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Abstract

Because most finishing rations contain a high proportion of grain, better processing of sorghum grain to increase grain utilization should improve ration efficiency. Work in Texas, Oklahoma, Arizona, and Fort Hays has indicated that processing sorghum grain increased digestibility and utilization. This trial compared digestibility and feedlot performance of beef steers fed steam flaked, popped, reconstituted or dry-rolled sorghum grain.

Keywords

Cattlemen's Day, 1971; Report of progress (Kansas State University. Agricultural Experiment Station); 546; Beef; Performance; Digestibility; Sorghum grain

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Feedlot Performance and Digestibility of Beef Steers Fed Steam Flaked, Popped, Reconstituted And Dry Rolled Sorghum Grain

D. O. Yauk, C. L. Drake and R. L. Schalles

Introduction

Because most finishing rations contain a high proportion of grain, better processing of sorghum grain to increase grain utilization should improve ration efficiency.

Work in Texas[1], Oklahoma[2], Arizona[3] and Fort Hays[4] has indicated that processing sorghum grain increased digestibility and utilization. This trial compared digestibility and feedlot performance of beef steers fed steam flaked, popped, reconstituted or dry-rolled sorghum grain.

Material and Methods

Sixty good to choice yearling steers averaging 717 pounds each were randomly allotted to twelve lots. Ten were group fed in two groups of five each and five were individually fed in each of the four treatments.

Steam-flaked sorghum grain was obtained by subjecting sorghum grain to steam in an over-sized steam chamber for 40 minutes at 210°F under atmospheric pressure and rolled through a heavy duty Ross roller mill with no tolerance on the rolls. The flaked sorghum grain weighed about 23.5 pounds per bushel with 18 to 20% moisture off the rolls. Flaking was done daily.

Reconstituting was by adding water to dry sorghum grain so

[1]McGinty, D. D., L. H. Breuer and J. K. Riggs. 1966. Digestibility of dry and reconstituted grain sorghum by beef cattle. Beef Cattle Res. in Texas. 2424 p. 37.
[2]Newson, J. R., R. Totusek, R. Renbarger, E. C. Nelson, L. Franks, V. Neuhaus, 1968. Methods of processing milo for fattening cattle. Oklahoma Feeder's Day Rpt. No. 80, p. 47.
[3]Hale, W. H., Luis Cuitun, W. J. Saba, B. Taylor and B. Theurer, 1966. Effect of steam processing and flaking milo and barley on performance and digestion by steers. J. Animal Sci. 25:392.
[4]Brethour, J. R. and W. W. Duitsman, 1970. Feeding high-moisture harvested milo and reconstituted ensiled milo. Round Up Rpt. Bul. 535.

the end product would contain approximately 28% moisture. Grain was in oxygen free storage three weeks before being fed. Fresh grain was rolled twice daily.

Dry heat (popped) sorghum grain was obtained by subjecting the grain to 450°F. Popped grain was then rolled. The end product weighed about 24.5 pounds per bushel and contained 8.5% moisture. Whole sorghum grain was hauled and popped at the Herington, Kansas Tri-county Feedlot. Popping was accomplished using a Cabomatic popper with 4-ton capacity and cooking chamber temperature of 450 to 500°F. Moisture was added to the popped grain before it was fed so the moisture level would be comparable to that of steam flaked grain.

Grain, supplement and roughage were fed twice daily (Table 17).

An attempt was made to evaluate chemical changes in the starch portion of the sorghum from processing, using an enzymatic technique Anstaett et al., (1969). Results are reported in Table 18.

Digestion studies were conducted using four 940 pound Hereford steers in a 4 x 4 Latin square to obtain digestion coefficients (Table 19).

Results and Discussion

Feedlot performance and carcass data are presented in Table 20. July and August temperatures reduced gains for all treatments. Average daily temperature was extremely high, including ten consecutive days of +102°F. Shades were not available and concrete surfaces of pens seemed to increase heat stress so feed consumption was reduced. An effort was made to reduce heat stress by continuously sprinkling the cattle.

