Abstract # W 117

Effects of Microbial Inoculants and Dry Matter Content at Harvest on the Fermentation, Aerobic Stability and Digestion of NDF of Two Corn Silage Hybrids

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Abstract

The objective of this study was to compare the effects of microbial inoculants on the ensiling process of two corn silages ensiled at different DM contents. Two hybrids (DeKalb 6339 and Pioneer 33A88) were harvested at four DM contents (30, 32, 37 and 42%) and untreated or treated with 11CFT (Pioneer Hi-Bred International, Inc., Johnston, IA) at a rate of 1×10^5 cfu of *L. buchneri* PTA6138 and 1×10^4 cfu of *L. casei* PTA6135 or with Buchneri 500 (Lallemand Animal Nutrition, Milwaukee, WI) at a rate of 4×10^5 cfu of *L. buchneri* 40788 and 1×10^5 cfu of *P. pentosaceus* 12455 per g of wet forage. Approximately 600 g of fresh forage was ensiled in vacuumed and heat sealed bag silos (quadruplicate per treatment) and stored for 150 days. At the time of opening, a representative sample was taken and analyzed for fermentation end products, microbial populations, aerobic stability and nutritive value. NDF digestion was determined using dried samples ground through a 6-mm screen in a Wiley mill, weighed into in situ bags and incubated in the rumen of fistulated steers for 48 h. There were hybrid × DM × treatment interactions for all fermentation end products except lactic acid, numbers of lactic acid bacteria and aerobic stability. Over all hybrids and DM contents, corn silages treated with Buchneri 500 and 11CFT had higher ($P < 0.0018$) concentrations of acetate when compared with untreated silages (1.52 and 1.55 vs. 1.05% of DM). The same response was observed for 1,2-propanediol (0.57 and 0.52 vs. 0.24% of DM) and the number of lactic acid bacteria (8.22 and 8.01 vs. 6.30 $\log_{10}$ CFU/g). Buchneri 500 and 11CFT silages were also more stable when exposed to air (291 and 269 h for silage temperature to reach 2°C above ambient vs. 203 h for control) and had fewer yeasts at the time of opening (0.84 and 0.76 vs. 2.35 $\log_{10}$ CFU/g in untreated silages). Inoculation did not statistically improve NDF-D for either hybrid, but when combined as a main effect there was a trend ($P < 0.1026$) for silage treated with 11CFT to be more digestible than untreated silage (45.49 vs. 43.96 % of NDF). Corn silage harvested at different maturity stages increased starch concentration without changing NDF digestion.

Introduction

Corn silage is a popular forage crop that is used on many dairy farms in the United States because of its high energy content and high yield of digestible nutrients. The preservation of this crop as silage can be improved by the utilization of microbial inoculants. Homolactic bacteria improve fermentation efficiency by increasing lactic acid production whereas heterolactic bacteria are used with the objective of preserving forage quality by increasing the production of anti-fungal compounds. Specifically, *Lactobacillus buchneri* has been demonstrated to improve aerobic stability of silages by increasing acetate production and reducing the growth of yeasts (Ranjit and Kung,2000). Recently, a new strain of *Lactobacillus buchneri* (PTA6138) capable of producing ferulic acid esterase was identified during a screening process performed by Nsereko et al. (2008). Interest has currently focused on the possible use of this enzyme to break the link between hemicellulose and lignin to improve fiber digestibility. According to Nsereko et al. (2008), inoculation of silage with these bacteria can enhance ruminal degradation of fiber and improve conservation and feeding value of ensiled crops. However, Hofherr et al. (2008) and Kang et al. (2009) reported inconsistent results for NDF-digestion of different corn hybrids treated with this microbial inoculant.

Objective

The objective of this study was to compare the effect of microbial inoculants on the fermentation, digestibility of fiber and aerobic stability of corn hybrids harvested at different DM (maturity) contents.

Materials and Methods

- Two corn silage hybrids (DeKalb 6339 and Pioneer 33A88) were harvested at 30, 32, 37 and 42% dry matter (DM)
- Treatments were as follow: 1) Control (untreated), 2) 11CFT silage inoculant (Pioneer Hi-Bred International, Inc., Johnston, IA) at a theoretical rate of inoculation of 1×10^5 cfu of *Lactobacillus buchneri* PTA6138 per gram of wet forage and 1×10^4 cfu/g of *Lactobacillus casei* PTA6135 and 3) Buchneri 500 (Lallemand Animal Nutrition, Milwaukee, WI) at a theoretical rate of inoculation of 4×10^5 cfu/g of *Lactobacillus buchneri* 40788 and 1×10^5 cfu/g of *Pediococcus pentosaceus* 12455.
- Approximately 600 g of fresh forage was ensiled in vacuumed and heat sealed bag silos (quadruplicate per treatment) and allowed to ferment for 150 days.
- Forage was analyzed for fermentation end products, microbial populations, aerobic stability (hours before a 2°C rise in temperature after exposure to air) and nutritive value. Digestibility of NDF was determined using dried samples ground through a 6-mm screen in a Wiley mill, weighed into in situ bags and incubated in the rumen of fistulated steers for 48 h (Pioneer Hi-Bred International, Inc., Johnston, IA).
- The experiment was performed in a completely randomized design and the data were analyzed with the GLM procedure (SAS Institute, 2002). The model included effect of the inoculant, hybrid and DM content and statistical significance was declared at the 5% level.

