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Grain Sorghum Processing for Beef Cattle

This NebGuide discusses the feeding value of grain sorghum relative to corn and various grain processing methods for grain sorghum.

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It has been widely recognized that grain sorghum (milo) must be processed to be efficiently used by finishing cattle. Grain sorghum shows more improved utilization from processing than corn, wheat and barley. Dry ground or rolled grain sorghum has a relative feeding value of 85% to 95% (avg 90%) of dry rolled corn. Processing grain sorghum by more sophisticated methods (early harvesting, steam-flaking, etc.) greatly enhances its feeding value.

Chemical composition suggests that there should be less difference in the feeding value of grain sorghum compared with corn than what actually exists. Starch, which represents 70% of the dry matter, and protein appear to be less digestible in grain sorghum than in other grains. The rate that starch is digested in the rumen of cattle is also much slower for grain sorghum than for other grains. Thus, processing grain sorghum increases rate and extent of starch digestion resulting in large improvements in its feeding value.

Rolling vs. Grinding

Processing of grain ruptures the seed coat, reduces particle size and increases surface area so digestion

can occur more rapidly and extensively. Dry rolling usually results in a larger particle size that contains less powder and dust compared with grinding. However, the data indicate little difference in animal acceptability, daily gain or efficiency between grinding and rolling if proper processing methods are used.

A comparison of coarsely rolled and finely rolled grain sorghum illustrates the importance of particle size (*Table I*). All kernels must be processed or feed efficiency is reduced. Unlike corn, whole grain sorghum kernels will not be broken down and digested by the animal.

Table I. Comparison of coarsely rolled and finely rolled grain sorghum. Summary of five Kansas trials (220 yearling steers, 14 pens).

Item	Treatment		Percent Improvement
	Coarsely Rolled	Finely Rolled	
Dry matter intake, lb/day	23.35	24.33	-4.0%
Gain, lb/day	3.33	3.43	+3.0%
Feed/gain	7.60	7.06	+7.1%

Based on ten experiments, fine grinding shows an improvement of 5% in feed efficiency compared with coarse grinding (*Table II*). Particle size seems to be more important when grinding than rolling. A large, fluffy particle produced by rolling may be multifractured, exposing a large surface area for digestion. Grinding probably produces fewer multifractured particles. Fine grinding may be necessary to increase the surface area in ground grains.

Table II. Method of processing grain sorghum

No. of Trial	Processing Method		Improvement Over Control Method		
	Test	Control	Daily Gain	Daily Feed	Feed per Unit Gain
			%	%	%
4	Pelleted	Roll	+5	-8	+7
5	Finely Ground	Dry Rolled	-1	-2	+1
10	Finely Ground	Coarse Ground	+1	-6	+5
3	Finely Rolled	Coarse Rolled	-4	-3	0
4	Steam Rolled	Dry Rolled	-2	0	-2
8	Pelleted	Ground	+4	-6	+9

Comparisons of finely rolled to finely ground grain sorghum are confusing. Seven trials conducted before 1982 indicated that finely ground grain sorghum was utilized slightly more efficiently than finely rolled grain sorghum (*Table III*). However, eight trials conducted between 1982 and 1984 greatly favored finely rolled grain sorghum (*Table IV*). Performance of the cattle fed finely ground grain sorghum was not improved by increasing roughage quantity or quality.

Table III. Comparison of finely rolled and finely ground grain sorghum. Summary of seven Kansas trials prior to 1982 (231 yearling steers).

Item	Treatment		Percent Improvement
	Finely Rolled	Finely Ground	
Dry matter intake, lb/day	22.61	21.83	-3.4%
Gain, lb/day	2.99	2.92	-2.4%
Feed/gain	7.67	7.51	+2.1%

Table IV. Comparison of finely rolled and finely ground grain sorghum. Summary of eight Kansas trials (690 yearling steers) conducted from 1982 to 1984.

Item	Finely Rolled	Finely Ground	Percent Improvement
Dry matter intake, lb/day	23.06	22.23	-3.6%
Gain, lb/day	3.02	2.67	-11.6%
Feed/gain	7.70	8.29	-7.7%

Steam Rolling

Steam rolling (*Table II*) appears to have no advantage over dry rolling. Steam rolling produces a product which has good physical form, enhancing the "appearance" or "appeal" to the cattle feeder.

Steam and Pressure Flaking

Atmospheric steam flaked or steam pressure processed flaked grain sorghum improved gain by 7.8% and feed efficiency by 11.6% over dry rolled grain sorghum (*Table V*). Best results were obtained when flakes were flat and weighed 24 to 28 pounds per bushel.

Table V. Comparison of grain sorghum processing systems[a] (Arizona)

Processing Method	Dry Rolled	Flaked	Reconstituted	Popped Exploded and Micronized
Daily gain, lb	2.56	2.76	2.76	2.76
Dry matter intake, lb	16.8	16.0	15.7	16.0
Feed/gain	6.57	5.80	5.67	5.80
Grain level, %	74	74	78	74
Improvement in ration efficiency, %		11.6	13.7	11.6
Improvement in grain efficiency, %		15.7	17.6	15.7

The response to steam processing is highly variable. Variation in steaming time, temperature, moisture, roller pressure, roller tolerance and volume influence the value of the final product. Variations in bushel

weight, foreign material content and moisture content also can affect the value of steam-flaked grain sorghum. Most feedlots use a grain conditioner and mechanical grain moisturizers to insure moisture penetration and to add palatability to the flakes.

