IMPACTS OF CITRUS PULP ADDITION AND WILTING ON ELEPHANT GRASS SILAGE QUALITY

IMPACTO DA ADIÇÃO DE POLPA CITRÍCA E DO EMURCHECIMENTO NA QUALIDADE DA SILAGEM DE CAPIM-ELEFANTE

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ABSTRACT: The objective of this work was to evaluate the use of citrus pulp addition and wilting on fermentative characteristics, chemical composition as well as gas and effluent losses of elephant grass silage. The elephant grass (70 growth days) was collected manually; one portion was immediately chopped and another one was allowed to wilt in the sun for a period of 6 h and subsequently chopped for the production of silage. Experimental PVC silos (10 cm diameter x 30 cm height) were used and sand bags were placed at the bottom of the silos. Citrus pulp (80 g kg^{-1} of MN) was added at the beginning of ensilage. The ensiled material was manually compressed to provide a specific mass of approximately 600 kg m^{-3} of silage. After 60 days, the silos were opened; gas and effluent losses were calculated and we determined pH, dry matter (DM), crude protein(CP), neutral detergent fibre (NDF), lignin, ammonia nitrogen, ash and *in vitro* dry matter digestibility (IVDMD). We added 0 or 80 g kg^{-1} of citrus pulp to wilted and un-wilted elephant grass. We used a completely randomised design with a 2 x 2 factorial arrangement (wilted or un-wilted) x (with or without citrus pulp), totalling treatments with five repetitions. Average values were compared using the F test with a probability of 5%. The addition of citrus pulp resulted in reduced levels of NDF, lignin, ash, $N\text{-}NH_3$ and pH and in increased values of DM and IVDMD of silages. Wilting increased the DM, NDF and lignin values and reduced the concentrations of CP, IVDMD and $N\text{-}NH_3$. Based on our results, citrus pulp addition improves the chemical composition of elephant grass silage and increases its *in vitro* dry matter digestibility.

KEYSWORDS: Additive. Moisture. *Pennisetum purpureum.*

INTRODUCTION

Among the factors affecting cattle productivity in Brazil, forage production seasonality has been highlighted. Grasses potentially produce high amounts of dry matter. However, biomass production is highly influenced by climatic factors, and extremely dry periods may result in substantial losses (BOTREL et al., 2002; ALENCAR et al., 2009).

In this context, pasture-based animal production is highly dependent on forage production, and particularly in the rainy season, the application of forage surplus conservation methods is required (GONÇALVES et al., 2008). Among forage conservation methods, silage making is widely used by producers due to its simple application. However, dry matter contents and concentrations of soluble carbohydrates at silage time significantly impact silage quality (SANTOS et al., 2010). As tropical grasses are perennial with a high dry matter production during the rainy season, silage lends itself as a method to minimize forage shortages during the dry season using the production surplus (ALENCAR et al., 2009; FERREIRA et al., 2015).

Among the grasses used for silage production, elephant grass has a particularly high dry matter production and nutritional value. However, despite the high nutritional value, the dry matter content, soluble carbohydrate level and buffer capacity of this species are not suitable for an efficient fermentation process (BERGAMASCHINE et al., 2006; FERREIRA et al., 2015). Citrus pulp is extremely absorbent, increasing its weight by up to 145% when in contact with moist forage, thereby preserving nutrients that would be lost by secondary fermentation or in the form of effluents (RIBEIRO et al., 2009).

In this sense, the use of techniques to reduce moisture, in addition to other techniques improving nutritional values of silage, might be important in establishing a grass silage fermentation pattern and,

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consequently, in the production of high-quality livestock feed.

This study evaluated the use of citric pulp in silage making and the effects of forage wilting on fermentation traits, chemical composition and losses of elephant grass silage.

MATERIAL AND METHODS

Elephant grass (*Pennisetum purpureum Schumach.*) used in silage production was harvested in the elephant grass cv. Taiwan A-146 area, Universidade Federal Rural do Rio de Janeiro (22°46'25'' S, 43°41'15'' W and 36 m of elevation), Seropédica, State of Rio de Janeiro, Brazil. Climate has been characterized as Aw type according to the Köppen classification (KOTTEK et al., 2006). The area has a mean annual rainfall of 1,285 mm; the rainy season (October to March) is warm, while the dry season, representing winter (April to September), is mild.

