CULBAC® and ADD-F® (formic acid) Additives for Sudangrass and High Moisture Shelled Corn Silages[1]

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Summary

Laboratory silos were used in three trials to evaluate sudangrass (slightly or moderately wilted) and high moisture corn silages, each receiving the following treatments: (1) control (no additive); (2) CULBAC® dry; (3) CULBAC® liquid; and (4) ADD-F® (formic acid). Although the 12 silages were well preserved visually, there were differences in their chemical compositions. Silages treated with CULBAC dry had the highest DM recoveries and probably the most efficient fermentations. As expected, formic acid restricted the amount of fermentation, but surprisingly, it did not improve DM recovery.

Introduction

In two previous trials with alfalfa silages, CULBAC® reduced dry matter (DM) losses and lowered pH's. In a third trial with whole-plant corn, CULBAC reduced the DM loss and dramatically increased bunk life (Report of Progress 427). These trials were conducted using a laboratory-scale silo that we developed (see Report of Progress 394) and have used successfully to compare various silages, including additive-treated silages. In most of Northern Europe, formic acid has been used to improve the quality of hay-crop silages, particularly when wet, rainy weather makes field-wilting difficult or impossible.

Our objectives were to determine the efficacy of using CULBAC in dry or liquid form and formic acid on sudangrass and high moisture shelled corn.

Experimental Procedures

Silage was made in 1982 from: (1) first-cutting, hybrid sudangrass in the early-boot stage and slightly wilted to 77% moisture or moderately wilted to 64% moisture and (2) high moisture (HM) shelled corn containing 26% moisture. Sudangrass (Northrup King Trudan 6) was cut and swathed or 4 p.m. on July 27 and left to wilt until 1 p.m. on July 29 (slightly wilted, Trial 1) and at 4 p.m. on July 30 (moderately wilted, Trial 2); HM corn was harvested on September 16 (Trial 3). It was the same source of corn described on page 58 of this Progress Report. Four treatments were compared: (1) control (no additive); (2) CULBAC in dry form; (3) CULBAC in liquid form; and (4) formic acid (ADD-F®). CULBAC was applied at the manufacturer's recommended rate, and ADD-F was applied in an 80% liquid solution at 2.5 liters per ton of fresh crop.

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[1]CULBAC® is a non-viable lactobacillus product, manufactured by TransAgra Corporation, Memphis, TN 38138. ADD-F® is an 80% formic acid solution produced by British Petroleum. Partial financial assistance was provided by TransAgra.

For each treatment an appropriate amount of crop was placed in a Harsh Mobile Mixer® and the additive applied. After mixing, about 28 to 34 lb of crop was tightly packed into the laboratory silos (six per treatment) and the filled silos weighed. Samples of pre-treated and post-treated, pre-ensiled crop were taken and frozen immediately in liquid nitrogen. In all cases, less than 2 hours elapsed from the time material left the field until laboratory silos were sealed.

In each trial, at about 105 days post-ensiling, silos were weighed and the silage mixed in a cement mixer and sampled. Dry matter loss was determined for each silo. All silage samples were analyzed for DM, pH, ammonia-nitrogen, lactic acid, volatile fatty acids, crude protein, and hot water insoluble-nitrogen. All pre-ensiled crop samples were analyzed for DM, pH, crude protein, and hot water insoluble-nitrogen. Bunk life was measured by procedures described on page 28 of this Progress Report.

Results and Discussion

Trial 1. All four silages were reasonably well preserved and there were no obvious visual differences. As shown in Table 14.1, ADD-F silage had the lowest ($P<.05$) DM recovery; CULBAC dry and liquid silages had numerically higher recoveries than the control. Although ADD-F restricted fermentation, as evidenced by lower lactic and total acids ($P<.05$), its higher DM loss was inconsistent with its chemical analyses. Only the CULBAC dry silage had more lactic acid (8.04 vs. 7.48%) and a lower pH (4.15 vs. 4.27) than the control silage, but those differences were not statistically significant.

The ratios of lactic to acetic acid and lactic to DM loss were numerically highest for CULBAC dry silage. These ratios suggest that CULBAC dry gave a slightly more efficient fermentation than the control. The ratios are likely not appropriate for evaluating ADD-F silage, since its mode of action is to restrict acid production. As expected, the two silages that had the highest ammonia-nitrogen's, also had the highest pH's (CULBAC liquid and ADD-F). Aerobic stability results showed that all four silages were extremely stable and did not heat until days 18 to 21.

Trial 2. Visually all four silages were of similar and acceptable quality. As shown in Table 14.2, CULBAC dry silage had numerically higher DM recovery, lactic acid, and ratios of lactic to acetic and lactic to DM loss than the control silage. Although differences ($P<.05$) among silages occurred for total acids, ammonia-nitrogen, and hot water insoluble-nitrogen, these may have little, if any, practical significance. ADD-F restricted fermentation in Trial 2, but to a lesser extent than in the wetter sudangrass in Trial 1. Control and CULBAC dry and liquid silages were moderately stable in air and ADD-F silage was highly stable.

The slightly wilted and much wetter silages in Trial 1 had higher total fermentation acids, higher ammonia-nitrogen's, higher pH's, and lower lactic to acetic ratios than the moderately wilted, drier silages in Trial 2. These data indicate that the wetter silages should have lost more DM than the drier silages. They did not. The silages in Trial 1 had an average DM loss of 4.0%; silages in Trial 2, 4.2 percent.

The control silages in both sudangrass trials were of very acceptable quality: high lactic acids, no butyric acid, low ammonia-nitrogen's and low pH's. Thus one would expect any improvement in silage quality due to the three additives to be rather small. Only CULBAC dry improved DM recovery over the control in both trials and it likely improved fermentation efficiencies, as judged by lactic acid, lactic to acetic ratios, and lactic to DM loss ratios. All eight sudangrass silages had similar ammonia-nitrogen and hot water insoluble-nitrogen levels.

