

A Final Report on

An Evaluation of Silaferm and a Microbial Inoculant on the Fermentation and Aerobic
Stability of Corn Silage

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AN EVALUATION OF SILAFERM AND A MICROBIAL INOCULANT ON THE FERMENTATION AND AEROBIC STABILITY OF CORN SILAGE

ABSTRACT

We studied the effects of adding Silaferm and a microbial inoculant on the fermentation and aerobic stability of corn silage. Freshly chopped whole-plant corn was treated with nothing (untreated silage), urea (U) added at 15 lb/ton of wet forage, Silaferm added at 50 (A1) or 100 (A2) lb/ton, Silaferm and urea (60% and 40% of the added CP, respectively) added at 47 lbs/ton, and *Lactobacillus buchneri* and *Pediococcus pentosaceus* (400,000 and 100,000 cfu/g of wet forage, respectively). Addition of various N-based compounds had minimal effects on the fermentation end products of corn silage with the exception of predictable increases in the concentrations of ammonia-N and CP. Corn silage treated with *L. buchneri* had more acetic acid and 1,2 propanediol and fewer yeasts than did untreated silage. Treatment with *L. buchneri* and AU improved the aerobic stability of silage when compared to untreated silage. Dry matter recovery was not different among treatments. Future research should focus on the ability of a high level of A plus U to improve aerobic stability. Treatment with AU has potential for improving the aerobic stability of corn silage.

INTRODUCTION

Various nitrogenous compounds have been added to silages to improve their nutritive value (Muck and Kung, 1997). The added benefits from such additives specifically fall into two categories: 1) increased concentration of nitrogenous compounds that can be used by rumen microbes for synthesis of microbial protein and 2) an antifungal effect that inhibits the growth of yeasts and molds thereby improving the stability of silages when they are exposed to air. The objective of this study was to determine the effect of various nitrogenous additives and a microbial inoculant on the fermentation and aerobic stability of corn silage.

MATERIALS AND METHODS

Corn crop: Forage corn grown in the 2004 season was harvested at a whole plant DM of about 39%. Six 50-kg piles of chopped whole plant corn were prepared. One pile of forage was treated with either: 1) nothing, control (C), 2) urea added at 15 lb/ton of wet forage

(about 7% added CP/ton DM), 3) Silaferm added at 50 lb/ton (**A1**) (about 3.5% added CP/ton DM), 4) Silaferm added at 100 lbs/ton (**A2**) (about 7% added CP/ton DM), 5) Silaferm A1 and urea added at 47 lb/ton (**AU**) (about 7% added CP, 60% of CP from urea and 40% from A1), or 6) *L. buchneri* and *P. pentosaceus* (400,000 and 100,000 cfu/g of wet forage, respectively) (**LBC**). All N compounds were supplied by Ajinomoto, USA, Inc, Eddyville, IA. The microbial inoculant was supplied by Lallemand Animal Nutrition, Milwaukee, WI.

Silos: All additives were applied uniformly using a hand sprayer or via manual application onto the forage while constantly mixing. After thorough mixing, about 300 g of each treatment were packed into Micro-layered® bags and vacuumed and heat sealed (Best-Vac External Vacuum Sealer, Minipack America, Orange, CA). Three bags were opened for each treatment after 3 and 7 d of ensiling. Treated forages were also ensiled in four 20-L macro silos (27 cm, diameter × 36 cm, height) for each treatment (total of 24 macro silos) and allowed to ensile for 120 d before opening. Macro silos were sealed at the top with two layers of plastic (3 mil) and duct tape. All silos had a pack density of about 200-220 kg of DM/m³. Viability of the inoculants was assessed by pour plating serial 10-fold dilutions of dissolved inoculants on de Mann Rogosa Sharpe agar (Oxoid CM361, Hampshire, England). Plates were incubated aerobically at 32°C for 48 h. All silos were stored between 23 to 26°C. Weights of empty and full macro silos were recorded at filling and at opening.

