NUTRITIVE VALUE OF SUGARCANE SILAGE TREATED WITH CHEMICAL ADDITIVES

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ABSTRACT: The use of ensiled sugarcane has been increased lately in Brazil due to the benefits that this technique represents. The objective of this study was to evaluate the effects of chemical additives on the nutritive value of sugarcane silages. The trial was carried out in a completely randomized experimental design with four replicates per treatment. The following additives were applied onto the fresh forage before ensiling: *L. buchneri*, lime or limestone, 1.0 and 1.5% (wet basis) each, and gypsum 1.0% (wet basis), all of them diluted into 40 L of water per ton of fresh weight of forage. The analyzed variables were: ash, crude protein, neutral detergent fiber, acid detergent fiber and organic and dry matter digestibility. The addition of lime or limestone before ensiling produced silages with higher nutritive value compared to all other treatments, due to the increase of the ash content and dry matter and organic digestibility, and also by reducing the fiber content. The crude protein content range was similar to the values observed in the fresh forage. The treatments containing *L. buchneri* or gypsum were ineffective in improving the nutritive value of sugarcane silages and became similar to the control silages. Treatment containing lime or limestone improved the nutritive value of the sugarcane silage.
Key words: calcium carbonate, calcium oxide, calcium sulfate

VALOR NUTRITIVO DA SILAGEM DE CANA-DE-AÇÚCAR TRATADA COM ADITIVOS QUÍMICOS

RESUMO: A utilização da cana-de-açúcar na forma de silagem constitui-se em um tema que vem se destacando nos últimos anos, e que desperta o interesse de produtores e pesquisadores em função dos benefícios que essa técnica representa**.** O objetivo do presente trabalho foi avaliar o efeito de aditivos químicos no valor nutritivo da silagem de cana-de-açúcar. O experimento foi desenvolvido em delineamento inteiramente casualizado com quatro repetições por tratamento. Os seguintes aditivos foram utilizados para a confecção das silagens: *L. buchneri*, cal virgem ou calcário em doses de 1,0 e 1,5% da MV e gesso agrícola a 1,0% da MV, diluídos em 40 litros de água por tonelada de forragem. As variáveis analisadas foram: matéria mineral, proteína bruta, digestibilidade da matéria seca e orgânica, fibra em detergente neutro e fibra em detergente ácido. Para as variáveis de valor nutritivo, as silagens tratadas com cal virgem ou calcário apresentaram, no momento da abertura, maior teor de cinzas, menor concentração de componentes fibrosos e maiores coeficientes digestibilidade da matéria seca e orgânica. O teor de proteína bruta encontrado para esses tratamentos está dentro da amplitude preconizada para a forragem fresca. A ensilagem da cana-de-açúcar com *L. buchneri* ou gesso apresentaram desempenho semelhante ao tratamento controle para as variáveis acima mencionadas. O tratamento com cal virgem ou calcário melhorou o valor nutritivo da silagem de cana-de-açúcar.
Palavras-chave: carbonato de cálcio, óxido de cálcio, sulfato de cálcio

INTRODUCTION

The use of sugarcane (*Saccahrum officinarum*) has been recommended as forage in animal production systems. Recently, an increase of the use of sugarcane silage has been observed in animal feeding. Gains in daily operations of harvesting, chopping and hauling of the crop and better post-harvesting management were the main factors to boost the use of this forage. However, during the fermentation process, the high water soluble sugar contents result in sugarcane silage with high ethanol levels, which in turn increases dry matter losses and lowers its nutritive value.

Silage fermentation may be altered by using chemical and biological additives. Analyzing the available research on sugarcane silage, an interest can be noted in the identification of additives that are efficient in inhibiting the ethanol production in the silage. When the material is ensiled without additives, the silage presents an extensive yeast activity, with substantial conversion of water soluble carbohydrates to ethanol (Preston et al., 1976). Alli et al. (1982) noted an increase of acid detergent fiber (ADF) levels from 29.9% to 43.1% for the sugarcane ensiled without additives. Pedroso et al. (2005) preserved the sugarcane without additives and noticed a reduction of 15 % in the *in vitro* organic matter digestibility.

