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Effects of ensiling whole crop maize with bacterial inoculants on the fermentation, aerobic stability, and growth performance of lambs

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ABSTRACT

The aim of this study was to determine effects of ensiling whole crop maize with the bacterial inoculants *Bonsilage mais flussig* (BMF) and *Lalsil Fresh LB* (LFLB) on fermentation, aerobic stability and growth of lambs. Whole crop maize (288 DM g/kg) was ensiled with no additive, BMF or LFLB for 60 days in 1.5 l jars and 3 months in 210 l drums. To follow the fermentation dynamics during ensiling, 1.5 l jars were opened on days 0, 4, 10, 21 and 60 of ensiling for sampling and analysed for pH, water-soluble carbohydrates (WSCs), volatile fatty acids (VFAs), lactic acid, ammonia-N, dry matter (DM), organic matter (OM), metabolizable energy (ME), crude protein (CP), ether extract (EE), ADF and NDF. The aerobic stability of silage was determined by opening jars on day 60 and putting silage in an aerobic environment until day 65. After 3 months of ensiling the 210 l drums were opened, sampled and analysed as for the laboratory scale silos. Silages were fed to 24 South African Dorper lambs ($n = 8$/treatment) weighing 20.6 ± 0.62 kg to determine intake in a 63-day experimental period. Results from the small silos showed that the inoculants decreased ($P<0.05$) pH, butyric acid and ammonia-N while increasing WSC, lactic acid and acetic acid compared to the control silage. Aerobic stability of the silage was improved with inoculation as indicated by lower ($P<0.05$) CO_2 production when compared with the control silage. Furthermore,

Abbreviations: ADF, acid detergent fibre; ADG, average daily gain; BMF, *Bonsilage mais flussig*; BW, body weight; CFU, colony-forming units; CP, crude protein; DM, dry matter; EE, ether extract; FCR, feed conversion ratio; LA, lactic acid; LAB, LA bacteria; LFLB, *Lalsil Fresh LB*; ME, metabolizable energy; aNDF, amylase treated neutral detergent fibre; OM, organic matter; VFA, volatile fatty acid; WSC, water-soluble carbohydrate.

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the control silage showed a rise in pH and a changed decline in lactic and acetic acid concentrations when exposed to air, as compared to the inoculated silages. Inoculants did not affect DM, pH, OM, CP, ME, EE, ADF and NDF contents of the silage from 210 l drums. However, bacterial inoculants increased ($P<0.05$) WSC, lactic acid and acetic acid, while reducing butyric acid and ammonia-N compared to the control. Lambs fed the LFLB inoculated silage had higher ($P<0.05$) intakes of DM, OM and CP, higher final body weights and average daily gains (ADGs) compared to the other treatments. It was concluded that both bacterial inoculants improved fermentation dynamics and aerobic stability of whole crop maize silage, and improved lamb performance occurred when LFLB inoculated whole crop maize silage was fed.

1. Introduction

Maize (*Zea mays*) is the most popular cereal crop conserved as silage in many parts of the world due to its low buffering capacity, relative high dry matter (DM) content, and adequate water-soluble carbohydrate (WSC) level for fermentation to lactic acid (McDonald et al., 1991). Maize silage is the major silage crop used in most intensive ruminant production systems in South Africa, where it is often produced without use of silage additives (Meeske and Basson, 1998). One of the objectives of silage additives is to enhance efficient fermentation through stimulation of lactic acid production (Honig and Deanicke, 1993), which subsequently results in increased feed intake and organic matter (OM) digestibility by the animals (Chamberlain, 1982; Meeske et al., 2002). However, inoculants that contain homofermentative lactic acid bacteria (LAB) have often reduced the aerobic stability of silage (Muck and Kung, 1997; Rust et al., 1989; Weinberg et al., 1993) due to lower production of anti-fungal compounds (Moon, 1983).

In a warm climate, such as that of South Africa, whole crop maize silage is susceptible to aerobic deterioration because aerobic yeasts that metabolize lactic acid to carbon dioxide and water (producing heat) are most active at 20–30 °C (Ashbell et al., 2002). This causes metabolism of nutrients and production of fermentative residual products, which increases silage temperature (Reis et al., 2005). Silage that has spoiled is undesirable because of its poor hygienic quality due to the increased risk of proliferation of potentially pathogenic or undesirable micro-organisms which negatively affect animal performance (Driehuis et al., 1999; Trevisi et al., 2003). Consequently, *Lactobacillus buchneri* (*L. buchneri*), a heterofermentative LAB, was used to improve the aerobic stability of silages via its accumulation of acetic acid (Driehuis et al., 2001; Muck, 1996; Ranjit et al., 2002). However, reports on the influence of acetic acid on animal performance are not consistent. Steen et al. (1998) and Wilkinson et al. (1971) reported negative relationships between intake and the concentrations of acetic acids from silage. Mbanya et al. (1993) could not confirm a depression of voluntary intake when acetic acid was ruminally infused, while other studies (Driehuis et al., 1999; Krizsan et al., 2006; Ruser and Kleinmans, 2005) reported no effect of *L. buchneri* on feed intake despite the higher acetic acid level of the inoculated silage.

Bonsilage mais flussig (BMF) and *Lalsil Fresh Lactobacillus buchneri* (LFLB) are heterofermentative LAB inoculants that have been used extensively to improve the aerobic stability of silage. In our previous study (Nkosi et al., 2009), effects of BMF on whole crop maize improved the aerobic stability of silage through its high acetic acid content and low CO_2 production while this inoculant was tested on whole crop maize with high DM contents (400 g/kg DM), *Lalsil Fresh LB* has also been reported to improve the aerobic stability of maize silage through high production of acetic and propionic acids (Bach et al., 2005; Driehuis et al., 1999). This inoculant is currently used in South Africa, but independent research data on its effects is limited.

The objectives of this study were to evaluate the effects of two heterofermentative inoculants, BMF and LFLB, on the fermentation characteristics of whole crop maize with low DM content (288 DM g/kg), and their effect on intake and growth of lambs in South Africa.