Analytical procedures: Analytical procedures were as outlined by Kung and Ranjit (2001). Before ensiling, samples were obtained after the addition of each treatment and stored on ice until they were returned to the lab for processing. The DM content of fresh forages and silages were determined by drying at 60°C for 48 h in a forced-draft oven. Samples of forages and silages (25 g) were homogenized in 225 ml of sterile quarter-strength Ringer's solution for 1 min and then, filtered through Whatman 54 filter paper (Whatman, Inc., Clifton, NJ). The pH of the homogenized solutions were determined with a Corning pH meter (model no. 220, Corning Science Products, Corning, NY). The filtered water extract were acidified with 15 µl of 50% (wt/vol) H₂SO₄ to reduce the pH of the extract to < 2.0 before freezing. Water extracts were analyzed for ammonia-N by using the phenol-hypochlorite procedure described by Weatherburn (1967). Water-soluble carbohydrates (WSC) were analyzed by the procedure

described by Nelson (1944). After oven drying, feed samples were ground through a 1-mm screen using a Cyclone Sample Mill (Udy Corp., Fort Collins, CO). Samples were analyzed for laboratory DM by placing 0.5 g into a 100°C oven for 24 h. Samples were also analyzed for NDF by using sulfite and amylase (Van Soest et al., 1991) and ADF (Robertson and Van Soest, 1981) using an Ankom²⁰⁰ Fiber Analyzer (Ankom Technology, Fairport, NY). Total N was determined by combustion using a Leco CNS 2000 Analyzer (St. Joseph, MI) and CP was calculated by multiplying total N by 6.25. Total N was analyzed only for d0 and d 120 samples. The ash content was determined by placing 0.5 g of sample into a 600°C furnace for 4 h. Silages were also analyzed for fermentation end products as previously described. For analysis of lactic acid, acetic acid, propionic acid, butyric acid, and ethanol, water extracts were prepared and analyzed by HPLC.

The numbers of lactic acid bacteria on fresh forage and silages were determined on water extracts by pour plating serial 10-fold dilutions on de Mann Rogosa Sharpe agar. Yeast and molds were determined by pour plating in malt extract agar (Oxoid CM59) that had been acidified, after autoclaving, by the addition of 85% lactic acid at a concentration of 0.5% vol/vol. Plates for lactic acid bacteria and yeasts and molds were incubated at 32°C for 48 h.

Dry matter recoveries were calculated from measuring the weight of the empty silos, and knowing the initial and final silo weights and DM concentrations of the fresh and ensiled material. Aerobic stability was determined by returning 5 kg of each replicate to a clean 20-L silo without packing. Thermocouple probes were placed in the geometric center of each sample mass and a double layer of cheesecloth was placed over each silo to prevent drying and contamination, but allowing exposure to air. Ambient temperature as well as the temperature from each bucket were recorded every min and averaged after 2 h by a data logger (model number CR10X, Campbell Scientific, Inc., Logan, UT). The samples were allowed to aerobically deteriorate at room temperature (22 to 24°C). Aerobic stability was defined as the number of h before the temperature of the mass increased 2°C above the ambient temperature (Moran et al., 1996).

Statistical analysis: All microbial data were transformed to \log_{10} and are presented on a wet weight basis. Chemical data are presented on a DM basis. Data were analyzed using the general linear models procedure of SAS (1998) for a completely randomized design. Differences among means were tested using Tukey's Test (Snedecor and Cochran, 1980). An α level of $P < 0.05$ were deemed significant.

