Commercial Culture and Inoculant Additives for Alfalfa and Whole-Plant Corn Silages[1]

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Summary

Experimental 5 gallon plastic silos were used in three trials to evaluate these alfalfa and corn silages: 1) control (no additive); 2) CULBAC® culture; 3) McNess® inoculant; 4) SILA-GREEN® inoculant; and 5) Biomax S I® inoculant. Two silos per treatment were opened on days 1, 2, 4, 7, 14, and 56 post-ensiling in trial 1 (alfalfa) and trial 2 (corn) and the changes that occurred during the ensiling process were compared by using nonlinear models. Only 56-day silages were evaluated in trial 3 (alfalfa). All silages were of acceptable quality. The four culture/inoculant additives had no consistent effects on 56-day end-product silages in the three trials or the ensiling dynamics in trials 1 and 2. Aerobic stability of corn silage was enhanced by the culture/inoculant treatments, while all 10 alfalfa silages were highly stable in air, regardless of treatment.

Introduction

In our previous trials, enzyme, inoculant, and non-protein nitrogen additives have generally improved corn, sorghum, or alfalfa silages in farm-scale silos (Report of Progress 413, Kansas Agricultural Expt. Station). So many commercial silage additives are available that it is almost impossible to determine their effectiveness, using the limited number of farm-scale silos at most universities. By using laboratory-scale, experimental silos, more treatments can be studied, each treatment can be replicated several times, smaller amounts of crop are needed, the entire contents of a silo can be sampled, and silos can be opened at various time intervals.

In the following trials, an experimental silo we developed was used to evaluate four culture/inoculant additives for alfalfa and whole-plant corn silages. Silos were opened at various times to follow the changes during the ensiling process.

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Experimental Procedures

The experimental silo was a plastic container (5 gallon capacity) made air-tight by a lid fitted with a rubber 0-ring seal and Bunson valve. The silos were packed with a hydraulic press, which permitted all silages to be made at similar densities.

The alfalfa and corn silage treatments compared were: 1) control (no additive); 2) CULBAC culture from TransAgra Corp.; 3) McNess inoculant from Furst-McNess Co.; 4) SILA-GREEN from Casey Products, Inc.; and 5) Biomax S I from Chr. Hansen's Laboratory, Inc. Additive rates were those recommended by the manufacturers. CULBAC, McNess, and SILA-GREEN were applied as dry products; Biomax was applied in a solution of de-ionized water.

Trial 1. Alfalfa silages were made on July 16, 1981, from 3rd cutting, pre-bloom alfalfa from a single field. The alfalfa was swathed with a mower-conditioner at 9 AM and approximately 1.5 tons were harvested at 1 PM on the same day at about 35% dry matter (DM). For each treatment, 500 lb of alfalfa was put into a Harsh Mobile Mixer and, after the additive had been applied, mixed for 10 minutes. Twelve plastic-container silos then were filled with 26 lbs of alfalfa each (32.5 lb per cubic ft). The order of applying the additives was selected at random; between treatments the mobile mixer was thoroughly cleaned with a chlorine solution and rinsed. In less than 2 hr, all 60 silos had been filled, sealed, weighed, and stored in a room at 32 C. Samples of pre-treated alfalfa were taken from each treatment and chilled immediately in liquid nitrogen to reduce the effect of plant respiration upon initial chemical composition.

Two silos per treatment were opened on days 1, 2, 4, 7, 14, and 56 post-ensiling.

Aerobic stability (bunk life) of each 56-day silage was measured in triplicate by procedures described on page 32 of this Progress Report.

Trial 2. Whole-plant corn silages were made on August 26, 1981, from late-dent, 35 to 36% DM corn from a single field. Procedures were similar to those in trial 1. Each silo was filled with 28.5 lb of corn plant material (35.6 lb per cubic ft).

Trial 3. Alfalfa silages were made on June 24, 1982, from 2nd cutting, pre-bloom alfalfa. Procedures were similar to those in trial 1. There were six silos per treatment and all silos were opened at 56 days post-ensiling.

Statistical Analyses. The 56 day, end-product silages were analyzed by one-way analysis of variance. In trials 1 and 2 a nonlinear estimation procedure and model comparison technique were used to describe how silage characteristics changed during the ensiling process.

