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Silage Quality of two energy-cane cultivars produced with different additives

Qualidade da silagem de duas cultivares de cana-energia produzidas com diferentes aditivos

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ABSTRACT

This study examined the quality of silage from two cultivars of energy cane (*Saccharum spontaneum*) produced with different additives. The experiment was laid out in a completely randomized design with a 2×5 factorial arrangement of treatments consisting of two cultivars (VG3, VG1126) and four additives (1% urea; 1% NaOH; 1% CaO; and 1.0 × 1011 CFU g^{-1} of *Lactobacillus plantarum*- LP) + control, with eight replicates. Experimental mini-silos were used, which were opened 72 days after ensiling. The dry matter (DM), crude protein (CP), organic matter (OM), mineral matter (MM), ether extract (EE), neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents, and silage degradability were. We identified significant interactions effect between cultivar and type of additive for DM, CP, EE, NDF. ADF. Organic and mineral matter percentage were similar between the two cultivars. LP was the least beneficial additive for DM degradation. After 72 h of fermentation, *in vitro* NDF degradation of cultivar VG3 increased due to urea, NaOH, and CaO, whereas degradation cultivar VG1126 decreased when inoculated with LP or CaO. The NaOH and CaO improved silage degradability thus improving its quality. The use of LP in the present study did not benefit silage for energy-cane cultivars. The use of NaOH and CaO improves the quality of the silage, two varieties

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of sugarcane energy VG3 and VG1126, enabling its use with better efficiency for animal feed.
Keywords: chemical and microbial inoculum, chemical composition, forage preservation, in vitro degradability

RESUMO

Este estudo avaliou a qualidade da silagem de duas cultivares de cana-de-energia (*Saccharum spontaneum*) produzidas com diferentes aditivos. O experimento foi instalado em delineamento inteiramente casualizado, com arranjo fatorial 2 × 5 de tratamentos composto por duas cultivares (VG3, VG1126) e quatro aditivos (1% uréia; 1% NaOH; 1% CaO; e 1,0 × 1011 UFC g -1 de *Lactobacillus plantarum*- LP) + controle, com oito repetições. Foram utilizados minisilos experimentais, os quais foram abertos 72 dias após a ensilagem. Os teores de matéria seca (MS), proteína bruta (PB), matéria orgânica (MO), matéria mineral (MM), extrato etéreo (EE), fibra em detergente neutro (FDN) e fibra em detergente ácido (FDA) e degradabilidade da silagem foram avaliados. Identificou-se efeito de interação significativo entre cultivar e tipo de aditivo para MS, PB, EE, FDN. ADF. As porcentagens de matéria orgânica e mineral foram semelhantes entre as duas cultivares. LP foi o aditivo menos benéfico para a degradação da MS. Após 72 h de fermentação, a degradação in vitro da FDN da cultivar VG3 aumentou devido à uréia, NaOH e CaO, enquanto a degradação da cultivar VG1126 diminuiu quando inoculada com LP ou CaO. O NaOH e o CaO melhoraram a degradabilidade da silagem, melhorando assim sua qualidade. O uso da LP no presente estudo não beneficiou a silagem para cultivares de cana-de-energia. O uso de NaOH e CaO melhora a qualidade da silagem, duas variedades de energia da cana-de-açúcar VG3 e VG1126, possibilitando seu uso com melhor eficiência para ração animal
Palavras-chave: inoculo químico e microbiano, composição química, preservação de forragem, degradabilidade in vitro.

INTRODUCTION

In view of the demand for food and the need to intensify agricultural systems, several lines of research focus on the production scenario. One of these highly researched fields is the breeding of sugarcane, given its importance as the main raw material in the production of ethanol and sugar as well as its wide use as a forage for animal feed. In addition to being highly productive, the crop has its greatest nutritional value in periods of water scarcity—a time when the production of other forage plants is stagnant (Moraes et al., 2017).

One of the major obstacles to using sugar cane on farms is the cost of labor for harvesting and transport. However, the material can be chopped, processed and stored in the form of silage, substantialy reducing production costs (Moraes et al., 2017; Rigueira et al., 2018).

