Table 6. Pooled Correlations Between Classification Scores of Yearling Bulls, Steers, and Heifers and Carcass Measurements

	Beef Character	Total Score
Hot Carcass Weight	.24	.28
Rib Eye Area Per Cwt.	—.26	—.04
Fat Thickness Per Cwt.	.20	.20
% Retail Cuts	—.26	—.29
% Trimmed Round	—.12	—.12

Correlations equal to or greater than 0.12 or equal to or less than −0.12 are significant ($P < .01$).

ferent from zero they were generally small. All significant correlations between hot carcass weight and fat thickness per cwt. were positive indicating that heavier, fatter animals were scored higher. All significant correlations between percent retail cuts and percent trimmed round were negative. This is probably a further reflection of the tendency to give fatter animals higher scores.

Methods of Processing Milo for Fattening Cattle*

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Story in Brief

Six methods of processing milo—coarse grinding, fine grinding, dry rolling, reconstituting-rolling, reconstituting-grinding, and steam-process-flaking—were compared in a high concentrate ration. All processing methods significantly improved feed efficiency compared to coarse grinding, with greatest improvements noted for reconstituting-rolling and steam-process-flaking. Steam-process-flaking resulted in the fastest rate of gain; gains on the other processed grains were similar. Feed intake was significantly lower on reconstituted-rolled milo, reflecting more efficient utilization since rate of gain was not depressed. Carcass merit and dressing percentage were not affected by processing method.

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Introduction

Milo (sorghum grain) has been the most readily available and cheapest grain for fattening cattle in Oklahoma and throughout the Southwest. The trend toward increased cattle feeding in this area indicates that milo will be even more widely used as a feed grain in the future.

Previous research has shown that the feeding value of milo is lower than its chemical composition indicates, possibly due to a lower protein digestibility and a lower starch availability compared to corn or barley. The availability of starch is especially important, since starch comprises 70-75 percent of milo grain, and milo is included in rations primarily as a source of energy. Since many fattening rations today contain as much as 80-90 percent or more milo, any improvement in the feeding value of milo would be of great benefit to the cattle feeding industry.

The most promising method of improving starch availability and the utilization of the energy of milo, and thereby feed efficiency, is in the area of grain processing. The milo kernel must be ruptured before feeding to cattle. Whole milo grain, because of the hard, waxy seed coat, passes through the animal undigested in large quantity. In the past, milo has most commonly been coarsely ground, dry rolled or steam rolled ("conventional" steam rolling, with 3-5 min. exposure to steam). Considerable research at this station and elsewhere has indicated very little difference in feeding value of milo processed by these three methods.

Previous work at this station showed that pelleting milo improved its utilization 5-9 percent, but lowered carcass grade and dressing percent were rather consistently observed. The high cost of pelleting is a further and major deterrent to its use. A 5 percent improvement in feed efficiency from fine grinding of milo, compared to coarse grinding, has also been indicated. However, finely ground milo may present a problem with dust and "fines," especially in rations which contain no molasses, fat or silage.

High moisture (25-35 percent) harvesting of milo has been reported by the Kansas and Texas stations to improve dry matter utilization an average of 10 percent. Reconstituting of milo (adding water to air-dry milo to raise the moisture level to about 30 percent and subsequent fermentation with exclusion of air) has shown a similar improvement in feed efficiency.

Work at the Arizona station has indicated a 4 percent or greater improvement in feed efficiency, along with increased feed intake and rate of gain, from the partial cooking of milo by live steam followed by "flaking" through a roller mill. Research at the California station has indicated an occasional but inconsistent response from pressure cooking of milo followed by rolling.

The objective of this experiment was to compare six methods of processing milo—coarse grinding, fine grinding, dry rolling, reconstituting-rolling, reconstituting-grinding and steam-process-flaking—in a 90 percent concentrate ration.

