Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 1391

1973

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Recommended Citation

Bolsen, K.K.; Riley, Jack G.; and Hoover, J.D. (1973) "Four forage sorghum silage additives evaluated," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. https://doi.org/10.4148/2378-5977.2794

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Abstract
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Keywords
Cattlemen's Day, 1973; Report of progress (Kansas State University. Agricultural Experiment Station); 568; Beef; Forage sorghum; Performance; Crude protein

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This Research Report article is available in Kansas Agricultural Experiment Station Research Reports: https://newprairiepress.org/kaesrr/vol0/iss1/1391

Four Forage Sorghum Silage Additives Evaluated

K. K. Bolsen, J. G. Riley and J. D. Hoover

Summary

Two trials were conducted to evaluate four forage sorghum silage additives: ammonium iso-butyrate, aureomycin, sodium hydroxide, and a mixture of acetic and propionic acids. A control silage received no additives.

In an animal performance trial, each of the five silages was fed to 15 heifer calves for 112 days. All heifers were full-fed silage plus 4 lb. of rolled milo and 2 lb. of a soybean meal supplement daily. There were no significant differences in gain or feed consumption. Heifers receiving sodium hydroxide silage required more feed per lb. of gain ($P<.05$) than those receiving ammonium iso-butyrate or organic acid silages. Feed cost per 100 lb. gain was lowest for heifers fed the silage with no additive.

In a digestion trial, each silage was fed to 3 wether lambs in two, 12-day preliminary and 7-day collection periods. Digestion coefficients for dry matter, organic matter, and nitrogen retention were not influenced by silage treatment; however, crude protein digestibilitv was lower ($P<.05$) for lambs fed the sodium hydroxide silage ration than for lambs fed any of the other four silage rations.

Silage analyses showed pH, ash percentage and butyric acid percentage highest in the sodium hydroxide silage.

These results indicate that feeding values of forage sorghum silage were not significantly improved by any of the four additives.

Introduction

Many factors affect the fermentation and quality of corn and forage sorghum, the two principal silage crops in Kansas. Five of the factors are plant maturity and moisture content at harvest, fineness of chop, type of storage structure, and anaerobic conditions. Previous research with silage additives has focused on developing acid conditions in the silage or minimizing production of undesirable fermentation end-products.

The four additives evaluated in these experiments may inhibit mold growth and alter fermentation or change the chemical structure and nutritive value of the silage.

Experimental Procedure

All forage sorghum used was grown in the same location and was the same variety. It was harvested between September 17 and 24, 1971, to minimize plant maturity differences between the silage treatments. Approximately 50 tons of each silage were ensiled in upright, concrete stave silos (10 ft. x 50 ft.) at about 68% moisture (at harvest). The forage chopper had a 2-inch recutter screen.

The silage treatments were:

Silage Treatment	Description
1	Control - no additive
2	Ammonium iso-butyrate (AIB)[1], 10 lb. per ton of wet forage
3	Aureomycin, 1 gram per ton of wet forage (1 gm of aureomycin premixed with 1 lb. of finely ground milo)
4	Sodium hydroxide (NaOH), 28 lb. per ton of wet forage
5	Organic acid mixture[2,3], 30 lb. per ton of wet forage

The additives were added at the silo blower.

Trial 1. Seventy-five Hereford heifers averaging 411 lb. were used in a 112-day growing trial beginning January 19, 1972. Three pens of five heifers each were randomly assigned to each of the five silage treatments. All rations contained a full feed of the appropriate silage, 4 lb. of rolled milo and 2 lb. of supplement (table 1) daily. Grain was added to assure a minimum average daily gain of 1.70 lb. No attempt was made to neutralize the sodium ions in the NaOH silage or to compensate for the additional nitrogen in the AIB silage. The rations were mixed and fed twice daily. Initial and final weights of heifers were taken after 15 hours without feed or water; 28-day, intermediate weights were taken after the a.m. feeding.

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[1] Supplied by W. R. Grace and Co., Washington Research Center, Clarksville, Md.
[2] Organic acid mixture (trade name - ChemStor) contains 60% acetic and 40% propionic acids.
[3] Supplied by Celanese Chemical Co., Corpus Christi, Texas.

Trial 2. Fifteen Ramboullet wether lambs averaging 90 lb. were used in a digestion and nitrogen balance trial. Each of the five silage treatments was fed to three lambs in two, 12-day preliminary and 7-day collection periods. The rations contained 78 percent silage and 22 percent soybean meal based supplement (dry matter basis). During each preliminary period, silage was offered free-choice from day 1 through day 10. Silage voluntary intake was determined for each lamb on days 8, 9, and 10.

Results

Chemical analyses of the silages are shown in table 2. Only slight differences were obtained in proximate and structural components among the five silages. Ash content was highest and neutral detergent fiber content lowest in the NaOH silage. Crude protein analysis indicates that only about 20 percent of the nitrogen in the AIB was recovered in the silage after fermentation and storage. AIB contains 84 percent crude protein equivalent so the calculated crude protein in the AIB-treated silage when ensiled was 6.40 percent. Its crude protein content was 5.40 percent when fed.

