The effect of different types of inoculants on DM losses, fermentation pattern and aerobic stability of sorghum silage

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Introduction Sorghum silages play an important role in the feeding of ruminants, particularly in semi-arid climate zones. Also in continental Europe, e.g. Germany, this crop has recently attracted significant attention due to its higher tolerance to drought stress than corn. In many areas, especially those with light, sandy soil and low precipitation, sorghum may be an alternative source of silage for ruminants, and also a substrate for biogas production. However, information has been scarce on ensilability, DM losses during fermentation, fermentation pattern and aerobic stability on sorghum grown in temperate climates. Therefore, this study aimed to evaluate the effects of different inoculant types on quality of sorghum silage.

Material and Methods Sorghum (*Sorghum bicolor*, variety: SuperSile 18) was grown on the research farm of Humboldt Universität in Thyrow, State of Brandenburg, Germany and harvested on October 1st, 2007 by a Pöttinger plot harvester. The crop was chopped to a theoretical particle size of 40 mm. The material was packed into either 1.5 L glass jars for strict anaerobic storage for 98 days, or into 1.5 L jars which had a hole (diameter: 5 mm) in the lid of the jar and one at 5 cm above the bottom. These holes were closed by rubber stoppers. On day 28 and 50 of fermentation, the rubber stoppers were removed to allow free air ingress for 24 hours. The length of this type of experiment was 57 days. All jars were stored at constant temperature of 25 °C, and three replicates per treatment were prepared.

The following treatments were tested: C - Control, LP - *L. plantarum* DSM 3676/*L. plantarum* DSM 3677 (50%/50%, $1x10^5$ cfu/g forage), LB - *L. buchneri* DSM 13573 ($1x10^5$ cfu/g forage), LP+LB ($2x10^5$ cfu/g forage). All additives were diluted with tap water to give an application rate of 10 mL per kg fresh forage. Ten mL of tap water per kg fresh forage were added to the control treatment.

Chemical analysis of the fresh crop was performed according to official German standards for feed evaluation. DM of silages was measured and corrected for the loss of volatiles during drying according to Weissbach and Kuhla (1995). Determination of pH was done potentiometrically using a calibrated pH electrode. Lactic acid was analysed by HPLC; volatile fatty acids and alcohols were determined by GC. Ammonia concentration was analysed photometrically. Losses of DM during fermentation were calculated according to Weissbach (2005). Aerobic stability was measured by the temperature method (Honig, 1990). Data were statistically evaluated by employing the procedure MIXED of SAS. Differences among means were tested by Tukey test, and significance declared at $P \leq 0.05$.

Results and Discussion Fresh forage contained 33.5 % DM, 3.6% crude ash, 3.6% crude protein, 33.1% crude fibre and 18.7% water-soluble carbohydrates (all nutrient based on DM).
Treatment had no effect on DM concentration of silages, and butyric acid was not found in any of the experimental silages (data not shown). Data presented in table 1 indicate pronounced effects of silage additives on DM loss, fermentation pattern and aerobic stability. All inoculant types increased DM losses during fermentation, which can be explained by the observed fermentation pattern. Homofermentative LP increased ethanol content, whereas the heterofermentative *L.*

buchneri-containing additives produced higher amounts of acetic acid (and 1,2-propanediol). Both fermentation pathways result in the production of CO_2, which escapes from the silo. Silages stored for 57 days were more susceptible to aerobic deterioration than was seen in silages after 98 days of fermentation. There was no effect of homofermentative inoculation on aerobic stability. The single use of *L. buchneri* DSM 13573 as well as its application in combination with the homofermentative *L. plantarum* strains significantly improved stability upon exposure to air so that silages remained stable throughout the entire experimental period.

Conclusions Regardless of treatment, all silages were of good fermentation quality as butyric acid was not found and ammonia levels were low. Inoculation of sorghum with different inoculant types resulted in modified fermentation pattern which had the most prominent effect on aerobic stability: The sole use of *L. buchneri* DSM 13573 and its combination with *L. plantarum* DSM 3676 and DSM 3677 significantly improved stability upon exposure to air. Increased anaerobic DM losses associated with the use of *L. buchneri* DSM 13573 are overcompensated by the reduction in aerobic DM losses. The use of this heterofermentative LAB alone or in combination with homofermentative strains is therefore highly recommended.

References

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Table 1. Effects of inoculants on DM losses, fermentation pattern and aerobic stability of sorghum silage

Parameter	Treatment[1)]				SED	P level
	Control	LP	LB	LP+LB		
DM loss (% DM)	6.3^{a}	6.8^{b}	7.5^{c}	7.4^{c}	0.11	<0.001
pH	3.78^{b}	3.76^{ab}	3.75^{a}	3.78^{b}	0.01	<0.01
NH_3-N (% total N)	7.7^{b}	7.5^{b}	6.7^{a}	6.5^{a}	0.18	<0.001
Lactic acid (% of DM)	4.63^{b}	5.27^{c}	4.20^{ab}	3.91^{a}	0.20	<0.001
Acetic acid (% of DM)	1.33^{a}	1.28^{a}	2.73^{b}	2.91^{b}	0.07	<0.001
Ethanol (% of DM)	0.83^{b}	1.33^{c}	0.43^{a}	0.40^{a}	0.06	<0.001
1,2-propanediol (% of DM)	0.13^{a}	0^{a}	3.81^{c}	4.26^{d}	0.10	<0.001
ASTA[2)] (hours)	101^{a}	83^{a}	168^{b}	168^{b}	11.48	<0.001
ASTA[3)] (hours)	199^{a}	194^{a}	336^{b}	336^{b}	3.13	<0.001

[1)] for description see Materials and Methods; [2)] aerobic stability measured after 57 days of fermentation for 168 hours; [3)] aerobic stability measured after 98 days of fermentation for 336 hours; means in columns with unlike superscripts differ significantly