Effect of Replacing Alfalfa Silage with Red Clover Silage in the Diets of Lactating Dairy Cows

G.A. Broderick and E. Sterrenburg

Introduction

Alfalfa silage (AS) is the forage most commonly fed to dairy cows in the Midwest U.S. However, during ensiling as much as 60% of its CP can be converted to NPN. This formation of NPN in the silo substantially reduces efficiency of utilization of the CP in alfalfa silage (Nagel and Broderick, 1992). Red clover silage has been found to contain significantly less NPN (Albrecht and Muck, 1991). An enzyme system in red clover, polyphenol oxidase, converts several phenols that are also present in red clover into quinones (Jones et al., 1995); these quinones react rapidly with proteases, the enzymes that break down proteins in the silo. Thus, red clover silage (RCS) contains substantially less NPN than AS. The objective of this trial was to compare the protein value of AS and RCS when fed as the sole source of dietary forage to lactating dairy cows. Yields of milk and milk components were used as the indicator of the dietary protein status. Also, the forage serving as the better protein source should give rise to a smaller response in yield of milk and milk components with supplementation of bypass protein (from fish meal).

Materials and Methods

A replicated 4 x 4 Latin square lactation trial was conducted to compare the production of lactating cows fed either AS or RCS. Red clover silage was wilted to about 40% DM from two cuttings taken on 6/16/94 (first cutting) and 7/29/94 (second cutting) and ensiled in a concrete stave silo. Alfalfa silage was harvested from two cuttings taken on 8/30/94 (fourth cutting) and on 9/1/94 (third cutting) and ensiled in another concrete stave silo. Samples of both forages were collected as fed during the trial and analyzed for composition (Table 1). Four diets were fed (Table 1): two that contained 60% DM from either AS or RCS plus 36% DM from ground (3/8″ screen) high moisture corn (HMC), and two that contained the same basic ingredients except 3% ruminant grade fish meal (Sea-Lac) was substituted for some of the HMC. The only other difference in these diets was the source of forage; no attempt was made to equalize CP of the diets fed in this trial. Twenty-four cows (16 multiparous and 8 primiparous cows) averaging 59 DIM were blocked into six groups of four cows each by parity and DIM and randomly assigned to diets in balanced 4 x 4 Latin squares. Diets were fed for 3-wk periods (total 12 wk) before switching; production and intake data were analyzed from the second and third wk of each period. Four additional cows that were later in lactation and equipped with permanent ruminal cannulae were also used in a single 4 x 4 Latin square for ruminal sampling on the last day of each period.

Results and Discussion

The CP content of the two AS fed in this trial averaged 7.1 percentage units more CP than the two RCS; as a result, the RCS diets contained 4.2 percentage units less CP (Table 1). The two forages contained similar levels of NDF and ADF. In two previous trials, RCS was only 1.5 percentage units lower in CP than AS judged to be of "equal" maturity (i.e., about equal NDF content). As expected, RCS had substantially less NPN—only about 60% of that of AS (Table 1). Intake of DM was 1.5 kg/d lower on the two RCS diets and was not influenced by fish meal feeding (Table 2). Without fish meal supplementation, milk production was 1.5 kg/d greater on AS than on RCS, but there were no differences between these two diets in production of fat, protein, lactose and SNF (Table 2). Fish meal feeding resulted in similar increases in yield of milk, protein, lactose and SNF on both the AS and RCS diets; protein yield was increased on both diets by 70 g/day (Table

2). Previously, fish meal supplementation of AS was observed to increase protein yield by 100 g/d (Broderick, 1995). Interestingly, efficiency (milk : DMI) was greater on RCS than on AS; adding fish meal to the diet removed this difference in efficiency between RCS and AS. This suggests that, although diets were formulated to be equal in NEL, the availability of energy in RCS was greater than that in AS. Reduced blood and milk urea and ruminal ammonia on RCS were confounded by the much lower CP on the RCS diets (Table 2). A surprising finding was the elevated blood glucose on RCS which may be related to the significantly lower levels of milk fat on that forage (Table 2).

Summary and Conclusion

Results from this trial indicated that both DMI and milk yield were lower on RCS than on AS, but there were no differences in yield of milk components on these two forages. The magnitude of the response in milk and component yields to supplemental bypass protein (from fish meal) were similar for both AS and RCS, suggesting that protein status of the cows was similarly limiting on both forages. Greater production efficiency and slightly elevated blood glucose suggest availability of energy in RCS may be greater than that in AS. Dietary protein levels should be more nearly equal in future experiments designed to compare the nutritional value of these two forages.

