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Nutritive value, total losses of dry matter and aerobic stability of the silage from three varieties of sugarcane treated with commercial microbial additives

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ABSTRACT

The practice of ensiling sugarcane without additives results in marked reduction in silage nutritional value due to the rapid fermentation of water-soluble carbohydrates by yeasts. Using commercial inoculants containing homo and heterolactic bacteria during the ensiling process is an important alternative. However, the effectiveness of these inoculants has not been determined. Thus, we aimed to evaluate the effect of using two commercial inoculants during the fermentation of three varieties of sugarcane on the nutritive value, total losses of dry matter and aerobic stability of the silages. We used a completely randomized design in a 3×3 factorial scheme (three varieties and three treatments) with five repetitions. The silages were produced in experimental PVC silos (50 cm height and 10 cm diameter), remaining closed for a period of 30 days. Treatments consisted of no inoculant, inoculant A (Lalsil® sugarcane, *Lactobacillus buchneri*, strain NCIMB 40788, 2.5×10^{10} CFU/g) and inoculant B (Silobac® 5, *Lactobacillus plantarum*, strains CH 6072 and L286, 1×10^5 CFU/g). In all treatments, silages showed increased concentrations of NDF and ADF, and reduction in DM relative to material prior to ensiling. Treatment with inoculant B resulted in greater total losses of DM and fractions of ammonia nitrogen, as well as lower levels of IVDMD and smaller ME, especially for variety RB92579. Treatment with inoculant A improved aerobic stability of silages. The high concentration of sugars (Brix) presented by RB92579 seemed to favor the activity of the yeast and consequently the losses.

1. Introduction

The use of fresh sugarcane as cattle feed during the dry season is a practice traditionally used by ranchers in Brazil (Lopes and Evangelista, 2010; Pedroso et al., 2011b). During the dry season the crop reaches maturity and has higher nutritional value as a result of accumulation of sugars in their tissues. In addition, the dry season coincides with lower productivity

Abbreviations: DM, dry matter; ADF, acid detergent fiber; NDF, neutral detergent fiber; IVDMD, *in vitro* dry matter digestibility; ME, metabolizable energy; OM, organic matter; CP, crude protein; EE, ether extract; NDIP, neutral detergent insoluble protein; ADIP, acid detergent insoluble protein; TC, total carbohydrates; NFC, non-fiber carbohydrates; BC, buffering capacity; NDIN, neutral detergent insoluble nitrogen; ADIN, acid detergent insoluble nitrogen.

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pastures in Central (Bernardes et al., 2007) and Northeast regions of Brazil. These factors contribute to sugarcane being used primarily as fresh, chopped forage, fed to animals without undergoing any preservation process (Evangelista et al., 2009). A limitation to the use of sugarcane on a large scale is the labor required for harvest and processing, especially when feeding quantities required to sustain larger herds (Fortaleza et al., 2012). This limitation could be overcome by ensiling the sugarcane. Cutting sugarcane for silage only once during the growing season can reduce manpower costs, and maximize the use of machinery (Castro Neto et al., 2008). Therefore, sugarcane silage can be an alternative for ranchers who seek more efficient management of forage in their forage-livestock systems, especially for those interested in using sugarcane as forage for medium and large herds (Nussio et al., 2009).

Ensiling sugarcane without additives typically results in alcoholic fermentation from the growth of yeasts. This results in a loss of nutritional value as the total concentration of sugars and sucrose decline. Lactic acid bacteria have been extensively evaluated as inoculants in silage. Their function is to increase the number and competitiveness of beneficial bacteria in the silage mass, which increases lactic acid production and inhibits the growth of undesirable microorganisms (Ávila et al., 2010). Most commercial inoculants contain homofermentative strains of bacteria. The principal effect of adding these bacteria during ensiling is the rapid decrease in pH resulting from the production of large quantities of lactic acid. However, studies have shown that the use of these bacteria may impair aerobic stability of the silage (Kleinschmit et al., 2005; Hu et al., 2009). Inoculants containing heterofermentative bacteria have been evaluated to improve the aerobic stability of silages. These bacteria help to control the population of yeast through the production of volatile fatty acids, which hinder the development of these microorganisms (Filya, 2003). Therefore, using inoculants during ensiling improves fermentation, maintains nutritional characteristics and increases aerobic stability of silage.

