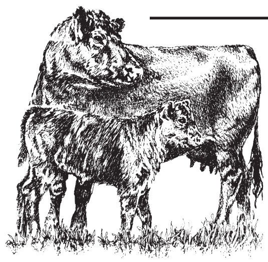

Western Beef Resource Committee

Cattle Producer's Library

Nutrition Section CL333

Influence of Grain Type and Processing Method on Beef Cattle Consuming Forage-based Diets

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Energy intake from forage is often inadequate for range cattle during periods of increased nutrient requirements (late gestation, lactation, following weaning, harsh weather, etc.). Consequently, many beef cattle producers supplement their animals with cereal grain(s) in order to improve or maintain acceptable levels of production.

Grains are high in starch, which is a major source of dietary energy (Table 1). However, whole grain starch digestibility is not equal for all types of cereal grains. Therefore, many grains are processed to improve starch availability and animal performance. Grain processing also affects preference and consumption by cattle.

Research with corn, sorghum, and oats suggests that beef cattle prefer, in order of preference, whole grain, cracked grain , and ground grain. As a result, a common question concerning grain supplementation is "Does the grain need to be processed?" The answer to this question is dependent on many variables including processing costs, type of grain, animal age, and expected animal performance.

Table 1. Starch content of cereal grains.

Grain	Percentage starch (Dry matter basis)
Corn	72
Barley	60
Oats	45
Sorghum	74
Wheat	65

The following discussion will concern the use of grains as energy supplements for beef cattle consuming forage based diets. We will limit our review to grains routinely used in the western United States (corn, barley, oats, sorghum, and wheat) and to processing methods commonly available to most cow/calf producers (grinding, dry rolling, and steam rolling).

Method of Processing

Common methods of grain processing for supplementation of beef cattle consuming forage based diets are grinding, dry rolling, and steam rolling. There are other methods of processing grain; however, these are expensive and are used primarily with high concentrate diets fed to finishing cattle (steam and pressure flaking, reconstituting, extruding, etc.).

Grinding—Grinding is a process by which a feedstuff is reduced in particle size by impact, shearing, or attrition. Grinding is normally accomplished using a hammermill, with particle size controlled by screen size, hammermill size, and moisture content of the grain. Grinding is the most common, cheapest, and simplest method of grain processing. A major advantage of grinding compared with other processing methods is the economic feasibility of having a portable grinder/mixer available on the ranch. Potential disadvantages of grinding include increased dust, increased wastage, lower palatability (and consequently lower intake), and increased danger of ruminal disorders (e.g., acidosis) compared with whole grain.

Dry Rolling—Also known as cracking or crushing, dry rolling refers to the passing of grain between closely fitted steel rollers (without steam), which are usually grooved on the surface. The kernel is broken, resulting in a product resembling coarsely ground grain.

Steam Rolling—Also known as crimping or steam crimping, steam rolling refers to exposing grain to steam for a short period of time followed by rolling as described above.

Grinding vs. Dry Rolling—Grinding results in considerable dust, which can reduce feed intake and increase wastage compared with dry rolling. However, research suggests that ground grains are more energetically efficient compared with those that have been dry rolled.

Dry vs. Steam Rolling—Research indicates that steam rolling offers little or no advantage in feed efficiency over dry rolling. However, it is possible that steam rolling may decrease dust and the amount of fines compared with dry rolling.

Type of Grain

The type of grain used in cattle diets can affect animal performance. However, processing grain can minimize potential performance differences due to increased nutrient digestibility. Also, type of grain will effect the magnitude of response to processing. Consequently, a beef producer must weigh the costs of grain and processing with the value of the expected improvement in animal performance when deciding on a grain feeding plan.

A compilation of research data evaluating the effects of grain species (corn, barley, oats, sorghum, and wheat) on dry matter intake (DMI), average daily gain (ADG), and feed/gain is presented in Table 2. It should be mentioned that the majority of these data were obtained using processed grains fed to finishing cattle consuming high grain diets (>75% of diet dry matter). Briefly, ADG was not significantly different between grain sources but tended to be lower for diets containing large quantities of sorghum grain and wheat. Also, DMI tended to be lower for wheat-based diets. However, cattle consuming sorghum grain had numerically greater dry matter intakes compared with the other grain sources. As a result, feed/gain was poorer for sorghum.