There were no significant differences in rate of gain among treatments as shown in Table 20. However, steers fed the processed sorghum grain gained an average of .2 pound per day more than those fed dry rolled grain. Steam flaking produced the highest rate of gain, followed by popping.

Daily consumption on a dry basis was highest for steers receiving dry rolled ($P<.05$) and lowest for steam flaked sorghum grain. Steers consumed more popped grain than steam flaked, especially during the first 60 days of the trial.

Feed efficiencies were significantly ($P<.05$) increased by each processing method (Table 20). Steers receiving processed sorghum grain required an average of 2.15 pounds less feed per pound of gain than those receiving dry rolled grain. There were

no significant differences in feed efficiency among steers receiving steam flaked, popped, or reconstituted sorghum grain. Carcass characteristics did not differ significantly among treatments.

Apparent coefficients of digestion for rations containing sorghum grain processed by four methods are presented in Table 19. Coefficients of digestion for protein, crude fiber,and ether extract were not significantly altered by processing. Total digestible nutrients and the COD of dry matter and nitrogen free extract differed significantly.

Digestion coefficients for dry matter, nitrogen-free extract compared to reconstituted sorghum grain. Total digestible nutrients, nitrogen-free extract, gross energy, and dry matter of popped grain exceeded ($P<.05$) that of rolled sorghum grain. Reconstituting increased ($P<.05$) the digestibility of nitrogen-free extract and gross energy, but total digestible nutrients and dry matter did not differ from those of dry rolled grain.

Starch alteration (gelatinization) during processing was evaluated. Starch changed most in popped grain, as indicated by mg maltose per gram of sample (Table 18). Steam-flaked grain (weighing 22 pounds per bushel) produced 110 mg maltose per gram sample: reconstituted, 25 mg; and dry rolled, 29.8 mg. Reconstituting changes starch very little. Sorghum grain steamed and not flaked yielded 20 mg of maltose, indicating that steaming at atmospheric pressure a short time does not greatly modify starch. Steam flaking altered starch indicating that both physical pressure and heat are essential for gelatinization.

CORRECTION:

Page 21, Paragraph 2, 1st sentence:

Digestion coefficients for dry matter and nitrogen-free extract were greater ($P<.05$) for steam flaked than reconstituted sorghum grain.

Page 21, Paragraph 2, 2nd sentence:

Delete - total digestible nutrients.

Table 15
Proximate Analysis of Sorghum Grain
Processed by Indicated Method

Item	Processing method			
	Recon-stituted	Popped	Steam flaked	Dry rolled
Composition, DM basis, %				
Protein (N x 6.25)	10.62	11.39	10.08	9.79
Ether extract	2.50	2.76	2.56	2.73
Ash	1.75	1.78	1.58	1.70
Crude fiber	1.89	2.40	2.08	2.07
N-free extract	83.24	81.67	83.70	83.71
Original moisture	25.80	7.11	17.92	15.09
Gross energy, kcal/gm	4.408	4.396	4.430	4.364

Table 16
Chemical Composition of Feedlot Rations Containing
Sorghum Grain Processed By Indicated Method

Item	Recon-stituted	Popped	Steam flaked	Dry rolled
Composition, DM basis %				
Protein (N x 6.25)	13.09	13.66	14.89	14.08
Ether extract	2.92	2.62	2.43	2.81
Ash	2.86	2.95	2.55	2.97
Crude fiber	3.93	4.37	3.98	4.49
N-free extract	77.22	76.39	76.15	75.65
Original moisture	27.39	21.97	19.28	18.50
Gross energy, kcal/gm	4.338	4.286	4.378	4.329

Table 17

Ration Composition to Compare Four Processing Methods With Sorghum Grain

Ration Ingredient	Processing method	
	Reconstitution[1]	Dry rolled steam flaked popped
	%	%
Haylage	10.000	10.000
Sorghum grain	88.235	88.055
Salt	0.5	0.5
Limestone	0.5	0.5
Urea	0.67	0.85
Vitamin A	0.015	0.015
Chlorotetracycline	0.030	0.030
Trace mineral	0.050	0.050

[1]Two rations were necessary to insure isonitrogenous rations as grain used in reconstituted ration differed from that used in other rations.