Though commercial inoculants have helped improve the ensiling of many forage crops, it is still uncertain how effective such additives are for ensiling sugarcane. Because sugarcane has many varieties with very diverse characteristics, attention should be given to the specificity of the crop to be ensiled. Pedroso et al. (2011a) assessed the fermentation characteristics of silage made from the variety IAC862480 treated with *Lactobacillus buchneri* and observed a reduction of the ethanol content and losses in silage. In contrast, Freitas et al. (2006a) evaluated the silage of the variety RB855536 with the same inoculant and did not observe improvements in silage. Thus, there are some general relationships between variables that make a crop more or less prone to instability. Among them, the crops that have greater concentrations of sugars tend to have greater numbers of yeasts (Kung et al., 2007). However, if a forage has low sugar content at ensiling there may be little opportunity for an inoculant to significantly affect the quality of silage. The epiphytic population of lactic acid bacteria can be so high that the inoculant bacteria do not dominate the fermentation (Muck, 2010). In this study, we evaluated the effect of two commercial inoculants during ensiling of three varieties of sugarcane on the nutritive value, total losses of DM and aerobic stability of the silages.

2. Materials and methods

2.1. Experiment site and varieties of sugarcane

The experiment was conducted on the dependencies of the Unidade Acadêmica de Garanhuns/Universidade Federal Rural de Pernambuco – UAG/UFRPE and analyses were done in the laboratories of the Central de Laboratórios de Garanhuns (CENLAG) and Laboratórios de Nutrição Animal (LANA) – UAG/UFRPE.

Three varieties of sugarcane were used: RB867515, SP784764 and RB92579. They were harvested and ensiled at 14 months of age and had Brix readings of 18.8°, 19.4° and 22.0° Brix, respectively. The buds originated from Usina Estreliana (Ribeirão-PE) and were planted 18 cm deep at a rate of 18 buds per linear meter. The herbicide Diuron® was applied by spraying 20 days after planting at a rate of 3.2 kg/ha. Nitrogen, phosphorous and potassium fertilization was carried out based on soil analysis and in accordance with the recommendation of Cavalcanti et al. (1998) for culture. The sugarcane forage was harvested manually and senescent leaves were removed. Samples were chopped in a stationary forage machine, providing an average particle size of approximately 2.0 cm.

2.2. Treatments

Three treatments were applied: no inoculant, inoculant A, containing heterolactic bacteria (Lalsil® sugarcane, *Lactobacillus buchneri*, strain NCIMB 40788, 2.5×10^{10} CFU/g) and inoculant B, containing homolactic bacteria (Silobac® 5, *Lactobacillus plantarum*, strains CH 6072 and L286, 1×10^{5} CFU/g).

2.3. Silage making

The silages were produced in experimental polyvinyl chloride (PVC) silos (50 cm height and 10 cm diameter), with a compression density of 600 kg forage/m^3, with 2.2 kg of forage per silo. Prior to use, the inoculants were diluted in the laboratory according to product labels (Lalsil® sugarcane, 100 g/50 tons of fresh forage; Silobac® 5, 50 g/50 tons of fresh forage), where 1.10×10^{12} CFU/g *L. buchneri* and 2.20×10^{8} CFU/g *L. plantarum* were added per silo. Inoculants were manually mixed into chopped forage at the moment of ensiling with the aid of a spray bottle. Manual compression of the material was achieved by applying pressure with a wooden bat. The silos were sealed with PVC lids and silicone, and fitted with valves