Pressure processing gives the best results when the grain is exposed to live steam for about 1.5 minutes at 45 to 60 pounds per square inch. Excessive treatment produces an over-gelatinized product that depresses feed consumption and gains. Pressure processing appears to produce a less fragile flake that does not need to be as flat to obtain the desired improvement. Cost is greater for pressure processing compared with steam flaking.

High Moisture Harvesting and Reconstitution

High moisture processing results in about an 8.5% to 20% improvement in feed efficiency for high moisture harvested and reconstituted grain sorghum compared with dry processed grain sorghum (*Tables V* and *VI*). Rate of gain may not be affected.

Moist grain sorghum must be rolled or ground before feeding for efficient utilization. Rolling moist grain before feeding improves performance as compared with grinding (*Table VI*).

Table VI. High moisture vs. finely ground dry grain sorghum

Processing Method	Daily Gain	Feed per Unit Gain	Improvement Over Fine Grinding
	lb	lb	%
Finely ground, dry	2.4	6.3	
Recon., ground[ab]	2.3	5.8	8.5
Recon., rolled[ab]	2.7	5.3	16.8
HMH, rolled[bc]	2.2	5.4	14.8
HMH, rolled[bc]	2.6	5.2	18.3

[a]Reconstituted in oxygen-limiting structure.
[b]Ground or rolled immediately before feeding.
[c]High moisture harvested and stored in oxygen-limiting structure.

Grain sorghum must be stored in the whole kernel form during reconstitution (*Table VII*) to improve feed utilization. Chemical changes during reconstitution may be similar to those in germination. Maintenance of the whole, intact kernel is required to permit hormonal and enzymatic reactions which may help convert the starch to a more available form. Thus, oxygen-limiting storage structures are required.

Table VII. Physical form for reconstituted grain sorghum (Oklahoma)

Processing Method	Daily Gain	Feed per Unit Gain	Improvement Over Dry Grain Sorghum
	lb	lb	%
Dry, ground	2.3	5.7	

Stored whole	2.6	5.1	+9.4
Stored ground	2.3	5.9	-4.8

In contrast to reconstitution, high moisture harvested grain sorghum can be stored in either whole or ground form and still retain the improved feeding value. If a trench silo is used, high moisture harvested grain sorghum must be ground or rolled to obtain adequate packing. Whole grain sorghum will mold and deteriorate.

Data suggest that 30% moisture is superior to 22% for storage of high moisture grain sorghum, but that there is little advantage in exceeding 30% (*Table VIII*). It is rather easy to raise the moisture of dry grain sorghum to 20%-22%, but difficult to raise the level to 30% or higher. Water uptake can be increased by using hot water or small amounts of other grains, such as wheat or barley, which absorb water more readily.

Table VIII. Moisture level reconstitution (Oklahoma)

Method of Processing Grain Sorghum	Daily Gain	Feed per Unit Gain	Improvement Over Dry Rolled
	lb	lb	%
Dry rolled	2.5	6.1	
Recon. 22%	2.7	5.9	+ 4.0
Recon. 30%	2.4	5.4	+11.8
Recon. 38%	2.3	5.4	+12.1

Reconstituted grain sorghum should be stored a minimum of 10 days and preferably 20 days before feeding. Lower temperature and moisture content favor longer storage times. Shorter storage times permit more rapid turnover, lowering the processing cost per ton.

Conclusions regarding high moisture grain sorghum:

1. High moisture harvested and reconstituted grain sorghum consistently improve feed efficiency (8.5% to 20%) compared with dry rolled or ground grain.
2. Field losses (shattering, bird damage, lodging) will frequently be 6%-20% less when harvested as high moisture. In addition, drying costs will be eliminated.
3. High moisture grain sorghum should be about 27-30% moisture.
4. High moisture harvested grain sorghum can be stored ground in trench silos or whole in sealed storage.
5. Reconstituted grain sorghum should be reconstituted to about 30% moisture, and stored whole in sealed structures for 10-20 days, and then rolled before feeding.

Chemical Preservation

Organic acids will keep wet feeds from molding. Preservation of reconstituted whole grain sorghum with an organic acid mixture produced acceptable gains and feed efficiencies in Kansas trials (*Table IX*). Special care and caution must be used in applying acids to insure satisfactory results. The current cost of applying acid limits its use with grain sorghum.

Table IX. Preservation for reconstituted grain sorghum (Kansas)

Item	Gain	Feed per Unit Gain
	lb	lb
Steam flaked	3.0	6.3
Reconstituted		
Air-tight silo[a]	3.2	6.5
Acid treated[a]		
Trench silo	3.2	6.8
Metal bin	3.3	6.7
Rolled trench silo	2.9	7.2
[a]Stored whole and rolled prior to feeding.		