Procedure

Seventy-two Hereford steer calves with an average weight of 535 lb. and an average age of 10 mo. were started on trial December 28, 1966. They were selected from 154 calves, which were produced in Oklahoma State University experimental herds. The calves were started on feed four weeks before the trial was initiated. The starter ration consisted of 48.5 percent coarsely ground milo, 10.0 percent cottonseed meal, 10.0 percent chopped alfalfa hay, 30.0 percent cottonseed hulls, 1.0 percent salt and 0.5 percent bonemeal.

The steers were divided into four blocks on the basis of shrunk weight and condition score, and randomly assigned to the six treatments within each block. Four pens of three steers each were assigned to each treatment. The six types of processed milo were fed in a high concentrate ration, as shown in Table 1. All ingredients other than milo were combined into a premix, which was mixed with the milo in the ratio of 83.4 percent milo to 16.6 percent premix. Proximate analyses of the premix and the processed milo grains are shown in Table 2.

Table 1. Ration Composition

Ingredient	Percent
Milo	83.4
Alfalfa hay, chopped	6.0
Cottonseed hulls	4.0
Cottonseed meal (41% crude protein)	4.0
Urea (42% nitrogen)	1.0
Salt	1.0
Bonemeal	1.6
	100.0
Added, Per lb. of Ration	
Vitamin A	1500 I. U.
Aureomycin	
1st 40 days	10 mg.
Remainder of trial	5 mg.

Table 2. Proximate Analyses

	Dry[1] Matter	Ash[2]	Crude[3] Protein	Ether[3] Extract	Crude[3] Fiber	N.F.E.[4]
	Percent					
Coarsely ground	87.0	1.92	10.03	2.54	1.70	83.81
Finely ground	87.3	1.85	10.00	3.42	1.58	83.15
Dry rolled	87.3	2.03	10.11	2.79	1.76	83.31
Recon. rolled	79.9	1.98	10.54	2.03	1.72	83.73
Recon. ground	80.9	2.01	10.70	1.55	1.67	84.07
Steam-Proc.-Flaked	83.2	2.11	10.77	2.18	1.38	83.56
Premix	90.4	7.48	36.99	4.08	16.33	35.12

[1] Average of 7 determinations.
[2] One determination.
[3] Average of 3 determinations.
[4] 100—(sum of figures reported for ash, crude protein, ether extract, and crude fiber).

Processing Methods

Coarsely and finely ground milo was produced with a hammer mill, using 3/16 and 1/8 in. screens, respectively. Reconstituted milo was produced in a 14 x 27 ft. glass-lined, air-tight Harvestore silo. Water was added to the air-dry grain (14 percent moisture) as it was augured into the silo, raising the moisture level to approximately 24 percent. Before feeding, it was either rolled with approximately .003 in. tolerance between the rollers, or ground through a 1/8 in. screen. Dry rolled milo was produced by rolling air-dry milo with a roller tolerance in excess of .003 in.

Steam-process-flaking was accomplished by using the procedure reported by Hale and co-workers at the Arizona station. Milo was subjected to steam in an unpressurized steam chamber for 20 min. at 205° F., then rolled immediately with no tolerance between the rollers. The steaming chamber was 1 x 2 x 5 ft., with a capacity of 500 lb.

All milo used in this trial was produced on the Fort Reno station and was of the variety Northrup King 222. Air-dry whole milo was stored in a 14 x 27 ft. Harvestore silo. All rolling was done through a heavy duty Ross 18 x 24 in. roller mill.

Feeding

The three "wet" grains, reconstituted-rolled, reconstituted-ground and steam-process-flaked, were processed daily, with the exception that enough was processed on Friday to feed through the weekend. The coarsely ground and finely ground grains were processed, combined with premix and stored in quantities of one ton. The three rolled products were combined with the premix by hand in the feed trough to preserve the character of the grain as produced by the processing methods. The cattle were fed once daily in suffiicent quantity to assure availability of feed until the next feeding. Feed was weighed to the nearest .5 lb. and unconsumed feed was weighed and removed frequently. The steers had access to open-sided sheds and outside lots, with water (warmed in winter) available at all times.