It is important to note that the use of inoculants is essential to obtain high-quality sugar cane silage. When inoculants are not used, there are increases in the generation of ethanol, effluents, and gases, which translate into loss of nutritional value of the silage (Dias et al., 2014).

Various materials are available for the different sectors (ethanol, sugar and animal feed production), but energy cane (*Saccharum spontaneum*) has attracted the attention of producers (Matsuoka et al., 2014; Guimarães et al., 2016). Originating from the cross of ancestors and commercial hybrids, energy cane can be grown in marginal areas, poorer soils and in regions with unstable climate. When grown in low-fertility soils and in unfavorable environmental conditions, energy cane can produce more than twice as much as conventional cane in the same conditions (Matsuoka et al., 2014; Antonini et al., 2017).

Another important characteristic of energy cane is high fiber production. This, however, does not reduce the possibilities of using it in ruminant diets. Owing to its high biomass yield, energy cane has the potential to produce a considerably larger amount of cellulosic sugars per hectare than sugar cane.

Given its many desirable characteristics, energy cane is a promising agricultural plant. Nonetheless, research is warranted to determine its real potential for use in animal feed. Therefore, the present study was developed to examine the chemical composition and degradability of silage from two cultivars of energy cane treated with different additives.

MATERIALS AND METHODS

The study was conducted from 10 Oct, 2016, to 15 Nov 15, 2018, at Campus II of the Federal University of Goiás, located in Goiânia-GO, Brazil (16º35’52’’ S, 49º17’11’ W, 723 m above sea level).The climate of the region is classified as semi-humid tropical (Aw), with a well defined dry season from May to October. Average annual temperature is 23.2 ºC, with minimum and maximum means of 17.9 and 28.9 ºC, respectively, and annual precipitation is 1578 mm (Pereira et al., 2010). Average air humidity in the region is 71%, with the lowest indices occurring in the month of August.

The experiment was laid out in a completely randomized design with a 2×5 factorial arrangement consisting of two cultivars and four additives + control, with eight replicates, totaling 80 experimental units.

Two energy cane (*Saccharum spontaneum*) cultivars, VG3 and VG1126, were used in the following treatments: **Control** – production of energy-cane silage without the use of additives; and the following four additves: **LP**: - *Lactobacillus plantarum* (SILOBAC 5 strains CH6072 and L286, with 1.0 × 1011 CFU g^{-1}) used at the rate of 50 g for 50 Mg of fresh cane, following the manufacturer's recommendations; **Urea** - $(NH_2)_2CO$, at 1% of the fresh mass; **NaOH** - sodium hydroxide, at 1% of the fresh mass (using caustic soda at a concentration of 96-99%); and **CaO** - calcium oxide, using virgin lime as a source, at 1% of the fresh mass. All additives were diluted in water at the rate of 5 L of water for 100 kg of fresh cane. The control received 5 L of water (without any additives) for each 100 kg of fresh cane to balance the moisture content with those of the other treatments.

The second-ratoon crop cycle of energy cane was harvested manually at 0.05 m above soil level. The forage (whole plant) was ground into 10-20 mm particles through a stationary chopper. Before ensiling, samples of each cultivar were dried in a forced-air oven at 55 ºC, for 72 h, to determine the partial dry matter (DM). Subsequently, the samples were ground through a Willey mill with a 1-mm mesh sieve and their composition was determined in

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accordance with the methodology of Detmann et al. (2012).

After the material was chopped, the additives were applied and homogenized in the proportions mentioned above. Next, the material was added to plastic buckets that were used as mini-silos (29 cm wide × 31 cm high), where the mass was compacted using iron rods until reaching a density of 500 - 650 kg of silage m^{-3}. Before ensiling, the buckets were weighed. Fine sand (1 kg), cotton fabric and a shade cloth were added to the bottom of each container to retain effluents for later quantification.

After 72 days of anaerobic fermentation, the mini-silos were weighed and opened. For analysis, samples were collected from the central part of the mini-silos.

To determine the partial DM, the sub-samples were dried in a forced-air oven at 55 ºC until reaching constant weight. Subsequently, they were ground through a Willey mill with a 1-mm sieve for later determination of the percentages of DM, crude protein (CP), mineral matter (MM), organic matter (OM), ether extract (EE), neutral detergent fiber (NDF) and acid detergent fiber (ADF), as proposed by Detmann et al. (2012).

