



Nutritional value, total dry matter losses, effluent production and pollutant potential in *Brachiaria brizantha* cv. Paiaguás grass

[Valor nutricional, perdas totais de matéria seca, produção e potencial poluidor de efluentes em silagem de *Brachiaria brizantha* cv. Paiaguás]

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ABSTRACT

The objective of the present study was to evaluate losses, production and polluting potential of the effluent, nutritional value and aerobic stability of silages of *Brachiaria brizantha* cv. Paiaguás grass, in different particle sizes and compaction density in silage. Three theoretical particle sizes (TTP 5; 8 and 12mm) and three compaction densities (DC 550; 600 and 650kg/m³) were evaluated, distributed in a factorial design (3 x 3), with four repetitions. The highest volume of effluent was found in silages with higher compaction densities (600 and 650kg/m³) and lower TTP (5 and 8mm). The highest chemical oxygen demand and biochemical oxygen demand were registered in the treatment with TTP of 5mm and higher DC (600 and 650kg/m³). Greater *in vitro* digestibility of DM was verified in the silage chopped at 5 and 8mm. There was no break in aerobic stability for 216 hours. Silage with a low compaction density 550kg/m³ and processing with a theoretical particle size of 12mm reduces effluent losses. In general, the nutritional value of Paiaguás grass was not influenced by the treatments. Different particle sizes and compaction density did not change the aerobic stability of silages.

Keywords: compaction, oxygen demand, *in vitro* digestibility, conserved forage, particle size

RESUMO

Objetivou-se avaliar perdas, produção e potencial poluidor do efluente, valor nutricional e estabilidade aeróbia de silagens do capim *Brachiaria brizantha* cv. Paiaguás, em diferentes tamanhos de partícula e densidade de compactação na ensilagem. Foram avaliados três tamanhos teóricos de partícula (TTP 5; 8 e 12mm) e três densidades de compactação (DC 550; 600 e 650kg/m³), distribuídos em arranjo fatorial (3 x 3), com quatro repetições. O maior volume de efluente foi verificado nas silagens com maiores densidades de compactação (600 e 650kg/m³) e menores TTP (5 e 8mm). As maiores demanda química de oxigênio e demanda bioquímica de oxigênio foram registradas no tratamento com TTP de 5mm e nas maiores DC (600 e 650kg/m³). Maior digestibilidade *in vitro* da MS (média de 57,2%) foi verificada na silagem picada a 5 e 8mm. Não houve quebra da estabilidade aeróbia durante 216 horas. A ensilagem com baixa densidade de compactação (550kg/m³) e o processamento com tamanho teórico de partículas 12mm reduzem as perdas por efluente. O valor nutricional da silagem de capim-paiaguás, em geral, não foi influenciado pelos tratamentos. Diferentes tamanhos de partícula e densidade de compactação não alteraram a estabilidade aeróbia das silagens.

Palavras-chave: compactação, demanda de oxigênio, digestibilidade *in vitro*, forragem conservada, tamanho de partícula

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INTRODUCTION

The *Brachiaria* genus corresponds to forages of African origin, widespread in the Brazilian territory, mainly due to its characteristic high yield of dry matter (DM), easy establishment, resistance to illness and good vegetative growth throughout the year (Silva *et al.*, 2016). Besides this, in proper management situations, they present good nutritional composition (Cruvinel *et al.*, 2017). This context implies the need to develop technologies and good practices for production and conservation with smaller loss of dry matter. Silage is a technology that can be used successfully in the conservation of grass, with the aim to preserve the nutritional value of the forage. However, care must be taken with the silage of forage with DM below 21%, soluble carbohydrates below 2.2% and low relation between carbohydrates and sealing, for they present greater risk for the occurrence of secondary fermentation (McDonald *et al.*, 1991).

Inadequate fermentation results in loss of nutrients, elevated concentration of butyric acid, ammonia, amines and acetic acid, which reduce the consumption of silage with consequent fall in animal performance (Jobim and Nussio, 2013). Furthermore, silages with high humidity present significant production and release of effluents to the environment, contributing with pollution, especially when reaching the water courses, where macrobiotic flora demands high quantities of oxygen during metabolism (Loures *et al.*, 2003). This situation renders the environment anaerobic, risking the life of other aquatic organisms (Schmidt *et al.*, 2011), and this is the main environmental concern regarding the release of silage effluents (Savoie and Jofriet, 2003; Borreani *et al.*, 2017).