Popping

Popped grain sorghum was equal to steamed flaked grain sorghum in California tests. For popping, grain sorghum containing 10%-15% moisture is heated at 700-800 degrees Fahrenheit for 15-30 seconds. The resulting produce is then rolled. Approximately 50% of the grain is popped in this process. Lower temperatures (500 degrees Fahrenheit) and longer times (40-120 seconds) also will pop grain sorghum. Starch digestibility in popped grain sorghum is increased by expansion of starch granules.

In Texas studies, maximum popping (45%) was achieved at 15% grain moisture. Self-feeding the popped mixture, the completely popped fraction, or the partially and non-popped grain sorghum fractions in rolled, all-concentrate rations results in reduced feed intakes compared with dry rolled grain sorghum rations. Feed efficiency was improved, but daily gains and carcass desirability were decreased slightly. All three heat-treated fractions were more digestible than unheated grain, indicating the improvement was due to dry heating rather than popping.

Initial investment and operating costs (per ton) are lower for popping than for steam flaking.

Micronizing

Micronized grain sorghum is produced by heating the sorghum to 300 degrees Fahrenheit with an infrared generator and then rolling it through knorling rolls to produce a product that looks like steamed flaked grain. Feed efficiency appears to be comparable to steam flaking. Some ration adaptation may be required for maximum feed intake and gain when cattle are placed on micronized grain sorghum in high concentrate rations.

Exploding

Exploded grain sorghum was compared with three different degrees of steam flaking: 36, 28 or 20 pounds per bushel. The puffed material produced feed intake, gain and feed efficiency competitive with the best performing flaked grain treatment.

In this process dry grain is exposed to live steam at 250 pounds per square inch. When the pressure is

relieved, the grain expands greatly, producing a "puffed" grain without hulls.

Extruding

In this process grain is forced through an extruder by tapered screws, producing both heat and pressure. As the pressure is relieved, the product expands.

In Kansas trials, grain sorghum processed by dry rolling, high moisture storage, steam flaking and extrusion produced similar gains; however, feed efficiency was 9% and 15% better for the flaked and extruded treatments, respectively, compared to dry rolled grain sorghum. Results were similar to steam flaked and high moisture grain.

Grain Combinations

The feeding value of grain sorghum is greatly enhanced when it is fed in combination with early harvested high moisture corn or dry rolled wheat (*Tables X and XI*). The grain mixtures appear to reduce the occurrence of acidosis associated with high moisture corn and wheat and optimize starch utilization in the digestive tract of cattle. The greatest improvement occurs during the grain adaptation period when cattle are adjusting to high grain rations. The complementary or associative effect occurs when grain sorghum is fed with a grain source that has a fast rate of digestion (high moisture corn, wheat, barley), but not when fed with a grain source having a slower rate of digestion (dry rolled corn).

Grain Source or Variety

Grain sorghum variety and the environment (locality, season, etc.) in which the grain sorghum is grown may influence feed value as much as processing. This is one reason why grain sorghum produces such variable feedlot responses.

In a study of 102 lines of hybrids of sorghum grain, each grown in three locations (Texas, Kansas and Nebraska), Texas researchers found both variety and location (environment) affected laboratory digestibility when sorghum was ground or reconstituted. Kansas State researchers observed that four different yellow endosperm hybrids averaged 95.1% the value of regular corn, but white endosperm varieties averaged only 85.8% the value of corn for finishing cattle. Steers fed a bird-resistant variety produced the slowest gains and feed efficiency of all varieties tested. In another Kansas study, feed efficiency was improved 9.6% and 25.1% respectively, for hetero-yellow varieties compared with red brown sorghum varieties.

Table X. Complementary effects of feeding dry rolled grain sorghum and early harvested, high moisture corn; nine trials, 69 pens of cattle (Nebraska)

Item	High Moisture Corn: Dry Rolled Grain Sorghum			
	100:0	**50:50**	**30:70**	**0:100**
Dry matter intake, lb/day	20.81	20.87	21.25	22.26
Complementary effect, %[a]		-1.6	-1.3	
Gain, lb/day	3.21	3.24	3.23	3.03
Complementary effect, %[a]		+2.5	+3.6	

Feed/gain	6.43	6.36	6.54	7.21
Complementary effect, %[a]		-4.8	-4.8	

[a]Calculated [(observed value - expected value (weighted means of 100% high moisture corn and 100% dry rolled grain sorghum))÷ expected value] x 100.

Table XI. The complementary effect from feeding finely rolled grain sorghum with rolled wheat in steer finishing rations[a]

Item	Ration			Complementary Effect[a]
	Grain Sorghum	Grain Sorghum and Wheat	Wheat	
Dry matter intake,				
lb/day	23.72	22.64	20.44	+2.5%
Gain, lb/day	3.61	3.35	2.84	+3.8%
Feed/gain	6.58	6.55	6.97	-3.4%

[a]Calculated as in *Table X*.

Some types of sorghum may respond less to processing than others due to better starch availability. Thus, in the future, plant breeding may have as much potential for improving sorghum utilization by feedlot cattle as processing techniques have in the past.

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