Effect of BioPreserve silage inoculant on fermentation profile of corn silage

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Introduction

Inoculants are used to improve the ensiling process and to increase stability of the silage during feedout. BioPreserve inoculant is produced by Advanced Crop Nutrition and contains a consortium of live microorganisms that has never been dried or frozen. Initial research when rye silage was inoculated with BioPreserve resulted in improved feedlot performance for cattle fed rye silage inoculated with BioPreserve (Inwood Feedlot, 2015). Use of BioPreserve has resulted in corn silage having higher starch levels; lower acid detergent insoluble nitrogen; and less ammonia when compared to other inoculants or no inoculant during on-farm or on-feedlot side by side comparison. Based on these initial evaluations, a trial was conducted in the fall of 2016 to compare the fermentation profile of corn silage inoculated with 1) No inoculant; 2) BioPreserve; and 3) another company's inoculant that has historically been commonly used.

Procedures

Corn silage was harvested in Sioux County Iowa on Sept 2, 2016. The yield of the corn silage was 24.5 tons/acre with estimated corn yield of 212 bu/acre. One load of silage was unloaded on a concrete pad adjacent to the pile of corn silage being made for the feedlot. Nine polyethylene totes (40"L × 48"W × 46" H) had their top removed; their bottom valves closed; and were filled with corn silage using a skid steer loader. There were three totest per treatment with the treatments being: **1) No inoculant; 2) BioPreserve; and 3) Inoculant-X**. The silage was sprayed with either 1) water; 2) BioPreserve; or 3) Inoculant-X. Care was taken to get all of the silage sprayed with each treatments application. The control (no inoculant) silage was added to their respective totes first. Then the three totes were filled with corn silage as BioPreserve was sprayed onto the silage as it was loaded into each tote. The third treatment's totes were filled as Inoculant-X was sprayed onto the silage as it was loaded into each tote. Each tote was weighed empty and again after it was filled with silage. A Prime Scales floor scale equipped with a Prime Scales Model PS-IN108M scale head was used to measure the weight of each tote. After the totes were weighed a concrete weight was applied to the top of each tote. There were two weights used with the weight ranging from 1100 to 1300 lb. The weights were placed on each tote for 10 minutes. The heavy weight was used on two out of the three totes for each treatment. After packing the silage, the totes were sealed with an 8mm Raven silage tarp. On day 7 after filling the totes, pH of the corn silage was measured using an Oakton pH 150 probe.

BioPreserve was inoculated at a rate of 2 ounces/ton of silage. Inoculant-X was added according to manufacturer's labeled rates. Each of the inoculants was diluted in 1 gallon of distilled water.

Measurements

Corn silage temperature was measured daily for 28 days using a 3 foot long temperature probe (ReoTemp Inst. Corp., San Diego, CA). After the silage temperature was measured by poking the probe through plastic, silage tape was used to seal the hole. Corn silage was weighed at initiation of the experiment and again, 60 days later, when the totes were emptied out onto a concrete pad. Corn silage samples were taken on the day that the silage was chopped. Corn silage samples were also taken on day 60. That is the day that the silage was removed from the totes. Prior to the silage being removed, a sample was taken out of the center of each tote. Another sample was taken once the totes were emptied out. Samples were taken on days 1, 2, and 3 after the silage was removed from the totes. This was done to simulate silage feed-out so that we could evaluate aerobic stability of the silage.

After corn silage samples were taken, they were frozen prior to being sent to Cumberland Valley Analytical Services Laboratory. Near infrared and wet chemistry laboratory procedures were used.

Results

The data from the composite sample taken on the day that the totes were emptied and the samples from the three subsequent days were used to calculate the treatment means. Table 1 contains the initial and final weight of the silage and the percent shrink over the 60-day fermentation period. The silage inoculated with BioPreserve had 19% less shrink than the non-treated silage with 3.6% lower shrink than Inoculant-X. Under near-perfect storage conditions during the 60-day storage period, the Control had 3.7% more shrink vs BioPreserve. The shrink extrapolated over a typical storage period would be much higher. BioPreserve and Inoculant-X performed similarly with regard to shrink.

Table 2 contains the initial dry matter and nutrient profile of the corn silage used in the experiment. With the starch content of 35% and average ADF of 22%, the silage is representative of high energy corn silage.

