Fermentative characteristics of acid whey rehydrated grain corn silage

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Introduction Rehydrated corn grain silage is a strategy used to ensure food availability during the year. Rehydration with 35% moisture content is important to be achieved for proper fermentation and conservation of silage. Co-products such as whey have in their composition considerable concentrations of lactic acid bacteria (LABs), which are used in the fermentation process. Thus, the use of alternative liquid sources to rehydrate grains beyond water can modernize this technique and favor the production of this type of food. In order to improve fermentation and reduce nutrient losses, bacterial inoculants are also incorporated into the ensiling process. Therefore, the objective of the present study was to evaluate the effects of rehydration of corn grains with whey on the fermentative characteristics of silages.

Material and methods The corn grains used to make the silages were grinded 1.5 mm the moisture content determined in the grains was 11.7%. The mass was hydrated with 35% humidity according the treatments: Water; Reconstituted whey powder with water; Fluid whey; Whey powder reconstituted with water and inoculant; Fluid whey with inoculant. The experimental design was completely randomized with 5 treatments and 6 repetitions. The inoculant added to the mass to be ensiled consisted of *Propionibacterium acidipropionici, Lactobacillus plantarum, L. acidophilus, Pediococcus acidilactici, Enterococcus faecium, L. buchneri, L. curvatus* at a concentration of $70x10^9$ CFU/g and 8% cellulolytic enzymes. The ensiled mass was packed in 4 L polyethylene mini-silos, with an initial average weight of 4.36 ± 0.17 kg. The compaction was performed manually, having as average density of 1020 ± 0.04 kg/m^3 of natural matter (NM). All silos were sealed with a plastic cap and appropriate plastic tape, and stored for 45 days until the opening date, which reached a final weight of 4.28 ± 0.20 kg. Corn grain was evaluated for chemical composition (dry matter (DM) = 88.3% NM, crude protein (CP) = 9.27%, mineral matter (Ash) = 1.55%, ether extract (EE) = 3.18%, neutral detergent fiber (NDF) = 12.62%, acid detergent fiber (ADF) = 2.58%, lignin = 1.13% in% DM) according to AOAC (2000) and fluid whey (DM = 6%, CP = 8.65%, Ash = 0.34%, EE = 0.35% in DM, pH = 6.30 and acidity = 0.13°D) according to Zenebon et al. (2008). Determination of buffer capacity (BC) and amonical nitrogen ($N\text{-}NH_3$) were performed according to Playne and McDonald (1966) and hydrogenic potential (pH) to Phillip & Fellner (1992) at opening and after 10 days of exposure to oxygen for fermentative profile evaluation. The data were submitted to analysis of variance (ANOVA) using the RStudio statistical program considering the 5% significance level.

Results and discussion The buffer capacity of the rehydrated corn grain silages (Table 1) did not show significant difference between treatments ($P > 0.05$). The $N\text{-}NH_3$ silage was significant between treatments ($P < 0.05$) only during 10 days of air exposure of the ensiled mass. This increase is observed at 10 days of exposure to air where treatment with fluid whey shows superiority in

terms of fermentative quality compared to treatment with acid whey powder plus inoculant (Table 1). However, Silva et al. (2019) presented N-NH_3 values of 0.03 at the opening and 0.07% after 10 days exposure air in water rehydrated corn grain silages.

Table 1. Fermentative quality of whey rehydrated corn silage

Variables[1]	Tratamentos					
	Water	Whey Powder*	Fluid acid whey	Whey powder and inoculant	Fluid acid whey and inoculant	*P-value*
BC (e.mg/100g DM)	25.99 ± 1.78	23.16 ± 3.03	27.68 ± 5.27	24.34 ± 1.67	26.63 ± 1.73	0.13
N-NH_3 opening	0.06 ± 0.04	0.05 ± 0.009	0.05 ± 0.02	0.04 ± 0.03	0.04 ± 0.01	0.63
N-NH_3 exposure	0.19 ± 0.08^{ab}	0.09 ± 0.03^{bc}	0.07 ± 0.01^{c}	0.22 ± 0.08^{a}	0.13 ± 0.04^{abc}	0.01
pH opening	4.53 ± 0.07^{a}	4.38 ± 0.14^{ab}	4.26 ± 0.09^{b}	4.35 ± 0.12^{ab}	4.43 ± 0.03^{ab}	0.01
pH exposure	6.13 ± 0.08^{a}	5.44 ± 0.41^{b}	4.31 ± 0.11^{c}	6.47 ± 0.18^{a}	5.14 ± 0.70^{b}	0.01

$^{a–c}$Averages with different letters differ from each other ($P < 0.05$) [1]Amonical Nitrogen (% of total nitrogen) and pH at opening and exposure to air; * Whey powder: DM = 97%, CP = 11%, Ash = 6%, EE = 1.5% in DM, pH = 6.30 - 6.80 and acidity = 0.13 (°D), obtained commercially and reconstituted with water for grain rehydration.

The pH values evaluated in the silages showed a significant difference ($P < 0.05$) in the opening of the silos and on the tenth day of exposure to air. McDonald et al. (1991) considers the values from 3.8 to 4.2 ideal. The rehydrated corn grain silage with fluid whey maintained the pH at opening and exposure, close to the values considered ideal for silage fermentative quality. This may be due to the composition of whey, which has in its composition carbohydrates used as substrates by LABs in the fermentation process, unlike water that does not offer this type of substrate. Oliveira et al. (2019) found similar pH values at 4.25 opening and 6.50 on the fifth day of air exposure for water rehydrated corn grain silage.

Conclusions Rehydration of corn grain using whey can be used as an alternative source of reconstituting corn grain and obtaining silage that ensures good fermentative quality for use in animal feed.

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