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Effect of bacterial inoculants on the fermentation and preservation efficiencies and nutritive value of alfalfa silage for growing steers

Abstract

Two silage bacterial inoculants from Pioneer Hi-Bred International, Inc. were evaluated using second-cutting alfalfa. The Pioneer brand 1174® inoculant and a Pioneer experimental inoculant each increased the rate and efficiency of the ensiling process in both farm-scale and laboratory-scale silos. The two inoculants increased the DM recovery in the farm-scale silos compared to the untreated silage. Steers fed the experimental inoculant-treated silage gained faster ($P < .10$) (2.56 vs. 2.37 lb per day), had a 4.0% higher DM intake, and were 4.3% more efficient than steers fed the untreated silage. The 1174-treated silage supported a numerically but not statistically better steer performance than the control silage. When the DM recovery results were combined with the feed per gain results, the silages with 1174 and experimental inoculant produced 5.3 and 10.5 lb more steer gain per ton of crop ensiled, respectively, than the control silage.

Keywords

Cattlemen's Day, 1997; Kansas Agricultural Experiment Station contribution; no. 97-309-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 783; Beef; Alfalfa; Silage; Inoculant; Preservation; Nutritive value

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**EFFECT OF BACTERIAL INOCULANTS ON THE
FERMENTATION AND PRESERVATION
EFFICIENCIES AND NUTRITIVE VALUE OF
ALFALFA SILAGE FOR GROWING STEERS¹**

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Summary

Two silage bacterial inoculants from Pioneer Hi-Bred International, Inc. were evaluated using second-cutting alfalfa. The Pioneer brand 1174® inoculant and a Pioneer experimental inoculant each increased the rate and efficiency of the ensiling process in both farm-scale and laboratory-scale silos. The two inoculants increased the DM recovery in the farm-scale silos compared to the untreated silage. Steers fed the experimental inoculant-treated silage gained faster ($P < .10$) (2.56 vs. 2.37 lb per day), had a 4.0% higher DM intake, and were 4.3% more efficient than steers fed the untreated silage. The 1174-treated silage supported a numerically but not statistically better steer performance than the control silage. When the DM recovery results were combined with the feed per gain results, the silages with 1174 and experimental inoculant produced 5.3 and 10.5 lb more steer gain per ton of crop ensiled, respectively, than the control silage.

(Key Words: Alfalfa, Silage, Inoculant, Preservation, Nutritive Value.)

Introduction

Adding selected strains of lactic acid bacteria (LAB) has become common practice in silage-making. Bacterial inoculants have improved silage fermentation quality, reduced DM losses in the silo, and increased rate and efficiency of gain in over 30 growing/backgrounding trials with corn and sorghum silages at Kansas State University (KAES Re-

port of Progress 651, page 101). The LAB are intended to dominate the fermentation phase of the ensiling process. Alfalfa and other legumes can be difficult to ensile because of their low sugar content and high buffering capacity. However, we have shown in numerous trials over the past 15 years that inoculants help ensure that as much of the fermentable carbohydrates as possible are converted to lactic acid, which removes some of the risk of having a poorly preserved, low-quality silage.

The objective of this study was to determine the effect of two LAB inoculants on the fermentation, preservation, and nutritive value of alfalfa silage.

Experimental Procedures

On June 22 and 28 of 1995, second-cutting alfalfa was swathed with a mower-conditioner; field-wilted for 24 hours; and ensiled in six, 10 × 50 ft, concrete stave silos by the alternate windrow and load method. The three treatments were: 1) no additive (control), 2) Pioneer brand 1174® inoculant, and 3) a Pioneer experimental inoculant. The inoculants were applied in water solutions at the silage blowers and supplied approximately 150,000 colony-forming units (cfu) of LAB per gram of ensiled alfalfa. The control received only water and the carrier ingredients contained in the inoculants without the LAB. Nine thermocouple wires were spaced evenly in the forage mass in each silo to measure ensiling temperatures during the first 8 weeks of storage. On each of the 2 silo-filling days, chopped alfalfa was removed from a

¹Financial assistance, technical support, and bacterial inoculants were provided by Pioneer Hi-Bred International, Inc., Johnston, IA.

²Sul Ross University, Alpine, TX.

randomly selected load, and control and inoculated forages were ensiled in 18 PVC laboratory-scale silos per treatment. Triplicate PVC silos were opened at 1, 2, 4, 7, 21, and 90 days postfilling.

One farm-scale silo for each treatment was opened on September 13 and December 3 and emptied at uniform rates during a 12- to 16-week period. Samples were taken twice weekly for DM recovery calculations and chemical analyses. Each silage was fed to 20 steer calves in a 75-day growing trial (November 8, 1995 to January 22, 1996). The calves were housed in individual pens, and ration DM intake was measured daily. The complete mixed rations were fed to appetite and contained 76% silage and 24% concentrate (cracked corn-based) on a DM basis. The concentrate was formulated to provide each steer with 200 mg of Rumensin; 50 mg of Tylan; 20,000 IU of vitamin A; 3,000 IU of vitamin D; and 150 IU of vitamin E daily.