The alkali treatment of sugarcane silages has shown positive effects in the preservation of nutrients. The use of alkaline additives increases the initial pH of the ensiled crop and limits the proliferation of yeasts (Alcántara et al., 1989). Siqueira (2005) highlighted that the use of NaOH minimized the qualitative losses in sugarcane silage. Assessing the effect of lime in sugarcane silages, Cavali et al. (2006) and Balieiro Neto et al. (2005) reported lower levels of neutral detergent fiber (NDF), ADF and hemicellulose and higher *in vitro* dry matter digestibility (IVDMD) coefficients in the treated silage. In this context, the aim of this trial was to evaluate the effect of chemical additives (limestone, lime and gypsum) on the nutritive value of a sugarcane silage.

MATERIAL AND METHODS

The trial was conducted in Piracicaba, São Paulo state, Brazil (22º43' S; 47º39'W; 547 m), using green chopped sugarcane obtained in a stationary chopper adjusted to a mean particle size of 1 cm. The forage was ensiled in 20 L plastic buckets, mixed with 1.0% (fresh forage) of gypsum (18.45% of sulfur and 23.20% of calcium) and with 1.0 and 1.5% (fresh forage) of lime (94.08% of calcium oxide) or finely ground limestone (50.40% of calcium oxide). The control treatments were composed of silage without additives and treated with *L. buchneri* (2 g t^{-1} of fresh forage of a commercial strain of Lactobacillus buchneri) a heterolactic bacteria. All of the treatments were diluted in a water solution at a rate of 40 L t^{-1} of fresh forage. The sugarcane treated with the microbial additive was used as a positive control, based on the good results of this product (Schmidt et al., 2007; Pedroso et al., 2007), thus used as a reference to evaluate the performance of other treatments. At the bottom of the buckets had a sand layer covered with cheese cloth and a fine plastic sieve to allow effluent collection. Packing density in the buckets was standardized to reach 500 kg m^{-3} fresh forage. Buckets were closed and equipped with Bunsen valves.

Samples of sugarcane were collected before ensiling and after 90 days of storage, were dried in a forced-air oven at 60°C for 72 hours according to Silva (1981) and ground in a Wiley mill (1 mm screen). Chemical analysis for dry matter (DM), ash, crude protein (CP), NDF, ADF and IVDMD were performed by Near Infrared Reflectance Spectroscopy (NIRS) (Berzaghi et al.,1997) in a spectrophotometer model NIRS 5000 (NIRSystems®, Silver Spring, MD, USA). The samples selected by NIRS were submitted to wet chemical analyses.

The dry matter and ash content were determined according to the AOAC method (AOAC, 1990). The NDF and ADF determination was made with an ANKOM Fiber Analyzer (ANKOM® Technology Corporation, Fairport, NY), described by Holden (1999). Crude protein was determined indirectly by nitrogen determination (N × 6.25) using a LECO FP 528 nitrogen analyzer (LECO Instruments, St Joseph, Michigan, USA). IVDMD was performed in an ANKON Daisy Incubator (ANKOM® Technology Corporation, Fairport, NY) and described by Holden (1999).

The trial was carried out in a completely randomized experimental design with four replicates per treatment. Statistical analyses for all variables were performed according to PROC GLM by SAS (1999), and means compared by the Tukey test.

RESULTS AND DISCUSSION

The dry matter, NDF and ADF contents (Table 1) are in agreement with the values registered in the literature. Working on several cultivars of sugarcane (Andrade et al., 2002), observed dry matter levels varying between 24 and 37%, NDF between 36 and 56% and ADF between 21 and 36%. Likewise, the crude protein content is within the range of 1.80 to 4.70% of the dry matter reported by Faria (1993). The parameters of digestibility were within the variation between 54 and 64% related by Boin & Tedeschi (1993). The high levels of ashes observed in the forages treated with chemical additives showed the effect of the additive on modifying the mineral fraction in forages.

As expected, the treatment with chemical additives produced silages with markedly greater concentrations of ash compared with all other treatments (Table 2). The increase of mineral fraction in silages treated with chemical additives is reported by several authors. Simkins et al. (1965) observed 6.9% of ash in the silage treated with 0.5% of limestone in fresh forage, against 5.2% for the control treatment. Alcántara et al. (1989) used 3.0% of NaOH in sugar-

Table 1- Chemical composition and nutritive value of sugar cane treated with additives at the time of ensiling.

