Effect of Storage System and Dry Matter Content on Composition of Alfalfa Silage

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Introduction

It is recommended that alfalfa should be ensiled at 30 to 35, 35 to 45, or 45 to 60% DM, when using, respectively, bunker, tower, or O_2-limiting storage systems. Despite minor effects of silage DM on total CP and fiber content, DM at ensiling can cause profound changes in the N profile and fermentation products of alfalfa silage. Nutritional evaluation of forages by conventional wet chemistry procedures is expensive and time-consuming. Near infrared reflectance spectroscopy (**NIRS**) offers a rapid, low-cost method of analysis. The objectives of this study were to evaluate the effects of DM content on the composition of alfalfa ensiled using different storage systems on commercial dairy farms and to compare forage evaluation by NIRS with wet chemical analyses.

Materials and Methods

Sixty alfalfa silage samples were collected—21 from bunker, 19 from tower, and 20 from O_2-limiting silos, on 43 commercial dairy farms. Farms were located in Wisconsin and Minnesota. Sub-samples from each silo were sent to two commercial laboratories for NIRS analyses of DM, CP, ADIN, ADF, NDF, Ca, P, K and Mg. Sub-samples also were analyzed in our laboratory for DM, CP, ADF, NDF, ADIN, neutral detergent insoluble N (**NDIN**), NH_3, total AA, NPN, organic acids and ash by wet chemistry, and for pH.

Results and Discussion

Regression of DM determined by NIRS by the commercial laboratories on oven DM yielded slopes of .93 and .94 and coefficients of determination (r^2) of .98 and .99, indicating that DM analyses by NIRS and at 105°C were in good agreement. However, silage contents of CP, ADF and NDF determined by NIRS and wet chemistry differed greatly; slopes from regressions of NIRS results on chemical analysis data ranged from .57 to .90 and coefficients of determination ranged from .59 to .84. The NPN content of the silages from the tower and O_2-limiting silos was lower than that of bunker silages (Table 1). The NH_3 concentration in bunker silages was higher than that in silage from the other two systems (Table 1). In all three silo types, the drier the silage the lower the NH_3 formation during storage. Regressions of ADF and NDF on DM suggested that silages with DM lower than 45% had higher concentrations of both fiber fractions. At DM higher than 50%, ADF and NDF concentrations were not correlated with DM content. Silage from bunker silos had higher ADIN concentrations than those from the other two storage systems (Table 1). Low coefficients of determination and slopes that were not different from zero indicated that DM content was not related to ADIN in silages from any of the three systems ($P > .84$). There was a positive relationship between NDIN and DM content when silage DM was greater than 55%. Wetter silages had greater concentrations of total organic acids. Lactic acid tended to decrease with increasing DM for the tower and O_2-limiting silages. Butyric acid was not detectable in silage from any of the tower or O_2-limiting silos; however, butyric acid was present in half of the samples from bunker silos. Higher butyric and lower lactic acid concentration in the bunker silages may reflect a shift in microbial population, from lactate to butyrate producing. As expected, silages with higher DM tended to have higher pH. The wetter bunker silages also tended to have higher pH, probably reflecting the greater NH_3 content. Bunker silages had lower relative feed value (RFV) than O_2-limiting and tower silos (Table 1). The RFV of bunker silages increased with DM; however, low coefficients of determination and slopes not different from zero for both O_2-limiting and tower silages ($P > .33$) indicated that RFV was not related to their DM content. The poorer quality found for the bunker silages may be due to poorer management used in their preservation.

Conclusions

Despite a wide range of DM contents of the silages ensiled in three storage systems, bunker silages were wetter, and O_2-limiting silages were drier, than tower silages. Wetter silages stored in bunker silos had greater amounts of NPN and ADIN than bunker silages with higher DM. Bunker silages had greater amounts of NPN and ADIN and lower RFV than silages stored in tower and O_2-limiting silos. Chemical analysis of samples from commercial dairy farms indicated that silages from tower and O_2-limiting silos were of higher nutritional quality than silages from bunker silos. Important differences were found in results from analysis of silages by conventional wet chemistry and by NIRS. Thus, caution should be used when interpreting composition data obtained from NIRS analysis of alfalfa silage samples.

Table 1. Effects of storage system on chemical composition of alfalfa silage.[1,2]

Item	Bunker	O_2-limiting	Tower	RMSE	*P* > F[3]
DM, %	36.8[b]	54.0[a]	49.6[a]	8.9	.001
Crude protein, % of DM	19.4	20.7	19.7	2.9	.268
NPN, % of total N	62.3[a]	55.4[b]	55.0[b]	10.0	.014
NH_3, % of total N	13.11[a]	6.79[b]	7.14[b]	5.54	.008
Total AA N, % of total N	32.3	32.2	33.3	9.2	.269
ADF, % of DM	40.5[a]	34.9[b]	35.9[b]	4.1	.001
NDF, % of DM	45.8[a]	41.5[b]	41.8[b]	5.9	.020
ADIN, % of total N	9.74[a]	6.67[b]	6.78[b]	2.04	.001
NDIN, % of total N	14.1	15.0	12.2	5.9	.626
NDIN - ADIN, % of total N	4.37	8.34	5.46	4.67	.122
Total organic acids, % of DM	8.91[a]	4.75[b]	6.66[b]	3.07	.003
Succinate, % of DM	.36[a]	.19[b]	.27[ab]	.24	.050
Lactate, % of DM	3.67[ab]	2.86[b]	4.42[a]	1.94	.028
Formate, % of DM	.018	.049	.038	.050	.030
Acetate, % of DM	2.87[a]	1.16[b]	1.46[a]	1.21	.001
Propionate, % of DM	.265[a]	ND[4]	.012[ab]	.27	.010
Butanediol, % of DM	.41	.31	.28	.20	.048
Ethanol, % of DM	.28	.18	.15	.26	.629
Butyrate, % of DM	1.04[a]	ND[b]	.02[b]	1.02	.021
pH	4.84	4.87	4.69	.34	.077
RFV, %	121.5[b]	140.8[a]	137.9[a]	24.6	.019

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

[1]NDIN = Neutral detergent insoluble N, RMSE = residual mean square error, RFV = relative feed value, ND = Not detectable.

[2]Wet chemistry results from 21 bunker silos, 20 O_2-limiting silos and 19 tower silos.

[3]Probability of an effect of storage structure.