Immediately after silage production, the silos were transported to Embrapa Gado de Leite, Juiz de Fora, Minas Gerais state, Brazil, for laboratory tests.

After a uniform cut of the experimental area, base fertilisation with 100 kg ha^{-1} N and K_2O was performed. Elephant grass was harvested when it reached a height of 1.8 m high at 70-days regrowth at 20 cm above the soil. One part of the grass was immediately chopped and ensiled, while the other part was left to wilt in the sun under a canvas for six hours and subsequently chopped and ensiled.

We used experimental PVC silos (10 cm diameter × 30 cm height) with Bunsen valves at the cover. For effluent collection at the bottom of the silos, sealed sewing TNT bags containing 0.5 kg dry sand at were placed into the silos at 65°C for 72 h.

Citrus pulp was homogeneously mixed with 80 g kg^{-1} elephant grass at ensiling (RODRIGUES et al. 2005); the ensiled material was manually compressed, providing 600 kg m^{-3} density. Silos were weighed empty and filled after ensiling. After 60 days, the silos were again weighted to determine weight loss and subsequently opened. After opening, the sand bags were also weighed to determine effluent losses.

Elephant grass and citrus pulp samples were taken prior to ensiling and silage samples at the time of opening the silos.

In accordance to Playne and McDonald (1966), for buffer determination, another grass portion was frozen, 15 to 20 g fresh material were weighed, following maceration in a blender with 250 ml distilled water. Macerate was firstly titrated at 3.0 pH with 0.1 N HCl to liberate bicarbonates and CO_2 and then titrated at 6.0 pH with 0.1 N NaOH. Buffer was expressed as alkali milligram equivalent required for changing the pH from 4.0 to 6.0 by 100 g dry matter, after titration correction for 250 ml water.

One part of the silage sample was weighed, dried in a forced ventilation oven at 55°C and ground at 1.0 mm in a Willy mill for chemical composition analyses. The other part was used to extract juice by a hydraulic press to determine pH, ammonia-nitrogen, and volatile fatty acids.

We performed the following chemical analyses: dry matter(DM, method number 967.03; AOAC, 1990), crude protein (CP, method number 984.13; AOAC, 1990), neutral detergent fibre (NDF, VAN SOEST et al., 1991) , lignin (sulfuric acid 72% w/w), ash (method number 942.05; AOAC, 1990) and *in vitro* dry matter digestibility (IVDMD) according to Tilley and Terry (1963), using the two-stage technique.

Dry matter losses by gases and effluents were quantified by weight difference. Gas losses were calculated using equation one (JOBIM et al., 2007):

GL = (ESW – OSW)/(EF x FEDM) x 1000; Eq. (1)

where: GL = gases loss at storage (g kg^{-1} of initial DM); ESW = ensiling silo weight; OSW = opening silo weight; EF = ensiling forage mass and FEDM = forage ensiling dry matter.

Effluent losses were calculated using the following equation (JOBIM et al., 2007):

EP = [(OSW – ESW)/(EFGM)] x 1000; Eq. (2)

where: EP = effluent production (g kg^{-1} as fed); OSW = opening set weight = (silo + sand); ESW = ensiling set weight = (silo + sand); EFGM = ensiled forage mass.

We used a completely randomised design with a 2 x 2 factorial arrangement (wilted or un-wilted) x (with or without citrus pulp), totalizing 4 treatments with 5 replicates with 20 parcels. The measured variables were analysed according to the following statistical model:

$$y_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij} + e_{ijk}; \qquad \text{Eq. (3)}$$

where y is the measured variable taken in the wilted ($j = 2$) or un-wilted ($j = 1$) silage contained in the k-th mini-silo with (i = 1) or without (i = 2) citrus pulp addition and $\alpha\beta_{ij}$ represents the interaction of citrus pulp and wilting. The model was fitted by using the MIXED procedure of SAS according to the recommendations described by Littell et al. (2006). The estimation procedure REML was used as the default and the heterogeneity of the variables was checked by the grouping command in the repeated sentence of the MIXED procedure. The grouping factors were α, β, and the interaction $\alpha\beta$. The random error term was assumed normal, independent and identically distributed. The best variance structure was chosen based on the Akaike Information Criterion (AKAIKE, 1974) corrected for small samples (SUGIURA, 1978), termed as AICc. The computed AICc values were compared by its derived measures according to Burnham and Anderson (2004) and Vieira et al. (2012). Confidence intervals were generated by considering a confidence level of 99% according to the recommendations presented by Cohen (2011). Confidence intervals were presented as follows:

$$99\%CI: \bar{y} \pm (upper - lower)/2; \quad \text{Eq. (4)}$$

where the quantity $(upper \quad lower)$ is the amplitude of the $99\%CI$ and y is the least squares mean of the variable.