Results

Dry matter recoveries, chemical analyses, and aerobic stabilities of the alfalfa and corn silages at 56 days are shown in Tables 14.1, 14.2, and 14.3.

In trial 1, all five silages were well preserved and free of mold or spoilage. pH was lowest for CULBAC and McNess silages; butyric acid, highest for SILA-GREEN and Biomax silages; and hot water insoluble nitrogen (HWIN), lowest for control silage. Lactic acid and ammonia nitrogen values were similar in all silages. Acetic acid values were exceptionally high in all five silages. Dry matter loss was highest for control silage (9.83%), and three additives (CULBAC, SILA-GREEN, and Biomax) significantly decreased DM loss. These lower losses for Sila-Green and Biomax silages are not consistent with their high butyric acid levels. The higher HWIN values in the four treated silages suggest that they contained more nitrogen as “true protein” than the control silage. All five silages were highly stable and showed no signs of spoilage during 14 days of air exposure.

In trial 2, all five corn silages were well preserved and had undergone normal lactic acid fermentations. Control and McNess silages had the lowest pH; Biomax silage, the highest lactic acid; control silage, the lowest acetic, propionic, and total acids; and control silage, the lowest ammonia-nitrogen. Dry matter loss was highest for control silage (11.42%), but only Biomax reduced DM loss significantly. Although significant differences occurred between the control and the four treated silages for silage quality measurements, these differences were small and reflect the high quality of all five silages. All four additive-treated corn silages were highly stable in air, but the control silage became unstable on the 2nd and 3rd day.

In trial 3, all five alfalfa silages were well preserved and, as indicated by chemical analyses, had undergone more efficient and desirable fermentations than alfalfa silages in trial 1. Silages in trial 3 had lower DM losses, higher lactic acid values, lower amounts of acetic, propionic, and butyric acids, and lower pH’s than silages in Trial 1. None of the four culture/inoculant additives significantly reduced the DM loss or improved the chemical composition when compared with control silage in trial 3. As in trial 1, all five alfalfa silages were highly stable in air.

Figure 14.1 shows curves of DM loss, developed from the mathematical models. When compared with the control silage, CULBAC silage lost less DM from days 7 to 30; SILA-GREEN silage, from days 2 to 36; and Biomax silage, from days 8 to 20. Although one-way analysis of variance (Table 14.1) indicated that these three additives lowered the DM loss in the 56 day silages, the models, which also considered the data at earlier periods, show DM losses were similar for all five silages. The DM loss curves for control and McNess silages were never different during the ensiling period. None of the other 12 models tested gave significant differences between curves for control and any of the four treated silages in trials 1 and 2.

Four conclusions can be made from these three trials:

1. The four culture/inoculant additives had no consistent effect on 56 day, end-product silages or the dynamics of the ensiling process.

2. In the 56 day silages there were several statistically significant differences. However, the magnitude of these differences was relatively small and, in most instances, not readily explainable.

3. Nonlinear modeling may be useful in describing the dynamics of silage fermentation. In trials 1 and 2, only alfalfa DM loss showed significant differences in the estimated models, when control silage was compared with each of the treated silages.

4. Aerobic stability of corn silage was enhanced by the culture/inoculant treatments, while all 10 alfalfa silages were highly stable in air, regardless of treatment.

Table 14.1. Dry Matter Losses and Chemical Analyses of the Alfalfa Silages in Trial 1 at 56 Days Post-ensiling[1]

Item	Silage treatment				
	Control	CULBAC	McNess	SILA-GREEN	Biomax
Dry matter:					
pre-ensiled, %	34.8	34.8	35.8	34.9	36.5
silage, %	31.9	32.5	33.1	32.6	33.8
	% of the dry matter ensiled				
Dry matter loss	9.83[c]	8.28[a]	9.23[bc]	8.56[ab]	8.73[ab]
	% of the silage dry matter				
Crude protein	20.35	20.00	20.30	20.12	19.95
Lactic acid	2.40	2.78	2.42	2.21	2.57
Acetic acid	6.94[abc]	7.59[c]	7.27[bc]	6.67[bc]	6.10[a]
Propionic acid	.22[b]	.19[a]	.19[a]	.26[c]	.22[b]
Butyric acid	.08[a]	.08[a]	.13[a]	.53[b]	.50[b]
Total ferm. acids	9.68[ab]	10.67[b]	10.04[ab]	9.70[ab]	9.41[a]
	% of the total nitrogen				
Ammonia-nitrogen	20.0	18.6	22.6	20.3	18.2
Hot water insol. nitrogen	31.5[a]	36.2[b]	35.3[b]	36.1[b]	38.0[b]
pH	5.36[c]	5.17[a]	5.19[a]	5.34[b]	5.38[d]