In general, it is observed that the density of compaction in silage, the size of the particle and production of effluents are related (Loures *et al.*, 2003, 2005), however, work that uses *Brachiaria brizantha* grass for silage are scarce in literature. Due to this, the objective of this research was to evaluate total loss of dry matter, production and potential pollution of effluent, nutritional value and aerobic stability of silage in *Brachiaria brizantha* cv. Paiaguás grass, in different particle sizes and compaction density in the silage.

MATERIAL AND METHODS

The experiment was conducted at the Fazenda Experimental de Iguatemi (FEI), which belongs to the State University of Maringá, located in the district of Iguatemi (23°25'38" S and 51°56'15" O) in the state of Paraná, Brazil. The climate in the region is type Cfa, meaning humid mesothermic subtropical, according to the Köppen classification (Produção..., 1994), with average temperature and precipitation of 22 °C and 1,200mm, respectively. Rain has a seasonal distribution with well-defined dry and rainy seasons and the soil is classified as Red Dystrophic Latosolo (Sistema..., 2018; Manual..., 2007). The experimental period ranged from December 13, 2016 to May 17, 2017, and the climatic data was collected from the FEI Meteorological Station (Figure 1). Paiaguás grass (*Brachiaria brizantha* cv. Paiaguás) was established in a 1ha area in a corrected and fertilized soil, according to the results of soil analysis (Table 1).

The soil preparation was conventional (disc plough and levelling grid). The sowing of Paiaguás grass was done by throwing, on December 13, 2016, with a sowing rate of 15kg ha⁻¹, using a fertilizer and seed distributor of the Vicon® brand. After the establishment of the grass, urea based nitrogenated fertilization was done (60kg ha⁻¹N). After 30 days of establishment, the height of the grass was monitored weekly, through measuring 30 random points, using a 100 cm ruler to follow the growth of the grass and determine the ideal height for cut and silage.

The cut of *Brachiaria brizantha* cv. Paiaguás was done in a development stage that contemplated the balance of the quality and quantity of the forage mass available (beginning of flowering) at a height of 10 cm from soil level (Cândido *et al.*, 2008). This moment occurred when the pasture presented, on average, 49.8 cm height, meaning 63 days after emergence. The cut was done with a harvester model JF92Z10®, regulated for the pre-defined heights as treatments. The evaluated treatments had three theoretical particle sizes (5; 8 and 12mm) and three silage compacting densities (550kg/m³; 600kg/m³ and 650kg/m³), distributed in a factorial arrangement (3 x 3) with four repetitions (silos) each.

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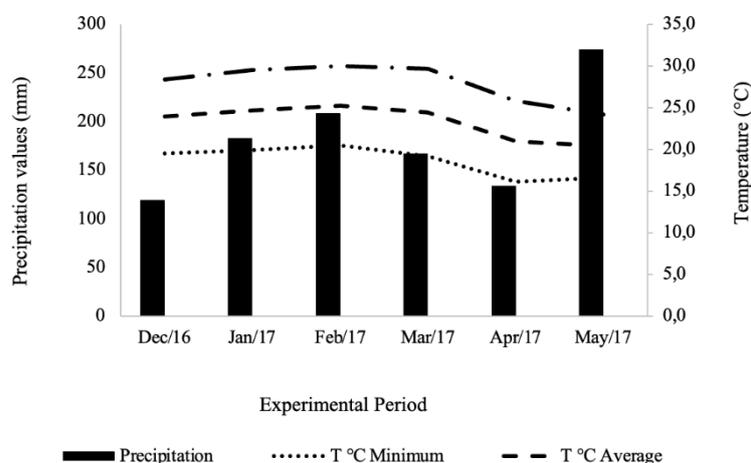


Figure 1. Average precipitation (mm) and ambient temperature (maximum, minimum and average) (°C) during the experimental period of *Brachiaria brizantha* cv. Paiaguás grass, silage. Source: Meteorological Station at Fazenda Experimental de Iguatemi, Iguatemi, PR.

