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EFFECT OF 1174® SILAGE INOCULANT ON THE FERMENTATION OF CORN SILAGES[1]

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Summary

The effect of 1174® Silage Inoculant on the ensiling process was studied using three Pioneer corn hybrids. All hybrids fermented rapidly, and 1174 did not significantly influence any of the fermentation characteristics during the 120 days. The epiphytic lactic acid bacteria (LAB) counts on the chopped corn plants were high; 14 times greater than the numbers of LAB provided by the inoculant. Although during fermentation, statistically significant differences occurred among the hybrids for fermentation end-products, no observed trends suggested that hybrid effects were real.

(Key Words: Silage, Corn, Bacterial, Inoculant.)

Introduction

About 75 to 80 million tons of corn silage are produced annually in the U.S., including about 1.5 million tons in Kansas. Whole-plant corn is recognized as the "near perfect" silage crop.

The epiphytic microflora (microorganisms naturally present on forages) are responsible for silage fermentation. Of greatest importance are the homofermentative lactic acid bacteria (LAB) (those producing only lactic acid). Normally, epiphytic LAB counts on silage crops are low and include primarily heterofermentative species. Adding homolactic bacteria at ensiling is one way to increase the numbers of desirable microbes. Although adding commercial bacterial inoculants has become common practice, their effects have been quite variable, particularly with corn and sorghum.

Our objective was to determine the effect of a commercial bacterial inoculant on the fermentation of three whole-plant corn hybrids. The effect of the inoculant on the microbial succession in this study was presented last year (KAES Report of Progress 623).

Experimental Procedures

Three corn hybrids (3377, 3379, and 3389; Pioneer Hi-Bred International, Inc., Johnston, Iowa) were grown under irrigation in 1989 and harvested at the 2/3 milk line of kernel maturity. They were chopped and ensiled with no additive (control) or 1174 Silage Inoculant (*Lactobacillus plantarum* and *Enterococcus faecium*; Pioneer Hi-Bred International, Inc.) to provide 1.5×10^5 colony-forming units (cfu)/g of fresh crop. All silages were treated as described for the alfalfa silages on page 118 of this report.

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Results and Discussion

Presented in Table 1 are the chemical compositions and epiphytic microflora counts of the chopped, pre-ensiled hybrids. Although all were ensiled at identical kernel maturities, 3379 was harvested 5 days later and had a 5.5 percentage unit higher DM content than the other two, due mainly to hot weather between the two harvest dates. All five categories of epiphytic microorganisms were found on the pre-ensiled material; Enterobacteriaceae and yeasts and molds predominated. The lactobacilli, pediococci, and leuconostocs (LPL) group was only a small part of the total population on all three hybrids (about 10^6 cfu/g).

As expected, fermentation characteristics were affected ($P < .01$) by time during the ensiling period (Table 2). pH decreased sharply during the first 3 days, reaching an average of 3.77. Lactic and acetic acids, ethanol, and ammonia-nitrogen increased throughout the 120 days. Propionic and butyric acids were not detected at any time. No significant interactions occurred between additive treatment and fermentation time, and adding 1174 did not affect ($P > .05$) any of the fermentation characteristics during the 120 days.

Also presented in Table 2 is the effect of hybrid on the fermentation characteristics at different times during the ensiling period. pH values were highest ($P < .05$) in 3379 silages and lowest ($P < .05$) in 3377 silages during the first 24 h. Both 3377 and 3379 had similar pH values after day 3, which were higher ($P < .05$) than pH of the 3389 silages. Lactic acid contents were highest in 3377 silages during the first 3 days, were similar in 3377 and 3379 after day 3, and were lowest ($P < .05$) in 3389 silages from day 7 to 120. Although statistically significant differences occurred among the hybrids for fermentation end-products at various times during the ensiling period, no observed trends suggested that hybrid effects were biologically significant.

Table 1. Chemical Composition and Epiphytic Microflora Count of the Chopped, Pre-ensiled Corn Hybrids

	Hybrid		
Item	3377	3379	3389
Dry matter, %	32.4	38.0	32.6
Buffering capacity, meq/kg of DM	214	252	169
Water soluble carbohydrates, % of the DM	14.8	13.2	13.1
pH	5.8	5.8	5.8
	---Count-[1]--		
Lactobacilli, pediococci, and leuconostocs	6.43	5.95	6.41
Enterobacteriaceae	7.18	7.69	7.47
Yeasts and molds	7.20	7.08	7.06
Lactate-assimilating yeasts	6.57	6.87	6.34
Lactate-fermenting clostridial spores	2.63	2.97	2.97

[1]Expressed as $\log_{10}$ cfu/g of fresh forage.