[1] Each value is the mean of two silos.

[abcd]Values on the same line with different superscripts differ (P<.05).

Table 14.2. Dry Matter Losses, Chemical Analyses, and Aerobic Stability of the Corn Silages in Trial 2 at 56 Days Post-ensiling

Item	Silage treatment				
	Control	CULBAC	McNess	SILA-GREEN	Biomax
Dry matter:					
pre-ensiled, %	37.15	36.10	37.30	35.95	35.85
silage, %	33.16	32.62	33.57	32.60	32.78
	% of the dry matter ensiled				
Dry matter loss	11.42[b]	10.86[b]	11.10[b]	10.76[a b]	9.74[a]
	% of the silage dry matter				
Lactic acid	6.28[a b]	6.30[a b]	5.20[a]	5.55[a]	7.33[b]
Acetic acid	3.13[a]	3.88[a b]	5.83[b]	5.77[b]	3.82[a b]
Propionic acid	.03[a]	.51[c]	.40[b c]	.48[c]	.33[b]
Butyric acid	.07	none	none	.04	none
Total ferm. acids	9.50[a]	10.68[a b]	11.41[a b]	11.83[b]	11.48[b]
	% of the total nitrogen				
Ammonia-nitrogen	6.9[a]	10.5[c]	9.4[b c]	9.5[b c]	8.7[b]
Hot water insol. nitrogen	45.3	40.9	43.6	44.4	42.7
pH	3.81[a b]	4.08[c]	3.89[a b]	4.03[c]	3.97[b c]
Day of initial temperature rise above ambient [2]	3.0	*	*	*	*
Max. temperature, C	50	*	*	*	*
Dry matter loss after 7 days[3]	22.65	<1.0	<1.0	1.12	2.49

[1]Each value is the mean of two silos.

[2]1.7 C rise of higher.

[3]% of the dry matter exposed to air.

*No rise in temperature occurred.

[a b c]Values on the same line with different superscripts differ (P<.05).

Table 14.3. Dry Matter Losses, Chemical Analyses, and Aerobic Stability of the Alfalfa Silages in Trial 3 at 56 days Post-ensiling

Item	Silage treatment				
	Control	CULBAC	McNess	SILA-GREEN	Biomax
Dry matter:					
pre-ensiled, %	36.3	36.3	36.0	35.8	35.9
silage, %	34.1	34.1	33.8	33.8	33.8
	% of the dry matter ensiled				
Dry matter loss	7.96	7.80	7.74	7.53	7.88
	% of the silage dry matter				
Lactic acid	4.68[a b]	5.03[b]	5.34[b]	4.56[a b]	3.94[a]
Acetic acid	5.18[a b]	5.00[a b]	4.74[a]	5.22[a b]	5.57[b]
Propionic acid	.10[a]	.10[a]	.11[a]	.12[a]	.17[b]
Butyric acid	.04	.01	.01	.02	.05
Total fermentation acids	10.03	10.23	10.20	9.76	9.73
	% of the total nitrogen				
Ammonia-nitrogen	16.0	15.1	15.1	15.5	14.5
Hot water insol. nitrogen	33.4[a]	32.3[a b]	32.9[a b]	33.0[a b]	31.0[b]
pH	5.08[a]	5.05[a]	5.13[b]	5.13[b]	5.16[b]
Day of initial temperature rise above ambient[2]	13.0	*	13.5	12.7	*
Max. temperature, C	30	*	34	51	*
Dry matter loss after 14 days[3]	5.0	<1.0	5.0	5.0	<1.2

[1] Each value is the mean of two silos.

[2] 1.7 C rise of higher.

