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Case Study: Adding a bacterial inoculant to corn silage removed from a bunker silo and stored in piles[1]

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ABSTRACT

Fully fermented whole-plant corn silage is often sold in small quantities to cattle producers. The purpose of this experiment was to determine if adding a bacterial-based silage inoculant to corn silage would reduce deterioration. A total of 18,000 kg of fully fermented corn silage was removed from a bunker silo and placed into a pile. The pile was subdivided into 8 sections with an inoculant top-dressed to alternating sections. Samples from the top 15 cm were collected at 0, 24, 48, 72, 120, 240, and 336 h after top-dressing the inoculant to the pile. Results indicated that there were no effects of inoculant on DM, NDF, ADF, CP, and ash content of the corn silage. There were no differences between treatments for lactic acid and pH over time. Acetic acid concentration was similar between treatments except the control treatment was higher at 120 h. Mold counts were higher in the control corn silage at 336 h compared with the silage that had inoculant applied. Yeast counts were higher at 24, 48, and 72 h for the control corn silage than for the inoculated corn silage. Deoxynivalenol and zearalenone were not affected by treatment. Top-dressing an inoculant did not overwhelmingly reduce spoilage when fully fermented corn silage was purchased in small quantities. Corn silage appears to maintain its nutrient concentration during the winter for up to 240 h.

Key words: corn silage, inoculant, storage life

INTRODUCTION

Because of lack of adequate quantities of corn silage or lack of adequate storage facilities, many cattle producers purchase fermented corn silage from other producers. This silage is relocated and often stored in unpacked piles either covered or uncovered. Deterioration of relocated silage is a problem and may be slowed by the addition of a bacterial inoculant at the air–silage interface. Common additives to corn silage include bacterial inoculants such as *Lactobacillus buchneri* (Driehuis et al., 1999), *L. buchneri* and *Lactobacillus plantarum* (Ranjit and Kung, 2000), and salt (McLaughlin et al., 2001). These additives are designed to enhance fermentation or maintain aerobic stability. Adding an inoculant containing *L. plantarum*, *Pediococcus pentosaceus*, and *Enterococcus faecium* to wet brewers grains reduced spoilage over 28 d (Marston et al., 2009), allowing for a longer feed-out period for wet brewers grains. The purpose of this experiment was to determine whether top-dressing an inoculant containing *L. plantarum*, *P. pentosaceus*, and *E. faecium* on fermented corn silage would reduce spoilage of corn silage stored in covered piles for 14 d.

MATERIALS AND METHODS

Whole-plant corn (Pioneer brand 38K06 and 38T27) was harvested at 1/3 to 1/2 milk line using a Gehl 1075 Kernel Processor (West Bend, WI) at a 1.27-cm theoretical length of cut. Pioneer Brand Corn Silage Inoculant 1132 (Pioneer, Johnston, IA) containing 90 billion cfu/g from *L. plantarum* and *E. faecium* was manually applied as a liquid providing 1.1 g of inoculant per 1,000 kg of fermented corn silage. The treated silage was stored in a bunker silo, which was covered with black plastic (6 mm) and secured with tire sidewalls to minimize exposure to air and sunlight.

The silage remained in the bunker silo for 5 mo before the commence-

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ment of the experiment. During the winter, approximately 18,000 kg of fermented corn silage was removed from the bunker silo and placed on a concrete pad.

The pile was approximately 32 m × 3 m × 3 m and was subdivided into 8 equal 4-m lengthwise sections. Alternating sections were then top-dressed with a lactic acid bacteria–containing inoculant providing a total of 25 billion cfu/g from *L. plantarum*, *P. pentosaceus*, and *E. faecium* (Silo-King WS, Agri-King Inc., Fulton, IL). Each section was top-dressed with 5.68 L of inoculant containing 1.10×10^{10} cfu/L (1.74×10^{9} cfu/section) and covered with black plastic (6 mm). Tire sidewalls, placed touching each other, were used to hold the plastic. The ambient temperature for the experiment was −1.03°C.