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of treatments and citrus pulp. The variables lactic:acetic acid ratio, propionic acid, acetic acid, lignin, ash, neutral detergent insoluble nitrogen, ADF and crude protein fitted best to the model of homogeneous variance. The parameters NH_3-N, NDF, IVDMD and DM fitted best to the heterogeneous variance for citrus pulp and wilting in regards to lactic acid fitted best to the heterogeneous variance for wilting. In terms of wilting x citrus pulp interaction, the most suitable model was also the heterogeneous variance structure for the variables pH, gases and effluents losses.

There was a significant interaction between citrus pulp and wilting on effluent loss (Table 2). As citrus pulp as wilting employment were effective regarding on reduced effluent loss, with no treatment elephant grass silage presenting the highest effluent loss and silage with two associated treatments presenting the lowest effluents loss, as well. Effluent production decreased as silage dry matter content increased. Wilting, citrus pulp use and both treatments combined reduced effluent production by 46.71, 63.28 and 90.2%, respectively. Loures et al. (2005) have reported significant effluent losses at a dry matter content below 300 g kg^{-1}. Similarly, Rezende et al. (2008) have observed an effluent loss of 24.89 g kg^{-1} in elephant grass silages with a dry matter content of 237.6 g kg^{-1}. Gas losses were reduced by wilting and citrus pulp employment, although the interactive effect of the two treatments was not significant (Table 2). Our data indicate that wilting and citrus pulp employment enhanced the fermentative process by reducing the moisture content of the ensiles material; the treatments using citrus pulp, contents of soluble carbohydrates were higher. The gas losses in our study were higher than those reported by Rezende et al. (2008) for elephant grass silage without citrus pulp (10.8 g kg^{-1} DM) and with 70 g citrus pulp kg^{-1} DM (25.5 g kg^{-1} DM). However, the authors have reported silages with higher dry matter contents (237.6 g kg^{-1} as fed with no citrus pulp and 269.2 g kg^{-1} as fed with citrus pulp). This fact can be explained by the high moisture absorption capacity of citrus pulp, leading to an improved fermentation profile (RIBEIRO et al., 2009).

Elephant-grass silages dry matter content was increased as by wilting as by citrus pulp (Table 3). With the use of citrus pulp, DM contents increased by 41.03% compared to the control, while wilting increased DM by 12.41% compared to the control. This suggests that the wilting period of six hours was insufficient. Although we observed DM increases in both treatments, Haigh (1999) has reported DM contents lower than 250 g kg^{-1} as feed for minimum effluent production and below 300 g kg^{-1} as feed for optimal fermentation (MCDONALD et al., 1991). The interaction effect of wilting and citrus pulp of crude protein contents was significant (Table 3). The lowest CP content was observed in silage with combined citrus pulp and wilting. According to Guim et al. (2002), this could be explained by the conversion of nitrate on ensiled grass into microbial protein. The values in our study were higher than those reported by Rezende et al. (2008) studying elephant grass silages with citrus pulp (70 g kg^{-1} DM) and without citrus pulp. Our values of CP were higher than 70 g kg^{-1} DM, the minimum value for optimum rumen function (SILVA; LEÃO, 1979).

The interaction effect between wilting and citrus pulp on NDF was not significant (Table 3). Addition of citrus pulp decreased elephant grass silage NDF, which might be explained by the low NDF content of this additive (259.7 g kg^{-1} DM) in comparison to that of elephant grass (729.7 g kg^{-1} DM).

Table 1. Chemical composition of elephant grass, wilted or un-wilted, citrus pulp and associations.

