EFFECT OF GRAIN SORGHUM PARTICLE SIZE AND DIGEST "M" ENZYME TREATMENT ON PERFORMANCE OF GROWING STEERS [1]

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Summary

A 73-day growing study utilizing 203 crossbred steers (681 lb) and a digestion trial examined the effect of sorghum grain particle size on rumen fermentation, ration digestibility, and performance of growing steers fed 37% grain and 63% ground alfalfa. Dry-rolled grain sorghum particle sizes in both trials were about 2000, 1500, and 1000 microns, for the coarse- (CR), medium- (MR), and fine-rolled (FR) treatments, respectively. Coarsely rolled corn (2000 microns) was included as a positive control. In the growing study, half of sorghum was treated at feeding time with an enzyme product, Digest "M". The rations were 35 to 37% dry grain plus ground alfalfa hay and supplement.

Total ration dry matter, neutral detergent fiber, and starch digestibilities increased linearly (P<.02) with decreasing sorghum grain particle size. Rumen pH, ammonia and total volatile fatty acid concentrations, and acetate-to-propionate ratio were unaffected by grain type or particle size. Dry matter intake was not influenced by grain types or particle size. Steers fed FR sorghum gained 9% faster (P<.03) during the first 28 days and tended to gain faster (5%, P<.14) over the entire trial than those fed CR sorghum, with gains on MR sorghum being intermediate. FR sorghum produced 6% more efficient gains (P<.07) than CR, and MR grain was intermediate. Digest "M" enzyme treatment of the sorghum grain had no influence. Feed conversions of CR, MR, and FR sorghum were 93, 94, and 99% of corn. This research indicates that grain sorghum in high roughage backgrounding programs should have a maximum average particle size of 1000 microns.

(Key Words: Grain Sorghum, Particle Size, Processing, Digestibility, Enzyme, Growing Cattle.)

Introduction

Grain sorghum is used widely for growing cattle and normally is dry-processed by either roller or hammer mill. Samples collected across Kansas indicate that particle size is often coarse. Although the effect of sorghum particle size has been studied in finishing rations, it has not been studied in higher roughage, growing rations. We investigated the influence of grain particle size on growing cattle performance and ration digestibility and also evaluated the effect of Digest "M", an enzyme product that has shown potential to improve sorghum digestibility.

Experimental Procedures

Digestion Trial. Sixteen ruminally fistulated steers (944 lb) were assigned randomly to four treatments: 1) dry-rolled corn (CO) with an average particle size of 2172 microns as a positive control, and 2) fine-rolled (FR, 1040 microns), 3) medium-rolled (MR, 1371 microns), and 4) coarse-rolled (CR, 2008 microns) grain sorghum. These particle sizes were selected to cover the spectrum of grain particle sizes typically observed in cattle rations. Feedstuff composition is shown in Table 1. Diets consisted of 37% of the respective grain and

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63% ground alfalfa. Steers were housed in an individual tie stall barn, with free access to water and a trace mineral salt block. Steers were fed once daily at 7 AM with dry matter intake limited to 2.25% of body weight. They were adapted to rations for 11 days. On day 12, ruminal fluid samples were taken at feeding and at 3, 6, 9, and 12 hours postfeeding. Beginning on day 13, feed samples were taken daily. Any feed refused was weighed back and sampled. On day 14, steers were fitted with fecal bags for total fecal collection to measure digestibility. Fecal samples were taken twice daily for 7 consecutive days.

Table 1. Composition of Diets and Feedstuffs Used in the Digestion and Steer Growing Trials

	Percent in		Dry Matter Basis			
Feedstuff	Ration	% DM	% Starch	% CP	% ADF	% NDF
Digestion trial:						
Dry rolled grain	37.0					
Sorghum, coarse		86.6	72.2	9.0	3.9	8.5
Sorghum, medium		86.9	73.6	9.4	3.4	9.0
Sorghum, fine		86.8	72.7	9.4	3.2	9.4
Corn, coarse		86.7	67.5	9.6	2.2	10.7
Alfalfa hay, ground	63.0	94.0	2.1	14.2	43.8	55.6
Steer growing trial:						
Dry rolled grain	35.0					
Sorghum, coarse		88.4	75.4	8.9	3.0	9.6
Sorghum, medium		88.4	77.1	8.6	2.9	9.1
Sorghum, fine		88.6	75.2	8.8	2.9	9.2
Corn, coarse		88.0	71.2	8.6	2.3	10.5
Alfalfa hay, ground	57.0	88.1	---	18.2	37.7	52.4
Supplement [1]	5.0	89.6	---	40.5	3.8	12.1
Molasses [2]	3.0	---	---	---	---	---

[1]Soybean meal-based supplement fortified with minerals and vitamins to meet 1996 NRC requirements, plus Rumensin®.
[2]Cane molasses was not analyzed.

Growing Steer Trial. Two hundred and three thin, short yearling, crossbred steers (681 lb) were weighed unshrunk on 2 consecutive days, blocked by breed type, and assigned randomly by weight to the same grain treatments described for the digestion trial, except that one-half of each sorghum particle size treatment was treated with Digest "M". This design resulted in seven treatments with five pens per treatment and five to six head

per pen. Pens were roofed partially and had concrete floors. Digest "M" application followed manufacturer's recommendations, including the addition of 5% water to the grain. Steers were fed a totally mixed ration (Table 1) once daily. The experiment started on February 27, 1996, and steers were weighed every 28 days. On days 73 and 74, the steers were weighed off-test, with the average serving as the final unshrunk weight.

