EFFECT OF A HOMO- AND HETEROFERMENTATIVE LACTIC ACID BACTERIA BLEND ON FERMENTATION QUALITY OF DIFFERENT SORGHUM VARIETIES

Celso Heinzen Jr.[1], Jan-Niklas Grund[1], Johanna Witt[2], Nicole Lau[2], Ewald Kramer[2]
[1] PROVITA SUPPLEMENTS Inc., Minnetonka, MN, USA, [2] ISF GmbH, Pinneberg, Germany

Keywords: male sterile sorghum, fermentation, sorghum-sudangrass.

INTRODUCTION

Sorghum is considered highly water-efficient and can be an alternative forage in drought-prone areas (Assefa et al., 2010). Recently, sorghum varieties available in the market has increased. Different varieties can be harvested in a wide range of moisture, being the highest values above 80%. The aim of this study was to test the effect of a mixture of homo- and heterofermentative lactic acid bacteria on fermentation of two different sorghum varieties harvested at very low dry matter.

MATERIAL & METHODS

- Sorghum-sudangrass was harvested at approximately 13% DM and forage sorghum was harvested at approximately 16% DM. Both hybrids were harvested from 3 different field locations (used as replication; 3 mini silos per treatment combination of inoculation and storage length) at Coffey Seeds Sorghum Nursery (Plainview, TX).
- Forage was sprayed with distilled water (CON); or 150,000 cfu/g wet forage of *L. brevis, L. buchneri, L. plantarum* (PRO, bonsilage PRO, PROVITA SUPPLEMENTS, Inc.), placed in vacuum pouches and vacuum-sealed using a standard food clamp vacuum machine.
- Each silo was randomly assigned to be stored for 3, 5 and 90 d. At opening, samples were sent to Dairyland Laboratories (Watertown, WI) to be analyzed for pH, water-soluble carbohydrates (WSC), fermentation profile and ammonia-N.
- For each hybrid, data were analyzed as a completely randomized design with a 2 × 3 factorial arrangement of treatments. Inoculant, storage length and their interaction were considered fixed effects. When an interaction was detected, the effect of microbial inoculant was studied within storage length.

Table 1. Effect of microbial inoculant and storage length on pH, water-soluble carbohydrates (WSC), fermentation profile, and ammonia-N of sorghum-sudangrass silage stored for 3, 5 and 90 d.

Item[1]		pH	WSC, % DM	Lactic acid, % DM	Acetic acid, % DM	Ethanol, % DM	1,2- propanediol, % DM	Ammonia-N, % total N
3 d	CON	4.19	3.84[b]	3.50[b]	0.58	0.61	0.00	1.27
	PRO	4.08	2.85[a]	4.43[a]	0.99	0.72	0.00	1.23
5 d	CON	3.62[b]	0.01	7.67	1.18	0.66[b]	0.00	1.88
	PRO	3.15[a]	0.01	7.11	1.00	0.46[a]	0.00	1.97
90 d	CON	3.75	0.22	9.25[b]	1.42	0.86[a]	0.00[b]	3.36
	PRO	3.83	0.01	8.10[a]	1.76	1.00[b]	0.13[a]	4.01
Inoculant effect	CON	3.85	1.36	6.80	1.06	0.71	0.00	2.17
	PRO	3.68	0.96	6.55	1.13	0.74	0.04	2.40
Storage length effect	3 d	4.13	3.35	3.95	0.61[c]	0.66	0.00	1.24[c]
	5 d	3.39	0.01	7.39	1.09[b]	0.56	0.00	1.93[b]
	90 d	3.78	0.11	8.68	1.59[a]	0.95	0.07	3.69[a]
	SEM	0.04	0.13	0.26	0.11	0.05	0.03	0.21
P-values								
Inoculant		0.001	0.01	0.26	0.53	0.52	0.03	0.19
SL		0.001	0.001	0.001	0.001	0.001	0.01	0.001
Ino x SL		0.001	0.03	0.001	0.21	0.01	0.01	0.25

[a-b] Means with different superscripts differ within column for each storage length ($P \leq 0.05$). [2] CON – distilled water; PRO – *L. plantarum, L. brevis* and *L. buchneri* at 150,000 CFU/g of forage. SL: storage length effect: 3, 5 and 90 d.

RESULTS

Propionic, iso-butyric and butyric acids were analyzed but not detected in any sample. Sorghum-sudangrass silage results are presented in Table 1:

- pH was similar between inoculants ($P = 0.03$) at 3 and 90 d (4.1 and 3.8, on average), while PRO had lower pH than CON at 5 d (3.2 vs. 3.6).
- PRO had lower WSC ($P = 0.03$) than CON at 3 d (2.9 vs. 3.8% of DM), however, no differences at 5 and 90 d (0.01 and 0.1% of DM, respectively).
- PRO had greater lactic acid ($P = 0.001$) at 3 d (4.4 vs. 3.5% of DM) and lower at 90 d (9.3 vs. 8.1% of DM).
- Acetic acid concentration was greater at 90 d, followed by 5 and then 3 d ($P = 0.001$; 1.6 vs. 1.09 vs. 0.61% of DM, respectively).
- CON had greater ethanol ($P = 0.01$) at 5 d (0.7 vs. 0.9% of DM) and lower at 90 d (0.9 vs. 1.0% of DM).
- PRO had greater 1,2-propanediol concentration ($P = 0.01$) at 90 d (0.1 vs. 0.0% of DM) and no differences at 3 and 5 d (0.0% of DM, on average).
- Ammonia-N concentrations were greater at 90 d, followed by 5 and 3 d ($P = 0.001$; 3.7 vs. 1.9 vs. 1.2% of total N, respectively).