The methodology described by Ankom technology (2012) was applied to measure the *in vitro* DM degradability of the silage. The rumen fluid used for this procedure was collected manually from different regions in the rumen of two Nellore animals that were fed a diet based on pasture (*Brachiaria grass*) and mineral salt in equal volumes. The fluid was stored in a thermal container until arriving at the laboratory, where it was placed in a blender at high high speed for 10 s, purged with CO_2, and then filtered through two layers of cotton fabric. The *in vitro* NDF degradability was determined according to Detmann et al. (2012). The experiment protocol was approved by the Ethics Committee on the use of animals at the Federal University of Goiás by opinion N°. 044/12.

The Shapiro-Wilk and Bartlett tests were applied ($\alpha = 0.05$) to check response-variable data for normality and homoscedasticity assumptions. The response variables that met the assumptions were subjected to ANOVA and means were compared by the Scott-Knott test at the 5% probability level.

To compare all the variables involved in the experiment and understand the multivariate relationships between cultivars and treatments (two cultivars × four additives + control), principal component analysis was performed using a correlation matrix.

RESULTS

Despite having a lower percentage of cellulose, cultivar VG3, showed a higher lignin percentage than cultivar VG1126.

Table 1. Lignocellulosic composition of energy-cane cultivars VG3 and VG1126 (% of neutral detergent fiber).

Parameter	VG3	VG1126
Cellulose	6.28	28.58
Hemicellulose	17.80	21.51
Lignin	48.15	23.65

The similar chemical composition of the cultivars prior to ensiling is remarkable,

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with DM and NDF being the most discrepant components in content (Table 2).

Table 2. Mean chemical composition values determined in the fresh mass of energy cane cultivars before ensiling.

Cultivar	Parameter						
	DM	CP	OM	EE	MM	NDF	ADF
VG3	33.93	2.09	98.32	2.28	1.67	52.74	29.20
VG1126	44.65	2.18	98.30	2.55	1.69	63.23	36.08

DM - dry matter; CP - crude protein; OM - organic matter; EE - ether extract; MM - mineral matter; NDF - neutral detergent fiber; ADF - acid detergent fiber.

Chemical composition analysis of silage from the energy-cane cultivars treated with different additives (Table 3) revealed that there was a cultivar x additive interaction for the percentages of DM, CP, EE, NDF and ADF.
The VG3 silages that best maintained their DM levels during fermentation were those where no additive was used or where CaO was added. In the silage from cultivar VG1126, on the other hand, non-use of inocula significantly reduced the DM content (Table 3).
When the factors were analyzed separately (Table 3), inoculation with urea increased the CP levels of the silages from both cultivars, with greater evidence seen in cultivar VG3. Inoculation of cultivar VG3 with LP resulted in decreased EE contents, whereas in the silage from cultivar VG1126 this reduction occurred with the use of NaOH.
Between the two cultivars, when not inoculated or when treated with NaOH or CaO, cultivar VG3 had its NDF content reduced. Comparing only the inocula, urea, NaOH and CaO were found to reduce the NDF contents of cultivar VG1126, whereas in cultivar VG3, NDF decreased with the use of CaO.
With the exception of cultivar VG1126 inoculated with LP, the ADF levels were similar between the cultivars. In the comparison between inocula, the lowest ADF levels in cultivar VG3 were observed when it was inoculated with urea and NaOH, whereas for cultivar VG1126 this occurred when it was inoculated with urea, NaOH and also with CaO.

Table 3. Mean percentage values of chemical components determined in energy-cane silages (VG3 and VG1126) subjected to different treatments.