Variable	C[2]	EG[2]	EGW[2]	EG+C[2]	EGW+C[2]
DM[1] (g kg^{-1} as fed)	849.3	133.4	167.7	172.6	219.6
CP[1] (g kg^{-1} DM)	70.6	113.0	104.7	115.5	108.1
NDF[1] (g kg^{-1} DM)	259.7	729.7	684.1	701.8	672.6
Lignin (g kg^{-1} DM)	71.4	62.1	67.8	76.4	66.4
Ash (g kg^{-1} DM)	17.6	22.8	21.5	22.1	21.7
SC[1] (g kg^{-1} DM)	276.7	195.6	192.2	206.4	201.5
BP[1] (mEqHCl 100g^{-1} DM)	-	22.95	23.01	23.94	21.85

[1] DM – dry matter; CP – crude protein; NDF – neutral detergent fiber; SC – soluble carbohydrates; BP – buffer power; [2] C – citrus pulp; EG – elephant-grass un-wilted; EGW – elephant-grass wilted.

Table 2. Effluents and gas losses of elephant grass silages produced with citrus pulp addition and wilting.

Variable	Citrus Pulp	Wilted		Mean	P - value		
		Without	With		W[1]	C[1]	W×C[1]
Gases losses (g kg^{-1} as fed)					0.1047	0.0836	0.4391
	Without	129.15±205.09Aa	63.26±29.72Ba	96.21±100.82			
	With	58.92±30.15Ab	31.77±10.45Aa	45.35±14.05			
	Mean	94.04±100.77	47.52±13.83				
Effluents Losses (g kg^{-1} DM[1])					0.0002	<0.0001	0.0417
	Without	105.87±10.37Bb	56.99±38.82Ba	81.43±18.48			
	With	34.88±16.83Ab	10.37+9.74Aa	22.63±7.63			
	Mean	70.38±7.65	33.68±18.57				

Means followed by the same letter, small letters on the same line and capital letters on the same column do not differ by F test (P<0.05).
[1] DM – dry matter; W – wilted; C – citrus pulp.

Table 3. Chemical composition of elephant grass silages produced with citrus pulp addition and wilting.

Variable	Citrus Pulp	Wilted		Mean	P - value		
		Without	With		W[1]	C[1]	W×C[1]
DM[1] (g kg^{-1} as fed)					<0.0001	<0.0001	0.8879
	Without	142.18±7.70Aa	163.19±7.70Ab	152.69±5.44			
	With	202.35±13.95Ba	226.33±13.94Bb	215.34±9.86			
	Mean	173.26±7.20	194.76±7.20				
CP[1] (g kg^{-1} DM)					0.0056	0.2129	0.0470
	Without	95.28±7.92Aa	92.44±7.92Ba	93.86±5.60			
	With	97.60±7.92Ab	83.08±7.92Aa	90.34±5.60			
	Mean	96.44±5.60	87.76±5.60				
NDF[1] (g kg^{-1} DM)					0.0326	<0.0001	0,0527
	Without	701.00±12.29Ba	702.98±12.29Ba	701.99±8.69			
	With	552.54±31.54Aa	585.72±31.54Ab	569.13±22.30			
	Mean	626.77±15.86	644.35±15.86				
Lignin (g kg^{-1} DM)					<0.0001	0.0047	0.5898
	Without	46.24±3.72Ba	55.36±3.72Ab	50.80±2.63			
	With	41.36±3.72Aa	51.88±3.72Ab	46.62±2.63			
	Mean	43.80±2.63	53.63±2.63				
Ash (g kg^{-1} DM)					0.0840	0.0231	0.3299
	Without	28.46±4.88Ba	23.70±4.88Aa	26.08±3.45			
	With	22.58±4.88Aa	21.18±4.88Aa	21.88±3.45			
	Mean	25.52±3.45	22.44±3.45				
IVDMD[1] (g kg^{-1} DM)					0.047	<0.0001	0.7978
	Without	487.78±19.59Ab	438.91±1.59Aa	473.14±13.85			
	With	619.40±38.59Ba	585.34±38.59Ba	602.37±27.29			
	Mean	553.59±19.74	521.92±19.74				

Means followed by the same letter, small letters on the same line and capital letters on the same column do not differ by F test (P<0.05); [1] DM – dry matter; CP – crude protein; NDF – neutral detergent fiber; IVDMD – *in vitro* dry matter digestibility; W – wilted; C – citrus pulp.

