Duration of storage and amylases on fermentative losses and nutritional value of rehydrated ground corn silage

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Introduction The rehydration of corn for silage production consists of returning to the grain the moisture necessary for fermentation. Although significant improvement on starch digestibility can be noticed after ensiling, other factors may alter silage starch digestibility including grain processing methods, particle size, and endosperm type (Ngonyamo-Majee et al., 2008). Further, the addition of amylolytic enzymes to the silage could also be a method to improved starch digestibility. However, whether the activity of amylases in silage within a relatively short period of fermentation is sufficient to achieve substantial hydrolysis of starch. This experiment was designed to evaluate the addition of amylases and different durations of storage on fermentative losses, nutritional values, and enzymatic activity in rehydrate ground corn silage.

Materials and Methods The experiment was conducted at the Animal Science Department - School of Agrarian Sciences of Federal University of Grande Dourados, Dourados, Brazil. Corn grain was milled to pass through 4 mm screen and water was added at 0.33 L kg^{-1} of ground corn at ensiling. Eighty-four experimental silos were used in a completely randomized design experiment composed of the following treatments: Control (CON); Glucoamylase (GLU), addition of glucoamylase (Kerazyme 4560, Kera Nutrição Animal, Bento Gonçalves, Brazil) at 300 mL t^{-1} of fresh matter; or Alpha-amylase (AMY), addition of alpha-amylase (Kerazyme 4577) at 300 mL t^{-1} of fresh matter. All silos were also inoculated with KeraSIL grão úmido® added at 4 g t^{-1} of hydrated ground corn. KeraSIL is composed by *L. plantarum* (4.0×10^{10} ufc g^{-1}) and *P. acidipropionici* (2.6×10^{10} ufc g^{-1}). Ensiling process was carried out in plastic buckets (30 cm of height and 30 cm of diameter) containing Bunsen valves to avoid gas penetration and allow gas scape. Silos were packed to a density of 950 kg m^{-3} and opened (7 experimental silos per treatment per time point) on days 7, 14, 21, and 28 of storage. Experimental silos were weighed and then opened to determine the gas losses. The silage, silo assembly, sand layer and nylon screen were weighed to quantify the effluent production. At the silos opening, one sample (500 g) of each experimental silo was collected to determine the DM, crude protein (CP), neutral detergent fiber (NDF), starch, lignin and ash contents using traditional wet chemistry methods. The *in vitro* DM degradation was performed by the filter bags method using an artificial rumen incubator (TE-150, Tecnal, Piracicaba, Brazil). Data were submitted to analysis of variance using

the PROC MIXED of SAS 9.3 as repeated measures. Differences among treatments were studied through orthogonal contrasts as follows: CON vs. GLU + AMY (C1) and GLU vs. AMY (C2).

Results and Discussion No treatment by enzyme interaction effects were detected (P≥0.321). Enzymes addition increased the gas, effluent and total losses (g kg^{-1} DM) (P≤0.033) in silage. Silos containing AMY had lower gas, effluent and total losses in comparison with those treated GLU (P≤0.035). DM *in vitro* degradation increased with longer periods of silage fermentation (P=0.001). No treatment by enzyme interaction effects were detected (P≥0.128) on parameters assessed. Enzyme addition increased silage DM (P=0.042) and starch (P=0.012) contents, and DM *in vitro* degradation (P=0.002) while decreased its NDF content (P=0.021) in comparison with CON. Silos containing AMY had higher starch content in comparison with those treated GLU (P=0.023).

Table 1 Amylolytic enzymes on fermentative losses and nutritional value of rehydrated ground corn silage (mean ± standard error).

Item	Treatment[1]			P-value[2]				
	CON	GLU	AMY	Time	ENZ	INT	C1	C2
Losses (% DM)								
Gas	9.98±0.67	10.2±0.71	6.62±0.76	0.001	0.033	0.654	0.721	0.035
Effluent	6.12±0.12	7.17±0.11	6.40±0.13	0.004	0.543	0.321	0.887	0.436
Total	16.1±1.08	17.4±1.00	13.0±1.04	0.001	0.023	0.543	0.431	0.003
Chemical composition, g kg^{-1} DM								
DM	573±0.23	585±0.22	592±0.22	0.001	0.032	0.431	0.042	0.432
CP	123±0.01	128±0.02	119±0.03	0.651	0.519	0.561	0.131	0.541
NDF	106±0.04	86.3±0.03	92.8±0.07	0.041	0.048	0.128	0.021	0.321
Starch	555±0.44	537±0.33	605±0.43	0.001	0.002	0.674	0.012	0.023
In vitro degradation, g kg^{-1} DM								
DM	830±0.54	927±0.67	893±0.68	0.001	0.001	0.754	0.002	0.044
DMR[3]	719±0.74	764±0.73	799±0.71	0.002	0.032	0.645	0.032	0.047

[1] Control (CON); Glucoamylase (GLU), addition of glucoamylase (Kerazyme 4560, Kera Nutrição Animal, Bento Gonçalves, Brazil) at 300 mL t^{-1} of fresh matter; or Alpha-amylase (AMY), addition of alpha-amylase (Kerazyme 4577) at 300 mL t^{-1} of fresh matter.

[2] Probabilities for effects of enzymes (ENZ), enzyme by duration of storage (INT), and orthogonal contrasts: C1 (CON vs GLU+ AMY); C2 (GLU vs AMY).

[3]DM recovery.

Conclusions Short periods of ensilage as well as amylases addition improve rehydrated ground corn silage composition and DM *in vitro* degradation and negatively influenced the fermentative losses. Glucoamylase presented great potential of use in rehydrated ground corn silage.