Parameter[1]	Treatments[2]						
	Control	LB	Lime 1.0%	Lime 1.5%	Limestone 1.0%	Limestone 1.5%	Gypsum 1.0%
DM, %	35.39	32.76	34.55	34.61	33.33	33.87	32.98
Ash, % DM	2.25	1.08	4.45	5.73	3.24	4.84	3.56
CP, % DM	2.85	2.75	2.61	2.57	2.62	3.05	2.90
NDF, % DM	52.93	48.11	50.75	51.76	51.39	54.27	49.17
Hemi, % DM	20.62	17.53	20.37	21.04	22.15	21.72	18.85
ADF, % DM	32.31	30.58	30.38	30.72	29.24	32.55	30.32
IVDMD, % DM	59.96	62.28	65.92	67.98	61.88	59.69	63.44
IVOMD, % OM	59.09	61.41	63.70	65.72	60.12	57.18	60.98

[1]DM = dry matter digestibility; CP = crude protein; NDF = neutral detergent fiber; Hemi = hemicellulose; ADF = acid detergent fiber; IVDMD = *in vitro* dry matter digestibility; IVOMD = *in vitro* organic matter digestibility. [2]The levels of chemical additives are expressed on wet basis; LB = *L. buchneri*, 2 g of commercial additive/ton of fresh forage;

Table 2 - Nutritive value of sugar cane silage after 90 day of ensiling[1].

Treatment[2]	Parameter[3]						
	Ash	CP	NDF	ADF	HEMI	IVDMD	IVOMD
	% DM						% OM
Control	1.75^{d}	3.98^{a}	67.10^{a}	43.78^{a}	23.32^{a}	48.74^{d}	47.96^{d}
L. buchneri	2.13^{d}	3.88^{a}	65.12^{a}	42.25^{a}	22.88^{a}	49.06^{d}	48.30^{d}
Lime 1.0%	6.09^{ab}	2.67^{cd}	52.56^{de}	35.40^{c}	17.16^{c}	70.45^{b}	67.47^{b}
Lime 1.5%	7.29^{a}	2.51^{d}	54.83^{cd}	35.07^{c}	19.76^{b}	74.21^{a}	72.34^{a}
Limestone 1.0%	4.71^{c}	3.08^{b}	55.84^{c}	35.41^{c}	20.43^{b}	58.60^{c}	54.83^{c}
Limestone 1.5%	6.04^{ab}	2.87^{bc}	51.58^{e}	34.94^{c}	16.64^{c}	61.76^{c}	57.34^{c}
Gypsum 1.0%	5.29^{bc}	3.85^{a}	61.83^{b}	39.10^{b}	22.73^{a}	52.06^{d}	50.33^{d}
C.V. (%)	12.4	3.7	2.4	3.4	4.9	2.4	2.5

[1]Means within columns with different superscripts differ ($p < 0.05$). [2]The levels of chemical additives are expressed on wet basis; *L. buchneri* = 2 g of commercial additive/ton of fresh forage. [3]CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; HEMI = hemicellulose; IVDMD = *in vitro* dry matter digestibility; IVOMD = *in vitro* organic matter digestibility.

cane silage and observed elevations in the ash levels (7.03% against 4.6% of dry matter for the silage without additive). The low levels of limestone used by Simkins et al. (1965) and of sodium hydroxide in the study of Alcántara et al. (1989) resulted in silages with ash content similar to those found in Table 2 for the silages treated with chemical additives.

After 90 days of storage, the concentration of crude protein was higher for the control treatment and silages contained *L. buchneri* or gypsum. In relation to the control treatment, the use of lime or limestone resulted in silages with smaller percentages of crude protein. However, comparing the levels of fresh forage, (Table 1) with the silage at the time of the opening (Table 2), a slight variation of this fraction was observed for these treatments. Apparently, the sugarcane fermentative process shows little effect on the protein degradation, once there was a small variation along time and the values for the silages at the moment of opening (Table 2) were within the range obtained by Faria (1993) for fresh forage(1.80 to 4.70% of dry matter).

