Corn Processing Method and Phase Feeding of Steers

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Story in Brief

Two hundred sixteen yearling 692-lb steers were fed high moisture or steam flaked corn (79 percent of ration dry matter) or whole shelled corn grain (88 percent of ration) for 133 days. Steers were switched among corn processes after 70 days on trial. During the first 70 days, rate of gain and feed efficiency favored the whole shelled corn ration over the other two rations. For the last 63 days, gain and feed efficiency were approximately equal for high moisture and whole corn fed steers but on the average superior to those fed steam flaked grain. Overall gains and feed intakes were greatest for steers fed the combination of whole shelled corn the first 70 days followed by high moisture corn. Due to the lower roughage level in the whole shelled corn ration, feed efficiency favored steers started on whole shelled corn and finished on high moisture or whole shelled corn. As a percentage of fecal dry matter, fecal starch averaged 17, 7 and 30 percent for high moisture, steam flaked and whole shelled corn rations, respectively. Carcass characteristics were similar for steers fed all corn types with no adverse effects with whole shelled corn except slightly increased fat thickness.

Introduction

Corn grain is processed by various methods for feeding steers. Feedlots commonly feed corn in the whole shelled, steam flaked, dry rolled and high moisture form. Particle size and moisture content influence the site and extent of starch digestion, which is reflected in feed efficiency and feed intake which affect both gain and feed efficiency.

Increased processing to maximize starch digestibility will increase the rate and extent of ruminal digestion. This may increase the incidence of acidosis and the need for supplemental roughage. Ruminal digestion of starch, with consequent methane and heat loss, yields about 30 percent less net energy than intestinal digestion of starch, but will yield more microbial protein. So the ideal site of starch digestion may differ with protein supplementation and animal age. Many feedlots mix grain processed by different methods to aid bunk management or to stretch limited grain supplies. Another alternative to stretch supplies is to "phase feed" so that method of grain processing is switched at a given point in the feeding period.

The objective of this study was to determine the rate of gain, feed efficiency and fecal starch response of feedlot steers to feeding whole shelled, steam flaked or high moisture corn continuously or switching among these types at the midpoint of a finishing trial.

Materials and Methods

Two hundred sixteen yearling steers averaging 692 lb were allotted to 27 pens of eight steers each with four Angus, two Herefords and two exotic breed crossbred steers

in each pen. Ground alfalfa hay replaced corn in the ration at levels of 26, 16 and 6 percent of ration dry matter for the first 4 days, 5 to 10 and 11 to 18 days after arrival, respectively. Composition of the rations and ingredients is given in Table 1. Supplements for whole shelled corn rations were pelleted to prevent separation from the ration. Steers were fed *ad libitum* the mixed 11.5 percent protein rations with fresh feed added twice daily. Steers were weighed full at approximately 30-day intervals and shrunk on days 0 and 70. On day 71, steers were re-fed their earlier ration and then switched to their subsequent rations (Table 2). On day 133, steers were transported to Booker, Texas, to obtain slaughter and carcass data. Final weight was calculated from carcass weight assuming a dressing percentage of 62 percent. Fecal samples were obtained from 73 to 81 steers on days 26, 63 and 123 of the trial for measurement of pH, dry matter and starch content.

Table 1. Ration Composition.

	Ration	
	WSC[a]	SF and HMC[a]
Corn grain	87.75	78.33
Corn silage	5.00	14.00
Supplement[b]		
Corn	.58	.55
Soybean oil meal	4.86	5.51
Dicalcium phosphate	.13	.12
Calcium carbonate	.98	.92
Potassium chloride	.40	.27

[a]WSC = whole shelled corn; SF = steam flaked corn; HMC = high moisture corn.
[b]Trace mineral mix, salt (0.3%), vitamin A and monensin added.

Table 2. Treatment allocation.

Number of pens	Period, days	
	0-70	71-133
3	WS[a]	WS
3	WS	SF[b]
3	WS	HM[c]
3	SF	WS
3	SF	SF
3	SF	HM
3	HM	WS
3	HM	SF
3	HM	HM

[a]Whole shelled corn.
[b]Steam flaked corn.
[c]High Moisture corn.
Rations were switched by replacing 25% increments of the old ration by the new ration each meal starting on day 71 of the trial.