Table 1. Chemical composition of the soil (0-20 cm deep) in the experimental area of *Brachiaria brizantha* cv. Paiaguás grass, in the beginning of the evaluation period

pH	H ⁺	Al ³⁺	H ⁺ +Al ³⁺	Ca ²⁺	Mg ²⁺	K ⁺	Ca ⁺ +Mg ⁺	SB	CTC	V	P	C	OM	
CaCl	H ₂ O	Cmol _c .dm ⁻³								%	mg.dm ⁻³	g.dm ⁻³		
5.60	6.30	3.30	0.0	3.30	4.41	2.00	0.25	6.41	6.60	9.96	66.9	7.29	8.82	15.2

Source: Sociedade Rural de Maringá Laboratory.

The silage was done in experimental PVC silos, with a volume of 0.013 m³ which allowed the silage of up to 8.45kg of grass, obeying the densities defined as treatments. After filling, the silos were sealed with a black canvas and a heavy transparent adhesive tape. At the base of the silos a plastic bag was placed to collect effluents, being sealed with adhesive tape to not allow the loss of produced liquid and the entrance of oxygen. The silos were stored in a covered area for 90 days, a period where there was the collection of effluent in order to determine the volume produced and evaluate its polluting potential. As it was produced, the effluent was removed from the collector bag, measured in a graduated beaker, and transferred to an opaque plastic container with a 200mL capacity, duly identified and stored at -20°C for posterior laboratory analysis. At the moment of collection, the pH of effluents was measured with the use of a digital measuring device by TECNAL, model Tec-3MP.

At the end of 90 days of storage, the total volume of effluents produced was determined. Of these, effluent samples were collected from approximately 30mL per repetition in each treatment and sent to the Laboratório de

Qualidade de Água e Controle de Poluição (Environmental Sanitation), belonging to the Universidade Estadual de Maringá, for the following analysis: Chemical Oxygen Demand (QOD) and Biochemical Oxygen Demand (BOD), according to APHA protocol (Standart..., 1995). The variables pH and loss of DM were analyzed through effluent according to methodology proposed by Schmidt (2007).

After 90 days of storage the silos were weighed to determine total loss of DM, and open to remove samples (approximately 500 g/silo) for chemical bromatological analysis, electrical conductivity (EC) according to Kraus *et al.* (1997) and to determine pH in the silage according to Cherney and Cherney (2003). After the collection of samples, the silos were decompressed to simulate the discharge conditions (Kung Jr., 2000). The material was later placed back into the silos, and during the next ten days, in two periods (10am and 2pm) the environment and silage (in the silos) temperatures were recorded through a digital thermometer, model *Gulterm 1001*, to evaluate the aerobic stability.

The DM losses (DML) of the silage were estimated, according to the equation: DML =

$[(DM_i - DM_f)/DM_i] \times 100$. Where DM_i = initial dry matter and DM_f = final dry matter (silo weight), according to the equation proposed by Jobim *et al.* (2007). The samples collected at the moment of silage, as well as those collected after opening the silos (approximately 500g) were dried in a forced air ventilation chamber at 55°C, ground in a cutting mill with a 1mm mesh sieve and sent to the Laboratório de Nutrição e Alimentação Animal - LANA (belonging to the Universidade Estadual de Maringá) for the following determinations: dry matter (DM, method 967.03), crude protein (CP, method 990.03), mineral matter (MM, method 942.05) and ether extract (EE, method 920.39) done according to AOAC (Official..., 1990).

In a sequential manner the levels of NDF were determined according to Mertens (2002), and ADF according to Van Soest (1973) and lignin (Van Soest *et al.*, 1991). Cellulose (CEL) and hemicellulose (HEM) were determined from the difference between NDF – lignin and NDF – ADF, respectively (CEL = ADF – LIG and HEM = NDF – ADF). The total carbohydrates (CT) were obtained by the sequence proposed by Sniffen *et al.*, (1992): CT = MO – (EE + PB). The chemical composition of *Brachiaria brizantha* cv. Paiaguás grass at the moment of cut was DM content 20.7%; CP content 10.2%; NDF content 65.8%; EE content 1.6% and TC of 79.8%.