Variable	Additive	Cultivar		Mean	P_1	P_2	P_3	CV%
		VG3	VG1126					
DM	Control	32.33bA	33.12aC	32.73D	<0.001	<0.001	<0.001	4.06
	LP	31.42bB	40.54aA	35.98B				
	Urea	31.22bB	39.97aA	35.60B				
	NaOH	30.10bC	37.84aB	33.98C				
	CaO	35.01bA	40.33aA	37.67a				
	Mean	32.01b	38.38a					
	Control	1.98aB	2.98aB	2.48B				

CP	LP	1.63aB	2.52aB	2.07B				
	Urea	10.88aA	7.72bA	9.30a	0.685	<0.001	<0.001	28.81
	NaOH	1.91aB	2.84aB	2.37B				
	CaO	1.74aB	2.57aB	2.15B				
	Mean	3.63a	3.72a					
OM	Control	98.26aA	97.97aA	98.12a				
	LP	97.25aB	97.08aB	97.17B				
	Urea	97.41aB	97.26aB	97.33B	0.400	<0.001	0.980	0.75
	NaOH	95.90aC	95.93aC	95.92C				
	CaO	96.20aC	96.10aC	96.15C				
	Mean	97.01a	96.87a					
EE	Control	2.46aA	1.95bC	2.20B				
	LP	1.25bB	1.80aC	1.53C				
	Urea	2.06aA	2.10aC	2.08B	0.005	<0.001	0.001	22.62
	NaOH	2.17bA	2.97aA	2.57a				
	CaO	1.81bA	2.45aB	2.13B				
	Mean	1.95b	2.25a					
MM	Control	1.70aC	2.07aB	1.89C				
	LP	2.74aB	2.78aB	2.76B				
	Urea	2.58aB	2.73aB	2.66B	0.283	<0.001	0.905	23.44
	NaOH	4.09aA	4.05aA	4.07a				
	CaO	3.79aA	4.13aA	3.96a				
	Mean	2.98a	3.15a					
NDF	Control	64.78bB	69.61aA	67.20B				
	LP	71.67aA	69.71aA	70.69a				
	Urea	65.10aB	65.21aB	65.15C	<0.001	<0.001	<0.001	3.59
	NaOH	59.35bC	63.55aB	61.45D				
	CaO	52.12bD	63.80aB	57.96E				
	Mean	62.60b	66.38a					
ADF	Control	37.16aB	39.19aA	38.18a				
	LP	41.40aA	38.01bA	39.70a				
	Urea	35.50aC	35.68aB	35.59B	0.175	<0.001	0.002	7.65
	NaOH	33.74aC	34.58aB	34.16B				
	CaO	29.75bD	34.30aB	32.03C				
	Mean	35.51a	36.35a					

Means followed by common lowercase letters in the row and uppercase letters in the column do not differ from each other according to the Scott Knott test at the 5% probability level.

DM - dry matter; CP - crude protein; OM - organic matter; EE - ether extract; MM - mineral matter; NDF - neutral detergent fiber; ADF - acid detergent fiber.
Inocula: Control - no inoculum; LP - *Lactobacillus plantarum*; Urea - urea; NaOH - sodium hydroxide; CaO - calcium oxide. P_1 - difference between cultivars; P_2 - difference between additives; P_3 - cultivar × additive interaction.

Similar OM contents were found in the two energy-cane cultivars (Table 3). Organic matter was influenced by the use of additives in the ensiling process, with

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highest values found in the silage that received no additives, followed by the silages treated with LP and urea. The lowest values for this variable were seen in the silages that received NaOH and CaO, whose results were similar.

Mineral matter contents responded similarly in the two cultivars, being influenced only by the type of additive used. The results found for MM are opposite to those obtained for OM. The highest MM levels were observed in the silages treated with NaOH and CaO, followed by those that received LP and urea. The MM levels in the silage that did not receive any type of inoculum was lower than in the others, for both cultivars (Table 3).

Below are the mean *in vitro* DM degradability values of the silages from the two energy-cane cultivars (Table 4). The soluble fraction (SF) of the silage from cultivar VG3 was lower than that of cultivar VG1126, only when the former was not inoculated. As for the inocula used, CaO stood out, increasing the SF of cultivar VG3. In cultivar VG1126, however, the SF content decreased regardless of the inoculum used.

With the exception of the silages inoculated with LP, degradation was higher in cultivar VG3 than in VG1126 at both fermentation times evaluated (48 h and 72 h). When the inocula were evaluated for their efficiency, the greatest degradation in cultivar VG3 was achieved with the use of CaO. In VG1126, the best degradation was obtained with the use of NaOH.

Table 4 Table 4. Mean *in vitro* dry matter degradability values (%) in silages from two energy-cane cultivars treated with different additives, at 48 and 72 h.