[3] % of the dry matter exposed to air.

* No rise in temperature occurred.

[a b] Values on the same line with different superscripts differ (P<.05).

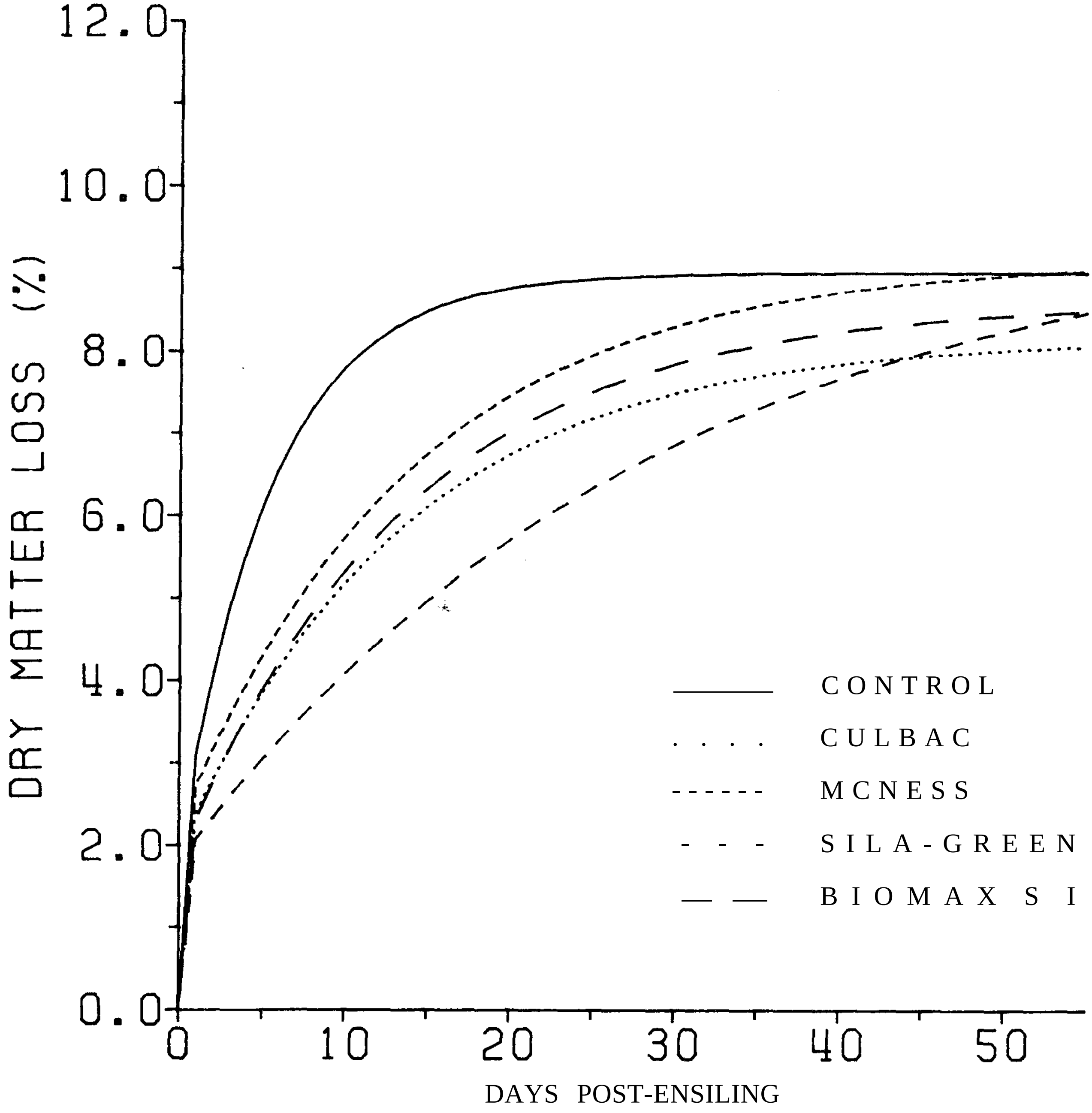

Figure 14.1. Model response curves for alfalfa silage dry matter loss dynamics (0-56 days) in trial 1