Forage sorghum silage results are presented in Table 2:

- pH was lower at 5 d, followed by 90 and 3 d ($P = 0.001$; 3.4 vs. 3.6 vs. 4.0, respectively).
- PRO had greater WSC than CON ($P = 0.001$; 7.5 vs. 6.8% of DM).
- Concentrations of WSC decreased over time ($P = 0.001$; 10.4 vs. 6.6 vs 4.4% of DM, for 3, 5 and 90 d, respectively).
- Lactic acid increased over time ($P = 0.001$; 2.7 vs. 5.3 vs. 8.7% of DM, for 3, 5 and 90 d, respectively).
- Acetic acid ($P = 0.03$) was lower for PRO at 3 d (1.3 vs. 1.6% of DM) and greater at 90 d (2.5 vs. 2.1% of DM).
- Ethanol was greater for PRO ($P = 0.001$; 0.9 vs. 0.6% of DM).
- 1,2-propanediol ($P = 0.03$) was not detected at 3 and 5 d, while PRO had greater concentration than CON at 90 d (0.2 vs. 0.0% of DM).
- Ammonia-N concentrations were greater at 90 d, followed by 5 and 3 d ($P = 0.001$; 4.6 vs. 2.7 vs. 1.4% of total N, respectively).

Table 2. Effect of microbial inoculant and storage length on pH, water-soluble carbohydrates (WSC), fermentation profile, and ammonia-N of forage sorghum silage stored for 3, 5 and 90 d.

Item[1]		pH	WSC, % DM	Lactic acid, % DM	Acetic acid, % DM	Ethanol, % DM	1,2-propanediol, % DM	Ammonia-N, % total N
3 d	CON	3.97	10.19	2.75	1.62[a]	0.50	0.00	1.41
	PRO	3.98	10.61	2.62	1.28[b]	0.77	0.00	1.36
5 d	CON	3.57	6.17	5.43	1.83	0.65	0.00	2.49
	PRO	3.31	7.10	5.31	2.01	0.78	0.00	2.98
90 d	CON	3.62	4.05	8.92	2.08[b]	0.66	0.00[b]	4.54
	PRO	3.59	4.67	8.44	2.46[a]	0.99	0.16[a]	4.56
Inoculant effect	CON	3.72	6.80[b]	5.70	1.84	0.60[b]	0.00	2.81
	PRO	3.63	7.46[a]	5.45	1.92	0.85[a]	0.05	2.97
Storage length effect	3 d	3.98[c]	10.40[c]	2.69[c]	1.45	0.55	0.00	1.38[c]
	5 d	3.44[a]	6.63[b]	5.36[b]	1.92	0.61	0.00	2.74[b]
	90 d	3.61[b]	4.36[a]	8.68[a]	2.27	0.74	0.10	4.55[a]
	SEM	0.07	0.23	0.36	0.12	0.06	0.03	0.18
P-values								
Inoculant		0.15	0.001	0.42	0.44	0.001	0.05	0.30
SL		0.001	0.001	0.001	0.001	0.10	0.03	0.001
Ino x SL		0.18	0.57	0.85	0.03	0.44	0.03	0.29

[a-b] Means with different superscripts differ within column for each storage length ($P \leq 0.05$). [1] CON – distilled water; PRO – *L. plantarum, L. brevis* and *L. buchneri* at 150,000 CFU/g of forage. SL: storage length effect: 3, 5 and 90 d.

CONCLUSION

Despite the very low DM for both hybrids, fermentation was successful even for the CON treatment. No butyric acid was formed, probably due to favorable conditions in the mini silos. However, inoculation with PRO resulted in a more efficient conversion of WSC into organic acids, which indicates a more controlled fermentation. In addition, acetic acid and 1,2-propanediol were increased with bonsilage PRO due to the activity of *L.buchneri* and would contribute to better aerobic stability at farm level. In general, ensiling sorghum at these low DM levels should not be recommended, especially without the use of an appropriate inoculant.

References: Assefa, Y., Staggenborg, S. A., and Prasad, V. P. V. 2010. Grain sorghum water requirement and responses to drought stress: A review. Online. Crop Management. DOI: 10.1094/CM-2010-1109-01-RV.

PERFECT COMPONENTS. MAXIMUM RESULTS.

www.provita-supplements.com | celso.heinzenjunior@provita-supplements.com