Corn silage was sampled before spraying the inoculant onto the subdivided pile (d 0) and again at 24, 48, 72, 120, 240, and 336 h postinoculation. Samples from the top 15 cm and approximately 1 m apart of silage were taken by hand from a random location from each section. Samples were taken from the top layer (15 cm) because the inoculant was only administered on the air–surface interface of the pile of silage. After sampling, the plastic was resealed with duct tape. Samples were frozen and stored at −20°C for later analysis.

The samples were analyzed for DM (105°C for 6 h), CP (AOAC, 1979), ADF (AOAC, 1990), NDF (Van Soest et al., 1991), lactic and acetic acid (Cancalon, 1993), yeasts and molds (AOAC, 1998), and pH (AOAC, 1999). Yeast and mold counts were logarithmically transformed after statistical analysis. The pH was determined using an Orion 420A (Cambridge, MA) and transformed to hydrogen ion concentration before statistical analysis (Murphy, 1982). Mean of hydrogen ion concentration was converted back to pH by logarithm transformation. Area under the curve for pH was determined using the trapezoidal rule. Zearalenone was analyzed using the Romer labs method (Version 95.5, Union, MO) with a Waters 470 Fluorescence Detector (Milford, MA). Deoxynivalenol was determined using Romer labs method (Version 95.2) deoxynivalenol HPLC method with a Beckman 166 detector (Schaumberg, IL). Silage samples were placed in a preheated 600°C furnace for 2 h for ash determination (AOAC, 1990). Calcium, P, Mg, and Na were measured using atomic absorption (AOAC, 1990). Potassium, S, and Cl were estimated using official methods (AOAC, 1990).

The data were analyzed using the MIXED procedure of SAS (SAS Institute Inc., 2000). Significance was designated at $P \leq 0.05$, and trends were designated as $0.05 < P \leq 0.10$. The statistical model used treatment, hour, and the treatment × hour interaction.

RESULTS

Dry matter, NDF, ADF, CP, and ash were not different between control and inoculated corn silage at each time measurement (Table 1). Mineral concentrations appear in Table 2. Calcium, P, K, and Mg contents of feeds were not different between control and inoculated feeds. Chloride concentration tended ($P < 0.10$) to be greater in the control than in the inoculated silage at 240 h (0.3 vs. 0.2%, respectively). Sulfur was similar across all hours and treatments (0.1%). Chloride concentrations tended to be less at 240 h for the

Table 1. Dry matter, fiber fractions, CP, and ash concentrations of control and inoculant-treated corn silage over various storage times

	Hours after formation of piles							
Item	0	24	48	72	120	240	336	SE
DM, %								
Control	34.8	36.3	37.0†	34.4	35.0	30.2	25.9	1.72
Inoculant	35.1	35.7	33.2	33.7	31.6	31.3	29.5	1.72
NDF, %								
Control	43.0	39.3	40.5	38.2	39.3	40.7	45.8	1.56
Inoculant	42.8	38.6	39.6	39.6	41.5	39.5	43.4	1.56
ADF, %								
Control	25.0	22.1	23.2	21.8	22.5	23.5	26.9†	1.00
Inoculant	25.0	21.9	22.2	23.0	23.6	23.1	24.4	1.00
CP, %								
Control	7.3	7.3	7.2	7.4	7.4	7.7	8.2	0.13
Inoculant	7.4	7.2	7.4	7.2	7.5	7.6	8.0	0.13
Ash, %								
Control	3.7	3.1	2.8	2.4	2.6*	3.5	3.7	0.2
Inoculant	3.8	2.9	2.6	2.7	3.1	3.5	3.7	0.2

*$P \leq 0.05$ and †$P \leq 0.10$ indicate differences and trends, respectively, between control and top-dressed corn silage piles at that specific time point.