Table 3 contains the dry matter and nutrient content of the silage from the three inoculant treatments. The dry matter post 60-days of storage was slightly higher compared with the initial dry matter. The protein of the samples varied slightly with the inoculated silage being higher in protein. Ammonia, either as a percent of dry matter or as a percent of crude protein was higher for the non-inoculated silage. There should be less ammonia produced in inoculated silage. The trend in NDF and ADF was lower levels in the silage from inoculant-X and the highest levels from the control, BioPreserve was intermediate. The converse occurred for starch. Importantly, ADICP was lowest for BioPreserve, which is an indirect measurement of available protein. Lower levels indicate less protein was tied up during the heat of fermentation. Additionally, ash was lower for the silage that was inoculated with BioPreserve having the lowest ash content.

Table 4 contains the organic acid profile after 60 days of fermentation. Total volatile fatty aicds (VFA) were higher for BioPreserve with the non-inoculated silage and the inoculant-X silage being similar. There was more lactic acid and less acetic acid as a percent of the dry matter for BioPreserve, however, inoculant-X had a higher lactic:acetic ratio.

Table 5 contains the digestibility of starch and NDF after 60 days of fermentation. The NDF digestibility of BioPreserve inoculated silage was highest at 60 days post-harvest. The treatment means are graphed by day after the silage was removed from the tote (Figure 5). The NDF digestibility of BioPreserve was highest on day 0 and 2 and similar to the inoculant-X silage on days 1, and 3. Control silage had the lowest NDF digestibility and highest uNDF. Starch content was lowest for Control, however, the starch digestibility was highest for the inoculant-X silage. The rate of starch digestion and starch digestibility was lowest for the BioPreserve silage. Furthermore, the lower starch digestibility in the silage from the BioPreserve silage is hypothesized to be due to this inoculant fermenting the more available starch resulting in higher VFA content. This difference was primarily due to the large decrease in starch digestibility at 3 days of the silage being removed from the tote and simulating a 3-day feed out of a pile of silage. This demonstrates that silage needs to be fed up within 2 days after being removed from the silage face.

Table 6 contains calculated milk production and calculated energy values based on the nutrient analyses by Cumberland Valley Analytical Services Laboratory. The milk per ton calculation was highest for the inoculated silages as were the RFC fill index and NSC. The RFC fill index is important when taking into account the rate of digestion of the carbohydrate fractions of the corn silage. A higher RFC fill index minimizes the constraint of gut fill on inclusion rate of the silage.

Summary: The inoculated silage had less shrink, NDF, ADF, and ammonia vs Control. Additionally, inoculated silage had more starch and increased digestibility. BioPreserve performed similarly to inoculant-X though there was less 1.45 percentage points less starch which may be partially explained by the 9.5% higher total VFA content. The largest change in starch digestibility occurred on the third day after removal from the tote. Due to these results, all silage that is removed from the face needs to be fed within 48 hours otherwise its feeding value greatly dimishes. BioPreserve improved corn silage quality vs non-inoculated silage.

Table 1. Initial and final silage weights and shrink.			
Item	Control	BioPreserve	Inoculant-X
Initial silage weight, lb	693	650	643
Final silage weight, lb	677	637	630
Difference, lb	16.0	12.7	13.0
Shrink, %	2.32	1.95	2.02
Change from Control, %	-	19.0	14.9
Change from Inoculant- X, %	-	3.6	-

Table 2. Initial silage dry matter and nutrient profile (data from 2 of the 3 totes from each treatment were used). All nutrients are on 100% DM basis.

Item	Initial corn silage analysis
Dry matter, %	33.5
Crude protein, %	8.4
ADIN, %	0.69
ADF, %	22.0
Starch, %	35.1
Ca, %	0.20
P, %	0.27
K, %	1.16

Table 3. Dry matter and nutrient content of the corn silage after 60 days of fermentation.			
Item	Control	BioPreserve	Inoculant-X
Dry matter, %	34.24	34.48	34.82
pH	3.94	3.83	3.85
Crude protein, %	8.34	8.68	8.75
Ammonia, % of DM	0.60	0.58	0.55
Ammonia, % of CP	7.22	6.65	6.28
ADF, %	22.20	21.35	20.70
NDF, %	35.23	34.92	33.38
Starch, %	36.90	37.41	38.86
ADICP, %	0.59	0.52	0.55
ADICP, % of CP	7.01	6.00	6.22
Ash, %	5.09	4.19	4.33

Table 4. Organic acid profile of corn silage after 60 days of fermentation.			
Item	Control	BioPreserve	Inoculant-X
Total VFA, %	5.87	6.33	5.78
Lactic acid, %	4.92	5.27	4.96
Acetic acid, %	0.95	1.04	0.81
Lactic acid, % of VFA	83.94	83.53	86.18
Lactic:Acetic	5.47	5.16	6.64

