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Preliminary Studies with Lambs on the Utilization of Corn Silage Treated with a Biological Additive

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PRELIMINARY STUDIES WITH LAMBS ON THE UTILIZATION OF CORN SILAGE TREATED WITH A BIOLOGICAL ADDITIVE[a]

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Summary

Corn forage was inoculated with an experimental biological additive and stored in 55-gallon steel barrels. The treated corn silage was compared to untreated corn silage in terms of chemical characteristics, nutrient utilization by lambs and preservation of dry matter.

Silage treated with the biological additive had higher titratable acidity, attributable mostly to a trend toward higher lactic, acetic and propionic acid contents. Greater quantities of carbohydrate appeared to be utilized in the formation of treated silage. Fermentation efficiency tended to favor the treated silage as indicated by a wider lactic to acetic acid ratio. Alcohol production was also lower in the treated silage than in the untreated silage.

There were no differences between untreated and treated silage in digestibility of dry matter, crude protein or organic matter. Lambs fed the treated silage retained slightly more nitrogen for productive purposes than lambs fed the untreated silage. Recovery of feedable dry matter was high for both silages, amounting to 97.8% for the untreated silage and 98.8% for the inoculated silage.

The overall evaluation indicated that the experimental biological additive may have provided a small improvement in silage quality. Additional research with this additive will be conducted utilizing farm scale tower silos.

(Key Words: Corn silage, Silage additives, Silage preservation).

Introduction

Interest continues in the use of biological products to enhance the quality and preservation of silage. A number of commercial products ranging from organic acids, nitrogen compounds, enzymes and viable microorganisms have emerged on today's silage additive market. Scientists are continuing to research the cost effectiveness and conservation efficiency of these compounds.

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[a] Experimental product of Ceva Laboratories, Overland Park, KS, a Division of Sanofi Sante Animale, Paris, France.

Microbiological additives such as Lactobacillus acidophilus and L. plantarum have given variable results when applied as inoculations to corn and legume forage. Inoculation of corn silage at the South Dakota Experiment Station has generally resulted in higher quality silage in terms of total acidity and concentration of lactic acid with slightly improved dry matter recovery compared to untreated silage. Feedlot performance has been similar for untreated and treated silages. Animals fed inoculated silage retained more absorbed nitrogen than those fed untreated silage, indicating a potential for increased deposition of protein in body tissue.

The object of this experiment was to study the value of an experimental biological additive as an enhancer of the chemical composition and feeding value of corn silage. Growing lambs were used to measure the effect of treatment on digestibility and nitrogen retention.

Procedures

Corn forage from the 1983 corn crop was harvested before frost on September 20, 1983. The forage contained 32.5% dry matter at ensiling and was elevated into a Kelly-Ryan mixing wagon[b] equipped with a scale. Weighed forage was dispensed into 55-gallon steel barrels (silos) equipped with a plastic liner and packed by walking on the forage surface during filling. Each barrel or silo had a lid which fastened securely in place with a ring-lock fastener. The silos were tared for weight and then reweighed after being filled with forage. Twelve silos were filled with untreated forage. Another 11 silos were filled with corn forage treated with an experimental silage biological additive[c] at the rate of 1 kg additive per ton of wet forage. The additive was applied to a weighed quantity of forage, mixed in the mixing wagon and dispensed into the silos. The silos were stored in an unheated building and opened for feeding after 198 days of storage.

Twelve lambs averaging 73.8 (trial I) and 86.6 lb. (trial II) were used in two total collection digestion and nitrogen balance trials. The lambs were sheared, ear tagged, dewormed and vaccinated against overeating disease prior to the start of the trial. The lambs were placed in individual pens and fed the silages for about 2 weeks. Then, the lambs were transferred to metabolism crates for an adjustment period. Each trial consisted of 5 days during which samples of feeds fed and feed refusals and aliquots of feces and urine were collected for chemical analysis. The silage was fed to appetite and .3 kg of a supplement top dressed to the silage. Silage and supplement were fed once daily. The supplement was composed of 17.3% ground corn, 80.3% soybean meal (48% protein) and 2.4% ground limestone. Vitamin A was included in the supplement to supply 1500 IU vitamin to each lamb daily. Digestion coefficients were calculated for dry matter, crude protein and organic matter. Nitrogen utilization was reported as fecal, urinary and retained nitrogen.