At the time of opening, the highest values of NDF and ADF were observed for the control and *L. buchneri* treatments, followed by the silage treated with gypsum. For the fraction hemicellulose, there was no difference between these treatments. Queiroz (2006) applied microbial inoculant in sugarcane silages and observed higher fiber levels in the control silages and in those treated with a dose of commercial *L. buchneri*. According to Queiroz (2006), the control silage presented NDF and ADF levels of 77.7% and 45.61%, respectively, and the treatment containing *L. buchneri* resulted in values of 75.56% of NDF and 45.55% of ADF. The respiration process and the undesirable fermentation process in sugarcane silage without additives deplete the water soluble carbohydrate and, according to Rotz & Muck (1994) the reduction in the water soluble concentration correspondingly increases the NDF and ADF fractions. Pedroso et al. (2005) found in sugarcane ensiled without additive the disappearance of approximately 71% of the sugars, during the first 15 days of storage.

The use of lime or limestone was effective in reducing the concentration of cell wall components of the silages when compared with the control treatment. Markedly reductions were observed for the variables NDF and hemicellulose in the silages treated with 1.0% of lime and with 1.5% of limestone. The alkaline treatment of crop residues solubilizes some hemicellulose while not changing the cellulose content (Klopfenstein (1978). Comparing the fresh forage (Table 1) with the silage (Table 2), a slight disappearance in the hemicellulose fraction can be observed during 90 days of storage, showing the effects of additive in the solubilization of the fiber components. Balieiro Neto et al. (2005) also found solubilization of hemicellulose in sugarcane silage treated with 2.0% of lime.

The solubilization promoted by the limestone explains, in part, the lower levels of fiber components found in the sugarcane silages. When the use of these additives in corn and sorghum silages is evaluated, a slight change in the fiber levels can be noted. According to Vieira et al. (2004), the addition of limestone before the ensiling of sorghum resulted in silages with nutritive value similar to the control treatment. Simkins et al. (1965), evaluating the nutritive values of corn silages without additives and treated with 0.5% of limestone in the FF (Fresh Forage), did not observe changes of crude fiber levels between the silages.

The treatment of crop residues with alkaline agents is effective in reducing the components of the cell wall. The higher solubility of the oxide in relation to carbonate suggests a stronger action of the first additive on the fiber fraction of sugarcane silage. Cavali et al. (2006) observed the effect of addition rates of lime on the cell wall fractions of sugarcane silage. According to these authors, rates between 1.73 and 1.49% resulted in silages with minimum levels of NDF and ADF (38.6 and 22.5%, respectively). Balieiro Neto et al. (2005) observed lower levels of NDF and ADF in the sugarcane silage treated with 2.0% of lime (49.47 and 36.52%, respectively), values that are similar to those obtained in this study for the treatments with lime or limestone.

The sugarcane treated with *L. buchneri* or gypsum resulted in silages with lower coefficients of digestibility and similar to those found in the control treatment (Table 2). Siqueira (2005), when ensiling sugarcane with *L. buchneri,* found coefficients of DM digestibility of 50%, similar to those observed in Table 2 for the control treatments and *L. buchneri*. Pedroso et al. (2005) observed IVDMD of 47.0% after 90 days of storage of sugarcane ensiled without additives.

The use of lime increased the digestibility of the sugarcane silage in relation to the control treatment. The highest coefficients were observed for the silages containing 1.5% of lime, followed by the treatment with 1.0% of the same additive. Balieiro Neto et al. (2005) observed that the treatment of the sugarcane cultivar 86-2480 with 2.0% of lime, resulted in silages with 79.23% of IVDMD. Cavali et al. (2006), working on different levels of lime, estimated the maximum values of IVDMD of 81.2% for the sugarcane silage treated with 1.8% of lime. Pedroso et al. (2007) reported maximum values of IVDMD of 67.3% for the sugarcane silage treated with 3.0% of NaOH. The dry matter digestibility coefficients observed by these authors are in agreement with the values observed in Table 2 for the silages treated with lime. Additionally, the values observed for the fresh forage (Table 1) and for the silage (Table 2) indicate that the use of lime limits the disappearance of digestible fractions. Alcántara et al. (1989) observed that the in vivo dry matter digestibility of fresh sugarcane and the NaOH-treated silage were similar, and higher than that of the control silage. Possibly, the presence of the additive inhibited the yeast activity and, as a consequence, resulted in silages with higher recovery rates of water soluble carbohydrates. Also, the low levels of fiber components (Table 2) contributed to the higher coefficients of digestibility observed in the silages treated with lime.