Variable	Additive	Cultivar		Mean	P_1	P_2	P_3	CV%
		VG3	VG1126					
SF	Control	29.920bC	33.429aA	31.675B	<0.001	<0.001	<0.001	4.070
	LP	22.294aE	20.935aC	21.615E				
	Urea	27.922aD	25.469bB	26.696D				
	NaOH	34.152aB	26.737bB	30.445C				
	CaO	44.371aA	26.790bB	35.550A				
	Mean	31.732a	26.672b					
48 h	Control	51.612aC	40.255bD	45.933C	<0.001	<0.001	<0.001	4.490
	LP	45.189aD	45.093aC	45.141C				
	Urea	52.582aC	48.305bB	50.443B				
	NaOH	58.483aB	52.922bA	55.703A				
	CaO	62.610aA	49.473bB	56.041A				
	Mean	54.095a	47.209b					
72 h	Control	54.608aD	48.341bC	51.474C	<0.001	<0.001	<0.001	3.110
	LP	50.051aE	48.910aC	49.480D				
	Urea	56.865aC	53.288bB	55.077B				
	NaOH	61.451aB	56.078bA	58.765A				
	CaO	67.439aA	52.014bB	59.727A				

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Mean	58.083a	51.726b

Means followed by common lowercase letters in the row and uppercase letters in the column do not differ from each other according to the Scott Knott test at the 5% probability level.
SF: soluble fraction.
Inocula: Control - no inoculum; LP - *Lactobacillus plantarum*; Urea - urea; NaOH - sodium hydroxide; CaO - calcium oxide. P_1 - difference between cultivars; P_2 - difference between additives; P_3 - cultivar × additive interaction.

By analyzing the *in vitro* degradation of NDF in the silages from the two energy-cane cultivars, it is observed that the soluble fraction of cultivar VG1126 was similar to that of cultivar VG3 when the former was inoculated with LP or urea (Table 5). Additionally, the soluble fraction of cultivar VG3 was higher when it was inoculated with urea, NaOH or CaO, whereas for cultivar VG1126, the use or non-use of any of the additives did not result in an increase in the soluble fraction.
The *in vitro* NDF degradability of both energy-cane cultivars at 48 h was similar when cultivar VG1126 was inoculated with LP or NaOH (Table 5). The soluble fraction and degradability at 48 h in cultivar VG3 was higher when the silage was inoculated with urea, NaOH or CaO. Non-inoculation of cultivar VG1126 compromised *in vitro* degradation up to 48 h.
At 72 h of fermentation, *in vitro* NDF degradability in cultivar VG3 was lowest when no inocula were used or when the silage was inoculated with LP (Table 5). Cultivar VG1126 had its degradation reduced when inoculated with LP or CaO.

Table 5. Mean *in vitro* neutral detergent fiber degradability values (%) in silages from two energy-cane cultivars treated with different additives, at 48 and 72 h.

Variable	Additive	Cultivar		Mean	P_1	P_2	P_3	CV %
		VG3	VG1126					
SF	Control	1.351aB	-1.162bA	0.094B	<0.001	0.006	0.011	160.0
	LP	-0.623aB	0.829aA	0.103B				
	Urea	2.452aA	0.535aA	1.494A				
	NaOH	2.523aA	0.243bA	1.383A				
	CaO	4.522aA	0.599bA	2.560A				
	Mean	2.045a	0.209b					
48 h	Control	33.439aB	22.169bC	27.804D	<0.001	<0.001	<0.001	8.87
	LP	31.544aB	30.211aB	30.878C				
	Urea	35.158aA	30.340bB	32.749B				
	NaOH	37.418aA	35.133aA	36.276A				

	CaO	37.310a A	31.255b B	34.282 B				
	Mean	34.974a	29.821b					
72 h	Control	39.310a B	38.091a A	38.700 A	<0.001	0.038	0.018	10.81
	LP	36.297a B	34.417a B	35.357 B				
	Urea	42.945a A	37.582b A	40.263 A				
	NaOH	42.031a A	38.457a A	40.244 A				
	CaO	44.996a A	32.875b B	38.936 A				
	Mean	41.116a	36.284b					

Means followed by common lowercase letters in the row and uppercase letters in the column do not differ from each other according to the Scott Knott test at the 5% probability level.
SF: soluble fraction.