RESULTS

The chemical and microbial composition of freshly treated corn forage prior to ensiling is shown in Table 1. Statistical analyses were not done because these values represent the analyses of one composite sample. Whole-plant corn was about 40% DM and had pH that ranged from 5.27 to 6.07. The numbers of lactic acid bacteria were greater than 6 log cfu/g and numbers of yeasts and molds were about 5.2 and 4.1 log cfu/g, respectively. The CP content of untreated corn was 8.56% and it was slightly greater in A1 (8.65%) but substantially increased with the addition of the additives that contained the higher amounts of N (U = 12.90%, A1 = 8.65, A2 = 14.48 and AU = 13.70). Only treatment with A1 did not increase the CP to near theoretical expected values. The fiber, ash, and WSC contents were as expected and similar among treatments. Compared to untreated silage that had 0.019% ammonia-N, silages treated with added N contained more than 0.20% ammonia-N. Treatment with A2 resulted in silage with 2.037% ammonia-N which is unexplainable at this time.

The microbial and chemical compositions of silages after 3 d of ensiling are shown in Table 2. Numbers of lactic acid bacteria were 8.38 log cfu/g and numbers of yeasts were log 2.16 log cfu/g in untreated silage. Treated silages all had numerically greater numbers of these microbes than did untreated silage. Molds were not detectable at d 3. After 3 d of ensiling, the pH had not decreased for untreated silage. However, silage pH had declined to below pH 5 for U and AU, and to below pH 4 for A1, A2, and LBC. Compared to untreated silage (lactic acid = 2.60% and acetic acid = 0.52%), silage treated with U had 4.17% and 0.78% lactic and acetic acid, respectively ($P < 0.05$). Relative to untreated silage, the concentrations of lactic, propionic, and acetic acids and 1,2 propanediol and ethanol were not affected by other treatments. The one exception to this was that silage treated with A2 had more ($P < 0.05$) propionic acid (0.16%) than did untreated silage (0.10%). Ammonia-N was

lowest ($P < 0.05$) in untreated silage and silage treated with LBC and was greater (0.29 to 0.60%, $P < 0.05$) in all other treated silages. Silages treated with U and AU had the lowest ($P < 0.05$) concentrations of WSC (1.23 and 1.30%, respectively) and silage treated with LBC also had lower ($P < 0.05$) concentrations of WSC than did untreated silage.

The microbial and chemical compositions of silages after 9 d of ensiling are shown in Table 3. Numbers of lactic acid bacteria were greater than 9 log cfu/g in all treatments and were unaffected by treatment. Numbers of yeasts were greater than 5.5 log cfu/g for A1 and A2 treated silages but only 3.68 log cfu/g in untreated silage ($P < 0.05$). Silage treated with LBC had the fewest ($P < 0.05$) numbers of yeasts (0.98 log cfu/g) than any other treatment. Molds were undetectable in any silage after 9 d. The pH of untreated silage was 3.77 and this was not different from the pH of silages treated with A1 (3.80), A2 (3.84) or LBC (3.78). Silages treated with U (4.15) and AU (4.09) had a higher pH ($P < 0.05$) than did all other silage. Compared to untreated silage (3.84%), silage treated with U had a greater concentration of ($P < 0.05$) lactic acid (5.09%). However, treatments had similar concentrations of acetic acid when compared to untreated silage. The concentrations of propionic acid were unaffected by treatments and 1,2 propanediol was undetectable in any silage. The concentration of ethanol was higher ($P < 0.05$) in silages treated with A1 (0.55%) and A2 (0.68%) than in untreated silage (0.18%). Ammonia-N remained high in all silages treated with N (0.318 to 0.642%) and was lowest ($P < 0.05$) in untreated (0.038%) and LBC (0.035%) silages. Silages treated with N containing compounds all had lower ($P < 0.05$) WSC than did untreated silage.