Data Obtained

Feed samples were taken at the end of each 21 day period for proximate analysis and dry matter determination. Dry matter percentages were used to adjust all rations to an equal dry matter content (90 percent). The grains were sieved and test weights were taken to determine particle size and density, respectively, as shown in Table 3.

Initial and final weights were taken after a 16-hr. shrink with no feed and water. Intermediate weights were taken at 21 day intervals, after a 16-hr. overnight shrink from water (feed was available). Performance data were summarized after 149 days on feed (May 26, 1967) because the steers were subjected to ultrasonic determinations and rumen sampling following this period. Ration treatments were continued until time of slaughter, which was on June 5, 6 and 7. Standard carcass data were collected after a 24-hr. cooler chill. Bladders were collected at slaughter and the amount of calculi in each bladder was determined.

Table 3. Particle Size[1] and Density[2] of Processed Milo

	Screen Size, in.									
	18/64	16/64	12/64	8/64	1/12	1/18	1/25	40 Mesh	40 Mesh	Wt. per Bu.
	% Retained on Screen								% Passed	lb.
Recon. ground	0	0	0	.24	1.94	16.30	20.04	26.79	34.69	40.7
Finely ground	0	0	0	.25	1.94	13.78	20.13	34.14	29.76	47.4
Coarsely ground	0	0	0	2.93	9.34	23.69	18.19	23.71	22.14	49.7
Dry rolled	.02	.30	.34	3.11	18.14	27.89	16.38	21.13	12.69	38.8
Recon. rolled	.44	1.09	5.49	24.69	26.89	14.39	6.24	11.60	9.17	28.4
Steam-Proc.-Flaked	13.65	19.08	40.25	17.55	4.35	2.15	.90	1.28	.79	23.3
Steam-Proc.-Flaked (after mixing in mechanical mixer)										35.7
Whole dry										59.1
Whole reconstituted										50.2

[1] Particle size: Five 100-gm. samples were sieved for each grain and averages are reported.
[2] Test weights reported are averages of several determinations throughout the trial. Considerably lower values were obtained at times for steam-proc.-flaked and recon. rolled (lowest values—steam-proc.-flaked-16.6, recon. rolled-26.6 lb./bu.). Values are on a 90% dry matter basis.

Results

Note the effect of processing method on dry matter (100 percent minus the percent moisture), shown in Table 2, and test weight per bushel (density) and particle size, shown in Table 3. The air dry milo, which was either rolled or ground, averaged approximately 13 percent moisture, while the steam-process-flaking, reconstituting-grinding and reconstituting-rolling procedures increased moisture levels to averages of 16.8, 19.1 and 20.1 percent, respectively.

All of the processing methods decreased the density of milo as compared to the whole milo. Steam-process-flaking and reconstituting-rolling resulted in the greatest decreases in density (58.4 and 47.2 percent less than whole milo, respectively). These two processing methods also produced the greatest change in particle size. However, steam-process-flaking, compared to reconstituting-rolling, produced more large particles (flakes) and much less fine material. The fine particles in both of the reconstituted products (rolled and ground) were very fluffy in nature. This characteristic resulted in a test weight per bu. for the reconstituted-ground milo that was less than that for the finely ground air-dry milo (45.3 and 48.9 lb. per bu., respectively), even though the reconstituted-ground milo contained slightly more fine material than the finely ground dry milo (34.69 and 29.76 percent through the 40 mesh screen, respectively).

Feedlot performance is shown in Table 4. Table 5 presents a further summary showing the relationship of other processing methods to coarse grinding in terms of rate of gain, feed intake and feed efficiency.

