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Processed Corn Silage Effects on Digestibility and Production of Growing Beef Replacement Heifers

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Introduction

Forage is generally the principle feedstuff in feedlot diets for growing cattle and, as such, its nutritive value will determine weight gain, feed intake and feed efficiency. In feedlot diets for growing cattle, corn silage can constitute up to 60% of the diet (DMB).

There are many management factors that go into production of corn silage. These include forage maturity and moisture at harvest, type of storage structure, feeding methods, and bunk management. Processing alters the structure of the stover and grain portions of the plant to ensure maximum nutrient availability.

Crop processing units utilizing counter rotating serrated rolls, operating at close spacing and differential speeds, crush and shear whole crop corn (Young, 1998). This crushing and shearing of the forage increases penetration and colonization of ruminal microorganisms into the stover and kernel (Harrison et al., 1997b), potentially improving its digestibility. Microbial attachment, as well as sites for colonization, are enhanced when the forage is disturbed through mechanical processing because the microbes can more easily penetrate the surface and enter inner portions of the plant (McAllister et al., 1994).

Other advantages of processing include decreased corn grain in feces, more evenly mixed diets and a reduction in the refusal of corn cobs by feedlot cattle (Harrison, 1998).

Results of feedlot studies using processed corn silage have been variable, with some studies exhibiting an improvement (Freckle et al., 1985; Young, 1998), whereas others have found no effect (Rojas-Bourrillion et al., 1987) on total DM digestibility and animal performance.

The objective of this study was to determine the effect on animal performance and digestibility of feeding mechanically processed corn silage to backgrounded British-cross beef replacement heifers.

Materials and Methods

In early October, whole plant corn (Pioneer hybrid 3223) was harvested and ensiled in plastic silage bags using two six-row John Deere Model 5830 silage harvesters, one of which had an in-line processing adapter. All whole crop corn was harvested over one day using the two harvester types with each harvester chopping every other six-row section to eliminate field effect. The theoretical length of cut (TLC) for the processed harvester was set at 19 mm and the unprocessed chopper was 13 mm. Roll spacing on processor was 1.5 mm. Whole plant particle size was determined from three sub-samples of each experiment.

Feeding Study

Ninety weaned heifer calves (645 lbs) were assigned to six pens of 15 head. All calves had been processed similarly prior to trial initiation by receiving a Brucellosis vaccination, parasite treatment, 8-Way Clostridial vaccine and intranasal respiratory product.

Three of the pens received the silage portion of their ration as processed corn silage (PR) and the other three pens served as unprocessed (UP) controls. The initial ration (0 to 28 d) consisted of 55.4% corn silage (CS), 22.3% alfalfa hay (AH), 19.6% wheat middlings (WM) and 2.7% supplement (SUPP) on a DM basis and fed ad libitum. After the 28 d period the ration was changed to 60.5% CS, 26.3% AH, 10.6% WM and 2.6% Supp (DM). Rations were fed once daily (8:00 a.m.) to appetite. All heifers were weighed individually on day 28 (trial start) and at trial termination (56 d). All feedstuffs were analyzed for nutrient analysis (Table 1).

Digestibility Trial

The diets fed during days 28 to 56 in the feeding trial were fed to four ruminally cannulated yearling beef heifers (700 lbs). Heifers were individually housed in open front pens with concrete floors. All feedstuffs were fed once daily at 8:00 a.m. Rations were fed to appetite but were totally consumed daily. During the collection period, fecal samples were obtained from each heifer and samples of the total mixed ration (TMR), feces and individual feedstuff samples were also obtained. During a 6 d collection period, ruminal fluid was obtained from the rumen via the rumen cannula of each heifer.

Results and Discussion

Physical properties of silage

The physical properties for UP and PR corn silages (Table 2) indicate differences for all variables. There was a difference in initial chop length but average particle size of the whole plants and kernels were lower in the PR samples. The whole cob fraction was reduced to zero as a percent of the total mass for PR with no cob slices observed. Undamaged and broken kernels were lower for PR corn silages. These results indicate that roll clearance as well as processing alters kernel and whole-plant particle size.

Effect on digestibility

Total volatile fatty acids, which are a primary energy source for ruminants such as beef cattle, were higher for the UP treatment although neutral detergent fiber (NDF) digestibility for the PR treatment was higher.

Other research (Harrison, 1997a) has shown that processing corn silage could have a greater effect on rate of fermentation with silage harvested at a more advanced maturity. Nutrient availability and value decreases in corn silage (stover and kernel portion of the plant) as maturity

Table 1. Nutrient composition of the feedstuffs (DM basis)

Feedstuff	DM (%)	ADF (%)	NDF (%)	CP (%)	Ca(%)	P (%)
Corn Silage						
Unprocessed	30.3	28.2	50.0	7.9	.17	.17
Processed	31.3	25.4	50.0	7.3	.19	.19
Alfalfa Hay	85.6	34.9	58.0	20.0	1.12	.25
Wheat Mill Run	86.0	10.6	33.1	18.1	.10	.92
Vitamin/Mineral Mix	95.0	ND[2]	ND	11.0	8.0	.50

[1]Consisted of 5.0% NaC1, .24% Mg, .76% K, 200 ppm Cu, 400 ppm Mn, 650 ppm Zn, 2 ppm Se, 22 ppm I, 9 ppm Co, 121000 $IU.kg^{-1}$ Vit. A, 37400 $IU.kg^{-1}$ Vit. D, 55 $IU.kg^{-1}$ Vit. E and 360 ppm Rumensin
[2]Not Determined

Table 2. Effect of processing on kernel and particle size.

	UP1	PR1
Whole Plant and Cob Fraction		
Whole cob fraction (% of total Mass)	6.4	0
Geometric mean particle size of whole plant (mm)	13.3	10.6
Kernel Fraction		
Undamaged kernels (% of total dry kernel mass)	117.3	1.8
Damaged kernels (% of total dry kernel mass)	18.2	4.3
Broken kernels (% of total dry kernel mass)	64.5	93.9
Geometric mean particle size of kernel fraction (mm)	6.6	4.7

[1]UP - unprocessed corn silage; PR- processed corn silage

increases (Harrison et al., 1996; Bal et al., 1996). In our study the whole plant corn may have been too immature to observe an increase in fermentation characteristics due to processing.

Effect on animal performance

Both UP and PR diets were consumed at high levels, but there were no differences between treatments for ADG, DMI or FE (Table 3). The high level of kernel damage in the UP as well as the PR corn silage may have contributed to this result by increasing nutrient availability in both silages.

Table 3. The effect of processing corn silage on digestibility and animal performance.

Item	UP[1]	PR[1]
Digestibility (%)		
Dry Matter	63.3	61.2
Acid Detergent Fiber	36.4	33.5
Neutral Detergent Fiber	63.2	65.5
Animal Performance (0 to 56 d)		
Average Daily Gain (lbs/day)	2.1	2.2
Dry Matter Intake (lbs/day)	16.6	16.7
Feed Efficiency	8.12	7.70

1 UP - Unprocessed corn silage; PR - processed corn silage

Conclusions

Processing whole plant corn decreases mean particle size and whole cob fraction of the whole plant resulting in a higher proportion of damaged and broken kernels and increased kernel surface area. These different physical properties of the PR silage did have a positive effect on NDF digestibility with an average increase in DM digestibility. This did not result in differences in animal performance, however. Other studies indicate stage of maturity is a factor that must be considered when determining potential advantages of processing whole plant corn. Rumen fermentation, digestibility and animal performance could be altered, depending on stage of plant maturity and this should be considered.

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