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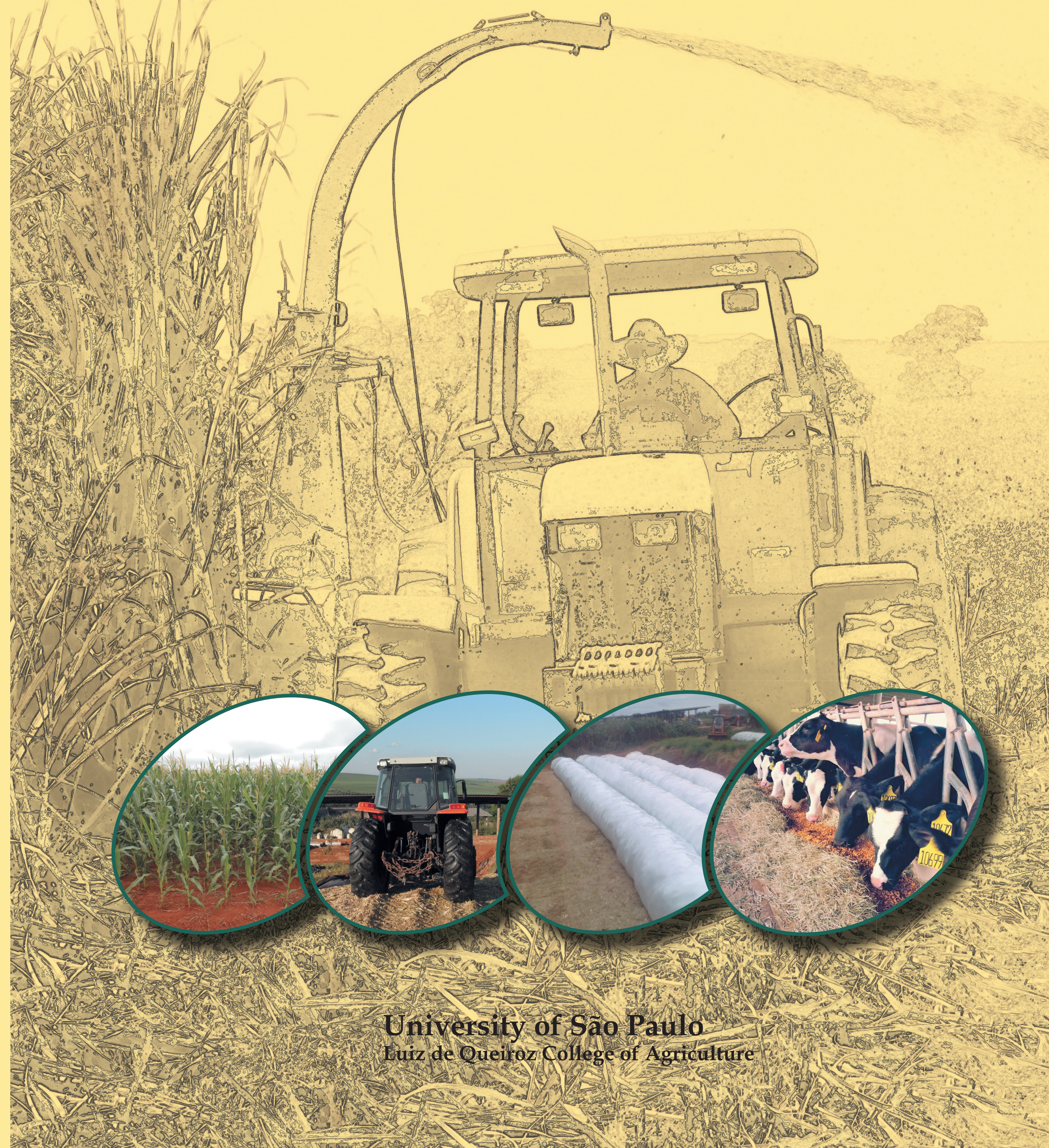

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Chemical composition of sugarcane silage with different levels of calcium oxide and crude glycerin

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Keywords ensilage, forage conservation, glycerol

Introduction The use of sugarcane silage is a feasible option for shortage of forage in pastures, increasing the losses during the fermentation process. However, the use of additives is required due to the high level of soluble carbohydrates, as well as the large number of yeasts that promote alcoholic fermentation with high CO_2 production, increasing losses during the fermentation process. This experiment aimed to evaluate the effects of calcium oxide and crude glycerin on the chemical composition of sugarcane silage.