Inocula: Control - no inoculum; LP - *Lactobacillus plantarum*; Urea - urea; NaOH - sodium hydroxide; CaO - calcium oxide. P_1 - difference between cultivars; P_2 - difference between additives; P_3 - cultivar × additive interaction.

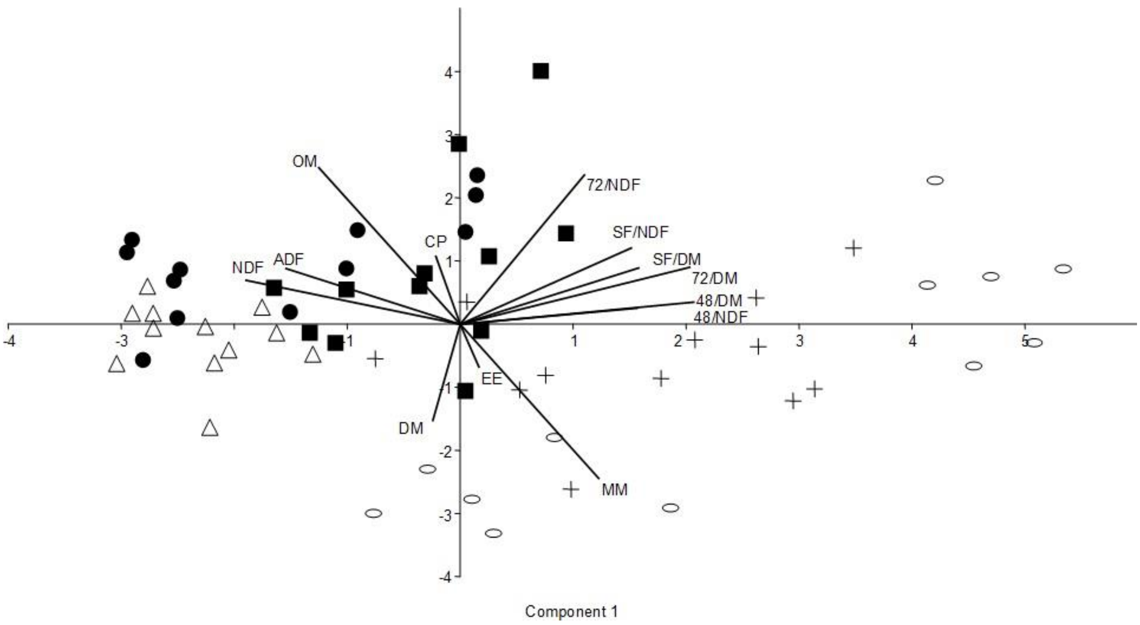

Figure 1. Principal component analysis of quality of silage from two energy-cane cultivars produced with different additives (Treatments: Triangle - LP: *Lactobacillus plantarum*; Empty circle - CaO: calcium oxide; Filled circle - Control, without inoculum; Square - urea; Cross - NaOH: sodium hydroxide).

Cultivars VG3 and VG1126 formed overlapping groups, which did not differ from each other. The main correlations in the analysis were the NDF, ADF and OM vectors, which were proportional to each other, that is, when one increases the other also increases. These same vectors were inversely proportional to MM, meaning when NDF, ADF and OM increase, MM decreases. Crude protein was also listed in this set of variables, but with little effect on the differences in cultivars (VG3 and VG1126).

Cultivar VG3 correlated with the SF/NDF, SF/DM, 72h/DM and 48h/DM variables, all of which were related to each other. These variables were inversely proportional to NDF, ADF and OM. The groups formed by the NaOH and CaO additives showed a higher correlation with each other, being related to the MM, SF/NDF and SF/DM parameters. The *Lactobacillus plantarum* and urea additives and control exhibited greater correlation with each other and were related to the OM, NDF, ADF parameters and weakly to CP.

DISCUSSION

Knowing the lignocellulosic composition of a feedstuff is essential for formulating ruminant diets (Table 1). When working with silage, another important factor to be considered is the quality of the material before the ensiling process (Table 2), so at the end of the process new analyses can be carried out and the success or non-success of the conservation process attested.