Table 5. Organic acid profile of corn silage after 60 days of fermentation.			
Item	Control	BioPreserve	Inoculant-X
NDF digestibility, % at 30h	19.41	19.92	18.93
uNDF, % at 30h	15.83	15.02	13.20
Starch digestibility, % at 7h	61.03	58.13	61.63
NDF digestibility rate, %/h	5.15	5.67	5.77
Starch digestibility rate, %/h	14.32	13.22	14.62

Table 6. Milk production and energy calculations.			
Item	Control	BioPreserve	Inoculant-X
Milk per ton, lb/ton	3229	3374	3352
NSC, % of DM	3.59	3.84	4.05
RFC – Fill index	3.59	3.84	4.05
TDN, %	73.20	74.50	74.83
NEl, Mcal/lb	0.76	0.77	0.77
NEm, Mcal/lb	0.78	0.79	0.80
NEg, Mcal/lb	0.50	0.51	0.52

Figure 1. Starch, % of DM

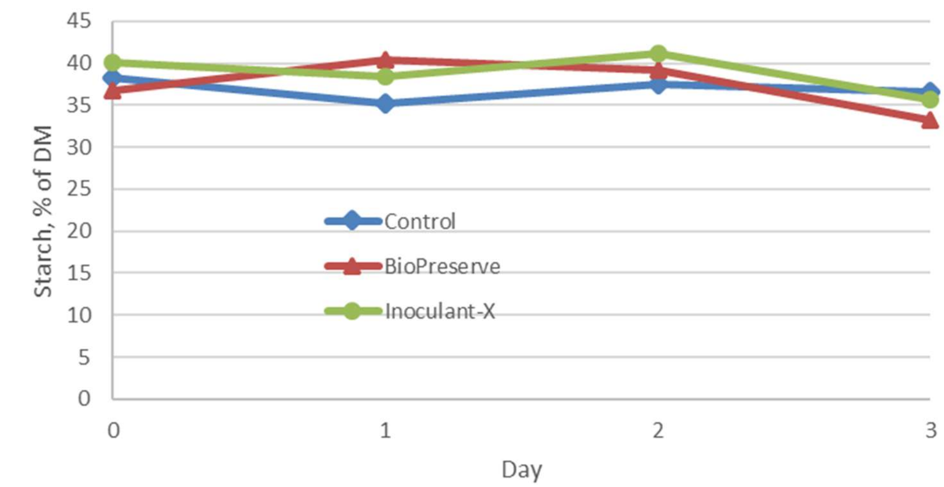

Figure 2. ADICP, % of DM

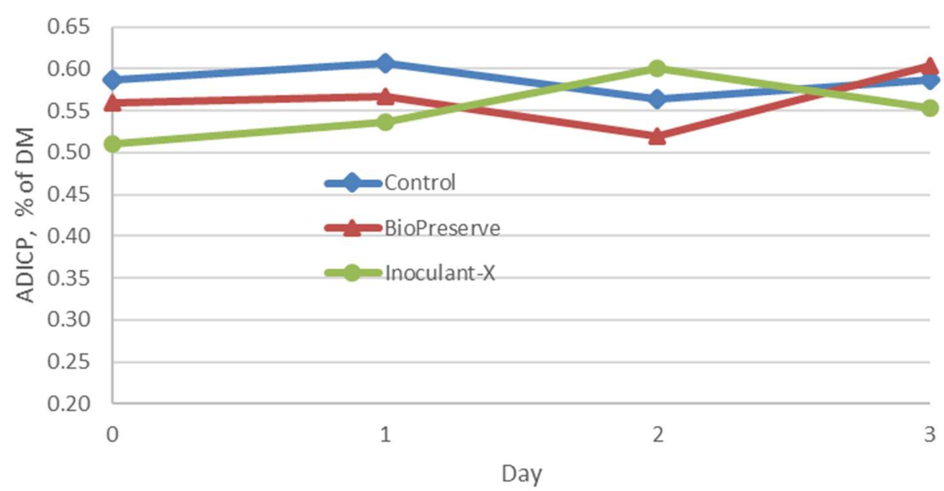

Figure 3. Lactic acid, % of DM

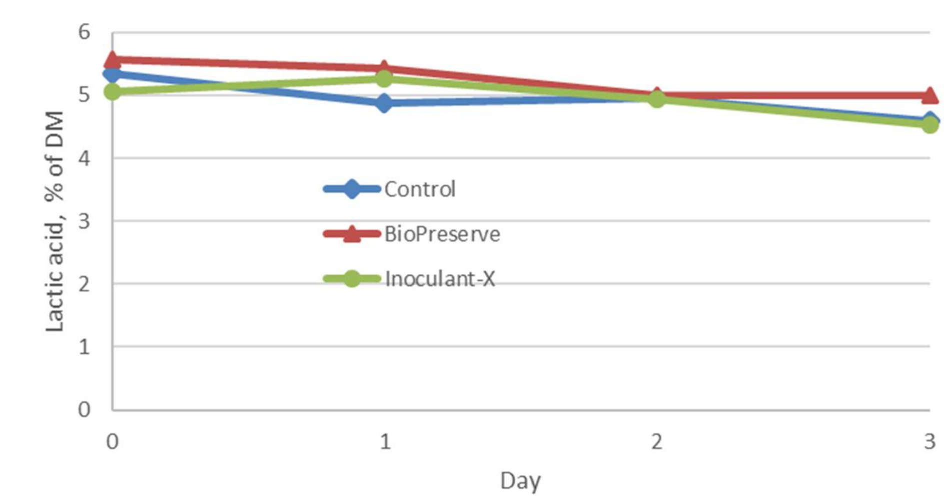

