Sugarcane vinasse as additive for whole-plant corn ensiling

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Introduction The additives applied during the ensiling process seek to reduce storage losses and maintain as much as possible the nutritional value of silage. The additives improve the fermentation process through different mechanisms, these include: limit respiration and proteolysis by enzymes of plants, manipulating fermentation and inhibiting the activity of microorganisms such as yeasts and molds and reducing losses due to effluents. The biofuels industry obtained ethanol from fermentation of sugarcane by the action of yeast, producing a residue called vinasse. The vinasse is a mixture of water and organic and inorganic compounds, is characterized by having an acid pH (4.0), high moisture content (82%), a protein content of 7% and high concentrations of organic matter (94 %) (Fernandez et al, 2009). These characteristics, together with its high production and high biochemical oxygen demand suggest that this product can be used as an acidifier and improve the fermentation process during ensiling. The aim of this study was to evaluate the sugarcane vinasse as acidifier in the corn silage production.

Materials and Methods Whole plants of corn (*Zea mays*) (ICA-109) were chopped and ensiled in laboratory silos fabricated with PVC tubes (10 cm diameter and 40 cm long). The treatments were: Three levels of vinasse inclusion (3, 6 and 9% of fresh matter) diluted in water at three different concentrations (10, 20 and 30% v/v), for a total of 9 treatments with five replicates each. The vinasse was added by aspersion onto the forage. The silos were opened after 100 days, in the solid fraction were determined the concentrations of dry matter (DM), crude protein (CP), ash, calcium, phosphorus, neutral detergent fiber (NDF) and acid detergent fiber (ADF). On the liquid fraction were determined concentrations of volatile fatty acids (VFA) by gas chromatography, ammonia nitrogen ($N\text{-}NH_3$) and pH with potentiometer (FAO, 2011). Data were analyzed by a 3 x 3 factorial arrangement and Tukey test ($\alpha = 0.05$) was used for comparison of treatment means.

Results and Discussion The silages had pH values between 3.5 and 3.6, indicating that an adequate fermentation process occurred. The $N\text{-}NH_3$ concentrations in silages were not altered by the treatments. The values for this variable were between 0.7 and 0.9%, indicating that limited proteolysis occurred during fermentation. The propionic and butyric acids were not detected in the silage. The acetic acid concentration was not affected by the treatment ($P>0.05$). The treatments had no effect on DM content of silages ($P>0.05$). The NDF and ADF concentrations in the silages decreased with the increased participation of vinasse in the treatment ($P<0.05$). However, the hemicellulose content was unchanged by the treatment, demonstrating that the vinasse promoted hydrolysis of cellulose during the fermentation process. The protein percentage was equivalent between treatments. The calcium and phosphorus concentration presented the same trend observed for the protein. The sugarcane vinasse has high amounts of potassium and other minerals for this reason the ash content increased as the level of participation of vinasse was increasing in the silage.

Table 1 Chemical composition and fermentation profile of silages

	Percentage of inclusion									Efects[1]		
	3			6			9					
Concentration, %	10	20	30	10	20	30	10	20	30	Inc.	Conc.	Inc. x Conc.
DM, %	17.6	18.9	17.4	17.2	17.4	18.3	17.0	18.3	19.2	ns	ns	ns
NDF, % DM	60.8	59.9	56.7	56.8	56.8	58.2	59.8	55.4	54.8	0.02	ns	ns
ADF, % DM	32.9	33.3	29.7	29.5	29.2	29.9	30.2	26.6	27.3	0.01	ns	0.01
Hemicellulose, % DM	27.8	26.6	27.0	27.3	29.6	28.3	29.5	28.8	27.5	ns	ns	ns
Crude protein, % DM	8.2	8.5	7.3	9.2	7.4	8.4	8.9	8.4	8.6	ns	ns	ns
Ash, % DM	7.8	6.6	7.3	8.1	7.7	8.4	8.2	8.4	7.9	0.01	ns	ns
Calcium, % DM	0.4	0.4	0.4	0.4	0.5	0.5	0.4	0.4	0.5	ns	ns	ns
Phosphorus, % DM	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	ns	ns	ns
Fermentation profile												
pH	3.5	3.6	3.6	3.5	3.6	3.6	3.6	3.6	3.6	ns	0.01	ns
N-NH3, % total N	0.8	0.9	0.9	0.7	0.9	0.9	0.8	0.8	0.8	ns	0.08	ns
Acetic acid, % DM	6.5	9.8	9.5	9.9	9.4	6.1	16.5	9.4	7.8	ns	ns	ns
Propionic acid, % DM	-	-	-	-	-	-	-	-	-	-	-	-
Butyric acid, % DM	-	-	-	-	-	-	-	-	-	-	-	-

[1] Inc. = inclusion; Conc. = concentration; Inc. x Conc. = interaction inclusion x concentration; ns = non significative

Conclusion The vinasse inclusion did not have the expected effect on the pH values in the silage. The high potassium, calcium and nitrogen levels in the vinasse could act as buffer during fermentation process, reducing the acidifying power of vinasse.

References

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