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[b] Blair Manufacturing Company, Blair, NE.

[c] Experimental product of Ceva Laboratories, Overland Park, KS, a Division of Sanofi Sante Animale, Paris, France.

Chemical analysis of silage samples collected at ensiling and at feeding followed a profile routinely used at this laboratory. Measurements included pH, dry matter (toluene distillation), alcohol content, lactic acid, carbohydrate content, total nitrogen, titratable acidity and volatile fatty acids. The profiles were used to measure chemical changes brought about by the biological additive during fermentation and subsequent storage.

All data were subjected to statistical analysis.

Dry matter preservation was determined by comparing the total forage dry matter ensiled with the dry matter of the silage removed from the silo. Spoiled silage was carefully separated from the feedable silage as each silo was opened.

Results

Chemical Characteristics

Chemical characteristics of the experimental silages at the time of feeding are presented in table 1. The silages contained about 35% dry matter and a low pH of 3.5. Silage treated with the inoculant had more acid measured as titratable acidity ($P<.01$) than untreated silage.

The crude protein content on a dry matter basis was 7.12% for the untreatd silage and 7.85% for the inoculated silage. However, differences of this magnitude were observed between the two treatments at the time of ensiling. Ammoniacal nitrogen, a measure of protein degradation, was not measured in this experiment, but nitrogen losses were believed to be minimal.

Lactic acid concentrations were about 9% higher for the inoculated silage. However, the values were not statistically significant. Volatile fatty acids, acetic (not significant) and propionic ($P=.06$) also tended to be higher in the inoculated silage. Butyric acid, an indicator of low quality silage, was not detected in the treated silage. The fermentation efficiency tended to favor the inoculated silage as indicated by a wider ratio of lactic to acetic acid, although this did not differ significantly.

Fermentation of carbohydrates was measured to relate the process of acid formation to levels of these compounds in the silages. Soluble total carbohydrate and reducing sugars as a percentage of those ensiled tended to be lower (not significant) in inoculated silage than in untreated silage. This suggests an effect of the inoculant on carbohydrate degradation. The extensive use of carbohydrate in acid formation is supported by the higher total acidity ($P<.01$), lactic (not significant) and volatile fatty acid values (propionic, $P=.06$) observed in the inoculated silage.

In the chemical reactions of silage formation, alcohols, methanol, ethanol and others may be observed. Total alcohol production was lowered ($P<.05$) in this study by the inoculation treatment. This is considered a desirable effect.

Digestibility and Nitrogen Utilization

Results of two digestion studies with lambs are presented in table 2. Digestibility of dry matter, crude protein and organic matter in the inoculated silage tended to be slightly lower than in the untreated silage. The differences, however, were small and not statistically significant.

Nitrogen utilization by lambs fed the experimental silages is presented in table 3. Lambs fed the inoculated silage consumed slightly more nitrogen than lambs fed the untreated. The difference of about 1 g per day was statistically significant but of little practical importance. Lambs fed the inoculated silage had higher fecal nitrogen levels in both trials (trial I, not significant; trial II, P=.09). However, they retained 20% more nitrogen (6.9 vs 5.7 g, P=.12) in trial I and 5% more nitrogen (9.3 vs 8.9 g, not significant) in trial II than lambs fed the untreated silage. Nitrogen retained as a percentage of nitrogen consumed tended to favor the inoculated silage treatment, but the difference was not significant.