The *in vitro* digestibility of dry matter (IVDDM) was determined using the *Daisy Incubator Ankom®* equipment, according to Holden (1999). The variable data obtained from silages were analyzed for each particle size, compaction density and interaction between both effects. The data obtained were submitted to variance analysis according to statistical analysis SAS (Property..., 1999), using the GLM procedure, where the averages were compared with the aid of the Tukey Test at 5% probability and the mathematical model used was:

$$Y_{ij} = \mu + D_i + \varepsilon_i + P_j + (DP)_{ij} + \varepsilon_{ij}, \text{ where:}$$

Y_{ij} = value observed for the variable response to the effect of density i and the size of particle j ; μ = average of treatments; D_i = effect of density i , i = 550kg/m³; 600kg/m³ and 650kg/m³; ε_i = random error associated to parcel i ; P_j = effect of the average size of the particle j , j = 5mm; 8mm and

12mm; $(DP)_{ij}$ = interaction between treatments i^*j ; ε_{ij} = random error associated to sub parcel ij .

RESULTS AND DISCUSSION

The greatest losses in dry matter in the silos (Table 2) were verified in the treatments with greater compacting densities (600 and 650kg/m³), which may be attributed to the pressure applied to the mass, which associated with the low DM content in the culture at the time of silage (20.7%), favors the leakage of cellular content (Jobim and Nussio, 2013; Borreani *et al.*, 2017), as verified in this work, with greater effluent volume produced in these treatments (Table 3).

The size of the particle didn't influence the electrical conductivity (EC) of the ensiled mass, which was only influenced by the density of compacting at the moment of silage ($P < 0.05$; Table 2). The greatest EC value was registered when using the 600kg/m³ (1533.9 μ /cm) density, being similar to the lowest compacting density of 550kg/m³ (1437.7 μ /cm). The measurement of the electrical conductivity of the material in analysis evaluates the intensity of the cellular rupture of the forage submitted to cut and consequent leaching of ions for the solution. Therefore, the greatest concentration of free ions with the rupture of the cellular wall occurs due to the process of fermentation or mechanical effect in the act of ensiling the culture (Bumbieris Junior *et al.*, 2010).

The pH of the silage was influenced by the theoretical size of the particle and by the density of compaction in the silage ($P < 0.05$; Table 2). The greatest value for pH (5.07) was registered in the silage with greatest theoretical particle size (12mm) and in the compacting density of 600kg/m³. The lactic acid is the main product of fermentation responsible for the reduction in pH, however, its combination with the other fermentation products is what determines the final pH of the ensiled material (Pahlow *et al.*, 2003). Grass silages naturally present greater pH than the observed in whole plant corn silages, for example, this is due to the low concentration of DM in these cultures, average concentration of soluble carbohydrates and high buffer capacity, which limits the capacity for fermentation (Jobim and Nussio, 2013). Elevated pH values, in a grass silage with greater particle size was also verified in the work by Loures *et al.* (2005). The lowest

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verified pH in the silages with smaller particle size (5 and 8mm) is due to the fact that the smaller particles compact better and release greater

amount of soluble carbohydrates for fermentation (Holmes, 2009).

Table 2. Dry matter losses (DML), electrical conductivity (EC) and pH of silages of *Brachiaria brizantha* cv. Paiaguás grass processed in different sizes of particles and different densities of compaction in the opening of silos

Variable	Particle size (mm)			Compaction density (kg/m ³)			SEM	P - Valor		
	5	8	12	550	600	650		P	D	P×D
DML (%) through silage	10,66	12.36	9.56	3.76 ^b	13.55 ^a	15.54 ^a	1.167	0.3006	<0.0001	0.2077
EC (µ/cm)	1418.34	1505.20	1376.68	1437.7 ^{ab}	1533.9 ^a	1324.3 ^b	35.49	0.228	0.0428	0.6734
Silage pH	4.39 ^b	4.49 ^b	5.07 ^a	4.5 ^b	4.8 ^a	4.6 ^b	0.07	<0.0001	0.01	0.59

Different lowercase letters in the same line differ through the Tukey test (P<0.05). SEM = standard error from the mean, P = effect of particle size, D = effect of density, P x D = interaction between the average particle size of the forage and density, EC = electrical conductivity.

There was an effect of the theoretical particle size and compaction density (Table 3), with greater loss of DM through effluent verified in the theoretical particle size 8mm and in the greater compacting densities (600 and 650kg/m³). The dry matter content in the plant below 25% favors the effluent losses (Jobim and Nussio, 2013). Associated to this is the greater processing of the plant in the reduction of particle size and greater pressure applied to the mass due to compacting is what justifies the greater amount of DM loss though effluent in the treatments mentioned (Jobim *et al.*, 2007; Holmes, 2009). Just as greater DM loss through effluent, the greater volume of effluent was verified in the treatments with densities of 600 and 650kg/m³. Regarding the theoretical particle size, the greater effluent volume was verified in treatments with 5 and 8mm. There was significant interaction (P<0.05) between the average size of the particle and the compaction density in the production of effluent.