Results and Discussion

Sorghum particle size did not influence rumen fermentation (Table 2). Corn produced a rumen fermentation profile similar to that with grain sorghum, except for a higher (P<.10) concentration of valerate than the FR and MR sorghum treatments. Ration starch and NDF digestibilities (Table 2) increased linearly (P<.02) with decreasing sorghum particle size, and dry matter digestibility increased linearly (P<.01) as a direct result of the increased digestibility of starch and fiber.

Because no interactions occurred between effects of grain particle size and enzyme treatment on steer performance, both were pooled (Table 3). Feed intake was not affected by grain type or particle size. Steers on FR sorghum gained (9%) faster (P<.03) than those on CR sorghum during the first 28 days; with gains on MR sorghum being intermediate. Feed conversions were 10 and 4% better for FR and MR than CR sorghum (P<.01 and P<.06, respectively) during the first 28 days, and the FR treatment was 6% more efficient (P<.07) than CR sorghum during the entire 73-day trial. Steers carried considerable mud and fecal matter during the middle of the trial, which affected the apparent gains toward the end. Digest "M" had no effect on intake or performance (Table 4).

Decreasing grain sorghum particle size in high roughage, growing rations increased total ration starch, NDF, and dry matter digestibility, which improved feed conversion. In fact, the fine-rolled grain sorghum produced feed efficiencies equal to those with dry-rolled corn. These results indicate that producers should strive to process grain sorghum to a maximum, average, particle size of about 1000 microns.

Table 2. Influence of Dry Rolled Grain Type and Particle Size on Apparent Digestibility and Ruminal Fermentation Characteristics in Beef Steers

	Corn	Grain Sorghum			Contrasts[2]	
Item	Coarse[1]	Fine	Medium	Coarse	L	Q
Digestion study:						
DM intake, lb/day	21.5	21.5	21.3	21.6	.99	.92
Apparent digestibility:						
Dry matter, %	71.2	70.9	68.2	65.0	<.01	.29
NDF, %	59.4	58.1	56.6	53.0	.02	.52
Starch, %	95.0	94.4	88.3	82.3	<.01	.14
Ruminal fermentation profile:					P-value[2]	
pH	6.01	5.90	6.17	6.21	.34	
VFA conc., mM	61.97	62.39	53.00	56.79	.47	
NH_3N, mM	2.48	1.57	1.49	1.78	.38	
VFA, mol/100 mol:						
Acetate	60.56	63.08	63.49	62.57	.27	
Propionate	17.99	17.46	17.40	17.76	.88	
A:P[3]	3.45	3.66	2.76	3.59	.67	
Butyrate	15.65	14.45	13.81	13.93	.28	
Isobutyrate	1.33	1.20	1.35	1.41	.14	
Valerate	2.23[a]	1.84[b]	1.86[b]	1.99[ab]	.09	
Isovalerate	2.23	1.98	2.10	2.34	.52	

[1]Grain mean particle sizes were: corn, coarse = 2172 microns; sorghum, coarse = 2008 microns, medium = 1371 microns, fine = 1040 microns.
[2]Probability of observing a significant F or P-value: L = linear response, Q = quadratic response to reducing sorghum particle size.
[3]Acetate:propionate ratio.
[ab]Means in same row not sharing the same superscript differ (P<.10).

Table 3. Effect of Grain Sorghum Particle Size on Dry Matter Intake, Average Daily Gain, and Feed Efficiency of Growing Steers

	Corn	Grain Sorghum		
Item	Coarse[1]	Fine	Medium	Coarse
Dry matter intake, lb/day				
0-28 days	22.6	23.4	23.4	23.6
0-56 days	24.6	25.8	25.8	26.0
0-73 days	25.6	26.5	26.8	26.9
Average daily gain, lb				
0-28 days	4.67	4.72[a]	4.54[ab]	4.32[b]
0-56 days	4.37	4.17	4.12	3.99
0-73 days	3.62	3.68	3.57	3.51
Feed/gain				
0-28 days	4.85	4.95[c]	5.15[c]	5.46[d]
0-56 days	5.62	6.21	6.25	6.45
0-73 days	7.14	7.25[c]	7.58[cd]	7.69[d]

[1]Grain particle sizes were: corn ,coarse = 2235 microns; sorghum, coarse = 1956 microns, medium = 1514 microns, and fine = 1077 microns.
[ab]Means in same row not sharing the same superscript differ (P<.03).
[cd]Means in same row not sharing the same superscript differ (P<.07).

Table 4. Effect of Digest "M" Treatment of Sorghum Grain on 73-Day Performance of Growing Steers

Item	Control	Digest "M"
Daily gain, lb		
0-28 days	4.48	4.55
0-56 days	4.09	4.09
0-73 days	3.57	3.60
Dry matter intake, lb/day		
0-28 days	23.4	23.6
0-56 days	25.9	25.8
0-73 days	26.8	26.7
Feed/gain		
0-28 days	5.21	5.18
0-56 days	6.29	6.29
0-73 days	7.46	7.41