Influence of Milo Processing Methods on Digestion of Starch in High Concentrate Beef Cattle Rations

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Story in Brief

The processing of cereal grains used in feedlot rations is a common practice. These processing methods usually result in increased feed efficiency and at times increased rates of gain. Since the major source of energy from cereal grains is derived from the starch portion, the extent and site of digestion of the starch in high concentrate rations may explain the increased performance from these rations.

The studies discussed in this paper indicate that steam flaking and micronizing milo significantly increased the digestion of starch when fed in a high concentrate ration. There were no differences in site or extent of starch digestion between the steam flaked and micronized milo in the first trial. The second trial indicated that increasing the degree of micronizing slightly increased ruminal digestion of starch. Only small amounts of starch from the heat treated milo rations escaped digestion. However, significant amounts of starch from the dry rolled milo ration were excreted in the feces and thus represented a loss of available energy to the animal.

Introduction

The processing of cereal grains for beef cattle rations has been studied widely in recent years. However, much of the research has been conducted with rations of less than 80 per cent concentrates while most rations presently being fed to feedlot cattle routinely contain 80-90 per cent concentrates. Research reports have shown that several processing techniques for cereal grains have improved the efficiency of utilization of these grains. The digestibility of the ration and the rates of gain were increased by grain processing in some experiments. Others have shown a

decreased feed intake and increased feed efficiency due to processing. The most consistent benefit seems to be the increased efficiency of utilization of the ration.

This improvement in efficiency may be due to a change in the pattern of rumen fermentation and/or an increased digestion of the starch portion of the ration. Since the major source of energy from cereal grains is derived from the starch, the site and extent of digestion of starch in cattle fed high concentrate rations may be related to the increased feed efficiency. The ruminant digests starch at two sites, the first being fermentation by the microorganisms in the rumen, and secondly, should some starch escape that process, by enzymatic digestion in the small intestine.

The capacity of this second system may be limited. In most rations almost all the ingested starch is digested by the animal but the site of digestion in a digestive tract may vary with the method by which the grain was prepared. The literature indicates that the amount of starch escaping ruminal fermentation is variable. Therefore, this experiment was conducted to study the influence of grain processing on the site and extent of starch digestion in high milo rations.

Procedures

Four Angus steers were fitted with permanent rumen and abomasal cannulae and were housed in individual pens with slotted floors. They were fed at hour intervals with the use of automatic feeders built for this purpose. This feeding system was used to maintain a constant flow of digesta through the digestive tract to aid in the sampling of ingesta and feces and to permit more accurate estimates of starch movements through the tract. With this system, feed intake was found to be similar to that found under feedlot conditions. Ration composition is given in Table 1. Chromic oxide was added to the ration as an external indicator to facilitate calculation of starch digestibility.

Table 1. Composition of High Milo Rations

Ingredient	%, 90% D.M. basis
Milo	84.0
Cottonseed hulls	7.0
Dehydrated alfalfa meal	3.0
Supplement	6.0
Soybean meal	3.3
Urea	0.7
Minerals, vitamins, & additives	1.55
Wheat middlings	0.2
Chromic oxide	0.25

Two trials were conducted to determine the influence of processing method on starch digestion. A commercial milo was processed by the following methods:

Trial 1	Trial 2
Dry rolled	Dry rolled
Micronized (26 lb/bu)	Micronized (32 lb/bu)
Steam flaked (28 lb/bu)	Micronized (25 lb/bu)
Ground	Micronized (18 lb/bu)

The dry rolled milo was prepared by passing milo through rollers set to crack all kernels. The micronized milo was prepared at the various densities by varing the length and degree of dry heat treatment and then passing through rollers under 130 pounds of pressure. Steam flaked grain was held in a steam chamber for 35 minutes and then passed through rollers set to produce a thin flat flake. Ground milo was produced by passing the grain through a hammer mill with a 3/16 inch screen.These rations were then rotated on a time schedule so that each steer received each ration during a given trial.

Samples of abomasal contents and feces were obtained three times daily on two days for each steer on each ration. Starch and chromic oxide determinations were conducted on the abomasal contents and feces and digestibility of starch calculated using the chromic oxide as an external indicator. The amount of starch digested in the rumen, intestines and total digestive tract were calculated.