Trial 3. As was observed for the sudangrass silages, all HM corns were well preserved and there were no obvious visual differences among them. Data are shown in Table 14.3. The CULBAC dry HM corn had the highest DM recovery (P<.05) and both CULBAC treatments contained lower (P<.05) total and individual acids, including butyric, than the control. Although the ADD-F HM corn had a much lower acid content than the other treatments, it had a similar DM loss. The control and CULBAC dry corns were highly stable in air, but the CULBAC liquid and ADD-F corns were only moderately stable and heated after 4 days.

Table 14.1. Dry Matter Recoveries and Chemical Analyses of the Slightly Wilted Sudangrass Silages (Trial 1).[1]

Item	Control	CULBAC dry	CULBAC liquid	ADD-F
Dry matter:				
pre-ensiled, %	22.7	22.9	22.1	22.0
silage, %	22.0	22.4	21.6	20.8
	% of the DM ensiled			
Dry matter recovery	96.1^{a}	97.0^{a}	96.8^{a}	94.1^{b}
	% of the silage DM			
Lactic acid	7.48^{a}	8.04^{a}	7.18^{a}	2.76^{b}
Acetic acid	4.28	4.08	4.99	4.46
Propionic acid	$.12^{ab}$	$.06^{a}$	$.20^{b}$	$.06^{a}$
Total fermentation acids	11.9^{a}	12.2^{a}	12.4^{a}	7.3^{b}
Crude protein:				
pre-ensiled, %	13.6	13.6	13.8	13.3
silage, %	14.6	14.7	14.6	14.5
	% of the total N			
Ammonia-N	9.5^{a}	9.2^{a}	14.6^{b}	13.6^{ab}
Hot water insol. N				
pre-ensiled, %	58.5	58.5	57.4	57.9
silage, %	35.9^{b}	36.4^{b}	36.6^{b}	40.7^{a}
pH	4.27^{a}	4.15^{a}	4.33^{ab}	4.60^{b}
Ratios:				
lactic:acetic	1.9^{a}	2.1^{a}	1.8^{a}	$.7^{b}$
lactic:DM loss	1.9^{a}	2.7^{a}	2.3^{a}	$.4^{b}$

[1]Each silage value is the mean of six silos.

[abc]Values on the same line with different superscripts differ (P<.05).

Table 14.2. Dry Matter Recoveries and Chemical Analyses of the Moderately Wilted Sudangrass Silages (Trial 2).[1]

Item	Control	CULBAC dry	CULBAC liquid	ADD-F
Dry matter:				
pre-ensiled, %	36.2	36.3	36.5	36.9
silage, %	34.8	35.1	34.7	35.2
	% of the DM ensiled			
Dry matter recovery	95.6	96.2	95.6	95.8
	% of the silage DM			
Lactic acid	5.08^{ab}	5.53^{a}	5.39^{a}	4.38^{b}
Acetic acid	1.73^{ab}	1.95^{a}	1.95^{a}	1.25^{b}
Propionic acid	.02	.02	.02	.03
Total fermentation acids	6.84^{a}	7.51^{a}	7.36^{a}	5.66^{b}
Crude protein:				
pre-ensiled, %	12.8	13.2	13.2	13.1
silage, %	14.3	13.4	13.6	13.8
	% of the total N			
Ammonia-N	6.8^{a}	7.7^{ab}	7.7^{ab}	8.4^{b}
Hot water insol.-N				
pre-ensiled, %	48.8	47.7	48.7	50.4
silage, %	40.4	40.4	41.7	41.7
pH	4.14	4.17	4.16	4.15
Ratios:				
lactic:acetic	3.0	3.1	3.0	3.8
lactic:DM loss	1.1^{ab}	1.4^{a}	1.1^{ab}	.8^{b}

[1]Each silage value is the mean of six silos.

[ab]Values on the same line with different superscripts differ ($P<.05$).

Table 14.3. Dry Matter Recoveries and Chemical Analyses of High Moisture Corn Silages (Trial 3).[1]

Item	Control	CULBAC dry	CULBAC liquid	ADD-F
	Silage treatment			
Dry matter:				
pre-ensiled, %	74.1	74.0	74.8	74.8
silage, %	72.3	72.5	72.7	72.3
	% of the DM ensiled			
Dry matter recovery	96.5[b]	97.3[a]	96.3[b]	96.7[b]
	% of the silage DM			
Lactic acid	1.26[a]	.84[c]	1.06[b]	.35[d]
Acetic acid	.19[c]	.12[b]	.13[b]	.09[a]
Butyric acid	.19[b]	.12[ab]	.13[ab]	.01[a]
Total fermentation acids	1.63[a]	1.08[b]	1.32[b]	.44[c]
Ethanol	.06[c]	.06[b]	.05[b]	.02[a]
Crude protein:				
pre-ensiled, %	8.53	8.67	9.08	8.85
silage, %	9.14	8.45	8.12	8.60
	% of the total N			
Hot water insol.-N				
pre-ensiled, %	94.4	85.1	86.2	95.0
silage, %	64.1	65.9	69.6	70.5
pH	3.95[a]	3.97[a]	3.99[b]	3.97[a]
Ratios:				
lactic:acetic	6.7[a]	7.3[a]	8.7[a]	4.1[b]
lactic:DM loss	.4[a]	.3[b]	.3[b]	.2[c]

[1]Each silage value is the mean of six silos.

[abcd]Values on the same line with different superscripts differ ($P<.05$).