The compositions of silages after 120 d of ensiling are shown in Table 4. Dry matter recovery was unaffected by any treatment. Lactic acid bacteria decreased from more than 9 log cfu/g at 9 d after ensiling to about 6.5 log cfu/g for most treatments after 120 d of ensiling. One exception was that silage treated with LBC had more than 8 log cfu of lactic acid bacteria per g of silage ($P < 0.05$). Numbers of yeasts were unaffected by treatment but was numerically lowest for silage treated with LBC. Silage treated with U had the highest pH (4.01) ($P < 0.05$) followed by silage treated with AU (3.93), followed by silages treated with A1, A2 and LBC (3.77, 3.83, and 3.81), and was lowest for untreated silage (3.74). The

concentration of lactic acid in untreated silage was 5.35% and was not different compared to other treatments. In contrast, silage treated with LBC had the greatest concentration (1.63%) of acetic acid compared to other treatments with the exception of U (1.33%). Treatment with A2 and AU resulted in silages with 0.15% and 0.14% propionic acid, respectively which was greater ($P < 0.05$) than that found in untreated silage (0.11%). Propanediol was detected only in silage treated with LBC (0.94%, $P < 0.05$). The concentration of ethanol was greatest in untreated silage (1.14%, $P < 0.05$), intermediate in silages treated with U, A1, A2, and LBC, and lowest (0.47%) in silage treated with AU. Although some differences among treatments were detected in NDF concentration, treatment had no effects on either NDF or ADF concentration of silage relative to untreated silage. The CP concentration of silages was greatest ($P < 0.05$) for silages treated with U, A1, A2 and AU and not different between silage that was untreated and silage treated with LBC. All added N compounds increased the CPT content of silages to levels theoretically expected. Similar findings were observed for the concentrations of ammonia-N. The ash content was not different among silages. All silages had WSC concentrations below 1.90% and those treated with LBC and A2 were lower than in untreated silage.

The aerobic stability of silages after ensiling for 120 d and being exposed to air is shown in Figure 1. Untreated silage spoiled in 28.5 h and treatments with U, A1 and A2 had no effect on stability. However, silage treated with AU was stable for 44 h and silage treated with LBC was stable for 66.5 h ($P < 0.05$).

DISCUSSION

In general, treatment with Silaferm alone (A1 and A2) had minor effects on fermentation of corn silage. A major exception to this finding was that these compounds predictably increased the CP and ammonia content of the resulting silages. Hydrolysis of added urea from treatments U and AU was apparent after 3 d of fermentation as the ammonia-N concentration of these silages were increased substantially from their initial values on day 0. From d 9 on, these silages also had a higher pH than did untreated silage possibly due to the release of ammonia. With the exception of a very high concentration of ammonia-N for A2 in freshly treated forage (which we cannot explain) the ammonia-N content of silages

treated with A1 (about 0.4%) and A2 (about 0.6%) remained rather constant throughout the ensiling period. Addition of U and AU also had minimal effects on most fermentation end products and populations of microorganisms. In the past, Bolsen et al. (1992) criticized the use of ammonia treatments because they caused prolonged fermentations resulting in poor DM recoveries. Treatment with ammonia raises the initial pH of cut corn to extremely high levels (between pH 7 and 9, Kung et al., 2000). This high pH is most likely the cause for a more prolonged fermentation and extended persistence of enterobacteria and lactic acid bacteria (Kung et al., 2000) that both are able to produce acetic acid. In the current study, the treatments containing urea (U and AU) had moderate effects on forage pH and did not change the lactic:acetic ratio. This suggests that these treatments did not prolong the fermentation process and this may be a reason that DM recovery was not adversely affected by these treatments in the current study.

Addition of U, A1 and A2 had no effects on the aerobic stability of corn silage which could be predicted because these treatments did not affect the numbers of yeasts in silage relative to untreated silage. The improvement in aerobic stability for AU relative to untreated silage cannot be explained by differences in detectable chemical or microbiological differences. Lower levels of ethanol in the silages treated with U, A1 or AU could not be consistently explained by either a shift from a heterolactic acid type of fermentation or by a reduction in number of yeasts. However, silage treated with A2 had a higher lactic:acetic acid ratio that could partially explain a lower concentration of ethanol for this treatment because there should be theoretically lower amounts of this alcohol produced in a homolactic than heterolactic fermentation. In past studies, addition of urea to various forage crops has had variable effects on the aerobic stability of silages. For example, when added to whole-plant corn (Britt and Huber, 1975), whole crop wheat (Hill and Leaver, 2002), and alfalfa silages (Keller et al., 1994), treatment with urea has improved aerobic stability. However, O'Kiely (1998) reported only marginal effects of urea on the aerobic stability of corn silage. In instances where addition of urea does not result in a large increases in ammonia-N and pH, its effect on aerobic stability would be probably less than from added anhydrous or aqua-ammonia (Muck and Kung, 1997).

