Chemical composition and organic acids profile of high-moisture corn silages inoculated with lactic acid bacteria and rehydrated with water or acid whey

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Introduction The fermentation of high-moisture corn (HMC) is often restricted because of its relatively moisture low and fermentable sugar contents, and the accumulation of total acids produced is quite low (Kung Jr. et al., 2007). As result, there is low aerobic stability after opening of the silos. However, this can be minimized using different strategies, as lactic acid bacteria (LAB) application or acid whey application (main sub-product formed in the dairy plants from manufacture of cheese). The acid whey can be not discarded in rivers or ponds because promote serious damages for the environment, increasing the biochemical oxygen demand (Gheri et al., 2003). This product has been used like fertilizer in agricultural systems and in the animal feeding, and has potential to use in the ensiling process. Thus, our aim was to evaluate the chemical composition and organic acids profile of HMC silages inoculated with lactic acid bacteria and rehydrated with water or acid whey.

Material and Methods We used the AG-4051 cultivar in this study. The corn was harvested to ensiling when the grains presented 14% of humidity. The following treatments were applied to the corn: control (untreated); inoculated with Maize All® (*Enterococcus faecium* and *L. plantarum*, 1.0 x 10^{10} cfu per gram of product, *P. acidilactici*, 1.0 x 10^9 cfu per gram of product, amylolitic and cellulolytic enzymes (1.5%), and proteolytic enzymes (2.0%)); rehydration with water or acid whey until reaches 30; 35 or 40% of humidity. The application rate of the inoculant was determined in accordance with the instructions from the manufacturer. Thus, the experiment was conducted in a completely randomized design, with four replicates in a factorial arrangement 3 (rehydration with three different humidity levels) x 2 (silage inoculated or not) x 2 (liquid used in the rehydration). As experimental silos were used PVC tubes with capacity of 4 L. After 30 days of ensiling, the silos were opened, and the silage was homogenized for chemical characterization. Total nitrogen (TN) was determined following the recommendations of AOAC (1996). The crude protein (CP) was obtained by the product between the TN and the factor 6.25. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were estimated using the techniques described by Van Soest et al. (1991). The pH values and volatile fatty acids (VFA) were analyzed. The VFA were determined by gas chromatograph. Data were subjected to ANOVA by SISVAR program, and the differences between the means were determined using Tukey test. Significant differences were declared at 5%.

Results and Discussion Acid whey application in HMC silages increased the acetic and lactic acid concentrations compared with the silages rehydrated with water. Perhaps, this result may be related with higher concentration of nutrients on acid whey (rich in minerals, as nitrogen, potassium and phosphorus). Thus, probably the LAB present in silos used this acid whey as substratum to development. The inoculant used in this study has only homofermentative LAB (produce mainly lactic acid), however, the lactic acid concentration decreased because of the inoculant application, which may be related with the increase in the acetic acid concentration. Lactic acid concentration decreases because of the increase in the rehydration. However, the pH values were not affected by factors evaluated in this study (Table 1). The CP, NDF and ADF contents decreased with the acid whey application, whereas there was not effect of the inoculant application. NDF content was higher with rehydration until 35%, whereas the ADF content was higher with 40% of humidity. However, we expected that the CP content increased because the acid whey has protein in your composition. As in the present work, Schingoethe et al. (1980) found positive responses with application of dried whole whey in sunflower silages, and observed improvement in the *in vitro* dry matter digestibility. Schingoethe et al. (1974) observed decreases of non-protein nitrogen with application of dried whole whey in corn silages.

Table 1 Chemical composition and organic acids profile (% of DM) of HMC silages inoculated with LAB and rehydrated with water or acid whey.

Item	Rehydration (%)			Liquid		Inoculant		P value[1,2]			
	30	35	40	Water	AW[3]	No	Yes	R	L	I	Interaction
Fermentation end products, % of DM											
pH	4.12	4.25	4.06	4.22	4.07	4.08	4.21	ns	ns	ns	ns
AC	0.17[b]	0.18[a]	0.17[b]	0.172[b]	0.179[a]	0.16[b]	0.18[a]	**	*	**	RxLxI**
PA	0.11	0.12	0.11	0.11	0.12	0.11[b]	0.12[a]	ns	ns	**	RxLxI**
LA	1.41[a]	1.30[ab]	1.24[b]	1.25[b]	1.38[a]	1.37[a]	1.26[b]	*	*	*	ns
Chemical composition, % of DM											
CP	9.98	9.37	10.39	10.47[a]	9.36[b]	9.85	9.98	ns	*	ns	ns
NDF	13.9[b]	20.12[a]	15.2[b]	18.37[a]	14.51[b]	16.66	16.22	**	**	ns	RxLxI*
ADF	2.05[b]	2.72[ab]	3.49[a]	3.38[a]	2.13[b]	2.69	2.82	**	**	ns	RxLxI*

*Means followed by different letters differ by Tukey test (P<0.05). [1]ns = not significant (P>0.05); *P<0.05; **P<0.01. [2]R = rehydration; L = liquid; I = inoculant; [3]AW = acid whey. AC = acetic acid; PA = propionic acid; LA = lactic acid; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber.

Conclusions High-moisture corn silages rehydrated with acid whey are more fermented, and have lower fiber content. Application of inoculant in high-moisture corn silage increases the production of acetic and propionic acids.

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