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Inoculant-treated corn silages for growing cattle

Abstract

Whole-plant corn silages were treated with Ecosyl® in one trial and Biomate4ll or Silagest® in a second trial. In both trials, the silages were well preserved and moderately stable in air during the feed-out period. Inoculated silages had slightly lower ensiling temperatures than control silages. Laboratory silo results indicated that all silages fermented extremely fast, but inoculated silages did have slightly lower pH and higher lactic acid values during the first 4 days post-filling. Calves fed inoculated silage rations tended to gain faster and more efficiently than those fed control silages. Gain per ton of crop ensiled also favored the inoculated silages.

Keywords

Kansas Agricultural Experiment Station contribution; no. 88-363-S; Cattlemen's Day, 1988; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 539; Beef; Inoculant; Corn silages; Growing cattle

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Inoculant-treated Corn Silages for Growing Cattle[1,2,3,4]

Keith Bolsen, Brett Kirch, Ahmed Laytimi, Jim Hoover and Harvey Ilg

Summary

Whole-plant corn silages were treated with Ecosyl® in one trial and Biomate® or Silagest® in a second trial. In both trials, the silages were well preserved and moderately stable in air during the feed-out period. Inoculated silages had slightly lower ensiling temperatures than control silages. Laboratory silo results indicated that all silages fermented extremely fast, but inoculated silages did have slightly lower pH and higher lactic acid values during the first 4 days post-filling. Calves fed inoculated silage rations tended to gain faster and more efficiently than those fed control silages. Gain per ton of crop ensiled also favored the inoculated silages.

Experimental Procedures

Trial 1. Whole-plant corn was treated with Ecosyl inoculant at the time of ensiling and compared to untreated (control) silage. Both silages were made by the alternate load method in 10 x 50 ft concrete stave silos on August 18 and 20, 1986 from Pioneer 3471 corn harvested in the mid to full-dent stage at 36.0% dry matter (DM). Ecosyl was applied at the blower as a liquid and supplied an average of 1.0 x 10^5 colony-forming units (CFU) of lactic acid bacteria (LAB) per gram of crop. The corn, as harvested, contained an average of 2.1 x 10^5 CFU of LAB per gram.

Each silo was partitioned vertically into thirds as it was filled, with approximately 15 tons per third. The partitions were separated by plastic mesh fencing. Two thermocouple wires and three nylon bags filled with 4.5 to 5.0 lb of fresh crop, were placed in the vertical center of each third. Ensiling temperatures were monitored for the first 6 weeks of storage. Twice during the filling of the stave silos, fresh forage was removed from randomly selected loads and control and Ecosyl-treated material was ensiled in PVC laboratory silos, 18 silos each. Triplicate silos were opened at 6, 12, 24 and 48 hours and 4 and 90 days post-filling. The farm-scale silos were opened on December 5, 1986 and emptied at a uniform rate

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1Ecosyl® contains Lactobacillus plantarum and is a product of C-I-L, Inc. London, Ontario, Canada.

2Biomate® contains Lactobacillus plantarum and Pediococcus cerevisiae and is a product of Chr. Hansen's Laboratory, Inc. Milwaukee, Wisconsin.

3Silagest® contains multiple strains of lactic acid bacteria and is a product of InterBio, Inc. Naperville, Illinois.

4C-I-L, Inc., Chr. Hansen's Laboratory, Inc., and InterBio, Inc. all provided partial financial assistance.

during the following 12 weeks. Samples were taken twice weekly for DM recovery calculations and chemical analyses. Each silage was fed to 16 steer and heifer calves (four pens of four calves per silage) in an 80-day growing trial, which began on December 6, 1986. Rations were full-fed and all contained 87.6% silage and 12.4% supplement on a DM basis. Rations were formulated to provide 12.0% crude protein (DM basis), 200 mg of Rumensin® per animal daily, required amounts of calcium and phosphorus, and vitamins A, D, and E. Supplements were top-dressed and partially mixed with the silages in the bunk. Feed offered was recorded daily for each pen and the quantity of silage fed was adjusted daily to assure that fresh feed was always available. Feed not consumed was removed, weighed, and discarded every 7 days or as necessary.

