Effect of Grinding High Moisture Corn on Its Utilization by Dairy Cows Fed Alfalfa Silage

C. Ekinci and G.A. Broderick

Introduction

Alfalfa silage (AS) is one of the forages most commonly fed to dairy cows. However, during ensiling 50 to 60% of its CP is converted to NPN. Synchronization of energy fermentation and CP degradation in the rumen may improve the efficiency of utilization of the NPN for microbial protein synthesis (MPS) and reduce the need for dietary RUP. Because of the structure of its starch granule (McAllister et al. 1993), corn is not extensively degraded in the rumen. Processing of corn improves its digestibility in the rumen and the intestine (Owens et al. 1986). Ensiling of high moisture corn is one of the methods used to increase corn digestibility (Hale 1973). Grinding of ensiled high moisture corn may have an additive effect on digestibility. Our objective was to determine if grinding high moisture corn would improve its utilization in lactating dairy cows by increasing ruminal MPS and reducing the need for RUP. Therefore, milk yield should increase, and response to RUP decrease, with the feeding of ground high moisture corn.

Materials and Methods

Fifty-two (52) Holstein cows (36 multiparous, 8 with ruminal cannulae and 16 primiparous) with mean (± SD) 35.8 (± 6.1) kg/d milk yield and 110 (± 39 d) DMI were randomly assigned to one of four diets during a 12-week lactation study. The main concentrate was either 68% DM high moisture ear corn (HMC), rolled before ensiling, or the same HMC that was ground (GHMC) through a 9.5 mm (3/8″) screen as it came out of the silo. Expeller soybean meal (ESBM) was added as a source of RUP to two of the diets. The four diets contained (DM basis): 1) 53% AS plus 42% HMC (HMC); 2) 53% AS plus 30% HMC plus 12% ESBM (HMC + E); 3) 53% AS plus 42% GHMC (GHMC); 4) 53% AS plus 30% GHMC plus 12% ESBM (GHMC + E). Diets contained either 16.3% CP (HMC and GHMC) or 21.3% CP (HMC + E and GHMC + E); NE_L content of all diets was 1.69 Mcal/kg. The NDF contents were 26% for the HMC + E and GHMC + E diets and 28% for the HMC and GHMC diets. Ration composition, yield of milk and milk components, ruminal pH and ammonia, blood and milk urea, and DM and starch digestion, estimated using indigestible ADF as an internal marker, were determined during the trial. Stimulation of MPS by HMC and GHMC was assessed from ammonia disappearance in duplicate in vitro incubations.

Results and Discussion

Changes in ammonia concentration in ruminal in vitro incubations conducted with HMC and GHMC are shown in Figure 1. Grinding of HMC significantly ($P <$ .01) decreased ammonia at 3, 4, 5 and 6 h of incubation, presumably by stimulating ruminal MPS. The results from the in vitro incubations reflected those observed in the lactation trial, which are summarized in Table 1. There were no differences in BW gain despite DMI being lower on diet HMC. Grinding of HMC significantly increased digestibility of DM and starch. The higher DMI and improved digestibility were reflected in improved yield of milk and milk components, particularly on diet GHMC; grinding of HMC resulted in equivalent production between diets HMC + E and GHMC. Although there was no difference in milk yield among the HMC + E, GHMC and GHMC + E diets, yields of fat, protein, and SNF were lower on diet GHMC + E than on diets HMC + E and GHMC. This result may have been related to hot weather occurring during the middle four weeks of the 12-week trial and not due to an adverse effect of feeding RUP. During the first four weeks of the trial, cows fed the GHMC + E diet produced more milk than those fed the GHMC diet but, after a four-week heat wave starting in week 5, cows receiving the GHMC + E diet began to decline. This may have resulted from greater incidence of sub-clinical mastitis in cows fed the GHMC + E diet because, by chance, the cows assigned to this diet had higher SCC before the trial. Moreover, their SCC increased more during the trial. As a result, the main effects of ESBM and grinding cannot be seen clearly because the two factors interacted (P = .06). Efficiency of milk yield (weekly milk yield divided by weekly DMI) was not different among the treatments. However, N efficiency was higher for the HMC and GHMC diets than for the two

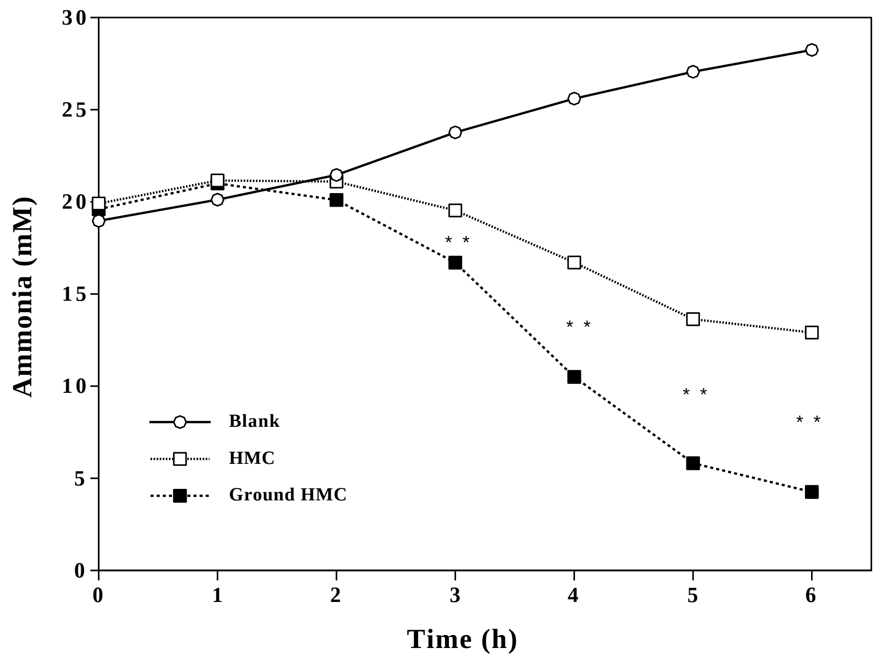

*Figure 1. In vitro ruminal ammonia concentration in 6-h incubations containing no added substrate (Blank), high moisture corn (HMC) or ground HMC (** P < .01).*