Materials and methods The experiment was conducted in Federal University of Mato Grosso in partnership with Embrapa Agrosylvipastoral. The sugarcane (*Saccharum officinarum* L.) cultivar RB 72-454, was chopped and ensiled in 36 PVC silos with a volume of 2.75 liters, provided with Bunsen valves. We used a factorial design (3×4) in a completely randomized design, with three replicates per treatment, consisting of: three levels of calcium oxide (0, 0.5 and 1%) and four crude glycerin levels (0, 4, 8 and 12%) in fresh matter (FM). The composition of crude glycerin was 82% glycerol, 0.52% (w/w) methanol and 70.34 g/kg of mineral. Samples were pre-dried in an oven with forced ventilation of air at 55ºC and ground to a diameter of 1 mm. DM analysis was determined by AOAC method (1990). The crude protein (CP) was obtained by determining total nitrogen, according to the micro-Kjeldahl method. The fiber analysis in neutral detergent (NDF) and in acid detergent (ADF) were performed according to Van Soest and Robertson (1985), while hemicellulose content (HEM) was calculated by the difference between the NDF and ADF. Total carbohydrates were calculated according to Sniffen et al. (1992). The effect of adding calcium oxide within each level of glycerin inclusion was assessed using Tukey's test, and for the evaluation of the effect of glycerin inclusion we made regression models, linear, quadratic and cubic, both considering a significance of 5% for type I error.

Results and discussion The values of dry matter (DM), organic matter (OM), crude protein (CP), total carbohydrates (TC), neutral detergent fiber (NDF), acid detergent fiber (ADF) and hemicellulose (HEM) are presented in Table 1. There was a significant difference ($P<0.05$) between DM values, with increased levels following the addiction of calcium oxide (CaO), and linear effect for crude glycerin addition, since calcium oxide is an absorbent additive (Santos et al. 2008), promoting increased DM in the ensiled material, and glycerin, though fluid, has a high level of DM. For OM, there was interaction between treatments, observing a linear reduction in the levels of 0 and 0.5% of calcium oxide inclusion, and for each 1% added glycerin, there is a reduction of 0.96% of OM. This reduction can be explained by the high mineral content of the crude glycerin, which provided increased mineral content of treatments. For the inclusion of 1% calcium oxide we did not find any model that would fit to the level of glycerin ($\hat{Y}_{MO}$ = 93.91).

Table 1 Average and of interaction of chemical variables of sugarcane silage with inclusion of calcium oxide and crude glycerin

	CaO (%FM)			*P*-value	Crude Glycerin (% FM)				*P*-value	SEM[3]	Int.[4]
	0	0.5	1.0		0	4	8	12			
DM[1]	24.14c	28.10b	30.97a	<0.0001	23.61	27.21	29.20	30.93	<0.0001	0.58	0.1167
OM[2]	95.91	94.98	93.91	<0.0001	95.15	95.25	94.66	94.69	<0.0001	0.27	<0.0001
CP[2]	2.19a	1.96b	1.89b	<0.0001	2.27	2.13	1.92	1.73	<0.0001	0.22	0.5704
TC[2]	92.23a	92.23a	91.86a	0.7193	92.46	92.16	91.64	92.17	0.6177	0.83	0.1838
NDF[2]	53.48a	43.34b	36.40c	<0.0001	49.77	46.12	40.44	41.31	<0.0001	1.40	0.3589
ADF[2]	30.14a	26.74b	20.72c	<0.0001	29.45	26.96	23.14	23.92	<0.0001	1.03	0.1003
HEM[2]	23.34a	18.41b	16.78b	<0.0001	20.32	20.03	17.30	20.38	0.0654	1.22	0.2887

Interaction effect between the levels of addition of calcium oxide and glycerin.

	CaO (%FM)	Glycerin (% FM)				Model
		0	4	8	12	
OM[2]	0	96.69a	96.38a	95.49a	95.09a	$\hat{Y}_{MO} = 96.76 - 0.1424*G$ ($r^2 = 93.64$)
	0.5	95.15b	95.27b	94.67b	94.87a	$\hat{Y}_{MO} = 95.21 - 0.0335*G$ ($r^2 = 41.91$)
	1.0	93.60c	94.11c	93.82c	94.11b	$*\hat{Y}_{MO} = 93.91$

[1] %; [2] % of DM; [3] error of the means; [4] interaction of variables. $\hat{Y}DM = 24.36 + 0.5583*G$ ($r^2 = 41.13$); YHEM = 19.50; $\hat{Y}TC = 92.11$; $\hat{Y}DNF = 49.09 – 0.7844*G$ ($r^2 = 79.01$); $\hat{Y}CP = 2.28 – 0.0416*G$ ($r^2 = 56.25$); $\hat{Y}ADF = 28.98 – 0.5133*G$ ($r^2 = 19.41$); Averages in the same row followed by same lowercase letters do not differ according to Tukey's test at 5% probability for type I error. *No model adjusted to the fermentation period.

The CP values showed a decrease with the addition of calcium oxide, possibly due to proportionate dilution of the cell wall components. The values also reduced with the inclusion of glycerin levels, due to the low concentration of nitrogen compounds in glycerin. The TC showed no significant difference ($P > 0.05$) for addition of calcium oxide and glycerin. Values of NDF, ADF and HEM linearly decreased with the addition of calcium oxide ($P < 0.05$). These results, according to Klopfenstein (1978), can be explained by the partial solution of the fibrous fraction, with the addition of alkaline agents, as well as the lack of fibrous compounds in crude glycerin. However, the addition of crude protein showed no effect in hemicellulose contents, presenting an average value of 19.50%.

Conclusion It is recommended the addition of 0.5% calcium oxide and 4% crude glycerin in sugarcane silage, because it improved the chemical composition, with potential use in animal feed.

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