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Assessment of quality and rumen degradability of mixed silages of sugarcane tops with Marabú forage

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Abstract

The quality and rumen degradability of sugarcane (*Sacharum spp.*) tops with forage of Marabú (*Dichrostachys cinerea L.*) ensiled in combination with either molasses, lactobacillus or fungi as well as their combination were assessed. The labscale silages were made in triplicate with material originating from a sugarcane crop and *D. cinerea* field both of two years old and harvested after 12 and 3 months of regrowth, respectively (Santa Clara, Cuba). Sugarcane tops and *D. cinerea* forage were mixed in a ratio of 60:40, respectively and either or not with one of the three following additives or their combination [fungal inoculant [FI; UC1 (*Penicillium sp.*) + UC13 (*Aspergillus sp.*) or *Trichoderma sp.* (L6+R6b)], *Lactobacillus plantarum* (LAB; 3×10^6 colony forming units/g fresh matter (FM)) and molasses (Mol; 39.4 g/kg FM)]. Both FI were inoculated at three doses (FD; 1.5, 3.0 and 4.5×10^5 spores/g of FM) in order to prepare 28 treatments [2FI×3FD×2LAB×2Mol treatments + 4 control treatments (2LAB×2Mol)]. The chemical proximate content (CPC) prior and after ensiling, as well as the ensilability and the apparently rumen degradable organic matter (ARDOM) of the silages were determined. The metabolisable energy (ME) was estimated from the CPC. The ensilability parameters (pH, lactate, acetate, ammonia, ethanol) were used to select the best silages based on the GLM procedure of SPSS with FI, FD, LAB and Mol as factors according to a full factorial design. The one way ANOVA procedure of SPSS was performed. The forages simultaneously ensiled by all additives showed the best silage quality, independently of FI or FD. However, the FD ($P<0.001$) but not the FI ($P>0.05$) affected the fiber fraction content after ensiling as well as ARDOM and methane production. The ADF content was lower ($P<0.001$) and the ME and ARDOM contents were enhanced ($P<0.05$) in those silages with higher FD. It was concluded that mixed silages of an invasive plant and fibrous by-product inoculated simultaneously with molasses, lactobacillus and fungi at doses of 3.0 and 4.5×10^5 spores/g of FM showed the best silage quality, the lowest ADF content and the highest ARDOM, independently of fungi strain. Nevertheless, the effects were modest.

Key words: ensiling, *Dichrostachys cinerea*, sugarcane tops, *rumen degradability*, *fungi*, molasses, lactobacillus

Introduction

Most tropical areas show feed deficits, especially during the dry season, which is one of the major challenges to the development of tropical livestock production (Ojeda, 2000; Lima-Orozco *et al.*, 2016). A constant availability of good quality feed throughout the year is one of the prerequisites and requires an efficient use and conservation of available feed resources during the rainy season and at the beginning of the dry season. Agriculture byproducts represent an important source of feed in agriculture-based economies, although a lack of technical knowledge impairs their proper use (Díaz, 1998; Ojeda y Cáceres, 2002). Sugarcane tops (*Sacharum spp.*) are an example of such a byproduct, while Marabú (*Dichrostachys cinerea*) is an invasive plant covering large areas of agricultural land. Currently a large volume of these potential feed resources are burned, or simply not used due to difficulty in their handling (Ojeda y Cáceres, 2002). In this respect, the sole or combined conservation (*e.g.* ensiling) of these products could be of interest. Furthermore, to produce a complete feed, a combination of forages and byproducts might be most appropriate. *E.g.* a combination of forages and byproducts with high (*e.g. D. cienerea*) and lower protein contents (*e.g. Sacharum spp.*) could be considered. However, to ensure appropriate silage quality additives (*e.g.* molasses and/or microorganisms) might be required and as such can play an important role in the search for alternative feeds for ruminants. Therefore, this research aimed to assess the quality and rumen degradability of mixed silages of sugarcane tops with Marabú forage in combination with either molasses, lactobacillus or fungi as well as their combination as silage additives.