The improvement in aerobic stability afforded by LBC may be primarily explained by the higher concentration of acetic acid and numerically lower numbers of yeasts for this treatment. These findings are common hallmarks for silages treated with *L. buchneri* (Ranjit and Kung, 2002; Kleinschmit et al., 2005). After 120 d of ensiling, only silage treated with LBC had detectable concentrations of 1,2 propanediol which is an additional end product of the anaerobic degradation of lactic acid by *L. buchneri*. Some microbes have the capacity to further metabolize 1,2 propanediol in some silages to propionic acid but this finding is inconsistent and did not occur in the current study because silage treated with LBC had similar concentrations of propionic acid as did untreated silage.

CONCLUSIONS

Addition of various N-based compounds had minimal effects on the fermentation end products of corn silage with the exception of predictable increases in the concentrations of ammonia-N and CP. Only treatment with AU improved the aerobic stability of silage relative to untreated silage. As has been documented in past studies, corn silage treated with *L. buchneri* had more acetic acid and fewer yeasts than did untreated silage. Although the aerobic stability of silage treated with *L. buchneri* was statistically not different than silage treated with AU, it was numerically greater. Future research should focus on the ability of a high level of A plus U to improve aerobic stability. Treatment with AU has potential for improving the aerobic stability of corn silage.

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Table 1. Chemical (DM basis) and microbial composition (wet basis) of freshly treated chopped, whole-plant corn after treatment but before ensiling.

Items	C ¹	U	A1	A2	AU	LBC
DM, %	39.13	40.73	40.41	41.38	40.82	40.24
LAB ² , log ₁₀ cfu/g	6.49	6.41	6.43	6.57	6.30	6.23
Yeasts, log ₁₀ cfu/g	5.09	5.20	4.84	5.14	5.24	5.31
Molds, log ₁₀ cfu/g	4.15	4.11	4.00	4.18	4.20	4.18
pH	5.95	6.49	5.61	5.27	6.07	5.77
NDF, %	48.10	48.04	47.46	48.60	46.03	49.07
ADF, %	32.10	26.34	25.83	28.70	28.62	29.58
CP, %	8.56	12.90	8.65	14.48	13.70	7.68
Ash, %	4.11	3.52	3.86	4.91	3.92	3.72
NH ₃ -N, %	0.019	0.030	0.240	2.037	0.207	0.019
WSC ³ , %	5.73	4.37	5.20	5.46	4.70	5.61

¹C = untreated silage, U = urea added at 15 lb/ton of wet forage, A1 = 3) Ajinomoto Silaferm added at 50 lb/ton, A2 = Ajinomoto Silaferm added at 100 lbs/ton, AU = Ajinomoto Silaferm and urea added at 47 lbs/ton, and LBC = *L. buchneri* and *P. pentosaceus* (400,000 and 100,000 cfu/g of wet forage, respectively).

²Lactic acid bacteria.

³Water soluble carbohydrates.

Table 2. Chemical (DM basis) and microbial composition (wet basis) of corn silage at 3 d of ensiling.