Table 2. Effect of grain source on average daily gain (ADG), dry matter intake (DMI), and feed/gain of finishing cattle (adapted from Owens et al. 1997; J. Animal Science, 75:868-879).

	Grain type				
Item	**Corn**	**Barley**	**Oats**	**Sorghum**	**Wheat**
ADG, lb	3.15	3.13	3.31	3.06	3.04
DMI, lb/day	19.7	19.3	20.2	20.8	19.1
Feed/gain	6.2	6.2	6.1	6.8	6.3

Table 3. Whole or cracked corn in growing rations for steer calves (adapted from Rush et al. 2000; Nebraska Beef Report, p. 38).[a]

	Type of corn	
Item	**Cracked**	**Whole**
Initial weight, lb	562	568
Final weight, lb	886	879
Average daily gain, lb	2.71	2.58
Dry matter intake, lb/day	19.3	19.3
Feed/gain	7.13	7.46
Feed cost, $/head/day[b]	.77	.77
Cracking cost, $/head/day[c]	.01	
Total feed cost, $/head/day	.78	.77
Total feed cost, $/lb gain	.29	.30

[a]Corn was fed at 5 lb/head/day

[b]Feed cost was calculated as 4¢/lb.

[c]Corn cracking charge was calculated as 20¢/cwt.

Corn—Whole corn has an impenetrable seed coat that results in poor digestion if the seed coat is not fractured. However, studies comparing whole corn to processed corn (mostly cracked, rolled, and ground) suggest that processing does not substantially increase performance of growing cattle. This is due to the ability of cattle to break the seed coat during mastication.

In addition, the net energy for maintenance (NEm) content of corn is not improved by processing. This is exemplified in a Nebraska study (Rush et al. 2000; Nebraska Beef Report, p. 38) that compared whole or cracked corn in growing rations (containing 60 percent forage, dry matter basis) offered to steer calves. They reported that farmers and ranchers can expect to obtain competitive rates and costs of gain by feeding whole compared with cracked corn (Table 3). Therefore, it is generally concluded that processing of corn for use in ruminant diets is not economically justifiable.

Barley—In contrast to corn, research with barley has indicated that processing is usually justified compared with feeding whole kernel grain. Barley has a thick and impermeable seed hull, much like corn. However, cattle are not able to fracture the seed hull during mastication as observed with corn. Consequently, barley will benefit more from processing.

In a review of literature comparing whole to dry rolled barley, rolled barley normally increased ADG, feed/gain, and grain digestibility by approximately 19, 36, and 16 percent, respectively. These data were obtained with cattle consuming diets ranging from 24 to 97 percent barley (dry matter basis). In addition, dry rolling barley is assumed to increase NEm by approximately 19 percent. Due to the large improvement in grain digestibility and animal performance often observed with processed compared with whole barley, dry rolling or grinding will be economically warranted in most situations.

Oats—Processing of oats offers little improvement in grain digestibility or animal performance. Most research with oats indicates that both dry matter and starch digestibility will be increased by only 4 to 6 percent with processing. As a result, whole oats can be efficiently used by beef cattle, thereby making it unlikely that processing costs can be justified in most production situations.

Sorghum—It is widely recognized that sorghum grain must be processed to be efficiently used. Beef cattle consuming whole sorghum grain will excrete greater than 50 percent of the grain dry matter undigested in the feces.

Also, processing improves sorghum grain digestibility and animal performance to a greater extent compared with other processed grains. This is primarily because of the resistance of sorghum grains' hard endosperm layer (seed coat) to water penetration and digestive action.

In addition, there are molecular cross-linkages between starch and protein in sorghum grain that further reduce the rate and extent of digestion. Consequently, dry rolled or ground sorghum is considered to have 85 to 95 percent of the feeding value of dry rolled corn. Processing of sorghum grain is required for efficient use in ruminant diets.