The addition of limestone before ensiling increased the digestibility in sugarcane silage when compared to the control. The reduced levels of NDF, ADF and hemicellulose observed in the silage containing limestone (Table 2) possibly justify the high coefficients of digestibility. However, some authors did not observe the effect of this additive on other forages. Essig (1968) did not notice a difference in the digestibility of cellulose and organic matter fractions in corn silages without additives or treated with 1.0% of limestone. Studying the same forage, (Klosterman et al., 1960), observed values of digestibility of organic matter of 67.1% and 67.4%, for the control treatment and for the silage treated with 1.0% of limestone, respectively. Vieira et al. (2004) did not observe increase in the IVDMD of sorghum silages treated with 0.5% of limestone (57.52% in the control treatment *vs* 61.21% in the treated silage)

CONCLUSION

Application of lime or limestone improved the nutritive value of sugarcane silage. The utilization of these additives in fresh sugarcane before ensiling resulted in silages with lower concentration of cell wall content and higher coefficient of digestibility. The treatments containing *L. buchneri* or gypsum did not alter the fermentation process.

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REFERENCES

ALCÁNTARA, E.; AGUILERA, A.; ELLIOT, R.; SHIMADA, A. Fermentation and utilization by lambs of sugarcane harvested fresh and ensiled with and without NaOH. 4. Ruminal kinetics. **Animal Feed Science and Technology**, v.23, p.323-331, 1989.

ALLI, I.; BAKER, B.E.; GARCIA, G. Studies on the fermentation of chopped sugarcane. **Animal Feed Science and Technology**, v.7, p.411-417, 1982.

ANDRADE, J.B.; FERRARI JÚNIOR, E.; POSSENTI, R.A.; OTSUK, I.P.; ZIMBACK, L.; LANDELL, M.G.A. Produção e composição de cultivares de cana-de-açúcar. In: REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 39, Recife, 2002. **Anais.** Recife: SBZ, 2002. CD-ROM.

ASSOCIATION OF OFFICIAL ANALYTICAL CHEMISTS. **Official methods of analysis**. 15 ed. Arlington: AOAC, 1990. v.1, 1117p.

BALIEIRO NETO, G.; SIQUEIRA, G.R.; NOGUEIRA, J.R.; REIS, R.A.; SILVA, D.N.; ROTH, M.T.P.; ROTH, A.P.T.P. Valor nutritivo da silagem de cana-de-açúcar cv. IAC 86/2480 (*Saccharum officinarum* L.) com doses de óxido de cálcio antes e depois da ensilagem e com 3, 6 e 9 dias após abertura do silo. In: REUNION DE LA ASOCIACÓN LATINOAMERICANA DE PRODUCCIÓN ANIMAL, 19., Tampico, 2005c. **Anais.** Tampico: ALPA, 2005. CD-ROM.

BERZAGHI, P.; COZZI, G.; ANDRIGHETTO, I. The use of near infrared analysis for *in situ* studies. **Journal of Dairy Science**, v.80, p.3263-3270, 1997.

BOIN, C.; TEDESCHI, L.O. Cana-de-açúcar na alimentação de gado de corte. In: SIMPÓSIO SOBRE NUTRIÇÃO DE BOVINOS, 5., Piracicaba, 1993. **Anais.** Piracicaba: FEALQ, 1993. p.107-126.

CAVALI, J.; PEREIRA, O.G.; SOUSA, L.O.; PENTEADO, D.C.S.; CARVALHO, I.P.C.; SANTOS, E.M.; CEZÁRIO, A. Silagem de cana-de-açúcar tratada com óxido de cálcio: composição bromatológica e perdas. In: REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 43., João Pessoa, 2006. **Anais.** João Pessoa: SBZ, 2006. CD-ROM.