The results show that there was a reduction in DM content when the energy-cane cultivars were ensiled (Table 2 and Table 3). This reduction may occur during the fermentation of the material. According to Alli et al. (1983) and Evangelista et al. (2009), this decrease in DM levels is in response to the consumption of soluble carbohydrates by microorganisms. As stated by McDonald et al. (1991), this reduction is worrying, as it may be associated with yeast fermentation, which, in addition to significantly reducing nutritional value, can reduce voluntary consumption of silage by the animal.

The decreased DM losses following the use of CaO in the silage from cultivar VG3 was an expected result (Table 3). Studies led by Vilela et al. (2014) showed that the use of CaO in the ensiling of sugarcane reduces variations in the silage DM levels.

The CP and EE contents of the silages were similar to those of fresh energy cane (Table 3). As also found in silages from conventional cultivars, the CP levels in both cultivars of energy cane are low. This, however, does not limit its use, since its complementary addition in the diet can be easily done at the trough. The increased CP levels observed in the silage treated with of urea as an inoculum are considerable and were already expected. Lopes & Evangelista (2010) reported increases of up to 12.33% in CP contents when 1% of the sugarcane fresh mass was inoculated with urea.

Another important result was the reduction in NDF contents of the silages from the two energy-cane cultivars when they were inoculated with NaOH or CaO (Table 3). This reduction suggests the occurrence of alkaline hydrolysis with partial solubilization of hemicellulose (Reis et al., 1991). Similar results were described by Pedroso et al. (2007), who used 1% NaOH and observed a decrease of approximately 14% in the NDF contents of the silage.

In nutritional terms, these results are of great interest, since a reduction of fibrous components improves the digestibility of forage (Cruz et al., 2011). According to NRC (2001), NDF has low rates of degradation, and the decreases

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observed here may provide a higher DM intake by the animals. Reductions in ADF levels were also observed when the silage was inoculated with NaOH or CaO, which was already expected. Carvalho et al. (2012) reported that the addition of alkaline additives such as NaOH and CaO induces reductions in fibrous components in sugarcane silage.

The *in vitro* degradability values of the silages from the two energy-cane cultivars evaluated here are invaluable for further studies (Table 4). Sodium hydroxide significantly increased the DM degradation of cultivar VG1126 at 48 h and 72 h of fermentation. This increased degradation rate drives the use of NaOH for the preservation of silage from this cultivar. Several studies have shown the advantage of using NaOH, e.g., Ezequiel et al. (2005) reported a 45% increase in digestibility and a 25% increase in DM intake of sugarcane treated with 1.5% NaOH, compared with fresh sugarcane.

For cultivar VG3, CaO was more advantageous in the degradation of silage DM at 48 h and 72 h of fermentation. With the restrictions on the use of NaOH due to the risks inherent to its handling, to the environment, and the risk of reducing the useful life of machinery, CaO (quicklime) emerges as an excellent inoculum. Balieiro-Neto et al. (2007) also demonstrated the benefits of using CaO. In addition to reporting increased digestibility in sugarcane before silage, those authors also report increased digestibility and recovery of digestible DM and non-fibrous carbohydrates after opening the silos.

In general, the effect of alkaline products such as NaOH and CaO on low-quality roughage (such as energy cane) is due to the partial solubilization of hemicellulose and the expansion of cellulose as a result of the hydrolytic attack of these substances on ester-type covalent bonds the between lignin and the cell wall. This allows the access of ruminal microbial enzymes to the cell wall, increasing the soluble fraction, reducing the insoluble fraction and elevating digestibility (Van Soest, 1994). Therefore, the results obtained in the present experiment corroborate these statements.

CONCLUSIONS

Here we show that the additives influence the chemical composition of the evaluated sugarcane silages. The alkaline additives NaOH and CaO can be used to reduce the fiber content and increase the mineral matter content of silages from energy-cane cultivars VG3 and VG1126. Additionally, the use of NaOH and CaO favors the degradability of the ensiled material, increasing the availability of the soluble fraction and fiber degradation. The use of *Lactobacillus plantarum* can be dismissed, since this additive does not favor degradability in silages from energy-cane cultivars VG3 and VG1126.

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