References

Albrecht, K. A. and R. E. Muck. 1991. Proteolysis in ensiled forage legumes that vary in tannin concentration. Crop Sci. 31: 464-469.

Broderick, G. A. 1995. Performance of lactating dairy cows fed either alfalfa silage or alfalfa hay as the sole forage. J. Dairy Sci. 78:320-329.

Jones, B. A., R. E. Muck and R. D. Hatfield. 1995. Red clover extracts inhibit legume proteolysis. J. Sci. Food Agric. 67:329-333.

Nagel, S. A. and G. A. Broderick. 1992. Effect of formic acid or formaldehyde treatment of alfalfa silage on nutrient utilization by dairy cows. J. Dairy Sci. 75:140-154.

C = high moisture corn.

Table 1. Composition of forages and diets[1].

Item	Forage	
	AS	RCS
DM, %	36.1	42.0
CP, % of DM	23.1	16.0
NPN, % of total N	49.2	30.6
NDF, % of DM	43.3	44.7
ADF, % of DM	33.2	31.0

Item	Diets			
	AS	RCS	AS + FM	RCS + FM
	% of DM			
Alfalfa silage	60.3	. . .	60.3	. . .
Red clover silage	. . .	59.9	. . .	59.9
Ground HMC	36.2	36.6	33.2	33.6
Soybean meal	2.4	2.5	2.4	2.5
Fish meal	. . .	. . .	3.0	3.0
Minerals & vitamins	1.1	1.1	1.1	1.1
Chemical composition				
CP	18.4	14.1	20.2	16.0
NDF	32	32	32	32
NE_L , Mcal/kg DM	1.59	1.57	1.58	1.57

[1]AS = alfalfa silage, RCS = red clover silage, FM = fish meal, HMC = high moisture corn.

Table 2. Effect of feeding forage as alfalfa silage (AS) or red clover silage (RCS), with or without supplemental fish meal (FM) on DMI, BW gain, production of milk and milk components, and concentrations of blood glucose, blood and milk urea, and ruminal pH and ammonia.

Item	AS	RCS	AS + FM	RCS + FM	SEM[1]	P > F[2]
DMI, kg/d	24.2[a]	21.6[b]	24.1[ab]	22.4[b]	0.6	< 0.001
BW change, kg/d	0.16	0.48	0.34	0.48	0.12	0.206
Milk yield, kg/d	33.4[b]	31.9[c]	34.9[a]	33.7[b]	0.3	< 0.001
Fat, %	3.78[a]	3.44[b]	3.51[ab]	3.36[b]	0.11	0.047
Fat, kg/d	1.20	1.12	1.20	1.14	0.03	0.185
Protein, %	2.96[bc]	2.92[c]	3.02[a]	2.98[ab]	0.01	< 0.001
Protein, kg/d	0.95[b]	0.92[b]	1.02[a]	0.99[a]	0.01	< 0.001
Lactose, %	4.81[a]	4.84[a]	4.77[b]	4.81[a]	0.01	0.001
Lactose, kg/d	1.55[b]	1.53[b]	1.63[a]	1.62[a]	0.02	0.015
SNF, %	8.31	8.47	8.50	8.51	0.08	0.320
SNF, kg/d	2.74[bc]	2.68[c]	2.89[a]	2.84[ab]	0.04	0.002
Efficiency[3]	1.38[b]	1.47[a]	1.45[a]	1.51[a]	0.02	< 0.001
Blood glucose, mg/dL	52.9[bc]	54.1[ab]	52.2[c]	54.2[a]	0.4	0.003
Blood urea, mg N/dL	17.8[b]	7.9[c]	20.9[a]	10.7[c]	0.3	< 0.001
Milk urea, mg N/dL	17.7[b]	7.2[d]	21.3[a]	10.7[c]	0.3	< 0.001
Ruminal pH	6.02	6.06	6.15	6.06	0.04	0.289
Ruminal ammonia, mM	16.1[a]	4.2[b]	17.4[a]	4.9[b]	0.6	< 0.001

[a,b,c]Means within the same row without a common superscript differ ($P < .05$).
[1]SE = Standard error of the mean.
[2]Probability of a significant effect of diet.
[3]Milk yield : DMI.