Material and Methods

The labscale silages were made in triplicate according to Lima Orozco *et al.* (2014) from material originating from a sugarcane crop and *D. cinerea* field both of two years old and harvested after 12 and 3 months regrowth, respectively (Santa Clara, Cuba). Sugarcane tops and *D. cinerea* forage (leaves and young stems harvested about 20 cm above the soil) were mixed in a ratio of 60:40, respectively and either or not in combination with one of the three following additives or their combination [fungal inoculant [UC1 (*Penicillium sp.*)+UC13 (*Aspergillus sp.*) or *Trichoderma sp.* (L6+R6b)], *Lactobacillus plantarum* (3×10^6 colony forming units/g fresh matter (FM)) and molasses (39.4 g/kg FM)] or not in order to prepare 28 treatments. Both fungi strain combinations were inoculated at three fungi doses (1.5, 3.0 and 4.5×10^5 spores/g of FM). The chemical proximate content (CPC) prior and after ensiling, as well as the ensilability and the apparently rumen degradable organic matter (ARDOM) of the silages were determined according to Lima Orozco *et al.* (2014). The metabolisable energy (ME) content and methane production were estimated from the chemical composition (Roche *et al.*, 1999) and short chain fatty acids (Demeyer and Fievez, 2000), respectively. The ensilability parameters (pH (3.8 – 4.2, lactic (0.7 – 0.9/Total fermentation acids (FA) and acetic acids (0.1 – 0.3/Total FA), ammonia (< 10 g/100 g N), ethanol (< 2 g/kg FM)) were used to select the best silages based on the GLM procedure of SPSS (2012) with FI, FD, LAB and Mol as factors according to a full factorial design. The CPC, ME and ARDOM of the best silages were compared using the one way ANOVA of SPSS (2012) and further, a post-hoc Tukey test (Tukey, 1949) was performed when $P<0.05$.

Results and Discussion

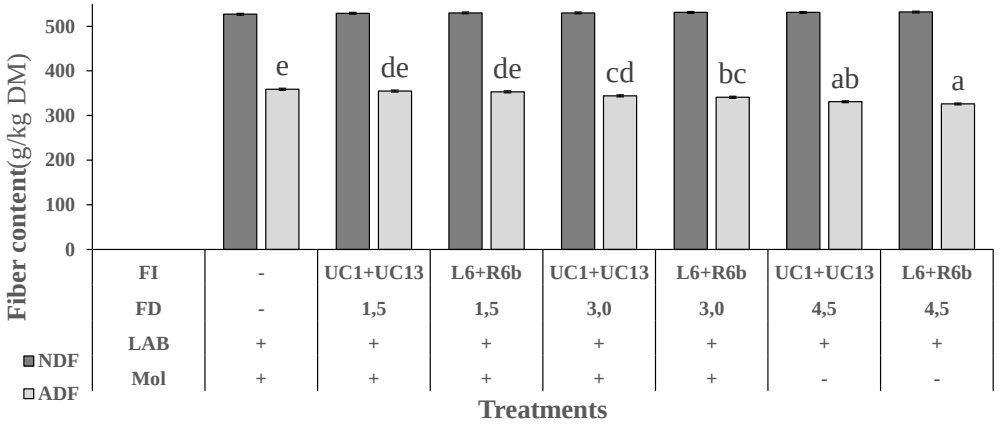
The forages simultaneously receiving all additives showed the best ensilability quality, independently of FI or FD (Table 1).

Table 1. Overview of the treatments of the mixed silages of sugarcane tops and Marabú forage after 30 d of ensiling (n=3) showing best ensilibility characteristics.