Items	C ¹	U	A 1	A 2	AU	LBC	S.E.
DM, %	41.88	40.66	40.18	41.88	40.63	42.43	0.53
LAB ² , log ₁₀ cfu/g	8.38	9.30	9.13	9.20	9.28	9.23	0.31
Yeasts, log ₁₀ cfu/g	2.16	3.63	4.83	5.15	3.79	3.23	0.94
Molds, log ₁₀ cfu/g	0	0	0	0	0	0	0
pH	5.96	4.27	3.99	3.97	4.27	3.91	0.82
Lactic acid, %	2.60 ^b	4.17 ^a	2.76 ^b	2.92 ^b	3.41 ^{ab}	2.68 ^b	0.18
Acetic acid, %	0.52 ^b	0.78 ^a	0.51 ^b	0.50 ^b	0.65 ^{ab}	0.56 ^{ab}	0.05
Lactate:acetate	5.03	5.39	5.55	6.05	5.22	4.83	0.45
Propionic acid, %	0.10 ^b	0.11 ^{ab}	0.14 ^{ab}	0.16 ^a	0.11 ^{ab}	0.11 ^{ab}	0.01
1,2 Propanediol, %	0	0	0	0.13	0	0	0.05
Ethanol, %	0.17	0.13	0.21	0.37	0	0.31	0.11
NH ₃ -N, %	0.03 ^d	0.29 ^c	0.45 ^{ab}	0.60 ^a	0.39 ^{bc}	0.03 ^d	0.03
WSC ³ , %	3.66 ^a	1.23 ^c	3.47 ^{ab}	4.25 ^a	1.30 ^c	2.57 ^b	0.20

¹C = untreated silage, U = urea added at 15 lb/ton of wet forage, A1 = 3) Ajinomoto Silaferm added at 50 lb/ton, A2 = Ajinomoto Silaferm added at 100 lbs/ton, AU = Ajinomoto Silaferm and urea added at 47 lbs/ton, and LBC = *L. buchneri* and *P. pentosaceus* (400,000 and 100,000 cfu/g of wet forage, respectively).

²Lactic acid bacteria.

³Water soluble carbohydrates.

Table 3. Chemical (DM basis) and microbial composition (wet basis) of corn silage at 9 d of ensiling.

Items	C ¹	U	A 1	A 2	AU	LBC	S.E.
DM, %	40.06	39.20	39.14	39.95	40.84	41.27	0.58
LAB ² , log ₁₀ cfu/g	9.03	9.23	9.09	9.03	9.07	9.14	0.04
Yeasts, log ₁₀ cfu/g	3.68 ^b	4.98 ^{ab}	5.66 ^a	5.77 ^a	4.85 ^{ab}	0.98 ^c	0.41
Molds, log ₁₀ cfu/g	0	0	0	0	0	0	0
pH	3.77 ^b	4.15 ^a	3.80 ^b	3.84 ^b	4.09 ^a	3.78 ^b	0.02
Lactic acid, %	3.84 ^{bc}	5.09 ^a	3.92 ^{bc}	3.96 ^{bc}	4.41 ^{ab}	3.04 ^c	0.20
Acetic acid, %	0.65 ^{ab}	0.80 ^a	0.54 ^b	0.50 ^b	0.77 ^a	0.55 ^b	0.03
Lactate:acetate	5.90 ^{cd}	6.38 ^c	7.27 ^b	7.91 ^a	5.71 ^d	5.53 ^d	0.11
Propionic cid, %	0.12	0.12	0.13	0.16	0.12	0.11	0.01
1,2 Propanediol, %	0	0	0	0	0	0	0
Ethanol, %	0.18 ^c	0.29 ^{bc}	0.55 ^{ab}	0.68 ^a	0.25 ^c	0.10 ^c	0.06
NH ₃ -N, %	0.038 ^d	0.318 ^c	0.428 ^{bc}	0.642 ^a	0.455 ^b	0.035 ^d	0.03
WSC ³ , %	2.22 ^a	0.48 ^c	1.28 ^{bc}	1.35 ^{bc}	0.97 ^{bc}	1.71 ^{ab}	0.18

¹C = untreated silage, U = urea added at 15 lb/ton of wet forage, A1 = 3) Ajinomoto Silaferm added at 50 lb/ton, A2 = Ajinomoto Silaferm added at 100 lbs/ton, AU = Ajinomoto Silaferm and urea added at 47 lbs/ton, and LBC = *L. buchneri* and *P. pentosaceus* (400,000 and 100,000 cfu/g of wet forage, respectively).