Our results are in agreement with those reported by Ferrari Júnior et al. (2009), who evaluated the effects of several additives to elephant grass ensilage. The silage NDF content was increased by wilting, which is in contrast to the results reported by Carvalho et al. (2007), who found lower NDF contents of wilted elephant grass silages. However, higher NDF contents were somehow expected for the wilted forages as a result of decreased amounts of soluble compounds due to sun exposure (EVANGELISTA et al., 2000). Citrus pulp silages presented NDF contents below the critical threshold of 600 g kg^{-1} DM, the NDF limit not affecting intake by ruminants (VAN SOEST, 1994).

Lignin contents were affected by wilting and citrus pulp employment (Table 3). Elephant grass silages produced with citrus pulp presented lower lignin contents due to the dilution effect caused by the citrus pulp. Wilting increased lignin contents. However, Carvalho et al. (2007) could not observed any differences in lignin contents between wilted or un-wilted elephant grass silages. According to Van Soest (1994), lignin is the limiting factor to plant cell wall availability to herbivore animals on anaerobic digestion as well as; it can therefore be considered as an anti-nutritional factor (FARIA et al., 2007). The values observed in our study were lower than those reported by Rodrigues et al. (2005) studying elephant grass silages with citrus pulp addition. Ash contents were reduced by citrus pulp addition, this result is in contrast to the findings reported by Ferrari Júnior et al. (2009), who observed increased ash contents with the addition of 50 g kg^{-1} of citrus pulp (Table 3). However, values reported were lower than those ones showed on literature (PEREIRA et al., 1999; CARVALHO et al., 2007). Wilting had no effect on ash contents, which is in agreement with the findings of Carvalho et al. (2007).

The interaction effect between citrus pulp addition and wilting on IVDMD was not significant (Table 3). Wilted elephant grass silages presented lower IVDMD values compared to un-wilted ones, which was most likely due to the higher fibrous fraction of wilted silages. Carvalho et al. (2007) observed no differences in IVDMD values of elephant grass silages wilted for 8 hours un-wilted. Citrus pulp addition increased elephant grass silage IVDMD, and this higher IVDMD value might be related to the lower fibre levels (REZENDE et al., 2008), in addition to the promotion of more favourable fermentation conditions by decreasing proteolysis through pH reduction (TAVARES et al., 2009). Ferrari Júnior et al. (2009) have reported higher IVDMD values when citrus pulp was added. The addition of citrus pulp had a notable effect on pH values, reducing the pH from (Table 4) 4.5 to 3.5, indicating an enhanced fermentation process due to higher fermentable substrate concentrations. Ferrari Júnior et al. (2009) have observed decreases in pH values with citrus pulp inclusion of 50 g kg^{-1} DM; however, Rodrigues et al. (2005) did not observe any effects of citrus pulp on pH values. The pH values of wilted silages were below the recommended threshold of 4.2 (MCDONALD et al., 1991).

The interaction effect between citrus pulp and wilting on NH_3-N contents was significant (Table 4). In silages with no citrus pulp, wilting decreased NH_3-N contents, while in silages with no wilting, citrus pulp decreased NH_3-N contents. Elephant grass silages produced with citrus pulp presented NH_3-N levels below 100 g kg^{-1} of N, indicating that the fermentation process does not result in excessive protein breakdown into ammonia (VAN SOEST, 1994). However, NH_3-N contents above 150 g kg^{-1} N in the control silage indicate intensive proteolysis. Therefore, the use of these silages might result in low acceptability and, consequently, low animal intake (FARIA et al., 2007). The NH_3-N values of wilted elephant grass silages were similar to those reported by Tosi et al. (1999), who reported 165 g kg^{-1} N in wilted elephant-grass silage.

We found no butyric acid in the silages, indicating that despite the high moisture and ammonia nitrogen contents, *Clostridium* bacteria were not present. The addition of citrus pulp affected lactic acid contents, indicating that citrus pulp provided additional soluble carbohydrates for the fermentation process (Table 4). Acetic acid contents were not affected by any of the treatments (Table 4). Citrus pulp addition was responsible for propionic acid content alterations (Table 4). In our study, organic acid contents were higher than those reported by Ferrari Júnior and Lavezzo (2001), who studied the use of wilted and un-wilted elephant grass for silage production. However, it should be mentioned that there was a short-term pH decrease, impeding secondary fermentation due to the high lactic acid contents and low acetic, propionic and butyric acid contents.