Results and Discussion

Daily gain, daily feed and feed efficiency for the first and second phase are presented in Table 3. Gains were excellent both periods. For the first 70 days, feed intake was least and gain and feed efficiency superior for steers fed whole shelled corn. Grain required per unit of gain was also superior for the whole shelled corn ration. During the second phase, intake, performance and efficiency were similar for steers fed high moisture and whole shelled corn. Intake and gain were lower for steers fed steam flaked grain. If starch damage is extreme during flaking, feed intake may be depressed and acidosis may occur. Test weight of the flaked grain was 26 lb per bushel, suggesting that the grain was not over-processed.

Performance for the 133 days for specific corn combinations are presented in Table 4. Total trial effects on daily gain were attributable to corn type fed during the first 70 days, whereas feed efficiency was influenced primarily by corn type fed during the last 63 days. The whole shelled corn advantage in feed efficiency and calculated net energy

Table 3. Performance of steers.

	HMC	SF	WSC
Pens	9	9	9
Days 0-70			
ADG	3.86^{a}	3.73^{a}	4.27^{b}
ADF	22.7^{a}	21.9^{a}	20.7^{b}
F/G	5.92^{a}	5.89^{a}	4.86^{b}
Grain/gain	4.93^{a}	4.90^{a}	4.38^{b}
Days 70-133			
ADG	2.99^{b}	2.55^{a}	2.96^{b}
ADF	20.1^{b}	19.0^{a}	20.3^{b}
F/G	6.78	7.57	6.93
Grain/gain	5.64	6.30	6.25

^{ab}Means in a row with different superscripts differ significantly (P<.05).

Table 4. Trial performance.

Corn type		Daily	Daily	Feed/	Grain/	
Initial	Final	gain	feed	gain	gain	NE_G
HMC	HMC	3.55^{c}	21.7^{bc}	6.11^{ab}	5.09	60.4^{ab}
	SF	3.24^{ab}	21.0^{bc}	6.47^{b}	5.38	57.3^{a}
	WSC	3.63^{d}	21.9^{c}	6.04^{ab}	5.21	60.3^{ab}
SF	HMC	3.33^{abc}	21.0^{bc}	6.30^{ab}	5.24	60.9^{ab}
	SF	3.13^{a}	20.5^{ab}	6.55^{b}	5.45	58.5^{a}
	WSC	3.50^{bcd}	21.5^{bc}	6.15^{a}	5.32	61.1^{ab}
WSC	HMC	3.51^{bcd}	20.4^{ab}	5.81^{a}	5.05	63.2^{ab}
	SF	3.34^{abc}	19.3^{a}	5.80^{a}	5.05	63.8^{b}
	WSC	3.54^{cd}	20.4^{ab}	5.77^{a}	5.20	64.3^{b}

^{abcd}Means in a column with different superscripts differ significantly (P <.05).

values can be partially explained by the higher grain content of the whole shelled corn ration. To adjust for this, one can calculate the amount of grain alone required per pound of gain. Based on starch analysis of the silage, the corn silage had only 23 percent of its dry matter from corn grain. Results are presented in the column entitled "grain/gain." Less grain was required when fed in the whole shelled form than in other forms. This indicates superior utilization of energy from corn fed in the whole shelled form, or possibly a negative effect from increasing silage content from 5 to 14 percent of the ration during the first 70 days. Benefit of the whole shelled grain ration was attained during the first phase of the feeding trial. For the second phase, efficiency was slightly superior for high moisture grain.

Grain processing may alter value by changing: 1) energy intake, 2) digestibility or 3) utilization of absorbed nutrients. Relative digestibility of the major component of the grain can be evaluated from analysis of feces for starch, dry matter and pH (Table 5). Starch as a percent of fecal dry matter was always greatest for steers fed whole shelled corn and least for steers fed steam flaked grain. Since the high moisture and steam flaked rations contained more roughage (and less starch), one might expect as much as one-third higher starch content of feces because of more feces being produced with higher roughage rations. Even after such adjustment, starch in feces was higher with whole shelled than high moisture or steam flaked corn grain. Consequently, greater digestibility of the whole corn ration cannot be responsible for its higher energy value. Since total energy intakes were similar, this suggests that efficiency of metabolism of absorbed nutrients must have been greater with corn in the whole shelled form.