For 5 days before the start of the growing trial, all steers were limit-fed a forage sorghum silage-based ration to provide a DM intake of 2.0% of body weight. Steers that were weighed individually on 2 consecutive days. For 2 days before the final weighing, the steers were fed their respective silage rations at a restricted DM intake of 2.0% of body weight. Then individual weights were taken on 2 consecutive days.

The alfalfa silages in the six farm-scale silos in this study also were fed to 60 early-lactation Holstein cows over a 7-month period (KAES Report of Progress 771, page 26).

Results and Discussion

A summary of the preservation and composition results for the three alfalfa silages is shown in Table 1. The average DM, CP, NDF, and ADF contents for the three silages were nearly identical, and these values reflect the uniformity of the wilted, preensiled alfalfa during the two silo-filling days. Further evidence of the uniformity of the preensiled alfalfa were results for the numbers of epiphytic (natural occurring) LAB per gram of forage -- alfalfa ensiled on June 23 had 1.0×10^5 cfu per gram and alfalfa ensiled on June 29 had 1.6×10^5 cfu per gram. Yeast and mold counts for the alfalfa

on the two filling days were approximately 1.0×10^5 cfu per gram of preensiled alfalfa.

Ensiling temperature results showed that silages treated with both 1174 and experimental inoculant averaged 1 to 3°F cooler than the untreated silage throughout the first 8 weeks of storage (data not shown). These cooler temperatures for the inoculated silages are consistent with several other inoculant studies using whole-plant corn and sorghum silages in the KSU farm-scale silos.

The fermentation profiles showed that the inoculated silages underwent a more efficient ensiling process in both the farm- and laboratory-scale silos than the untreated silages. The silages treated with 1174 and experimental inoculant were characterized by having higher lactic acid contents and lactic to acetic acid ratios; lower pH values; and lower contents of acetic acid, ethanol, and ammonia-nitrogen contents than the untreated silages. Both inoculants also increased the rate of the ensiling process, as evidenced by lower pH values and higher lactic acid contents at days 2, 4, 7, and 21 postfilling for inoculated silages compared to the untreated silages (data not shown). Both inoculants increased the DM recovery in the farm-scale silos compared to the control silage -- 1174 by 1.95 percentage units and the experimental inoculant by 3.6 percentage units.

Performance by the steers fed the three alfalfa silage rations is presented in Table 2. Steers fed the experimental inoculant-treated silage gained significantly faster (2.56 vs. 2.37 lb per day), had a 4.0% higher DM intake, and were 4.3% more efficient than steers fed the untreated silage. The 1174-treated silage supported a numerically but not statistically better steer performance than the control silage. When the DM recovery results in Table 2 are combined with the feed per gain results (Table 2), the 1174 and experimental inoculant silages produced 5.3 and 10.5 lb more steer gain per ton of crop ensiled, respectively, than the control silage.

Table 1. Fermentation and Preservation Efficiencies and Chemical Composition of the Three Alfalfa Silages in the Farm-Scale and Laboratory-Scale Silos

Item	Control		1174		Experimental	
	Farm ¹	Lab ²	Farm ¹	Lab ²	Farm ¹	Lab ²
Dry matter, %	41.8	40.8	42.8	41.0	42.1	41.6
DM recovery ³	81.20	---	83.15	---	84.80	---
pH	4.65	4.55	4.48	4.41	4.50	4.41
	-----% of the silage DM -----					
Lactic acid	7.42	7.62	8.24	8.28	8.37	8.30
Acetic acid	2.08	3.85	1.76	3.26	1.78	3.44
Lactic:acetic	3.6	2.0	4.8	2.5	4.8	2.4
Ethanol	.392	.515	.276	.465	.291	.490
Ammonia-nitrogen	.232	.230	.193	.190	.195	.218
Crude protein	18.5	---	18.6	---	18.7	---
NDF ⁴	41.6	---	41.6	---	41.6	---
ADF ⁴	34.6	---	34.5	---	34.5	---

¹Each value is the mean of 20 samples taken from the silos during the growing trial.

²Each value is the mean of 6 silos opened at 90 days postfilling.

³Expressed as a percent of the crop DM ensiled. Data are only for the three silos filled on June 23, 1995.

⁴NDF = neutral detergent fiber and ADF = acid detergent fiber.

Table 2. Performance by Calves Fed the Three Alfalfa Silage Rations

Item	Control	1174	Experimental
No. of steers ¹	19	19	19
Initial wt, lb	588.6	594.7	597.4
Final wt, lb	766.3	779.1	789.6
Avg daily gain, lb	2.37 ^b	2.46 ^{ab}	2.56 ^a
Daily DM intake, lb	17.4	17.9	18.1
Feed/lb of gain, lb ²	7.47	7.34	7.15
Silage fed, lb/ton of crop ensiled ³	1624	1663	1696
Silage/lb of gain, lb ³	14.2	13.9	13.6
Cattle gain/ton of crop ensiled, lb ³	114.3	119.6	124.7

^{ab}Means on the same line with different superscripts differ (P<.10).

¹One steer was removed from each of the three treatments because of extremely low DM intake during the first 28 days of the trial.

²100% DM basis.

³Adjusted to 40% dry matter.