EFFECT OF FORAFORM® ON FERMENTATION OF ALFALFA, CORN, AND FORAGE SORGHUM SILAGES[1,2]

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Summary

Foraform® was evaluated in four trials using alfalfa, corn, and two forage sorghums harvested in 1987 and ensiled in PVC laboratory silos. There was a dramatic crop by Foraform interaction, with Foraform delaying and restricting the fermentations, as expected, in alfalfa and corn. In both forage sorghum hybrids, although the ensiling process was delayed about 24 hours by the Foraform treatment, end-product silages had lower pH values and equal or higher lactic acid levels than untreated silages. Foraform was effective at both 60 to 90 F temperatures in alfalfa, with treated silages having lower lactic and acetic acids, ethanol, and ammonia-nitrogen contents and higher lactic to acetic acid ratios than untreated alfalfa silages. Similar results occurred in corn, except Foraform-treated silage had a twofold higher ethanol content than control. Although overall silage fermentation in the forage sorghums was apparently not reduced by Foraform, treated silage did have higher lactic to acetic acid ratios and lower ethanol levels, which are both indications of improved preservation.

Introduction

The relatively high fermentable sugar content of corn and sorghum has often produced silages with high organic acid levels and signs of excessive heating. In contrast, the relatively low sugar content of alfalfa, when combined with high moisture conditions, can produce silages that have high pH's, high butyric acid and/or ammonia-nitrogen levels, and low intake potential and nutritive value when fed.

In the wet climatic conditions of Northern Europe, the United Kingdom, and Scandinavia, mineral (i.e., sulfuric) and organic (i.e., formic) acids have been used throughout much of the 20th century to preserve grass as silage through direct acidification. Safer, less corrosive, easier to handle forms of these "acid" additives are available, but how these "acid-salts" affect the preservation of the traditional silage crops in Kansas is not known.

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[1] Foraform contains ammonium tetraformate, a salt of formic acid, and is a product of BP Chemicals, LTD, London, England.

[2] Partial financial assistance was provided by BP Chemicals, LTD.

[3] International Commercial Development Manager, BP Chemicals, LTD.

Our objective was to determine how Foraform, a complex liquid salt of formic acid, would affect the ensiling dynamics and silage fermentation end-products of alfalfa, corn, and forage sorghum. The effect of Foraform on preservation and feeding value of corn silage is presented on page 54 of this report.

Experimental Procedures

The PVC laboratory silo used in these trials, the treatment methods, the silo-filling techniques, and the chemical and microbiological analyses were similar to those described on page 67 of this report. Foraform was applied as a liquid at 5.0 liters per ton. In Trial 1, the alfalfa was field-wilted 3 to 4 hours; temperature was approximately 80 F when ensiled. The control and Foraform-treated silos were stored at 60 and 90 F.

In all four trials, triplicate silos per treatment were opened at 12, 24, and 48 hours and 4, 7, and 90 days post-tilling.

Results and Discussion

Presented in Table 23.1 is a description of the crops, harvest dates, chemical compositions, and micoorganism profiles. Each crop was representative of those produced in the I987 growing season.

Shown in Table 23.2 are pH's, fermentation dynamics, and chemical compositions for the Foraform-treated and control silages in the four trials. Trials 1 and 2, with alfalfa and corn, produced contrasting results to Trials 3 and 4, with forage sorghums.

Foraform gave a consistent response at both 60 and 90 F in alfalfa, with treated silages having lower lactic and acetic acids, ethanol, and ammonia-nitrogen contents than untreated alfalfa. Similar results were obtained with corn--a sharply restricted fermentation and a lower total acid end-product silage. However, Foraform-treated corn silage had a twofold higher ethanol content than control.

There was a dramatic difference when Foraform was applied to the two forage sorghums. Foraform delayed and restricted the fermentations in alfalfa and corn, but end-product forage sorghum silages had lower pH values and equal or higher lactic acid levels compared to untreated controls. Although the ensiling process was delayed for only about 24 hours in the sorghums, the Foraform-treated silages underwent more efficient fermentations, as evidenced by greater lactic to acetic acid ratios and lower ethanol values.