The fact that 1174 did not influence the counts of the LPL group (KAES Report of Progress 623) could be attributed to the relatively high initial epiphytic LPL count (Table 1), 14 times greater than the numbers provided by the 1174 inoculant.

Distinct differences occurred in the epiphytic microflora and fermentation characteristics of the three hybrids. As we reported last year (KAES Report of Progress 623), 3389 silage had no undesirable microorganisms (Enterobacteriaceae, yeasts and molds, lactate-assimilating yeasts, or lactate-fermenting clostridial spores) at the end of the 120-day ensiling period. 3389 had significantly less ammonia-nitrogen and lactic acid than silages from the other two hybrids. However, 3389 silages had the lowest pH values, perhaps due to a lower buffering capacity and antibiosis of

the epiphytic LAB. Silages from 3389 also had much greater aerobic stability than 3377 and 3379 silages (data not shown).

We have observed in numerous previous studies that whole-plant corn ferments rapidly, and bacterial inoculants have only a limited effect on the rate and efficiency of fermentation. That might be because of corn's high epiphytic LAB counts and good ensiling characteristics (i.e., high DM and WSC values and low buffering capacity). Furthermore, the epiphytic LAB on these three hybrids were almost totally homofermentative (page 113 of this report).

Table 2. Effects of 1174® Inoculant and Hybrid on the Fermentation Characteristics at

	Treatment[1]	Time in the ensiling period, days						
Characteristic	or hybrid	.25	.5	1	3	7	42	120
pH	Control	5.24	4.76	4.44	3.77	3.69	3.65	3.59
	1174	5.24	4.75	4.44	3.77	3.70	3.65	3.60
		-------- % of the silage DM --------						
Lactic acid	Control	.31	.74	1.35	3.19	3.59	4.51	5.44
	1174	.34	.69	1.54	3.12	4.22	4.54	5.35
Acetic acid	Control	.15	.55	.67	1.05	1.17	1.04	1.53
	1174	.16	.51	.67	1.12	1.13	1.17	1.45
Ethanol	Control	.07	.02	.08	.08	.07	.25	.43
	1174	.13	.02	.14	.13	.19	.38	.49
Ammonia-	Control	.07	.07	.07	.10	.10	.12	.13
nitrogen	1174	.08	.07	.07	.10	.10	.12	.12
pH	3377	4.90^{c}	4.30^{c}	3.86^{c}	3.65^{b}	3.70^{a}	3.66^{a}	3.67^{a}
	3379	5.57^{a}	5.48^{a}	5.51^{a}	4.01^{a}	3.71^{a}	3.67^{a}	3.67^{a}
	3389	5.26^{b}	4.50^{b}	3.94^{b}	3.64^{b}	3.66^{b}	3.61^{b}	3.43^{b}
		-------- % of the silage DM --------						
Lactic acid	3377	$.41^{a}$	1.14^{a}	2.26^{a}	4.63^{a}	4.47^{a}	4.98^{a}	6.28^{a}
	3379	$.46^{a}$	$.52^{b}$	$.62^{c}$	2.53^{b}	4.81^{a}	6.05^{a}	6.75^{a}
	3389	$.11^{b}$	$.48^{b}$	1.45^{b}	2.30^{b}	2.42^{b}	2.53^{b}	3.15^{b}
Acetic acid	3377	.13	$.52^{a,b}$	$.58^{b}$	$.73^{b}$	.79	1.17	2.02
	3379	.20	$.67^{a}$	$.87^{a}$	1.25^{a}	1.26	1.03	1.13
	3389	.15	$.40^{b}$	$.55^{b}$	1.28^{a}	1.40	1.12	1.32
Ethanol	3377	.19	0^{b}	.18	.06	.10	.57	.67
	3379	0	0^{b}	0	0	.23	.14	.31
	3389	.11	$.06^{a}$	.15	.26	.07	.25	.40
Ammonia-	3377	$.04^{b}$	.08	$.09^{a}$	$.09^{b}$	.09	$.11^{b}$	$.16^{a}$
nitrogen	3379	$.08^{a}$	.06	$.06^{b}$	$.09^{b}$	.10	$.11^{b}$	$.12^{b}$
	3389	$.09^{a}$	.08	$.08^{a}$	$.11^{a}$	.10	$.13^{a}$	$.09^{c}$

[1]Inoculant effect was not significant ($P > .05$).

[a,b,c]Means in the same column within each fermentation characteristic with different superscripts differ ($P < .05$).