The production of effluent was considerable, on average 14.7 L/t of ensiled material. This may be attributed to the low content of DM in the silages, which was an average of 20.7% at the moment of cutting, associated with a greater reduction of the particle size and pressure applied to the mass, which favors leaching of liquids from the cells. This liquid is composed mainly of water, but also carries soluble substances, nutrients which constitute loss of dry matter (Savoie and Jofriet, 2003; Jobim and Nussio, 2013). It is in this sense that the production of effluents deserves attention due to the nature of leached products and the reduction of silage quality. Soluble composts such

as: sugars, nitrogen, organic acids, vitamins and minerals may also be present in the effluent produced in the silages. It is also highly relevant to consider the possible environmental impacts that occur due to these effluents (McDonald *et al.*, 1991).

In the characterization of produced effluents, a significative interaction (P<0.05) was present between particle size and compaction density. The greatest values of COD and BPD were registered in the effluent of the silage with smallest theoretical particle size of 5mm, followed by the treatment with particle size of 8mm, the greatest values of COD and BOD were also verified in the treatments with greatest compaction density (600kg/m³ and 650kg/m³). These were also the treatments where the silages presented greatest effluent production, thus, greater nutrient loss. The COD is the amount of oxygen (mg/L) necessary to stabilize the organic matter through the application of a strong oxidative (potassium dichromate), and BOD is the amount of oxygen (mg/L) necessary for the aerobic microorganisms to stabilize the organic matter (constituted basically of sugars, proteins, fats, minerals, and other) present in the effluent (Valente *et al.*, 1997).

The leached from the silos sent to the environment is a factor of great importance related to the silage of grass with high humidity. Since the effluent has a great biochemical demand of O₂ it can quickly deplete the O₂ in the water, and consequently kill the aquatic life. In sandy and permeable soil, the effluent of the silage may also contaminate

subterranean water. (Savoie and Jofriet, 2003). The ratio COD/BOD related to the particle sizes 5; 8 and 12mm was 3,18; 2.74 and 4.66 respectively, and for evaluated densities 550; 600 and 650kg/m³ it was 4.00; 2.9 and 3.28. The average COD/BOD ratio was 3,5 units. The easily biodegradable residue was considered as that with a COD/BOD ratio below 2, recommending the

conventional biological treatment. However, the COD/BOD above 2 indicates the existence of non-biodegradable dry matter, needing, therefore, a physical-chemical treatment (Braile and Cavalcanti, 1993). Consequently, the effluent must be treated, and for this the initial step is its capture in a reservoir (Savoie and Jofriet, 2003).

Table 3. Dry matter losses (DML), production and characterization of effluent deriving from silages of *Brachiaria brizantha* cv. Paiaguás grass ensiled in different particle sizes and compaction densities

Variable	Particle size (mm)			Compaction Density (kg/m ³)			SEM	P - Valor		
	5	8	12	550	600	650		P	D	P×D
DML (%) through effluent	8.10 ^b	11.16 ^a	6,86 ^b	2.9 ^b	12.1 ^a	11.9 ^a	0.92	0.003	<.0001	0.03
Production of effluent (L/t)	14.39 ^a	15.02 ^a	5.60 ^b	6.50 ^b	14.8 ^a	14.4 ^a	1.30	<.0001	<.0001	<.0001
COD (mg/L)	18.97 ^a	12.09 ^b	9.70 ^c	10.8 ^b	14.8 ^a	15.1 ^a	1.10	<.0001	<.0001	<.0001
BOD (mg/L)	5.96 ^a	4.41 ^b	2.08 ^c	2.7 ^b	5.1 ^a	4.6 ^a	0.50	<.0001	<.0001	<.0001
pH of effluent	8.04	8.46	7.93	7.8	8.3	8.3	0.14	0.2003	0.19	0.4541

Different lowercase letters in the same line differ through the Tukey test (P<0.05). SEM = standard error from the mean, P = effect of particle size, D = effect of density, P x D = interaction between the average particle size of the forage and density, DML = dry matter loss via effluent, Production = production of effluent, COD = chemical oxygen demand, BOD = biochemical oxygen demand.