ESSIG, H.W. Urea-limestone-treated silage for beef cattle. **Journal of Animal Science**, v.27, p.730-738, 1968.

FARIA, V.P. O uso da cana-de-açúcar para bovinos no Brasil. In: SIMPÓSIO SOBRE NUTRIÇÃO DE BOVINOS, 5., Piracicaba, 1993. **Anais.** Piracicaba: FEALQ, 1993. p.1-16.

HOLDEN, L.A. Comparison of methods of *in vitro* dry matter digestibility for ten feeds. **Journal of Dairy Science**, v.82, p.1791-1794, 1999.

KLOPFENSTEIN, T.J. Chemical treatment of crops residues. **Journal of Animal Science**, v.46, p.841-848, 1978.

KLOSTERMAN, E.W.; JOHNSON, R.R.; SCOTT, H.W.; MOXON, A.L.; STAVERN, J.V. Whole plant and ground ear corn silages, their acid content, feeding value and digestibility. **Journal of Animal Science**, v.19, p.522-532, 1960.

PEDROSO, A.F.; NUSSIO, L.G.; PAZIANI, S.F.; LOURES, D.R.S.; IGARASI, M.S.; COELHO, R.M.; PACKER, I.H.; HORII, J.; GOMES, L.H. Dinâmica da fermentação e da microflora epífita em silagem de cana-de-açúcar. **Scientia Agricola**, v.62, p.427-432, 2005.

PEDROSO, A.F.; NUSSIO, L.G.; LOURES, D.R.S.; PAZIANI, S.F.; IGARASI, M.S.; COELHO, R.M.; HORII, J.; RODRIGUES, A.A. Efeito do tratamento com aditivos químicos e inoculantes bacterianos nas perdas e na qualidade de silagens de cana-de-açúcar. **Revista Brasileira de Zootecnia**, v.36, p.558-564, 2007.

PRESTON, T.R.; HINOJOSA, C.; MARTINEZ, L. Ensiling of sugar cane with ammonia molasses and mineral acids. **Tropical Animal Production**, v.1, p.120-126, 1976.

QUEIROZ, O.C.M. Associação de aditivos microbianos na ensilagem e o desempenho de vacas em lactação recebendo silagem de cana-de-açúcar comparada a volumosos tradicionais. Piracicaba: USP/ESALQ, 2006. 99p. (Mestrado).

ROTZ, C.A.; MUCK, R.E. Changes in forage quality during harvest and storage. In: FAHEY JUNIOR, J.C.; COLLINS, M.; MERTENS, D.R.; MOSER, L.E. **Forage quality, evaluation and utilization**. Madison: ASA-CSSA-SSSA, 1994. p.828-868.

SAS INSTITUTE. **SAS user's guide**: statistics. Cary: SAS Institute, 1999. 965p.

SCHMIDT, P.; MARI, L.J.; NUSSIO, L.G.; PEDROSO, A.F.; PAZIANI, S.F.; WECHSLER, F.S. Aditivos químicos e biológicos na ensilagem de cana-de-açúcar. 1. Composição química das silagens, ingestão, digestibilidade e comportamento ingestivo. **Revista Brasileira de Zootecnia**, v.36, p.1666-1675, 2007.

SILVA, D.J. **Análise de alimentos:** métodos químicos e biológicos. Viçosa: UFV, 1981. 166p.

SIMKINS, K.L.; BAUMGARDT, B.R.; NIEDERMEIER, R.P. Feeding value of calcium carbonated-treated corn silage for dairy cows. **Journal of Dairy Science**, v.48, p.1315-1318, 1965.

SIQUEIRA, G.R. Cana-de-açúcar (*Saccharum officinarum* L.) ensilada com aditivos químicos e microbianos. Jaboticabal: UNESP/FCAV, 2005. 92p. (Mestrado).

VIEIRA, F.A.P.; BORGES, I.; STEHLING, C.A.V.; GONÇALVES, L.C.; COELHO, S.G.; FERREIRA, M.I.C.; RODRIGUES, J.A.S. Qualidade de silagens de sorgo com aditivos. **Arquivo Brasileiro de Medicina Veterinária e Zootecnia**, v.56, p.764-772, 2004.

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