Table 23.1. Description, Harvest Date, Chemical Composition, and Microorganism Profile for the Crops Used in Trials 1 to 4

Item	Trial 1	Trial 2	Trial 3	Trial 4
Crop	Alfalfa	Corn	Forage Sorghum	Ibag Sorghum
Hybrid/Variety	Kansas Common	Oldhe 0-230	DeKalb FS-5	Pioneer 947
Harvest Date, 1987	June 19	Aug 11 & 12	Aug 28	Sept 4
Dry Matter, %	32.5	40.1	28.8	35.2
Buffer Capacity [1]	52.6	20.2	26.6	27.7
	- - - - - - - - - - % of the Crop DM - - - - - - - - - - -			
Crude Protein	20.7	6.3	8.3	8.4
Acid Detergent Fiber	33.7	24.7	28.0	27.2
Water Soluble Carbohydrates	5.4	7.0	8.6	8.1
Indigenous Microbes:	- - - - - - - - - - - - CFU [2] /gram of Crop - - - - - - - - -			
Mesophilic	3.8×10^{7}	1.6×10^{8}	3.4×10^{7}	4.4×10^{7}
Lactic Acid Bacteria	6.2×10^{5}	1.1×10^{7}	4.4×10^{5}	5.8×10^{6}
Yeast and Mold	7.0×10^{3}	6.2×10^{5}	5.5×10^{4}	4.0×10^{4}

[1] Milliequivalents of NaOH per 100 grams of crop dry matter required to raise the pH of the fresh material from 4.0 to 6.0.
[2] Colony-forming units.

Table 23.2. pH and Chemical Composition over Time for the Foraform-treated and Control Silages in the Four Trials

Time Post-filling and Item[1]	Trial 1: Alfalfa[2] Control 60 F	Control 90 F	Foraform 60 F	Foraform 90 F	Trial 2: Corn[3] Control	Trial 2: Corn[3] Foraform	Trials 3 and 4: Forage Sorghum[3] DeKalb FS-5 Control	DeKalb FS-5 Foraform	Pioneer 947 Control	Pioneer 947 Foraform
Initial:										
pH	5.5	5.95	5.05	5.05	5.78	4.48	5.92	5.36	5.93	5.24
Hour 12:										
pH	5.97	5.53	5.05	5.11	4.57	4.58[x]	4.93	5.40	4.75	5.25
Lactic	.42	1.45	.23	.30	1.06	.17	.94	.28	1.04	.24
Hour 24:										
pH	5.63	5.39	5.11	4.94	4.24	4.63	4.40	4.92	4.64	5.04
Lactic	.76	1.71	.21	.32	2.37	.15	1.52	.57	1.87	.58
Hour 48:										
pH	5.41	5.09	5.02	4.92	4.03	4.63	4.14	4.01[x]	4.41	4.40[x]
Lactic	1.52	3.40	.25	.98	3.58	.34	3.02	2.86	3.68	2.70
Day 4:										
pH	5.20	4.92	5.04	4.79	3.89	4.40	3.91	3.84[x]	4.21	4.05[x]
Lactic	2.20	4.20	.43	1.38	4.37	1.33	5.42	5.80[x]	4.80	5.06
Day 7:										
pH	4.95	4.82	5.02[x]	4.60	---	---	3.85	3.83	4.18	4.01[x]
Lactic	3.42	5.27	.88	1.96	---	---	6.84	6.34	4.70	5.24
Day 90:										
pH	4.59	4.58	4.41	4.38	3.91	4.08	3.86	3.84[x]	4.10	3.99[x]
Lactic	3.54	4.41	3.03	3.01	4.20	2.31	6.01	7.67	5.60	5.62
Acetic	3.78	3.23	1.37	1.41	1.04	.46	1.56	.83	1.42	1.00
Ethanol	.332	.400	.101	.093	1.020	1.750	1.579	1.046	.695	.371
NH_3-N	.269	.312	.208	.254	.060	.125	.040	.055[x]	.071	.086

[1] Acids, ethanol, and NH_3-N are reported as a % of the silage dry matter.

[2] Statistical analyses showed control vs Foraform means at the same temperature differed ($P<.05$), unless the Foraform mean has a superscript (x).

[3] Statistical analyses showed control vs. Foraform means within a trial differed ($P<.05$), unless the Foraform mean has a superscript (x).