Wheat—Whole kernel wheat can be expected to be approximately 65 to 75 percent digestible compared with 85 to 90 percent for processed wheat. Consequently, daily gains are usually 20 to 25 percent lower for cattle consuming whole compared with rolled wheat diets. As with barley, processing wheat can be expected to economically improve grain digestibility and ruminant performance.

Cattle Age

Age of cattle can affect the efficiency by which grains are used, especially whole grains. Most evidence suggests that young cattle (yearling cattle and younger) are able to digest 10 to 50 percent more whole grains (measured by fecal excretion) compared with older cattle because of increased chewing efficiency. However, some studies have reported no affect of cattle age on whole grain utilization. These conflicting results may be due, in part, to the type of grains used. For example, beef cows have been shown to more extensively damage whole corn kernels during mastication (chewing) compared with whole barley and wheat. This reduces grain particle size, increases surface area for ruminal fermentation, and facilitates digestion.

Cost and Efficiency Tables

In order to determine the economics of grain feeding and processing, the beef producer must be able to estimate expected performance and the value of gain resulting from feeding a known amount of grain. Tables 4 and 5 attempt to provide data that will assist in evaluating grain feeding. Table 4 lists the return per head per day for daily gains (over cattle receiving whole grain) ranging from .10 to .40 pound and valued from 60¢ to $1.00 per pound. Table 5 lists the total value of gain per ton of grain fed with no processing costs included.

We will work through an example that will demonstrate the applicability of these tables. The first thing that must be determined is the additional performance (if any) of feeding processed compared with whole grain. Cattle performance can be estimated by con-

Table 4. Value ($/head/day) of increased gain due to grain processing.

	Gain market value ($/lb)				
Increased daily gain, lb	**.60**	**.70**	**.80**	**.90**	**1.00**
.10	$ .06	$ .07	$ .08	$ .09	$ .10
.15	.09	.11	.12	.14	.15
.20	.12	.14	.16	.18	.20
.25	.15	.18	.20	.23	.25
.30	.18	.21	.24	.27	.30
.35	.21	.25	.28	.32	.35
.40	.24	.28	.32	.36	.40

Table 5. Break even cost ($/ton) of grain processing based on value of gain ($/head/day) and amount of grain fed (lb/head/day).

	Value of increased gain ($/head/day)							
Grain fed, lb/day	**.05**	**.10**	**.15**	**.20**	**.25**	**.30**	**.35**	**.40**
.50	200	400	600	800	1,000	1,200	1,400	1,600
1.00	100	200	300	400	500	600	700	800
1.50	67	133	200	267	333	400	467	533
2.00	50	100	150	200	250	300	350	400
2.50	40	80	120	160	200	240	280	320
3.00	33	67	100	133	167	200	233	267
3.50	29	57	86	114	143	171	200	229
4.00	25	50	75	100	125	150	175	200
4.50	22	44	67	89	111	133	156	178
5.00	20	40	60	80	100	120	140	160

sulting an extension educator, nutritionist, or by using the data and information found in CL300, CL 301, and CL 310. For this example we will assume that feeding processed grain will increase average daily gain by .15 pound per head compared with animals receiving whole grain. If we assume a value of $1.00/pound for the additional gain, the total value of gain would be 15¢/head/day (Table 4). The amount of grain fed is 5 pounds per head per day. As a result, the total value of the gain per ton of grain is $60 (Table 5). Therefore, the total cost of grain processing (labor, fuel, handling, etc.) must be less than $60/ton in order to yield an economic benefit.

Implications

Processing of cereal grains for use in ruminant diets can improve dry matter digestibility and animal performance. However, the potential improvement in a grains' nutritional value must be weighed against the associated processing costs. These include extra handling of the grain and the cost and availability of equipment, labor, and energy. In most cow/calf operations it will not be economically beneficial to process corn or oats for use as an energy supplement.

In contrast, processing of barley, wheat, and sorghum grain will significantly improve grain utilization and animal performance, thereby increasing the potential for positive economic returns. A beef producer should calculate the costs associated with processing and the value of the expected increase in animal performance (over feeding unprocessed grain) to decide if processing is a viable alternative.

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