diets with added ESBM; the GHMC + E diet had the lowest N efficiency. Persistency of milk yield tended to follow differences in milk yield and was lower for the HMC diet than for the other three diets. Concentration of urea in milk mirrored that in blood plasma; both were higher for diets containing ESBM. Elevated blood and milk urea observed with ESBM feeding probably resulted from inefficient use of excess dietary N at both the rumen and tissue level. Although ruminal pH was not significantly influenced by diet, grinding of HMC decreased ammonia concentration (P <.01). This suggested greater ruminal fermentation with the GHMC diet, compared to the HMC diet, increased ammonia utilization and MPS by the ruminal microbes. Adding ESBM to the diets increased ruminal ammonia.

Conclusions

Grinding of HMC improved milk yield 2.4 kg/d; cows fed the GHMC diet also had significantly greater yields of fat, protein, lactose, and SNF than cows fed the HMC diet. Milk yield of cows fed the GHMC + E diet was 2 kg/d lower than cows fed the HMC + E diet; this may be related to the higher SCC present in cows fed the GHMC + E diet. Grinding of HMC increased apparent total tract digestibility of DM and starch and decreased ruminal ammonia concentration. Greater ruminal fermentation of ground HMC, versus unground HMC, probably improved utilization of NPN from AS by increasing MPS. Grinding of HMC improved its utilization in the lactating dairy cow.

References

Hale, W.H. 1973. Influence of processing on the utilization of grains (starch) by ruminants. J. Anim. Sci. 37:1075-1080.

McAllister, T.A., R.C. Phillippe, L.M. Rode and K.J. Cheng. 1993. Effect of protein matrix on the digestion of cereal grains by ruminal microorganisms. J. Anim. Sci. 71:205-212.

Owens, F.N., R.A. Zinn and Y.K. Kim. 1986. Limits to starch digestion in the ruminant small intestine. J. Anim. Sci. 63:1634-1648.

Table 1. Effects of grinding high moisture corn on DMI and BW gain, apparent DM and starch digestion, yield of milk and milk components, blood and milk urea, and ruminal pH and ammonia.[1]

Item	HMC	HMC + E	GHMC	GHMC + E	SEM	$P > F$[2]
DMI, kg/d	21.2[b]	22.6[ab]	23.1[a]	22.2[ab]	.5	0.064
BW change, kg/d	.15	.09	.09	.18	.09	0.86
DM digestibility, %	66.1[b]	64.8[b]	69.7[a]	69.3[a]	1.1	<.01
Starch digestibility, %	94.5[b]	93.8[b]	98.7[a]	98.8[a]	.5	<.01
Milk yield, kg/d	30.1[b]	34.0[a]	32.5[ab]	32.1[ab]	.9	0.03
Fat, %	3.58[ab]	3.45[b]	3.75[a]	3.35[b]	.10	0.04
Fat, kg/d	1.07[b]	1.18[a]	1.21[a]	1.02[b]	.03	< .01
Protein, %	3.03[ab]	2.95[b]	3.17[a]	2.99[b]	.06	0.09
Protein, kg/d	.91[b]	1.01[a]	1.03[a]	.91[b]	.02	< .01
Lactose, %	4.71[b]	4.92[a]	4.93[a]	4.98[a]	.06	< .01
Lactose, kg/d	1.42[c]	1.70[a]	1.62[ab]	1.53[bc]	.04	< .01
SNF, %	8.43[b]	8.55[ab]	8.79[a]	8.66[ab]	.12	< .01
SNF, kg/d	2.53[b]	2.95[a]	2.88[a]	2.65[b]	.07	< .01
Efficiency[3]	1.43	1.52	1.42	1.46	.04	0.24
N efficiency[4], %	25.5[a]	20.4[b]	26.7[a]	18.8[c]	.5	< .01
Persistency[5]	.83[b]	.93[a]	.92[a]	.89[ab]	.02	0.01
Blood urea, mg N/dL	13.0[c]	21.9[a]	12.2[c]	19.0[b]	.5	<.01
Milk urea, mg N/dL	11.8[c]	21.0[a]	11.0[c]	18.6[b]	.5	<.01
Ruminal pH	6.24	6.07	6.04	6.09	.06	0.31
Ruminal ammonia, mM	10.1[b]	13.6[a]	6.9[c]	11.5[ab]	.6	<.01

[a,b,c]Means within the same row without a common superscript differ ($P < .05$).

[1]HMC = High moisture corn diet; HMC + E = High moisture corn plus expeller soybean meal diet; GHMC = Ground high moisture corn diet; GHMC + E = Ground high moisture corn plus expeller soybean meal diet; SEM = Standard error of the mean.

[2]Probability of a significant effect of diet.

[3]Milk yield / DMI.

[4]Milk N / N intake x 100.

[5]Pre-experiment milk yield / Experiment milk yield.