	Control	Treatments					
FI	-	UC1+UC13	UC1+UC13	L6+R6b	L6+R6b	UC1+UC13	L6+R6b
FD	-	1.5	3.0	1.5	3.0	4.5	4.5
LAB	+	+	+	+	+	+	+
Mol	+	+	+	+	+	-	-

FI: fungal inoculant; **FD**: fungal doses; **LAB**: *Lactobacillus plantarum* (3×10^6 colony forming units/g fresh matter (FM)); **Mol**: molasses (39.4 g/kg FM); **-**: no addition; **+**: addition; **UC1**: *Penicillium sp.*; **UC13**: *Aspergillus sp.*; **L6** and **R6b**: *Trichoderma sp.* Treatments showing excellent ensilability quality [pH (4.01 – 4.18), lactic acid (10.3 – 14.3 g/kg FM), NH_3-N (0.02 – 0.05 g/kg FM), acetate (1.32 – 2.93 g/kg FM) and ethanol (6.62 - 7.63 g/kg FM)] according to Ojeda *et al.* (1991), McDonald *et al.* (1991), Lima *et al.* (2010) and Lima *et al.* (2011).

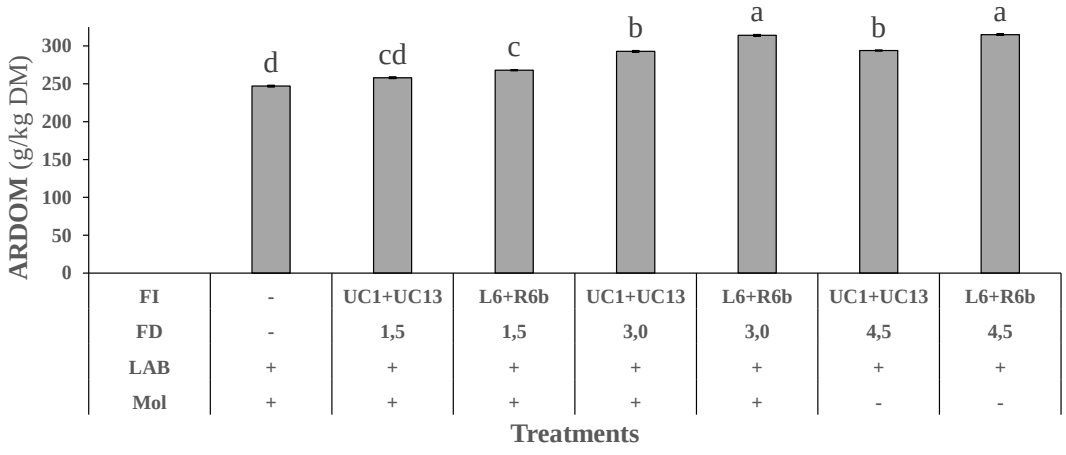
However, the FD (P<0.001) but not the FI (P>0.05) affected the fiber fraction content (Figure 1) and ARDOM (Figure 2).



Different superscript in the same parameter show statistical differences (P<0.05; Tukey test)

Figure 1. Content of neutral detergent fiber (NDF) and acid detergent fiber (ADF) of the better mixed silages of sugar cane tops and Marabú forage after 30 d of ensiling (n=3)

The ADF content was lower (P<0.001) and the ME content and ARDOM were enhanced (P<0.05) in those silages with higher FD. Those results suggest that the lingo-cellulolytic enzymes from fungi during first ensiling hours (aerobic phase) were capable of degrading 8.74 and 10.15 % of ADF in the best silages (UC1+UC13 and L6+R6b, both at maximum fungi doses and LAB addition) as compared to the ensiled control and the fresh material.



Different superscript show statistical differences (P<0.05; Tukey test)

Figure 2. Apparently rumen degradable organic matter (ARDOM) of the better mixed silages of sugarcane tops and Marabú forage after 24 h of *in vitro* rumen incubation (n=3)

In addition, those silages that showed higher ARDOM had lower methane production per unit of short chain fatty acids, probably due to the higher cellulolytic activity (Demeyer and Fievez, 2000), due to higher bioavailability of cellulose, released by fungal activity in the silo.

Conclusions and Outlook

Sugar cane tops and Marabú forage ensiled with a combination of molasses, lactobacillus and either one of the two fungal strains at doses of 3.0 and 4.5 $\times 10^5$ spores/g FM showed the best silage quality, the lowest ADF content and, the highest ME and ARDOM. Hence, in tropical ruminant feeding systems, mixed forage from protein-rich plants and fibrous by-products can be adequately ensiled when molasses, lactobacillus and fungi are simultaneously added prior to ensiling.

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