Previous studies have indicated that site of starch digestion shifts post-ruminally with less processing. This would mean that ruminal digestion of whole shelled corn is lower than ruminal digestion of processed corn (Owens *et al.*, 1979). Such a downstream shift in digestion reduces loss of heat and methane from fermentation in the rumen and could increase efficiency of energy use up to 30 percent. Such a reduction in heat production is visually evident in timing of winter hair coats of steers fed whole corn rations. Shifting digestion downstream may prove more useful during heat than cold stress.

Shifting site of digestion downstream in the digestive tract has disadvantages as well. Energy for microbial growth in the rumen is reduced so microbial protein supply to the small intestine may be reduced. Further, intestinal starch digestion is incomplete, so fecal energy loss increases. In this trial, fecal starch increased with time on feed for steers fed whole shelled corn. Younger or lighter cattle may chew their ration or digest starch intestinally to a greater degree than older cattle. The influence of animal age or animal breed (e.g., Holstein steers) upon whole corn utilization needs further research.

Table 5. Feces composition.

	Starch, %			Dry matter, %			pH		
Day	**26**	**63**	**123**	**26**	**63**	**123**	**26**	**63**	**123**
HMC	13.4[b]	23.0[b]	15.8[b]	21.9[b]	21.9[b]	21.8[b]	5.71[a]	6.05[a]	6.27[b]
SFC	6.1[a]	8.1[a]	6.8[a]	16.2[a]	18.4[a]	17.7[a]	5.75[a]	6.08[a]	6.10[a]
WSC	26.0[c]	29.5[c]	34.4[c]	24.6[c]	27.1[c]	24.6[c]	5.94[b]	6.33[b]	6.00[a]

[abc]Means in a column with different superscripts differ significantly ($P < .05$).

Dry matter content of feces paralleled starch content. Possibly non-starch components entrap water more completely than starch. Alternatively, intestinal contents may have become too dry for intestinal digestion. In either case, the wetter feces proved indicative of high starch digestion within or across corn types. Fecal pH was poorly related to starch content of feces either within or across corn types.

Carcass characteristics were generally similar across corn types (Table 6). Thickness of fat over the 12th rib was greater for steers fed whole corn during the last period. Whole shelled corn rations did not reduce marbling or quality grade.

Results from this trial should not be extrapolated to rations containing higher levels or other sources of roughage, to rations not containing monensin, or to rations fed to older cattle or to other grains or processing methods. One earlier comparison of rolled corn to whole corn (Wagner and Aimone, 1976) found the two rations equal for gain and efficiency when 6 percent cottonseed hulls were fed. Further study of roughage levels and sources and mixtures of whole and processed grain is needed. Whole shelled corn rations should prove economically useful to decrease feed processing cost while improving rate of gain and feed efficiency of steers, especially during the first half of a feeding period.

Literature Cited

Owens, F. N. 1979. Am. Soc. Anim. Sci. Abstracts, p. 396.
Wagner, D. G. 1976. Okla. State Agr. Exp. Sta. Rep. MP-96:70.

Table 6. Carcass characteristics.

Corn type						
Initial	Final	Dressing[c] %	Rib eye	Marbling	Cut	Fat thickness
HMC	HMC	61.8[b]	12.6	13.4[ab]	49.7	.49
	SF	60.7[ab]	12.4	13.4[ab]	49.9	.48
	WSC	60.6[a]	12.4	13.0[a]	49.2	.58
SF	HMC	61.0[ab]	12.6	13.3[ab]	49.5	.50
	SF	60.5[a]	12.4	14.9[b]	49.6	.50
	WSC	60.3[a]	12.3	13.7[ab]	49.2	.53
WSC	HMC	60.4[a]	12.2	14.6[ab]	49.5	.49
	SF	60.7[ab]	12.2	13.4[ab]	49.9	.45
	WSC	60.7[ab]	12.4	14.2[ab]	49.3	.54

[ab]Means in a column with different superscripts differ significantly ($P<.05$).
[c]Dressing percent computed from final unshrunk weight.