Table 18
Influence of Four Processing Methods
On Sorghum Starch Gelatinization

Item	Maltose mg/gm	Gelatinization %
Reconstituted	25.0	10
Popped	149.0	62
Steam flaked - 24#	87.1	36
Steam flaked - 22#	110.0	46
Dry rolled	29.8	12
Steamed - not flaked	20.0	8
Analytical standard (extruded)	240.0	100

TABLE 19 MEANS AND STANDARD ERRORS OF APPARENT COEFFICIENTS OF DIGESTION AND NITROGEN BALANCE OF STEERS FED SORGHUM GRAIN PROCESSED BY FOUR METHODS

Item	Recon-stituted	Popped	Steam Flaked	Dry Rolled
No. steers	4	4	4	4
Dry matter intake kg/day	4.2	3.6	3 9	3.9
Digestibility[a]				
Protein	75.2[b] ±1.2[c]	73.7[d] ±3.4	72 6[d] ±2.2	71.3[d] ±2.4
Crude Fiber	52.0[d] ±5.9	47.7[d] ±4.4	50.0[d] ±2.6	52.1[d] ±3.5
Ether extract	60.2[d] ±6.3	58.4[d] ±7.3	62.4[d] ±5.8	62.0[d] ±3.8
Nitrogen free extract	87.0[d] ±2.7	91.5[e] ±1.3	93.0[f] ±0.5	82.7[g] ±2.2
Dry matter	81.9[d] ±2.4	84.3[e] ±1.9	86.2[e] ±0.8	77.9[d] ±2.2
Total digestible nutrients	58.5[d] ±1.5	61.9[d] ±1.9	67.4[f] ±0.6	61.7[d] ±1.9
Gross energy	79.5[d] ±2.6	82.1[e] ±2.4	84.0[e] ±0.9	74.9[f] ±2.2
Digestibly energy Kcal/gm	2.6	2.6	2.8	2.5
Nitrogen balance				
Fecal	24.8 ±1.2	26.3 ±3.4	27.4 ±2.1	28.7 ±2.4
Urinary	52.4 ±3.8	48.0 ±3.0	60.2 ±7.0	57.4 ±3.9
Retention	22.8 ±2.7	25.7 ±4.7	12.4 ±2.6	14.0 ±10.4
Nitrogen retained gm/day	27.3 ±21.6	29.1 ±22.7	15.7 ±27.8	16.3 ±35.2

a. Percent of intake, coefficient of digestion (COD) as cited in text.
b. Percent of intake.
c. Standard error
d,e,f. Means in the same row with different superscripts differ significantly ($P<.05$)

Table 20
Performance and Carcass Data of Steers Fed Sorghum Grain
Processed By One of Four Methods (Summer 1970)

Item	Processing method			
	Recon-stituted	Popped	Steam flaked	Dry rolled
			Feedlot data	
No. steers	15	15	15	15
Avg. initial wt, lbs.	712.0	714.0	717.0	724.0
Avg. final wt., lbs.	1026.0	1028.0	1039.0	1021.0
Avg. daily gain, lbs.	2.65[a]±0.13[d]	2.65[a]±0.98	2.72[a]±0.11	2.46[a]±0.13
Avg. daily feed intake, lbs.	16.12[a]	15.24[a]	15.13[a]	18.69[b]
Avg. lbs. feed/lb gain	5.65[a]	5.96[a]	5.49[a]	7.85[b]
			Carcass data	
Avg. hot carcass wt, lbs.	634.0	633.0	635.0	632.0
Avg. rib-eye area, sq. in.	12.21	12.41	11.80	11.79
Avg. fat 12th rib, in.	.57[a]±0.14	.48[a]±0.60	.46[a]±0.31	.50[a]±0.57
Avg. carcass grade[c]	9.73[a]±0.22	9.86[a]±1.30	9.33[a]±0.27	9.80[a]±0.43
Avg. yield grade	2.88	2.61	2.77	2.82

[a,b]Means within rows with unlike superscripts differ significantly (P<.05).
[c]High good = 9; Low choice = 10.
[d]Standard error.