Dry Matter Recovery

Recovery of dry matter in untreated silage was 97.8% compared to 98.8% in inoculated silage (table 4). Since the silage was stored in nearly air-tight experimental silos, these high dry matter recovery values are routinely observed. Spoilage losses were confined to a small area on the top surface of the silage in the silo.

TABLE 1. LEAST-SQUARES MEANS FOR CHEMICAL CHARACTERISTICS OF CORN SILAGE AT TIME OF FEEDING

	Additive treatment	
	Untreated	Treated[a]
Number of samples	19	19
Dry matter, %[b]	34.72	35.03
pH	3.51	3.52
Titratable acidity[c]	10.08	11.25**
Ammonia nitrogen	ND	ND
Percent in dry matter		
Crude protein	7.12	7.85**
Lactic acid	3.98	4.32
Volatile fatty acids		
Acetic	.595	.605
Propionic	.168	.215+
Butyric	.005	None
Total	.768	.821
Lactic acid:acetic acid	6.83	7.50
Residual carbohydrate, percent of carbohydrate stored[d]		
Total carbohydrate	47.6	42.8
Reducing sugar	85.8	77.7
Alcohols[e]	.7054	.5902*

[a] Experimental product of Ceva Laboratories, Overland Park, KS, a Division of Sanofi Sante Animale; applied at 1 kg/ton forage.
[b] Toluene distillation with acid correction.
[c] Milliliters of .1N KOH to raise pH to 7.
[d] Extracted with cold water.
[e] Methanol, ethanol, 2-propanol.
ND = not determined.
Statistical difference between silage treatments: * = P<.05; ** = P<.01; + = P=.06.

TABLE 2. DIGESTIBILITY OF DRY MATTER, CRUDE PROTEIN AND ORGANIC MATTER IN UNTREATED AND TREATED[a] CORN SILAGE

	Trial no.	Additive treatment	
		Untreated	Treated[a]
No. of animals	I	6	6
	II	6	6
Dry matter intake, g/day	I	899.35	926.52
	II	1235.44	1226.85
Digestibility, %			
Dry matter	I	75.52	73.60
	II	74.02	72.94
Crude protein	I	78.95	78.59
	II	76.29	75.57
Organic matter	I	77.53	75.69
	II	75.80	74.86

[a] Experimental product of Ceva Laboratories, Overland Park, KS, a Division of Sanofi Sante Animale, Paris, France; applied at rate of 1 kg/ton forage.

TABLE 3. NITROGEN UTILIZATION BY LAMBS FED UNTREATED OR TREATED[a] CORN SILAGE

	Trial no.	Additive treatment	
		Untreated	Treated[a]
No. of animals	I	6	6
	II	6	6
Nitrogen consumed, g/day	I	23.82	25.14**
	II	30.27	31.15**
Fecal nitrogen, g	I	5.03	5.38
	II	7.18	7.61++
Urinary nitrogen	I	13.07	12.89
	II	14.23	14.21
Total nitrogen loss, g	I	18.09	18.27
	II	21.41	21.82
Nitrogen retained, g	I	5.72	6.86+
	II	8.86	9.33
Nitrogen retained as percent of consumed	I	24.07	27.29+++
	II	29.28	29.94

[a] Experimental product of Ceva Laboratories, Overland Park, KS, a Division of Sanofi Sante Animale, Paris, France; applied at rate of 1 kg/ton forage.

Statistical difference between silage treatments: ** = P<.01; + = P=.12; ++ = P=.09; +++ = P=.23.

TABLE 4. DRY MATTER RECOVERY OF UNTREATED AND TREATED[a] CORN SILAGE

	Additive treatment	
	Untreated	Treated[a]
No. of silos	12	11
Forage stored, lb.	3442	2890
Silage fed, lb.	3366	2855
As percent of forage stored	97.78	98.79
Silage spoiled, lb.	76	35
As percent of forage stored	2.22	1.21

[a] Experimental product of Ceva Laboratories, Overland Park, KS, Division of Sanofi Sante Animale, Paris, France; applied at rate of 1 kg/ton forage.