Although rate of gain did not differ statistically among the six treatments, it is interesting to note that gains for coarsely ground, dry rolled, reconstituted-rolled and reconstituted-ground milo were almost identical, while the steers on finely ground milo gained 3.2 percent faster and those on steam-process-flaked milo 11.9 percent faster than those fed coarsely ground milo.

Table 4. Feedlot Performance (149 days)

	Method of Processing Milo					
	Coarsely Ground	Finely Ground	Dry Rolled	Recon.-Rolled	Recon - Ground	Steam-Process-Flaked
No. Steers	12	12	11	11	10	11
Av. initial wt., lb.	533	533	533	526	533	547
Av. final wt., lb.	909	920	906	901	908	967
Av. daily gain, lb.	2.52	2.60	2.51	2.52	2.52	2.82
Av. daily feed, lb.[1]	16.98^{a}	16.81^{a}	16.27^{a}	14.58^{b}	16.16^{a}	16.42^{a}
Feed/lb. gain, lb.[1]	6.77^{a}	6.47^{ab}	6.43^{ab}	5.82^{b}	6.44^{ab}	5.90^{b}

[1] Any 2 averages without a common letter differ significantly ($P < .05$).

Table 5. Summary of Effect of Milo Processing Method on Feedlot Performance

	Coarsely Ground	% Change Compared to Coarsely Ground Milo				
		Finely Ground	Dry Rolled	Recon.-Rolled	Recon.-Ground	Steam-Process-Flaked
	lb.					
Av. daily gain	2.52	3.2	—.8	—.1	—.3	11.9
Av. daily feed	16.98	—1.0	—4.2	—14.1[1]	—4.8	—3.3
Feed/lb. gain	6.77	—4.4	—5.0	—14.0[1]	—4.9	—12.9[1]

[1] Significantly different ($P < .05$) than value for coarsely ground milo.

Significant differences in feed intake and feed efficiency were observed. The cattle fed steam-process-flaked milo required significantly less feed per lb. of gain (12.9 percent) than those fed coarsely ground milo. Average daily intake of reconstituted-rolled milo was significantly less than the other five treatments (14.1 percent less than coarsely ground milo) resulting in an increase in feed efficiency of 14.0 percent over coarsely ground milo. This difference was also statistically significant.

The six types of processed milo produced carcasses that were not significantly different for any of the criteria shown in Table 6. Quantities of calculi in the bladder were extremely small in all steers and apparently unrelated to the processing method.

Discussion

The results of this trial, comparing processing methods of milo fed in a high concentrate ration, were very similar to results of a previous trial[1] at this station in which processed milo was fed in a conventional ration containing approximately 26 percent roughage and 54 percent milo. A summary of the feedlot performance as influenced by processing method in the two trials is shown in Table 7, for those methods which were included in both trials. Coarsely ground milo was used as the standard of comparison. Note the average results. Fine grinding resulted in a slight increase in gain on a lower feed intake, and a consequent average improvement in efficiency of 6.0 percent. Reconstituting-rolling affected gain very little, but lowered feed intake markedly and improved feed efficiency 9.7 percent. On the other hand, steam-process-flaking increased gain considerably with very little additional feed, resulting in an improvement in feed efficiency of 8.8 percent.

[1] See Oklahoma Agr Exp. Sta. Misc. Pub. MP-79, p. 79.

Table 6. Slaughter and Carcass Information

	Method of Processing Milo					
	Coarsely Ground	Finely Ground	Dry Rolled	Recon.-Rolled	Recon.-Ground	Steam-Process-Flaked
Dressing %[1]	62.2	61.9	61.9	61.8	61.8	61.7
Carcass grade[2]	9.7	9.0	9.4	9.0	9.5	9.7
Ribeye area, sq. in.[3]	10.5	10.8	10.4	10.8	10.9	11.0
Fat thickness, in.[4]	0.65	0.67	0.63	0.60	0.52	0.72
Marbling[5]	12.9	12.8	13.8	11.9	12.9	14.8
Cutability, %[6]	49.2	49.2	49.1	49.8	50.0	48.7