Table 4. Fermentative characteristics of elephant grass silages produced with citrus pulp addition and wilting.

Variable	Citrus Pulp	Wilted		Mean	P - value		
		Without	With		W[1]	C[1]	W×C[1]
pH					0.125	0.0122	0.166
	Without	4.86±1.77Ba	4.14±0.79Ba	4.50±0.81			
	With	3.77±0.48Aa	3.72±0.13Aa	3.75±0.23			
	Mean	4.32±0.84	3.93±0.38				
NH_3-N[1] (g kg^{-1} N)					0.0034	0.0004	0.0083
	Without	352.48±132.85Bb	140.38±132.85Aa	246.43±93.24			
	With	96.15±15.97Ab	78.56±15.97Aa	87.36±11.29			
	Mean	224.32±6.36	109.47±66.36				
Lactic acid (g kg^{-1} DM)					0.5471	0.0022	0.1147
	Without	116.84±122.38Aa	181.60±46.75Aa	149.22±61.48			
	With	276.36±122.38Ba	245.98±46.75Ba	261.17±61.48			
	Mean	196.60±86.54	213.79±33.06				
Acetic acid (g kg^{-1} DM)					0.7242	0.0835	0.3183
	Without	64.44±16.34Aa	72.21±16.34Aa	68.32±11.56			
	With	59.87±16.34Aa	56.12±16.34Aa	57.99±11.56			
	Mean	62.15±11.56	64.16±11.56				
Propionic acid (g kg^{-1} DM)					0.3532	0.0001	0.0568
	Without	1.32±0.71Aa	2.05±0.71Ab	1.69±0.50A			
	With	3.05±0.71Ba	2.79±0.71Ba	2.92±0.50B			
	Mean	2.19±0.50a	2.42±0.50a				

Means followed by the same letter, small letters on the same line and capital letters on the same column do not differ by F test (P<0.05).
[1] NH3-N – ammoniacal nitrogen; W – wilted; C – citrus pulp.

CONCLUSION

The use of 80 g citrus pulp kg^{-1} markedly improves the quality of elephant grass silage.

RESUMO: Objetivou-se avaliar o uso de polpa cítrica e do emurchecimento sobre as características fermentativas, composição química e perdas de silagens de capim-elefante. O capim-elefante foi colhido manualmente com cerca de 70 dias de rebrota, uma parte foi picada imediatamente e outra foi emurchecida ao sol por 6 horas e posteriormente picado para confecção das silagens. Foram utilizados silos experimentais de PVC com 10 cm de diâmetro e 30 cm de altura, no fundo dos silos foram colocados sacos com areia. A polpa cítrica foi incluída na base de 80 g kg^{-1} da matéria natural no momento da ensilagem. O material ensilado foi compactado manualmente de forma a proporcionar massa específica de aproximadamente 600 kg m^{-3} de silagem. No momento da ensilagem foram pesados os silos vazios, os sacos com areia, o material ensilado e os silos cheios. Após 60 dias os silos foram pesados novamente e logo em seguida abertos. Foram calculadas as perdas por gases e efluentes e determinados o pH, conteúdo de matéria seca, teores de proteína bruta, fibra em detergente neutro (FDN), fibra em detergente ácido (FDA), celulose, hemicelulose e lignina, cinzas, nitrogênio amoniacal e digestibilidade in vitro da matéria seca (DIVMS). Foi utilizado o delineamento inteiramente casualisado em arranjo fatorial 2 (emurchecido ou não) x 2 (com polpa cítrica ou não), 4 tratamentos com 5 repetições, totalizando 20 parcelas. As médias foram comparadas pelo teste F a 5%. O uso de polpa cítrica reduziu os níveis de FDN, lignina, cinzas, N-NH_3 e o pH e aumentou a MS e a DIVMS das silagens. O emurchecimento aumentou a MS, FDN e a lignina e reduziu a proteína bruta, DIVMS e N-NH_3. O uso da polpa cítrica melhora a composição química e a digestibilidade in vitro da matéria seca de silagens de capim-elefante.

PALAVRAS-CHAVE: Aditivo. *Pennisetum purpureum*. Umidade.

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