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Impact of days post-burning and lime as an additive to reduce fermentative losses of burned sugarcane silages

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ABSTRACT

The objectives of our study were: 1) to investigate the effects of burning and the time elapsed between burning and ensiling on characteristics of sugarcane silages, and 2) to evaluate the effects of lime on fermentation and aerobic stability of *in natura* and burned sugarcane silages. In trial I, silages were prepared from burned sugarcane that remained in the field for varying number of days post-burning (1, 5, 10, 15, 20, 25, and 30 d). In trial II, the characteristics of burned and *in natura* sugarcane silages treated with various concentrations of lime (0, 5, 10, 15, and 20 g/kg of sugarcane, on an as-is fresh matter basis) were compared. In trial I, 10-d post-burning, sugarcane crop displayed great degrees brix (18.3°Bx) and sucrose (677.3 g/kg of sugarcane broth) values. The yeast population in sugarcane crop 1-d post-burning (4.47 cfu/g of fresh forage) was lesser than that 25-d post-burning (7.11 cfu/g of fresh forage). After the silos were opened, all silages showed low pH. The silage from 1-d post-burning had the least dry matter (DM) recovery (637.5 g/kg of DM). The greatest DM recovery was found in the silage prepared 15-d post-burning (740.0 g/kg). Silage from 20-d post-burning displayed the greatest aerobic stability (36.7 h); however, in general, all silages had low aerobic stability (<40 h). In trial II, both the *in natura* and burned silages had reduced fiber content due to lime addition. Considering the overall mean, burned silages produced 47 g acetic acid/kg of DM against 25.6 g/kg of DM in *in natura* silages. Lime was more effective in increasing the production of acetic acid in *in natura* silages, but only when applied at great concentrations (15 and 20 g/kg). DM recovery of *in natura* silages decreased with increased addition of lime, whereas the opposite effect was observed for burned silages. In natura and burned silages treated with lime at 15 and 20 g/kg had greater aerobic stability (>8 d) than those treated with lesser quantities of lime. Considering the approach in which this study was carried out, a period of 10–15 days is ideal for ensilage of burned sugarcane prior to the silage quality significantly drops. Lime may be used as an additive for both *in natura* and burned silages since in greater levels (15 and 20 g/kg).

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1. Introduction

Sugarcane crops display great herbage production (25–40 t/ha of dry matter [DM]) and great energy values at maturity compared to other crops (Ávila et al., 2009); it is widely used as silage in diets for beef cattle and dairy cows in Brazil (Bernardes and Rêgo, 2014; Millen et al., 2009) because the difficult to perform daily cuts of fresh sugarcane on the field. Sugarcane is often harvested during the dry season. In this period, there is a great risk of accidental burning, which prevents the use of sugarcane in a direct cut system. Therefore, ensiling may be an effective strategy to avoid greater losses of quality and DM in this situation, but the maximum time that sugarcane can remain in the field post-burning before quality declines significantly is not conclusive (Roth et al., 2010).

Conversely, sugarcane ensiling may result in large DM losses (>300 g/kg) during fermentation due to the conversion of sucrose to ethanol by yeast, leading to the reduction in silage nutritive value, aerobic stability, and feed intake by livestock (Kung and Stanley, 1982; Pedroso et al., 2005). Thus, the addition, of an alkaline agent (e.g., lime) at the farm level has been recommended for reducing the fungi population and increasing the growth of the lactic-acid bacteria (LAB) population (Cavali et al., 2010), as well as to increase DM recovery (Rabelo et al., 2014), and improve the sugarcane silage digestibility (Siqueira et al., 2007, 2011a). These treatment effects are relatively well known for *in natura* sugarcane silage, but few studies have evaluated the process of ensiling burned sugarcane or the effect of chemical additives on this process. In that few studies, lime addition increased the *in vitro* digestibility (Roth et al., 2010) and DM recovery of burned sugarcane silages (Siqueira et al., 2011a).

Therefore, our objectives were to investigate the effects of the time between burning and ensiling on sugarcane silage characteristics and the effect of lime on fermentation and aerobic stability of *in natura* and burned sugarcane silages.

2. Material and methods

2.1. Ensiling process

2.1.1. Trial I

In trial I, we used a crop of the IAC 86-2480 sugarcane cultivar after 12 months of growth (third cut). The sugarcane field was burned at sunset on the day before cutting. The stems were not severed from their roots until harvest taking into consideration any incidence of accidental fire.

On days 1, 5, 10, 15, 20, 25, and 30 post-burning, sugarcane was mechanically harvested using an ensilager (Menta Mit, ColhiFlex model, Cajuru, SP, Brazil). Mini-silos (plastic buckets of 7 L capacity) were used in quadruplicate for ensiling, which were closed with plastic lids and sealed with adhesive tape; a density of 676 kg fresh matter/m^3 was obtained.

2.1.2. Trial II

The sugarcane used in trial II was similar to that used in trial I. The sugarcane field was burned at sunset the day before cutting, and 1-d post-burning sugarcane was used to ensilage. After harvest, the burned and *in natura* sugarcane either remained untreated or was treated with lime (micro-pulverized calcium oxide) at 5, 10, 15, and 20 g/kg (on an as-is fresh matter basis). Lime was diluted in water at a ratio of 1.0 kg lime per 4 L of water and applied at 20, 40, 60, and 80 mL/kg of fresh sugarcane to obtain the concentrations described earlier. Lime was then well-mixed with the sugarcane multiple times to ensure good homogenization.

Mini-silos (plastic buckets of 20 L capacity) were used in quadruplicate for ensiling, and were closed with a plastic lid and sealed using adhesive tape; a density of 872 and 562 kg fresh matter/m^3 was obtained for burned and *in natura* sugarcane, respectively.

2.2. Fermentative losses

In both trials, the mini-silos were weighed immediately upon ensiling and after opening at the end of the ensiling period (56 d) to determine gas and DM losses, which were calculated as:

$$\text{Gaslosses(g/kgofDM)} = (((F_{en} \times DM_{en}) - (F_{op} \times DM_{op}))/(F_{en} \times DM_{en})) \times 100 \quad (1)$$

where F_{op} and DM_{op} = forage mass and DM content of the silos at opening, respectively; F_{en} and DM_{en} = forage mass and DM content at ensiling, respectively.

$$\text{DMrecovery(g/kg)} = (F_{op} \times DM_{op})/(F_{en} \times DM_{en}) \times 100 \quad (2)$$

where F_{op} and DM_{op} = forage mass and DM content of the silos at opening, respectively; F_{en} and DM_{en} = forage mass and DM content at ensiling, respectively.

2.3. Aerobic stability

To determine aerobic stability, a silage sample from each mini-silo was placed in a plastic bucket of 7 L capacity and kept at ambient temperature. A data logger was placed in the silage and the silage temperature was measured every hour for 9