[1] Calculated on basis of Ft. Reno live shrunk weight and chilled carcass weight.
[2] U.S.D.A. carcass grade converted to following numerical designations: high prime-15, average prime-14, low prime-13, high choice-12, av. choice-11, low choice-10, high good-9, av. good-8, low good-7.
[3] Determined from tracings at the 12th rib.
[4] Average of three measurements on ribeye tracing.
[5] Marbling scores: 1 to 30, 11=slight, 12=slight plus, 13=small minus, 14=small, 15=small plus.
[6] Percent of boneless trimmed retail cuts on carcass basis=51.34 (fat thickness)—.462 (% kidney fat) + .740 (ribeye area)—.0093 (chilled carcass wt.).

Table 7. Summary of Effect of Milo Processing On Feedlot Performance in Two Trials

	% Change Compared to Coarsely Ground Milo								
	Daily Gain			Daily Intake			Feed/lb. Gain		
	Trial 1[1]	Trial 2[2]	Av.	Trial 1	Trial 2	Av.	Trial 1	Trial 2	Av.
Finely Ground	3.3	3.2	3.2	—4.7	— 1.0	— 2.9	—7.6	— 4.4	—6.0
Recon.-Rolled	.4	—.1	.2	—5.0	—14.1	— 9.6	—5.4	—14.0	—9.7
Steam-Process-Flaked	8.2	11.9	10.0	4.3	— 3.3	1.0	—3.5	—12.9	—8.8

[1] Trial 1—54% milo ration
[2] Trial 2—83.4% milo ration

Both steam-process-flaking and reconstituting-rolling produced greater improvements in feed efficiency in this trial than in the previous trial (3.5 and 5.4 percent in the first trial and 12.9 and 14.0 percent in this trial, for steam-process-flaking and reconstituting-rolling, respectively). The greater improvements in efficiency in this trial may have been due to the higher concentrate ration which was fed, and the higher level of milo in the ration (83.4 vs. approximately 54 percent).

Dry rolled and reconstituted-ground milo produced very similar results in all respects. It should also be noted that results from fine grinding and dry rolling were very similar. Fine grinding has a definite advantage over coarse grinding, but little apparent advantage over rolling. This is consistent with results obtained at the Kansas Station.

It is interesting to note that the percent increases in feed efficiency paralleled the percent decreases in intake for the dry rolled, reconstituted-rolled and reconstituted-ground grains, while for finely ground and steam-process-flaked milo the increases in feed efficiency were of greater magnitude than the decreases in intake. For the first three, energy intake seemed to be the governing factor; that is, if utilization of a grain is increased, less is required to provide the same amount of energy. However, for the other two grains, particularly the steam-process-flaked, the improvement in feed efficiency seemed to be the result of faster gain without a significant decrease in intake, with the feed required for maintenance thus spread over a greater gain. Even if this is true, however, it is obvious that advantages in rate of gain and apparent feed efficiency are important economically. Furthermore, the faster gaining steers on the steam-process-flaked milo could be marketed earlier, resulting in a real improvement in feed efficiency not demonstrated in this experiment in which steers were fed a constant time rather than to a constant weight.

Results of this research indicate that the mechanical process of rolling improved the efficiency of utilization of milo grain. Dry rolling was superior to coarse grinding and reconstituted-rolled milo outperformed reconstituted-ground milo. Work at the Arizona station has shown that the success of the steam-process-flaking procedure depends on a flat flake produced by slow rolling with much roller pressure. The results of these two trials indicate that significant improvements in utilization can be obtained by combining proper rolling with either the reconstitution process or partial cooking with steam.

It should be pointed out that the "coarsely ground" milo used in this trial, ground through a 3/16 in. screen, was considerably finer than that used in many feedlots which is undoubtedly utilized much less efficiently than the "coarsely ground" milo used in this trial.