For 3 days before the start of the feeding trail, all cattle were limit-fed a forage sorghum silage ration to provide a DM intake of 2.0% of body weight. Cattle were then weighed individually on 2 consecutive days after 16 hr without feed or water. For 2 days before the final weighing, the cattle were fed their respective silage rations at a restricted intake of 2.0% of body weight.

Trial 2. Three whole-plant corn silages were compared: (1) control (no additive), (2) Biomate, and (3) Silagest. Both additives were applied at the blower and at the manufacturers' recommended rate. Biomate supplied an average of 2.1×10^5 CFU of LAB per gram of crop and Silagest supplied 6.6×10^4 per gram. The corn, as harvested, contained an average of 3.3×10^6 CFU of LAB per gram. The silages were made by the alternate load method in 10 x 50 ft concrete stave silos on August 25, 1986 from Pioneer 3475 corn harvested in the full-dent stage at 38 to 40% dry matter. Each silo was partitioned vertically into thirds as it was filled, with approximatley 14 tons per third. All other procedures for filling and emptying the silos and the cattle growing trial were identical to those described in Trial 1.

Results and Discussion

Ensiling temperatures for the two trials are shown in Table 41.1. In Trial 1, the initial forage temperatures were 82.7 F for control and 81.5 F for Ecosyl. Change from initial temperature was consistently 1 to 2 F lower for the inoculated corn silage during the first 4 weeks. In Trial 2, the initial forages were between 92.0 and 92.3 F and reflected the very warm air temperatures on the day the silages were made. Biomate silage had a 1 to 5 F lower temperature than control silage during the first 4 weeks; however Silagest silage was not consistently cooler than the control until day 10 post-filling.

Silage fermentation dynamics during the first 4 days post-filling for the five silages in the two trials are shown in Table 41.2. All silages fermented extremely fast, reaching a pH of 4.0 or below within the first 48 hours post-filling. In spite of the rapid pH drop in the two untreated silages, inoculated silages still had lower pH ($P<.05$) and higher lactic acid values ($P<.05$) at a few of the opening times.

Shown in Tables 41.3 and 41.4 are DM losses and fermentation end-products for control and inoculated silages. In both trials, all silages had low pH values, intermediate levels of total fermentation acids (predominately lactic acid), and low ammonia-nitrogen contents --- all characteristics of well preserved corn silage. In

Trial 1, silages from the concrete stave silos, buried bags, and PVC silos had similar fermentation profiles, although acetic acid content was lowest in PVC silos. Silage DM losses were consistently lower for the Ecosyl-treated corn silage. In Trial 2, silage from all three treatments had nearly identical fermentation end-products except DM loss and acetic acid values were slightly lower for Biomate and Silagest-treated silages.

Performance by cattle during the two 80-day growing trials is presented in Table 41.5. Mild weather and the high grain content of the silages combined to produce exceptional rates and efficiencies of gain. Although cattle fed Ecosyl-treated silage in Trial 1 made 8.7% faster gains and had 5.5% greater intake, these differences were not statistically significant. When the data for farm-scale silage recoveries were combined with cattle performance, the Ecosyl-treated corn silage produced 6.3 lb more gain per ton of crop ensiled than the control silage.

In Trial 2 the only significant improvement in cattle performance was a better feed conversion for those fed Silagest-treated silage, although cattle fed the Biomate and Silagest silages had 5.4% faster daily gains, on average, than those fed control corn silage. Cattle gains per ton of crop ensiled were 2.6 and 9.2 lb higher for Biomate and Silagest silages, respectively, than with control corn silage.