Results

- There were hybrid × DM × treatment interactions for numbers of lactic acid bacteria, aerobic stability and all fermentation end products except lactic acid.
- No hybrid × DM × treatment interactions were observed for nutritive value and NDF-D.
- Over all hybrids and DM contents, corn silages treated with Buchneri 500 and 11CFT had higher concentrations of acetate when compared with control (Table 1).
- The same response was observed for 1,2-propanediol and the number of lactic acid bacteria. Buchneri 500 and 11CFT silages were also more stable when exposed to air and had fewer yeasts at the time of opening (Table 1).
- Inoculation did not statistically improve NDF-D for either hybrid regardless of stage of maturity but when combined as a main effect there was a trend ($P < 0.10$) for silage treated with 11CFT to be more digestible than untreated silage (Figure 1).

Table 1. Main effects (averaged across 4 maturities and 2 hybrids) of microbial inoculants on fibrous components, fermentation profile, microbial population and aerobic stability of corn silages

Item	Treatment			SEM	*P* value
	Control	LBC[1]	11CFT[2]		
DM (%)	35.83	35.73	35.19	0.25	0.16
ADF (% of DM)	25.67[a]	25.14[ab]	24.44[b]	0.33	0.03
NDF (% of DM)	42.48	42.29	41.04	0.58	0.17
pH	3.71	3.74	3.74	0.01	0.06
Lactate (% of DM)	3.36	3.70	3.97	0.29	0.34
Acetate (% of DM)	1.05[b]	1.52[a]	1.55[a]	0.11	0.01
1,2-propanediol (% of DM)	0.24[b]	0.57[a]	0.52[a]	0.04	0.01
Yeast ($\log_{10}$ CFU/g)	2.35[a]	0.84[b]	0.76[b]	0.22	0.01
LAB[3] ($\log_{10}$ CFU/g)	6.30[b]	8.22[a]	8.01[a]	0.08	0.01
Aerobic stability (hours)	203[b]	291[a]	269[a]	10	0.01

[a,b,c] Means in the same row with different superscripts differ ($P < 0.05$).
[1] Pioneer 11CFT inoculant (Pioneer Hi-Bred International, Inc., Johnston, IA).
[2] Buchneri 500 inoculant (Lallemand Animal Nutrition, Milwaukee, WI).
[3] Lactic acid bacteria.

Figure 1. Neutral detergent fiber digestion of corn silage treated with microbial inoculant. Bars with unlike superscript differ ($P < 0.10$).

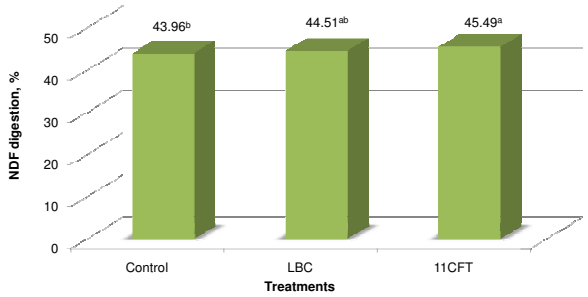
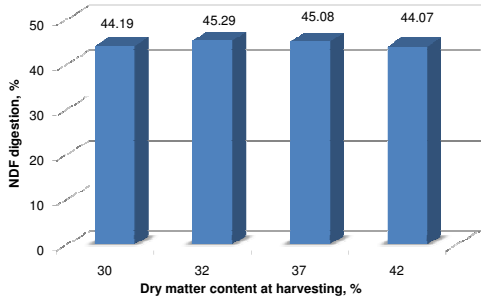


Table 2. Main effects of dry matter content at harvesting (averaged across 3 treatments and 2 hybrids) on nutritive value of corn silages treated with microbial inoculants

Item	Dry matter at harvesting (%)				SEM	*P* value
	30	32	37	42		
Dry matter (%)	29.47[a]	33.74[b]	37.38[c]	41.74[d]	0.29	0.01
Crude protein (% of DM)	9.39[a]	9.05[a]	8.02[b]	7.93[b]	0.14	0.01
ADF (% of DM)	26.93[a]	26.37[a]	24.48[b]	22.56[c]	0.38	0.01
NDF (% of DM)	43.29[a]	43.37[a]	41.90[a]	39.20[b]	0.68	0.01
ADL[1] (% of DM)	2.42[a]	2.33[a]	2.30[a]	2.04[b]	0.04	0.01
Starch (% of DM)	28.55[c]	26.42[d]	32.79[b]	35.39[a]	0.62	0.01

[a,b,c] Means in the same row with different superscripts differ ($P < 0.05$).
[1] Acid detergent lignin.

Figure 2. Neutral detergent fiber digestion of corn silage harvested at different dry matter contents.



- Over all hybrids and microbial inoculants, corn silages harvested at late maturity stages (more than 37%) accumulated more starch and reduced the deposition of cell wall components (Table 2).
- Only a small reduction in CP content was detected when corn silage was harvested at late maturity stages (above 37%).
- Furthermore, no statistical differences were observed for NDF-D across all the maturity stages (Figure 2).

Conclusions

Inoculation increased acetate and 1,2-propanediol concentration and the number of LAB. The application of these inoculants reduced the population of yeasts and improved aerobic stability after silo opening.

No significant improvement in NDF-D was observed when corn silage was treated with an LAB capable of producing ferulic acid esterase.

Corn silages harvested at late maturity stages accumulated more starch and reduced the concentration of cell wall components affecting NDF digestibility.

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