Figure 4. Acetic acid, % of DM

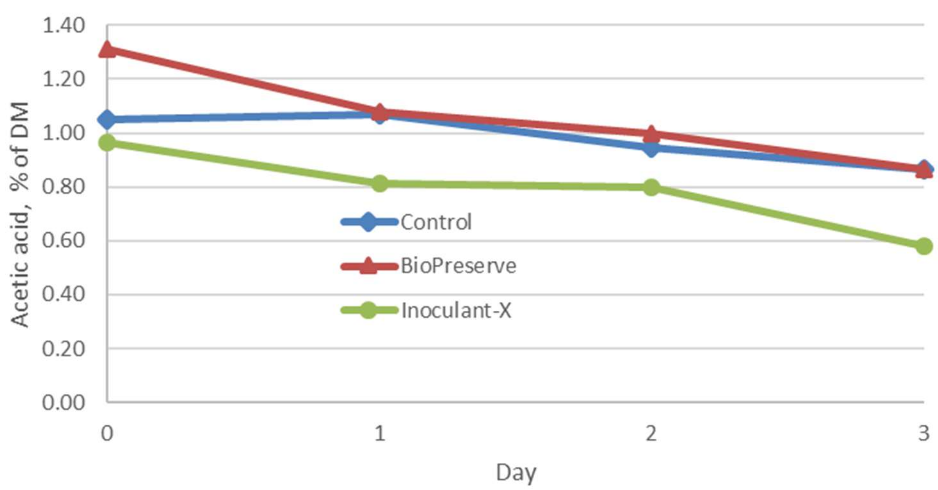

Figure 5. NDF digestibility, % of DM

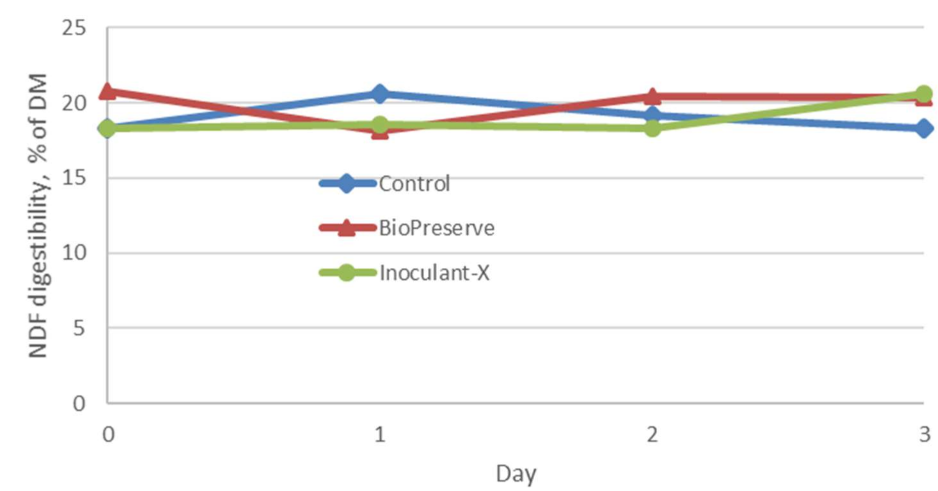

Figure 6. uNDF, % of DM

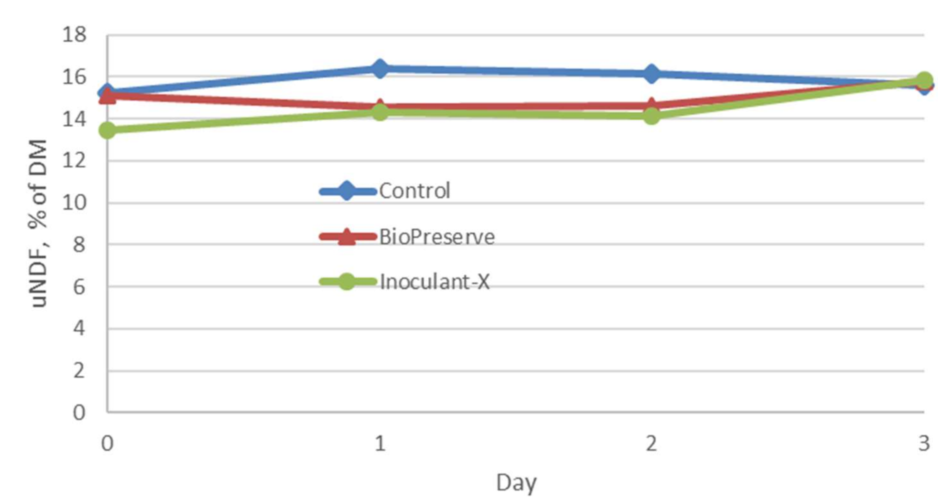

Figure 7. 7 h Starch digestibility, % of DM

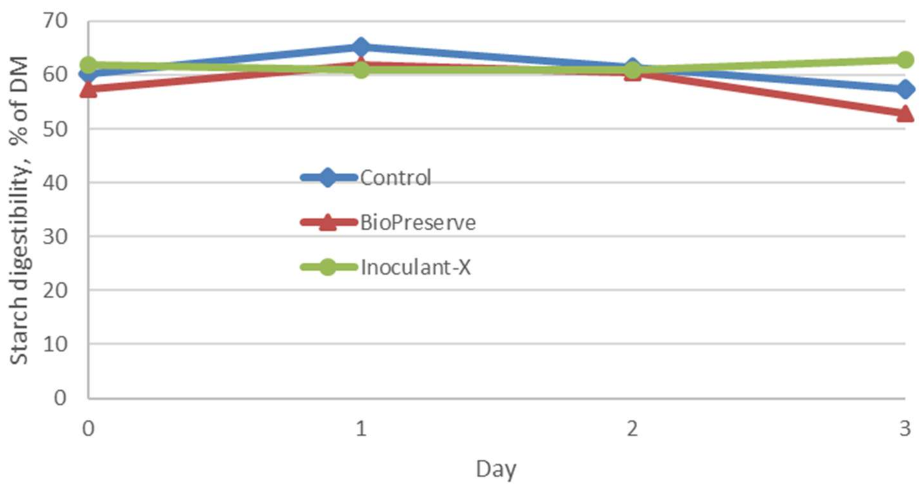

Figure 8. Starch digestibility, %/hour

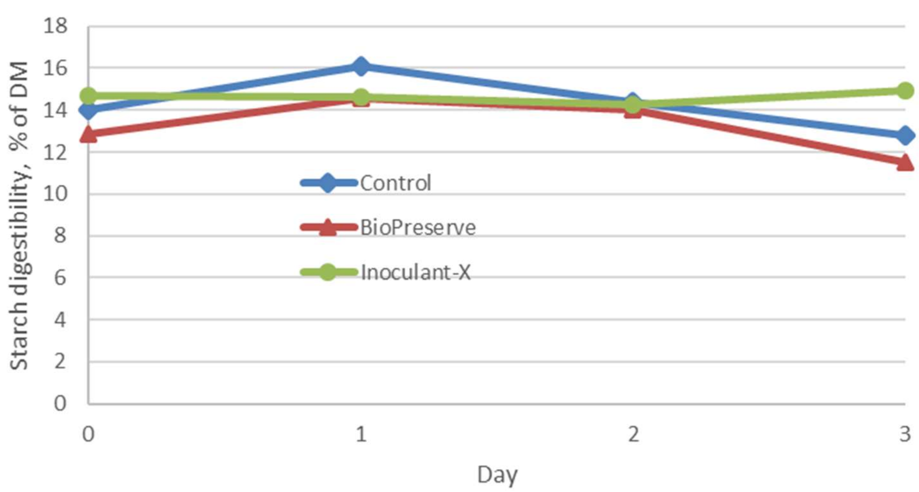

Figure 9. Silage dry matter, %