Table 41.1. Ensiling Temperatures as Change From Initial Temperature for Control and Incolated Corn Silages in Trials 1 and 2

Days Post-filling	Trial 1		Trial 2		
	Control	Ecosyl	Control	Biomate	Silagest
	---------- Inital Forage Temperature, F ----------				
	81.5	82.7	92.3	92.3	92.0
	---------- Change from Initial Temperature, F ----------				
1	+9.9	+9.3	+8.4	+7.6	+9.1
2	+12.7	+12.1	+9.3	+8.3	+10.0
3	+13.7	+13.2	+9.6	+8.7	+10.4
4	+14.1	+13.4	+9.5	+8.6	+10.5
5	+16.2	+14.7	+10.5	+9.1	+10.8
6	+16.0	+14.2	+11.0	+9.6	+11.0
7	+15.9	+13.8	+11.4	+9.4	+9.7
10	+15.0	+13.5	+10.7	+8.0	+9.7
14	+14.3	+12.9	+9.5	+5.9	+8.0
21	+12.0	+10.3	+8.8	+4.5	+5.7
28	+8.7	+7.8	+6.3	+1.2	+3.3

Table 41.2. pH and Lactic Acid during the First Four Days Post-filling for Control and Inoculated Corn Silages in Trials 1 and 2

Time Post-filling and Item[1]	Trial 1[A]		Trial 2[B]		
	Control	Ecosyl	Control	Biomate	Silagest
Initial: pH	5.90	5.89	5.92	5.93	5.93
6 hrs: pH*	5.62	5.59	5.44	5.29	5.40
Lactic*	.30	.28	.36	.43	.37
12 hrs: pH*	5.24	5.16	4.33	4.19	4.24[x]
Lactic	.50	.49[x]	.92	1.23	.84[x]
24 hrs: pH*	4.07	4.04[x]	4.02	3.92	3.93
Lactic	1.89	2.22	2.33	2.69	2.59
48 hrs: pH	3.85	3.85	3.78	3.77	3.78
Lactic	3.84	4.20	3.39	3.49	3.46
4 days: pH	3.78	3.71	3.71	3.77	3.70
Lactic*	4.42	4.69[x]	3.94	4.53	4.11[x]

[1]Lactic acid as a % of the silage dry matter.

[A]Each value is the mean of six laboratory silos.

[B]Each value is the mean of four laboratory silos.

*Statistical analyses showed control vs. inoculant means differed ($P<.05$), within a Trial, unless the inoculant mean has a superscript (x).

Table 41.3. Dry Matter Losses and Fermentation End-Products for the Control and Ecosyl Corn Silages from the Concrete Stave Silos, Buried Bags, and PVC Silos in Trial 1

Treatment and Location in the Silo or Days Post-filling		DM, %	DM loss[1]	pH	Fermentation Acids: Lactic	Acetic	Total	Ethanol	NH_3-N
					----------% of the Silage DM----------				
		Concrete Stave Silos							
Control:	Top	39.4	14.67	3.76	6.27	1.60	7.92	.34	.009
	Middle	37.5	9.04	3.57	8.57	1.77	10.44	.29	.109
	Bottom	37.1	4.49	3.58	9.96	2.13	12.24	.30	.122
	Avg.	38.0	9.48	3.64	8.26	1.83	10.20	.31	.108
Ecosyl:	Top	39.2	10.08	3.71	6.70	1.48	8.22	.34	.095
	Middle	37.5	8.99	3.55	9.47	1.49	11.08	.36	.116
	Bottom	37.5	2.40	3.62	9.14	2.48	11.75	.30	.129
	Avg.	38.1	7.14	3.63	8.44	1.82	10.35	.33	.113
		Buried Bags							
Control:	Top	37.6	5.33	3.62	7.59	---	---	---	.091
	Middle	35.7	7.17	3.59	5.79	---	---	---	.112
	Bottom	36.3	6.25	3.56	8.44	2.33	10.85	.27	.093
	Avg.	36.5	6.25	3.59	7.27	---	---	---	.097
Ecosyl:	Top	36.0	5.51	3.61	7.90	---	---	---	.088
	Middle	35.0	6.74	3.63	6.58	---	---	---	.117
	Bottom	37.0	4.19	3.60	8.33	2.56	11.04	.31	.110
	Avg.	36.0	5.48	3.61	7.60	---	---	---	.105
		PVC Silos							
Control:	90 Days	36.2	---	3.76	6.38	1.05	7.47	.47	.076
Ecosyl:	90 Days	36.9	---	3.71	7.30	.99	8.33	.37	.070

