Chemical characteristics of rehydrated acid whey corn silage

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Introduction The grain corn besides being the most used energy food in animal feed also allows the alternative of rehydration of dry grain to store as silage. Commonly used rehydration involves mixing the grain with water to reach around 35% humidity. However, research is conducted to include new liquids that allow the modernization of the technique and the sustainable form of food production. Whey, in turn has a chemical composition of considerable nutritional value and can be used as an excellent source of rehydration to contribute to the proper destinations of this co-product. The objective of the present study was to evaluate the effects of rehydration of corn grains with whey on the chemical characteristics of silages.

Material and methods The corn grains used to make the silages were obtained from an unknown corn hybrid from the School Farm of the State University of Londrina. The corn kernels were processed to reach an average particle size of 1.5 mm, after grinding the moisture content determined in the kernels was 11.7%. The mass was hydrated by adding chlorine-free water and or whey to reach 35% humidity according to the following treatments: T1 = Water; T2 = reconstituted whey powder with water; T3 = fluid whey; T4 = Whey powder reconstituted with water and inoculant; T5 = Fluid whey with an 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, Lactobacillus acidophilus, Pediococcus acidilactici, Enterococcus faecium, Lactobacillus buchneri, Lactbacillus curvatus* at a concentration of $70x10^9$ CFU/g and 8% cellulolytic enzymes. The ensiled mass was packed in 4 L polyethene mini-silos with an initial average weight of 4.36 ± 0.17 kg. The compaction was performed manually, with an average density of 1020 ± 0.04 kg / m^3 of natural matter. All silos were sealed with a plastic cap and appropriate plastic tape, and stored in a dry and ventilated place for 45 days until the opening date, which reached a final weight of 4.28 ± 0.20 kg. Whey fluid (DM = 6%, CP = 8.65%, Ash = 0.34%, EE = 0.35% in DM, pH = 6.30 and acidity = 0.13° D) was evaluated. chemically according to Zenebon, Pascuet and Tiglia (2008). Corn samples before grain silage (dry matter (DM) = 88.3% NM, crude protein = 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 (Lig) =1.13% in % DM) and silage at the opening of the silos (Table 1) were evaluated for the chemical composition according to the AOAC (2000) methodology and neutral detergent fiber (NDF), acid (ADF) and lignin according to the methodology described by Van Soest (1991). The data were submitted to ANOVA using the RStudio statistical program considering the 5% significance level.

Results and discussion The variables DM, Ash, CP and ADF did not present significant differences ($P > 0.05$) between treatments (Table 1). Despite the lack of significance, these values agree with those observed by Rezende et al. (2014) and Oliveira et al. (2019). The EE values were

significant (P < 0.05) between the treatments with whey powder and whey powder added with an inoculant. This result of 4.36% may be due to the chemical composition of commercial whey powder containing 1.5% fat, which is higher than the composition of fluid whey. The addition of the inoculant may have contributed to a higher value of this component as observed by Reis et al. (2001) that obtained EE values close to those of this study of 4.3 and 4.05% respectively, when the additive was used in the rehydrated grain silages.

Table 1. Chemical quality of rehydrated corn grain silage

Variables[1]	Treatments					*P-value*
	Water	Whey powder*	Fluid whey	Whey poder* and inoculant	Fluid whey and inoculant	
DM (% NM)	63.34 ± 0.38	62.98 ± 0.68	62.82 ± 0.53	62.57 ± 1.84	63.70 ± 0.34	0.41
Ash (% DM)	1.23 ± 0.25	1.20 ± 0.07	1.11 ± 0.06	1.27 ± 0.06	1.18 ± 0.05	0.29
CP (% DM)	10.30 ± 0.19	10.13 ± 0.17	10.47 ± 0.42	9.77 ± 1.74	10.12 ± 0.27	0.71
EE (% DM)	3.70 ± 0.55^{ab}	3.53 ± 0.30^{b}	3.72 ± 0.35^{ab}	4.36 ± 0.30^{a}	4.18 ± 0.47^{ab}	0.01
NDF (%DM)	12.88 ± 2.07^{ab}	13.73 ± 2.21^{a}	11.28 ± 0.77^{ab}	10.14 ± 0.96^{b}	12.86 ± 1.42^{ab}	0.01
ADF (%DM)	2.44 ± 0.46	1.74 ± 0.75^{a}	2.02 ± 0.23	2.10 ± 0.21	2.70 ± 1.00	0.10
Lig (%DM)	0.49 ± 0.57^{ab}	0.20 ± 0.23^{b}	0.24 ± 0.27^{b}	0.45 ± 0.31^{ab}	0.92 ± 0.14^{a}	0.03

$^{a–b}$Averages with different letters differ from each other (P < 0.05); *Chemical composition of 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 further rehydration of the grain.

Treatment with whey powder differed significantly (P <0.05) for NDF contents, with a lower value for rehydrated grain silage with whey powder plus inoculant. The presence of the inoculant may have decreased the percentage of NDF by the most effective fermentation process and the action of fiber-degrading cellulolytic enzymes and by altering the three-dimensional structure of the cell wall (Rezende et al., 2014) and as a consequence there may be an improvement in the digestibility of this food. The lignin content of corn grain silage rehydrated with fluid whey plus inoculant differed significantly (P <0.05) from rehydrated silage with whey powder and fluid whey. However, Oliveira et al. (2019) found values for lignin between 1.37 and 1.4% in rehydrated corn grain silages. The lignin content present in rehydrated grain silages may vary greatly due to the diversity of available corn cultivars and yield management.

Conclusions Rehydration of corn grain with whey presents an alternative source of silage with good nutritional value to be used in animal feed. In addition, the use of whey additives provides an improvement in fiber quality.

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