How does sodium benzoate application, relocation and storage time affect the fermentative losses and stability of sugarcane silage?

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Introduction The high concentration of sugars and a high epiphytic microflora of yeast in sugarcane promotes an expressive alcoholic fermentation in sugarcane silages. Causing large losses of dry matter and effluents (Schmidt et al., 2014). Sodium benzoate shows promising results in improving fermentation characteristics and increasing stability (Kleinschmit et al., 2005). However, there are some studies on the effectiveness of using chemical compounds in adverse situations, such as: silage relocation and storage times after silage relocation. Thus, this study aimed to determine the effects of sodium benzoate, relocation, and storage time on fermentative losses and aerobic stability of sugarcane silages.

Materials and Methods The experimental trial was conducted in UFRA, Brazil (at 01°07'S, 47 °36'W). Sugarcane was harvested with a traction harvester with a theoretical cut length of 20mm. The silages were made in experimental silos (15 L). The density was 476 ± 35 kg of FM (fresh matter) / m³. A completely randomized experimental design in a 2 × 4 × 2 factorial arrangement with four replications was used. The treatments included the addition of additive: without sodium benzoate (WB) and sodium benzoate (SB) at 2g kg^{-1} FM, relocation (no relocation (NR), 12, 48 or 72 hours of relocation), and silage storage time after relocation (ST; 10 or 60 days). The silos were stored for 120 days. Effluent losses (EL) and dry matter losses (DML) was obtained by an adapted equation of Siqueira et al. (2007) and Jobim et al. (2007), respectively. Accumulated effluent and dry matter losses were calculated by summing the total losses in the two experimental silos openings. The silage was subjected to the aerobic stability test. Data were analyzed by the SAS® program MIXED procedure observing the effects of additive (A), relocation (R), storage time (TA) and their interaction (A × R × TA). The averages were compared using the tukey test at 5% probability level.

Results and Discussion Effluent losses ($p < 0.05$) were altered by the effect of relocation and storage time of sugarcane silage, presenting higher values in silages relocated for 12h and 48h (29.13 and 25.48 g.kg-1 , respectively) and lower values in NR or 72h relocated silages (20.05 and 22.45 g.kg-1, respectively). The application of SB did not alter the effluent production of sugarcane silages. Relocated silages produced more effluent, because they went through the compaction process twice, which allows the removal of water present inside the forage cells, producing larger amounts of effluents (Michel et al., 2017). Silages stored for 60 days ($p < 0.05$) showed higher losses by effluent (33.35 g.kg-1). These losses may be mainly due to the variation in the effluent accumulation rate during the second ensiling period. According to Mcdonald et al. (1991) silages accumulate around 0.14 g.kg -1 per day during the first 90 days of silage. Thus, silages that spent longer time stored after relocation accumulated more effluents. DML ($p < 0.05$)

was altered by the interaction between additive use and silage relocation time (A × R) (Table 1). DML (p> 0.05) in sugarcane silage with SB did not differ from WB silage when: without relocation and relocated at 12 and 72h. There was an additive effect (p> 0.05) only when silages were relocated at 48h, presenting lower DML than in WB silages. Siqueira et al. (2007), the main microorganism responsible for the losses during sugarcane fermentation are yeasts that produce CO2 and ethanol, generating losses of DM (Mcdonald et al., 1991). Therefore, the increase in dry matter losses with relocation time may be related to the increase in yeast population, which also increased according to relocation time. The lack of SB effect on DML shows the loss in SB effectiveness after the relocation process. The effect of the additive is temporary, especially in sugarcane silages where they have enough substrate to continue growing (Lambert and Stanford (1999). The AE (p <0.05) were changed by the interaction between additive use, relocation time and storage time (A × R × ST) (Figure 1). Silva et al. (2014) describe the increased stability with the use of benzoate in silages. In the present study, independent of the use of SB, silages stored for 60 d showed higher aerobic stability (Figure 1) when not relocated. Silages with 60 days of storage had smaller yeast populations (3.4 log.ufc g^{-1}) and higher concentration of acetic acid. Higher concentrations of this acid increase stability under aerobic conditions (Muck, 2010). When relocating silages for 12, 48 and 72h, all decreased the aerobic stability of silages and showed higher deterioration rates, especially in silages relocated for 12 and 48h. This is because relocating silages inevitably exposes them to air, allowing yeasts to grow (Chen and Weinberg, 2014).

Table 1 Interaction of the effect of additive use and relocation (A × R) on sugarcane silages.

Dry matter losses (%)				
	NR	12h	48h	72h
Without S. Benzoate (WB)	15,55Ab	23,14Aab	25,04Aa	19,97Aab
Sodium Benzoate (SB)	16,04Ab	18,03Aab	13,03Bb	25,71Aa

[a–b]Means within a row with different superscripts differ (P < 0.05).

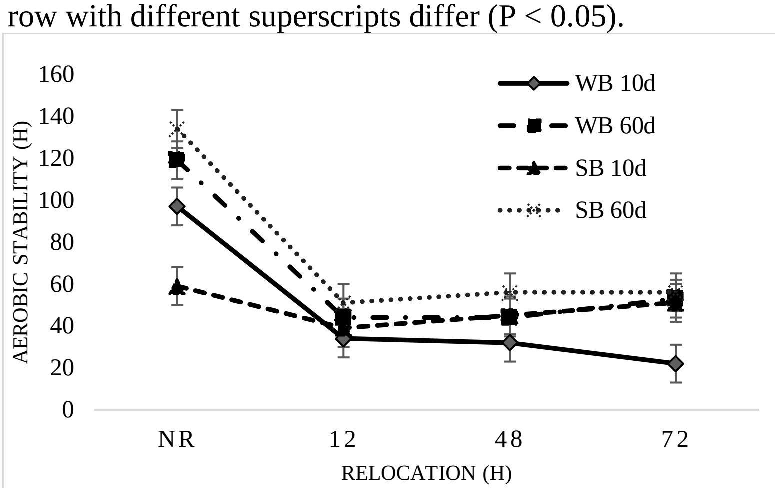

Figure 1 Interaction of additive use (2g kg^{-1} FM), relocation time (NR = no relocation) and storage time (10 or 60 d) (A × R × SY) on aerobic stability of sugarcane silages.

Conclusion SB is not effective in reducing effluent production in sugarcane silage. Relocation and storage time negatively affect effluent losses. Storage time of 60 days increases aerobic stability of silages independent of benzoate use. In relocated silages stored for 10d, benzoate is effective in increasing stability.