Results

Trial 1

The summary of data from Trial 1 is shown in Table 2. Daily feed intake was similar for the dry rolled, micronized and steam flaked milo rations, but the feed intake for the ground milo ration was considerably lower than for the other rations. This was probably due to the fineness of the ground milo resulting in a reduced palatability. Starch intakes reflected the feed intakes as starch contents of the rations were similar. The percent ruminal digestion of starch was not significantly different ($P>.05$) between rations. However, the starch digestion in the total tract was significantly lower ($P<.05$) for the dry rolled milo ration than for the other rations and this trend is also evident in the digestibility of the starch entering the intestines.

These data indicate that heat and pressure treating (steam flaking and micronizing) of milo increased the digestibility of the starch portion of the ration. The ground milo ration also had a higher digestibility of starch than the dry rolled ration but interpretation of this difference is

Table 2. Ruminal, Intestinal and Total Digestion of Starch in Trial 1

Item	Grain processing methods			
	Dry Rolled	Micronized	Steam Flaked	Ground
Feed intake, g D.M./day	5698	5187	5659	4260
Starch intake, g/day	3722	3382	3737	2687
Ruminal digestion of starch, g/day	2847	2848	3038	2319
Intestinal digestion of starch, g/day	592	520	661	336
Starch in feces, g/day	283	14	38	32
Total digestion of starch, g/day	3439	3368	3699	2655
Ruminal digestion, % of total starch intake	76.5	84.2	81.3	86.3
Intestinal digestion, % of starch entering intestine	67.7[1]	87.2[2]	95.4[2]	89.5[2]
Total digestion, % of total starch intake	92.4[1]	99.6[2]	99.0[2]	98.8[2]

[1,2] Values on the same line with different superscripts are significantly different ($P<.05$).

difficult since the level of starch intake was considerably lower with the ground milo.

Trial 2

A summary of data from trial 2 is shown in Table 3. Feed intakes of the four rations in this trial were very similar. There tended to be a slightly higher feed intake for the micronized milo rations indicating that micronization was not detrimental to palatability under these feeding conditions. Ruminal digestion of starch tended to increase as degree of micronization increased, however, these differences were not statistically significant. The largest differences in starch digestibility occurred in the lower digestive tract. Only 50.9 percent of the starch from the dry rolled ration entering the intestines was digested there, resulting in only 81.4 per cent total digestion of starch. For the micronized rations, over 90 per cent of the starch entering the intestinal tract was digested there. Thus, about 98 per cent of the ingested starch from the micronized rations was digested in the total digestive tract.

Discussion

The results of these two trials indicate that the total digestion of starch from high concentrate rations can be increased by steam flaking and micronizing. There were small differences in the amount of starch digested in the rumen. The greatest influence on starch digestion seemed

Table 3. Ruminal, Intestinal and Total Digestion of Starch in Trial 2

Item	Grain processing methods			
	Dry rolled	Micronized 32 lb/bu.	Micronized 25 lb/bu.	Micronized 18 lb/bu.
Feed intake, g/D.M./day	5516	5976	6156	6012
Starch intake g/day	3494	3778	3914	3746
Ruminal digestion of starch, g/day	2100	2297	2509	2544
Intestinal digestion of starch, g/day	744	1405	1338	1120
Starch in feces, g/day	650	76	67	82
Total digestion of starch, g/day	2844	3702	3847	3664
Ruminal digestion, % of total starch intake	60.1	60.8	64.1	67.9
Intestinal digestion, % of starch entering intestine	50.9[1]	95.4[2]	95.5[2]	92.9[2]
Total digestine, % of total starch intake	81.4[1]	98.0[2]	98.3[2]	97.8[2]

[1,2] Values on the same line with different superscripts are significantly different ($P<.05$).

to be the percentage of starch that was digested in the intestinal tract. In both trials the starch in the dry rolled milo ration had a lower intestinal digestion than any of the other rations. This would indicate that the processing of milo was altering the structural integrity of the starch granules in the milo kernel, allowing increased microbial and enzymatic digestion of the starch.

There were about 250 g and 580 g more starch digested per day from the heat treated milo rations than for the dry rolled milo rations in trials 1 and 2, respectively. This represents 0.52 and 1.20 megacalories of additional net energy available for gain from the heat and pressure treated milo rations from which one could expect an additional 0.31 and 0.70 pounds of daily gain from the same quantity of feed in trials 1 and 2, respectively. Therefore, the additional digested starch would provide considerable extra energy to the animal for production purposes.

Starch digestion for the dry rolled rations in trial 2 was lower than that in trial 1. These trials were conducted with two different sources and possibly different varieties of milo, apparently resulting in differences in digestibility.