²Lactic acid bacteria.

³Water soluble carbohydrates.

Table 4. Chemical (DM basis) and microbial composition (wet basis) of corn silage at 120 d of ensiling.

Items	C ¹	U	A 1	A 2	AU	LBC	S.E.
DMR ² , %	92.30	90.44	95.88	89.61	91.15	91.41	1.60
DM, %	39.65	40.41	42.30	40.60	40.67	40.47	0.66
LAB ³ , log ₁₀ cfu/g	6.72 ^b	6.41 ^b	6.39 ^b	6.33 ^b	6.57 ^b	8.21 ^a	0.21
Yeasts, log ₁₀ cfu/g	5.76	5.97	5.56	5.27	5.56	4.61	0.41
Molds, log ₁₀ cfu/g	1.20	0.71	0	0	0	0	0.41
pH	3.74 ^d	4.01 ^a	3.77 ^{cd}	3.83 ^c	3.93 ^b	3.81 ^c	0.01
Lactic acid, %	5.35 ^{ab}	6.58 ^a	5.01 ^b	4.80 ^b	5.78 ^{ab}	4.47 ^b	0.30
Acetic acid, %	1.07 ^{bcd}	1.33 ^{ab}	0.92 ^{cd}	0.75 ^d	1.12 ^{bc}	1.63 ^a	0.08
Lactate:acetate	5.01 ^b	4.94 ^b	5.47 ^b	6.43 ^a	5.18 ^b	2.77 ^c	0.13
Propionic acid, %	0.11 ^{cd}	0.11 ^{bcd}	0.13 ^{abc}	0.15 ^a	0.14 ^{ab}	0.10 ^d	0.01
1,2 Propanediol, %	0 ^b	0 ^b	0 ^b	0 ^b	0 ^b	0.94 ^a	0.03
Ethanol, %	1.14 ^a	0.69 ^{bc}	0.75 ^{bc}	0.84 ^b	0.47 ^c	0.61 ^{bc}	0.06
NDF, %	42.29	38.32	38.14	39.13	43.76	43.17	1.56
ADF, %	26.27 ^{abc}	23.85 ^{bc}	22.62 ^c	24.95 ^{abc}	28.47 ^{ab}	28.80 ^a	1.10
CP, %	8.40 ^c	15.12 ^a	11.22 ^b	14.66 ^a	14.89 ^a	8.65 ^c	0.19
Ash, %	3.43	3.09	3.10	3.38	3.64	2.90	0.26
NH ₃ -N, %	0.07 ^c	0.36 ^b	0.38 ^b	0.68 ^a	0.45 ^b	0.07 ^c	0.03
WSC ⁴ , %	1.89 ^a	1.30 ^{ab}	1.51 ^{ab}	1.29 ^b	1.36 ^{ab}	1.16 ^b	0.13

¹C = untreated silage, U = urea added at 15 lb/ton of wet forage, A1 = 3) Ajinomoto Silaferm added at 50 lb/ton, A2 = Ajinomoto Silaferm added at 100 lbs/ton, AU = Ajinomoto Silaferm and urea added at 47 lbs/ton, and LBC = *L. buchneri* and *P. pentosaceus* (400,000 and 100,000 cfu/g of wet forage, respectively).

²DM recovery.

³Lactic acid bacteria.

⁴Water soluble carbohydrates.

Figure 1. Effect of nitrogenous additives on the aerobic stability of corn silage after 120 d of storage. C = untreated silage, U = urea added at 15 lb/ton of wet forage, A1 = 3) Ajinomoto Silaferm added at 50 lb/ton, A2 = Ajinomoto Silaferm added at 100 lbs/ton, AU = Ajinomoto Silaferm and urea added at 47 lbs/ton, and LBC = *L. buchneri* and *P. pentosaceus* (400,000 and 100,000 cfu/g of wet forage, respectively).

