre	107	96	98
Percent grain	44.0	34.4	29.3
DM yield, ton/acre	6.6	7.6	8.8

Interactions between grain supplementation and the three sorghum silages were not statistically significant for any of the digestion criteria measured (Table 2). However, adding grain to the DeKalb 42Y and DeKalb FS-5 silage rations tended to reduce starch digestibility (14.1 and 3.9%, respectively). Starch digestibility of the DeKalb FS-25E silage rations was not affected by grain supplementation.

Intakes of DM and digestible DM were highest ($P<.001$) for steers fed the DeKalb 42Y silage rations (Table 2). Dry matter and OM digestibilities were highest ($P<.05$) for the DeKalb 42Y and DeKalb FS-5 silage rations. Acid detergent fiber digestibility was greatest ($P<.05$) for DeKalb 42Y silage

rations, but NDF and starch digestibilities and liquid and particulate passage rates were not affected (P>.05) by sorghum hybrid. Ammonia, acetate, propionate, butyrate, and total VFA concentrations were highest (P<.05), whereas acetate/propionate ratio and pH were lowest (P<.05) for steers fed DeKalb 42Y silage rations (Table 3). DeKalb FS-5 and DeKalb FS-25E silage rations produced statistically similar ruminal fermentation characteristics.

Grain supplementation increased (P<.001) intakes of DM and digestible DM by 25 and 34%, respectively, when compared to control rations (Table 2). Dry matter and OM digestibilities were increased (P<.05) by 5.1 and 5.2%, respectively, by grain addition. Starch digestibility tended to decrease (P=.06) with grain supplementation. Acid detergent fiber digestibility (P=.50), NDF digestibility (P=.21), liquid passage rate (P=.30), and particulate passage rate (P=.49) were not affected by grain supplementation of the sorghum silage-based rations.

Table 2. Effect of Hybrid and Grain Supplementation of Sorghum Silage-Based Rations on DM Intake, Intake of Digestible DM, and Nutrient Digestibilities and Passage Rates in Growing Steers [1]

	Sorghum Silage and Grain Addition									
	DeKalb 42Y		DeKalb FS 5		DeKalb FS 25E			Probability [2]		
Item	0	25%	0	25%	0	25%	SE	H	G	H×G
DM intake, lb/day	16.5	19.0	13.0	16.5	10.6	14.1	.62	.001	.001	NS
Intake of DDM, lb/day	10.1	12.1	7.7	10.1	5.5	8.6	.48	.001	.001	NS
Digestibility, %										
DM	62.1	63.8	59.5	61.3	52.5	59.8	1.70	.01	.05	NS
OM	63.4	64.5	61.0	62.6	55.5	62.3	1.80	.05	.05	NS
NDF	52.7	56.9	52.9	51.7	46.2	51.5	2.60	NS	NS	NS
ADF	53.2	53.6	44.4	39.9	41.7	39.8	3.50	.01	NS	NS
Starch	85.4	73.4	85.6	81.7	81.1	81.7	3.20	NS	NS	NS
Particulate passage rate, %/h	5.1	5.2	5.5	4.0	4.0	3.0	.94	NS	NS	NS
Liquid passage rate, %/h	7.8	8.4	9.3	9.9	9.5	7.1	.69	NS	NS	NS

[1]Values are least square means, and SE is the pooled standard error of the mean.
[2]H = hybrid, G = grain, H×G = hybrid x grain interaction, NS = not different.

Table 3. Effects of Hybrid and Grain Supplementation of Sorghum Silage-Based Rations on Ruminal Fermentation Characteristics in Growing Steers [1]

	Sorghum Silage and Grain Addition									
	DeKalb 42Y		DeKalb FS 5		DeKalb FS 25E			Probability [2]		
Item	0	25%	0	25%	0	25%	SE	H	G	H×G
pH	6.6	6.5	6.8	6.7	6.8	6.8	.02	.01	.01	NS
Ammonia, mM	5.7	5.5	4.5	4.2	4.7	3.8	.31	.01	NS	NS
VFA, mol/100 mol										
acetate	63.0	60.6	54.4	58.0	58.2	58.4	1.40	.01	NS	NS
propionate	18.6	19.8	15.9	16.8	16.2	16.0	.57	.01	NS	NS
butyrate	9.7	8.0	7.0	7.8	7.1	7.4	.29	.01	NS	.05
Total VFA, mM	97.5	94.6	81.8	88.1	86.8	86.8	2.30	.01	NS	NS
Acetate/ propionate	3.5	3.2	3.5	3.6	3.6	3.7	.07	.01	NS	NS

[1]Values are least square means, and SE is the pooled standard error of the mean.
[2]H = hybrid, G = grain, H×G = hybrid × grain interaction, NS = not different.