Characterization of the sugarcane silage effluent and the potential of environmental pollution

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Introduction Brazil is a major supplier of animal protein for the world. Recent estimative by FAO (2010) have projected a 29% growth in Brazilian meat exports until 2019. This growth brings with it several issues that must be studied, especially environmental issues. The use of sugarcane silage has increased in recent years, because of several advantages over other types of grasses, mainly the productivity of more than 35 t DM ha^{-1}. However, the inadequate utilization of this forage as silage may lead to the formation of effluent during the ensiling process, with unknown pollution potential. Thus, this study aimed to quantify and evaluate the pollutant potential of sugarcane silage effluents.

Materials and Methods The trial was carried out at the Centro de Pesquisa em Forragicultura (CPFOR) of Universidade Federal do Paraná, in Curitiba, PR, Brazil. The sugarcane variety RB 72-454 was harvested at 328 g kg^{-1} of dry matter (DM) and the following treatments were applied: CONTROL – no additives; ADD – chemical additive within LOW (4 g t^{-1}) or HIGH (8 g t^{-1}) dosages (wet basis), with five replicates for each treatment. The treated forage was ensiled in plastic buckets (20 L) equipped with a 2 cm tall plastic pallet on the bottom for recovery the effluent. The bulk density of the silos was 600 kg m^{-3}. Samples were collected for determination of DM, brix and pH (Table 1). Immediately after ensiling, a vacuum pump was used to remove the air in bottom of the silo. After 66 days of storage, the silos were opened and the effluents were collected from 10 silos, and five showed only a small and insufficient quantity of effluent for analysis. The effluent production was measured by differences in the weight of the empty silos before and after ensiling.

Soluble solids (brix) were measured immediately from sugarcane juice and in the effluent using an optical refratometer. Another sample of effluent was collected and stored in a freezer and used for determination of chemical oxygen demand (COD) as described by Peralta-Zamora et al. (2005), pH and DM content, under 55°C forced air oven. The density of the effluent was measured by weighing one mL of effluent using a high precision scale.

Results and Discussion There were no effects of treatments over the tested variables. The average amount of effluent production was 13.3 kg per ton of silage (wet basis). It is equivalent to 12.8 L t^{-1} (Table 2) and it is below the most common values found in literature, which is between 30 and 90 kg t^{-1} for sugarcane silages. Probably, this low effluent production could be related to the high DM content (328 g kg^{-1}) of good quality sugarcane used in this trial (brix 19.8%). Thus, the effluent production of sugarcane silages could be reduced by harvesting the plant at high maturity stages.

The effluent showed 568,497.7 mg L^{-1} average COD. This value is extremely higher than the mean value of 38,344.0 mg L^{-1} reported by Bernardino et al. (2005) for effluent of Elephant Grass silages. This shows the importance of avoiding silage effluent production because it is hundreds times more pollutant than other agents considered of great environmental importance, such as landfill leachate (Peralta-Zamora et al. 2005).

A strong correlation (R: 0.984) between brix and DM content of effluent suggests that large amounts of soluble solids, mainly sucrose, are lost by leaching. In this study it was observed losses of 1.83 kg of soluble dry matter as effluent for each ton of ensiled forage. The high DM content of the effluent caused a great demand for oxygen and resulted in the oxidation of all carbohydrates in this component. Likewise, the low pH indicates high concentration of organic acids that could be used by ruminants, but they were lost in this residue. When released into water sources, these components are readily metabolized by aquatic aerobic microorganisms, which reduce the oxygen content of water and generate large environmental impact.

Conclusion The effluent of sugarcane silages is rich in nutrients and shows a great potential for pollution of aquatic environments and therefore must be prevented. The brix can be used as a tool to estimate the amount of total soluble solids that are in the effluent of sugarcane silages.

Reference

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Table 1- Dry matter content, brix and pH of sugarcane before ensiling

Variables	Mean	Standard-deviation
Dry matter, g kg^{-1}	328	4.2
Brix, %	19.8	1.65
pH	6.10	0.06

Table 2- Chemical oxygen demand (COD), brix, pH, DM content, density and total production (kg t^{-1}) of the effluent from sugarcane silage

Variable	Mean	Standard-deviation
COD, mg O_2 L^{-1}	568,497.7	106,553.8
Brix, %	14.4	0.78
pH	3.17	0.26
Dry Matter, g kg^{-1}	138	7.8
Density	1.0465	0.02
Effluent, kg t^{-1}	13.3	9.34