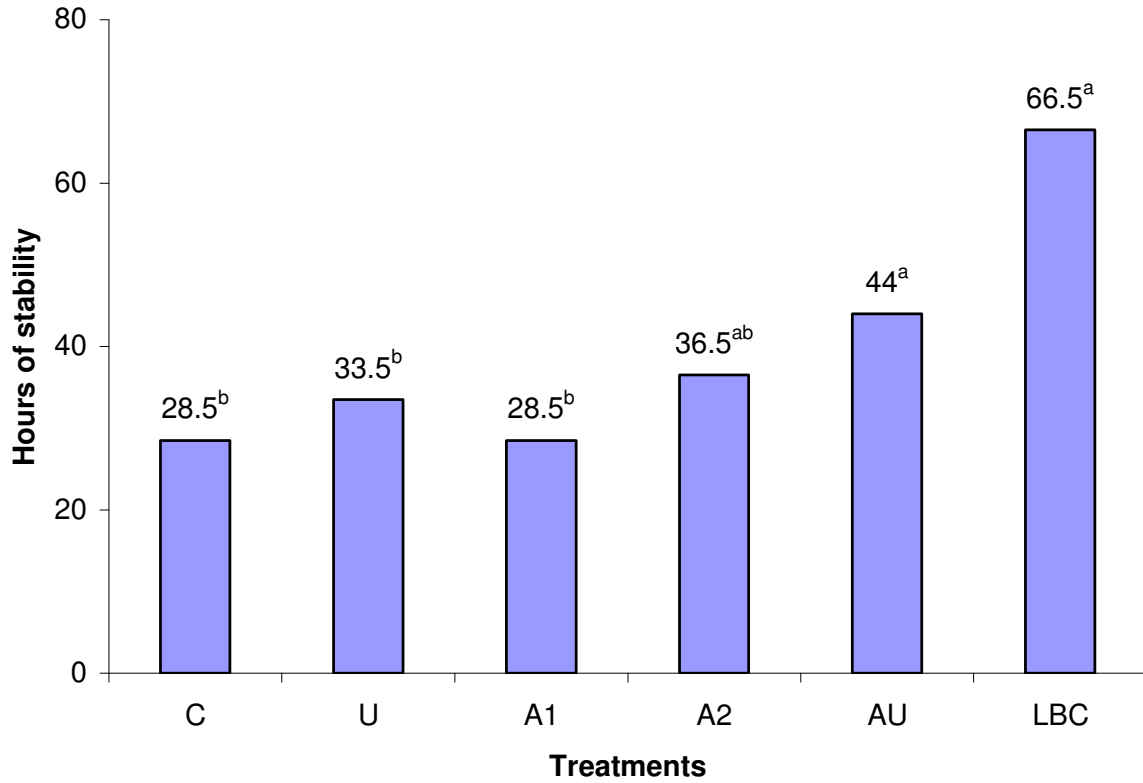


Table 5. True protein (DM basis) of corn silages at 0 and 120 d of ensiling.

Day	C ¹	U	A 1	A 2	AU	LBC	S.E.
0	6.16	7.00	7.17	7.49	7.19	6.06	
120	5.58 ^a	5.92 ^{ab}	5.95 ^{ab}	6.96 ^c	6.30 ^b	5.51 ^a	0.13

¹C = untreated silage, U = urea added at 15 lb/ton of wet forage, A1 = 3) Ajinomoto Silaferm added at 50 lb/ton, A2 = Ajinomoto Silaferm added at 100 lbs/ton, AU = Ajinomoto Silaferm and urea added at 47 lbs/ton, and LBC = *L. buchneri* and *P. pentosaceus* (400,000 and 100,000 cfu/g of wet forage, respectively).

abcMeans within row without common superscripts differ. P < 0.05.

Figure 2. In-vitro dry matter digestibility of silages, d 120.