[1]Percent of the DM ensiled.

Table 41.4. Dry Matter Losses and Fermentation End-Products for Control, Biomate, and Silagest Corn Silages from the Concrete Stave and PVC silos in Trial 2

Treatment and Location in the Silo or Days Post-filling		DM, %	DM loss[1]	pH	Fermentation Acids: Lactic	Acetic	Total	Ethanol	NH_3-N
					% of the Silage DM				
		Concrete Stave Silos							
Control:	Top	39.0	10.71	3.87	4.42	1.28	5.75	1.38	.089
	Middle	39.0	4.35	3.74	5.88	2.88	8.86	.25	.122
	Bottom	38.7	6.10	3.78	5.54	3.42	9.11	.30	.132
	Avg.	38.9	7.00	3.80	5.28	2.53	7.91	.64	.115
Biomate:	Top	37.9	12.57	3.83	4.75	1.73	6.53	1.39	.101
	Middle	39.8	3.94	3.75	5.53	2.26	7.59	.31	.111
	Bottom	38.2	3.41	3.75	6.11	2.48	8.59	.34	.113
	Avg.	38.6	6.20	3.78	5.46	2.16	7.57	.68	.108
Silagest:	Top	39.1	10.74	3.84	4.31	1.30	5.65	1.19	.086
	Middle	37.9	3.98	3.78	5.00	2.97	8.09	.21	.121
	Bottom	36.4	3.82	3.76	6.26	2.92	9.33	.28	.119
	Avg.	37.8	6.10	3.79	5.20	2.39	7.69	.56	.109
		PVC Silos							
Control:	90 Days	37.6	---	3.76	6.36	1.33	7.74	1.31	.077
Biomate:	90 Days	37.2	---	3.77	6.62	1.11	7.77	1.30	.075
Silagest:	90 Days	38.2	---	3.78	6.46	1.19	7.70	1.31	.076

[1]Percent of the DM ensiled.

Table 41.5. Performance by Cattle Fed Control and Inoculated Corn Silages in Trials 1 and 2

Item	Trial 1[1]			Trial 2[1]			
	Control	Ecosyl	SE	Control	Biomate	Silagest	SE
No. of Cattle	16	16		16	16	16	
Initial Wt., lb	561	569		569	567	564	
Final Wt., lb	763	789		771	773	781	
Avg. Daily Gain, lb	2.54	2.76	.14	2.53	2.62	2.71	.09
Daily Feed Intake, lb[2]	16.26	17.16	.44	17.03	17.35	16.98	.32
Feed/lb of Gain, lb[2]	6.46	6.26	.26	6.77[b]	6.62[ab]	6.30[a]	.16
Silage DM Recovery, % of the DM Ensiled	90.5	92.8		93.0	93.8	93.9	
Silage Fed, lb/Ton Ensiled[3]	1810	1857		1860	1876	1878	
Silage/lb of Gain, lb[3]	16.02	15.56		16.81	16.56	15.68	
Cattle Gain/Ton of Crop Ensiled, lb[3]	113.0	119.3		110.6	113.2	119.8	

[1]December 6, 1986 to March 2, 1987 (80 days).

[ab]Values in Trial 2 in the same row with different superscripts differ (P<.10).

[2]100% dry matter basis.

[3]Adjusted to 35% dry matter.