Value of Treating Alfalfa Silage With Fibrolytic Enzymes Prior to Feeding the Silage to Lactating Dairy Cows

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Introduction

Increasing energy intake in dairy cows enhances utilization of NPN in alfalfa silage by stimulating ruminal protein synthesis. Increased fiber digestion in the rumen also would be beneficial by increasing the supply of both energy and protein. Beauchemin et al. (1995) reported improved fiber digestibility and growth rate when steers were fed alfalfa hay or timothy hay, but not barley silage, that had been treated with a mixture of fibrolytic enzymes. Higginbotham et al. (1995) observed little effect of treating a TMR containing alfalfa hay and corn silage with another source of fibrolytic enzymes prior to feeding to lactating dairy cows. The objective of our research was to determine if treating alfalfa silage with a mixture of xylanases and cellulases would enhance fiber and DM digestibility, and milk yield, in lactating dairy cows when the enzymes were applied to the silage just prior to feeding.

Materials and Methods

Second-cutting alfalfa was field wilted to 40% DM, chopped to a theoretical length of 1.0 cm and ensiled in bunker and upright tower silos. Forty multiparous (eight with ruminal cannulae) and eight primiparous Holstein cows were blocked by parity and DIM into 12 groups of four and randomly assigned to one of the four enzyme levels used to treat alfalfa silage. Means for all 48 cows at the start of the trial were 573 kg BW, parity 2.7, 89 DIM, and 37 kg/d of milk. All cows were injected every 14 d with rBST (Posilac). The basal diet contained (DM matter basis): 50% alfalfa silage, 43% rolled high moisture ear corn, 6% solvent soybean meal, 0.5% sodium bicarbonate, supplemental minerals and vitamins, 16.9% CP, and 28% NDF. The four diets differed only in level of enzyme applied to alfalfa silage; cows were fed the same diets for all 14 weeks of the trial. Enzyme stock solutions of xylanase and cellulase, provided by FinnFeeds, were stored at 5°C. Enzymes were diluted daily with water and sprayed on at 1.0% of the as-fed silage as it mixed in a Rissler mixer. Alfalfa silage and enzymes were mixed for 10 min before adding the other TMR ingredients. The four treatments were: Control (water only); 0.7x (234 ml xylanase/ton plus 468 ml cellulase/ton); 1.2x (400 ml xylanase/ton plus 800 ml cellulase/ton); and 1.7x (567 ml xylanase/ton plus 1134 ml cellulase/ton). Body condition score (BCS) as well as milk yield and concentrations of rumen and blood metabolites were determined.

Results and Discussion

Composition of alfalfa silage was typical of good quality alfalfa, containing (DM basis): 19.8% CP, 45.9% NDF, 36.5% ADF, pH 4.78 and 57% NPN (percent of total N). Because it was higher than average in fiber, this silage should have been more amenable to improvement in nutrient value with treatment with fibrolytic enzymes. The silage was treated at four enzyme levels: 0x (Control), 0.7x, 1.2x, and 1.7x; cellulase was applied at two times the volume of xylanase. Level 1.2x was that recommended by FinnFeeds. Feed DMI, BW change and BCS, apparent digestibility, and milk yield data are in Table 1. There was no effect of enzyme treatment on apparent digestibility of DM, NDF or ADF. Although there was no effect at the lowest enzyme level, feeding diets containing alfalfa silage treated at 1.2x and 1.7x increased DMI by 1.0 and 2.4 kg/day ($P < 0.001$) versus Control. Despite increased DMI, there were no differences in BW gain, BCS or milk yield. Similar milk yields at greater DMI resulted in reduced efficiency (milk:DMI) for diets containing enzyme treated silage ($P < 0.001$). There were no differences in yield of fat, protein, lactose or SNF, but milk content of fat, protein and SNF were increased in cows fed the enzyme treated silages (P^2 0.04). Milk protein content, particularly on the 1.7x level of enzyme treatment, was unusually high. Average milk protein concentration found in 20 trials at the Dairy Forage Center in cows fed 60 different diets

Table 1. Effect of treating alfalfa silage with four levels of a mixture of cellulase and xylanase enzymes on DMI, BW gain, change in body condition score (BCS), apparent digestibility, production of milk and milk components, and somatic cell count (SCC).

	Enzyme level					
Item	0x (Control)	0.7x	1.2x	1.7x	SEM[1]	$P > F^2$
DMI, kg/d	23.1[c]	23.1[c]	24.1[b]	25.5[a]	0.3	< 0.001
BW change, kg/d	0.68	0.54	0.60	0.52	0.10	0.637
Change in BCS	0.32	0.25	0.38	0.20	0.09	0.595
DM digestibility, %	65.5	65.3	65.2	65.1	0.4	0.980
NDF digestibility, %	37.4	38.2	37.5	37.5	0.6	0.898
ADF digestibility, %	40.2	41.2	40.8	40.1	0.5	0.777
Milk yield, kg/d	35.1	34.2	33.6	35.2	0.6	0.762
3.5% FCM, kg/d	33.9	33.4	32.7	34.4	0.6	0.534
Fat, %	3.24[b]	3.36[ab]	3.28[ab]	3.46[a]	0.07	0.040
Fat, kg/d	1.14	1.15	1.11	1.19	0.03	0.237
Protein, %	3.28[b]	3.24[b]	3.30[ab]	3.41[a]	0.04	0.004
Protein, kg/d	1.16	1.10	1.12	1.17	0.02	0.062
Lactose, %	4.86	4.79	4.90	4.83	0.03	0.147
Lactose, kg/d	1.74	1.65	1.67	1.69	0.04	0.370
SNF, %	8.87[ab]	8.77[b]	8.93[a]	8.96[a]	0.05	0.011
SNF, kg/d	3.16	3.00	3.03	3.11	0.06	0.318
Efficiency[3]	1.53[a]	1.47[b]	1.40[c]	1.39[c]	0.03	< 0.001
SCC (x 10^3)	302[b]	430[ab]	708[a]	735[a]	128	0.032
Log10 SCC	2.01	2.11	2.24	2.25	0.08	0.101