Acid percentages in the silages after fermentation varied widely. The control and aureomycin-treated silages had similar amounts of acetate, lactate and butyrate. The AIB-treated silage contained 1.46 percent iso-butyrate. The NaOH-treated silage had the highest pH (6.40), the highest percentage butyrate, and only traces of lactate. It was also a much darker color (dark brown to black) than the other four silages.

Performance of heifers in trial 1 is shown in table 3. None of the differences in daily gain or feed consumption differed significantly. Heifers fed AIB and organic acid silage rations tended to gain faster than heifers fed the other three silage rations. NaOH silage was consumed in the largest amounts; but heifers fed this silage required more feed per lb. of gain ($P<.05$) than those fed AIB or organic acid silages. Also, consumption was more variable between pens of heifers being fed the NaOH silage than those fed the other silages. Heifers fed the control silage ration had the lowest feed costs per 100 lb. of gain. Adding NaOH or the organic acid mixture increased feed costs 18 and 8 percent, respectively.

Results of trial 2 are presented in table 4. Apparent digestion coefficients for dry matter and organic matter were not significantly affected by silage treatment. Crude protein digestibility was significantly lower ($p<.05$) and percentage of nitrogen retained tended to be lower in lambs fed the NaOH silage ration than in those fed any other ration. Lambs fed NaOH silage consumed 14 to 20 percent more silage dry matter during the preliminary periods than any other group.

Table 1. Composition of the Supplement.

Ingredient	% (dry matter basis)
Soybean meal	64.62
Rolled milo	29.42
Limestone	1.75
Salt	2.50
Fat	1.00
Trace Mineral Premix	0.25
Chlortetracycline[a]	0.35
Vitamin A Premix[b]	0.11

[a]Formulated to supply 70 mg. per heifer per day.
[b]Formulated to supply 30,000 IU per heifer per day.

Table 2. Silage Analyses (Dry Matter Basis).

Item	Silage treatment				
	Control	AIB	Aureomycin	NaOH	Organic acid
Dry matter, %	32.6	31.3	31.9	31.9	31.6
Ash, %	7.9	8.0	7.9	10.4	6.1
Crude protein, %	5.2	5.4	5.1	5.2	5.2
Crude fiber, %	27.3	27.5	27.3	27.2	25.0
Neutral detergent fiber, %	63.6	62.7	60.7	58.9	62.1
Acid detergent fiber, %	38.7	34.5	35.9	37.6	32.9
Lignin, %	7.5	5.8	6.0	7.3	6.0
pH	4.19	4.17	4.10	6.40	4.10
Acetate, %	0.81	0.98	0.92	2.12	1.88
Propionate, %	----[a]	----[a]	----[a]	0.44	1.19
Lactate, %	4.00	4.24	3.75	Trace	Trace
Butyrate, %	0.12	----[a]	0.17	4.08	Trace
Iso-butyrate, %	----[a]	1.46	----[a]	----[a]	----[a]

[a]None detected.

Table 3. Heifer Performance (Trial 1).

Item	Silage treatment				
	Control	AIB	Aureomycin	NaOH	Organic acid
No. of heifers	15	14[a]	15	15	15
Initial wt., lb.	408	408	408	423	406
Final wt., lb.	613	622	611	620	627
Avg. total gain, lb.	205	214	203	197	221
Avg. daily gain, lb.	1.83	1.91	1.81	1.76	1.97
Avg. daily feed[b]					
Silage, lb.	9.41	9.03	9.27	10.02	9.06
Milo, lb.	3.40	3.40	3.40	3.40	3.40
Supplement, lb.	1.74	1.74	1.74	1.74	1.74
Total, lb.	14.55	14.17	14.41	15.16	14.20
Feed/lb. gain, lb.	7.9[c,d]	7.43[c]	8.02[c,d]	8.62[d]	7.20[c]
Feed cost/100 lb. gain[e], $	19.34	19.37	19.50	22.95	20.91

[a]One heifer died (accidental cause).
[b]Dry matter basis.
[c,d]Means in the same row with different superscripts differ significantly ($P<.05$).
[e]Feed prices per ton: control silage, $10; AIB silage, $11.50; Aureomycin silage, $10.04; NaOH silage, $12.60; organic acid silage, $14.50; milo, $50; and supplement, $150.

Table 4. Ration Digestibility, Nitrogen Retention, and Voluntary Silage Dry Matter Intake by Lambs (Trial 2)[a]

Item	Silage treatment				
	Control	AIB	Aureomycin	NaOH	Organic acid
	Apparent digestion coefficients				
Dry matter, %	64.6	63.3	65.5	67.3	65.0
Organic matter, %	66.4	65.2	67.4	67.8	65.6
Crude protein, %	72.7[b]	71.6[b]	72.9[b]	65.9[c]	70.3[b]
Nitrogen retained, %	41.7	41.2	44.1	39.4	41.5
Voluntary silage dry matter intake[d]	100	105	106	120	100

[a] Each value is the mean of six observations.
[b,c] Means in the same row with different superscripts differ significantly ($p<.05$).
[d] Control silage valued 100; intake of the other silages reported as percentage of the control.