[a,b,c]Means within the same row without a common superscript differ ($P < 0.05$).
[1]SEM = Standard error of the mean.
[2]Probability of a significant effect of enzyme treatment.
[3]Milk yield: DMI.

with all of the forage from alfalfa silage was 2.99% (Broderick, unpublished). Increased protein and SNF content of milk is now more valuable in the U.S. with the advent of component pricing. Mean SCC was higher ($P < 0.03$) and there was a trend ($P = 0.10$) for log of SCC to be elevated in cows fed the 1.2x and 1.7x diets (Table 1). This suggested that, by chance, cows assigned to the enzyme treatments had increased incidence of subclinical and clinical mastitis, obscuring possible positive effects of the enzymes. Cows averaged 89 DIM and 37 kg/d at the start of the trial; mean milk yield was 34.5 kg/d during the trial, despite bi-weekly injections of rBST. That increased DMI did not alter yield of milk or milk components of cows on treatments 1.2x and 1.7x indicated that production in this trial was too low for the cows to respond to improved nutrient supply. No significant effects due to enzyme treatment were detected in concentrations of blood glucose and blood and milk urea, in ruminal ammonia and total amino acids, or in ruminal pH (Table 2). There was a highly significant ($P < 0.005$) effect of time after feeding on ruminal pH, but no differences due to enzyme treatment. Slight elevations of ruminal ammonia at 15 h (1.7x) and at 18 h (0.7x and 1.2x) after feeding (data not shown) suggested that those cows had substantial feed consumption at these times.

Beauchemin et al. (1995), using a similar preparation of FinnFeed fibrolytic enzymes, observed a positive response with enzyme treatment of alfalfa and timothy hays, but not barley silage. If the mixtures of xylanase and cellulase enzymes predigested some of the fiber, then NDF content of the alfalfa silage should have declined with time. Two 24-h time studies were conducted in which samples of the alfalfa silage were collected at the research farm immediately after enzyme treatment; these samples were held at room temperature (24°C) for 24 h. No pattern of decline in NDF content was observed over that time. Mean NDF contents of alfalfa silage samples were (DM basis): 42.5 (Control), 42.3 (0.7x), 42.3 (1.2x), and

42.0% (1.7x); these were not different ($P > 0.53$). In a laboratory study conducted later, two samples of alfalfa hay and two of alfalfa silage (including that fed in the lactation trial) were treated at the 1.2x enzyme level. After 16 h at 24°C, mean NDF content of the alfalfa hays declined (DM basis) from 48.7 to 43.8% with enzyme treatment; mean NDF contents of the two alfalfa silages were 43.2 and 42.4% without and with enzyme treatment. Alfalfa silage may have been unresponsive to the fibrolytic enzymes under the conditions of our experiment. Of course, effects of the enzyme treatment on intra-ruminal fiber digestion would not have been detected in these time studies.

Summary and Conclusion

Feeding lactating dairy cows diets containing alfalfa silage treated with a mixture of xylanases and cellulases elevated DMI. However, this increased feed intake was not accompanied by increased BW gain, BCS, or milk yield. Treating the alfalfa silage with the fibrolytic enzymes elevated milk content of fat, protein and SNF, but yields of these milk components were not increased. Blood glucose and urea, milk urea, and ruminal pH, ammonia and free amino acids were not influenced by the enzymes. Neither apparent digestibility of DM, NDF or ADF, nor content of NDF in alfalfa silage over time, was influenced by enzyme treatments. However, enzyme treatment decreased NDF content of alfalfa hay. Lack of response to fibrolytic enzymes in this trial may mean that alfalfa silage is not amenable to enhanced fiber digestion.

References

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Table 2. Effect of treating alfalfa silage with four levels of a mixture of cellulase and xylanase enzymes on concentrations of blood glucose, blood and milk urea, ruminal ammonia and total amino acids, and ruminal pH.

	Enzyme level					
Item	0 (Control)	0.7	1.2	1.7	SEM[1]	$P > F$[2]
Blood glucose, mg/dL	68.2	67.3	66.1	64.4	0.8	0.647
Blood urea, mg N/dL	16.9	15.9	18.0	16.3	0.3	0.155
Milk urea, mg N/dL	14.3	13.8	14.0	14.2	0.4	0.855
Ruminal ammonia, mM	8.77	9.79	9.38	9.80	0.39	0.760
Ruminal total amino acids, mM	2.03	1.48	1.83	1.56	0.19	0.320
Ruminal pH	6.14	6.09	6.32	6.31	0.03	0.570

[1]SEM = Standard error of the mean.
[2]Probability of a significant effect of enzyme treatment.