Table 4. Bromatological composition and *in vitro* digestibility of *Brachiaria brizantha* cv. Paiaguás grass, ensiled in different particle sizes and compacting densities

Variables (%)	Particle size (mm)			Compacting Density (kg/m ³)			EPM	P - Valor		
	5	8	12	550	600	650		P	D	P×D
DM	19.8	19.7	19.6	19.9	19.4	19.8	0.223	0.92	0.59	0.84
OM	90.7	90.7	91.2	91.2	90.3	91.1	0.182	0.52	0.13	0.96
CP	9.54	10.0	9.72	9.55	9.93	9.79	0.140	0.43	0.56	0.63
NDF	64.6	64.1	65.8	64.5	64.9	65.0	0.362	0.15	0.84	0.43
ADF	47.3	46.1	48.2	47.1	46.5	48.0	0.409	0.08	0.27	0.19
HEM	17.3	18.0	17.6	17.4	18.5	17.0	0.355	0.67	0.20	0.12
CEL	45.4	44.5	46.7	45.0	44.9	46.5	0.401	0.09	0.19	0.40
LIG	1.98 ^a	1.52 ^b	1.54 ^b	2.07 ^a	1.49 ^b	1.48 ^b	0.083	<0.01	<0.01	<0.01
EE	2.61 ^b	2.58 ^b	2.98 ^a	2.63	2.84	2.69	0.049	<0.01	0.08	0.47
IVDDM	57.8 ^a	56.6 ^a	53.3 ^b	55.4	56.7	55.4	0.623	<0.01	0.53	0.43

Uppercase letters in the same line differ by the Tukey test (P<0.05). SEM = standard error on the mean; P = effect of particle size; D = effect of density; P x D = interaction between the average particle size in the forage and density; DM = dry matter; OM = organic matter; CP = crude protein; NDF = neutral detergent fiber; ADF = acid detergent fiber; HEM = hemicellulose; CEL = cellulose; LIG = lignin; EE = ether extract; IVDDM = "in vitro" digestibility of DM.

There was no effect of treatments on pH of effluent, the values were confronted with the maximum and minimum limits established by CONAMA (Brasi, 2011), with the pH range of 5 – 9 as ideal for aquatic life. Regarding the bromatological composition of the silages (Table 4), there was a significant difference (P<0.05) in the content of lignin, with greater content (1.98%) when the silage was produced with a particle size

of 5mm. This response may influence the loss of nutrients due to the greater production of effluents verified in this silage (Table 3), which favors a greater concentration of lignin. For the 550kg/m³ compacting density the greatest concentration of lignin was verified (P<0.05). Lower density may have granted higher porosity of mass and consequent loss of nutrients (Holmes, 2009),

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concentrating the fractions of more difficult degradation, such as lignin.

The silage with the largest theoretical particle size (12mm) presented the greatest EE content in the silage ($P < 0.05$). For Loures *et al.* (2003, 2005), the smaller particle size allowed a greater compacting degree and greater expulsion of residual oxygen, while the larger particle makes compacting more difficult and favors the presence of residual oxygen, prolongs breathing promoting the consumption of sugars and concentrating EE.

Regarding IVDDM, there was an effect of the particle size ($P < 0.05$), with higher concentrations of IVDDM observed when the silage process happened with Paiaguás grass cut at 5mm and 8mm. In the present study, the theoretical increase in particle size (12mm) decreased IVDDM, this treatment also presented the greatest pH value (5.07). The greater particle size may have triggered the presence of more residual air in the silage, prolonging the time of cellular breathing (vegetable and microbial) and favoring the

secondary fermentations, creating greater consumption of soluble nutrients, which compromises the activity of lactic acid bacteria (LAB) and the quick conservation of nutrients (Borreani *et al.*, 2017). Consequently, the impact is seen in the reduction of potentially digestible nutrients for animals. The silos with smaller particles (5 and 8mm) presented a lower pH, which shows a better conservation of the mass, in this case a greater IVDDM was observed, but these particle sizes favor the losses due to production of effluent.

All the silages had elevated aerobiosis stability. For all the silages, in the period of 216 hours of aerobic stability, there was no elevation in mass temperature ensued above 2°C in relation to ambient temperature (Figure 2). On the other hand, a temperature fall was verified in the first 72 hours, due to the low ambient temperature (19°C). A temperature rise in the silage was later registered in all treatments, following the ambient temperature.

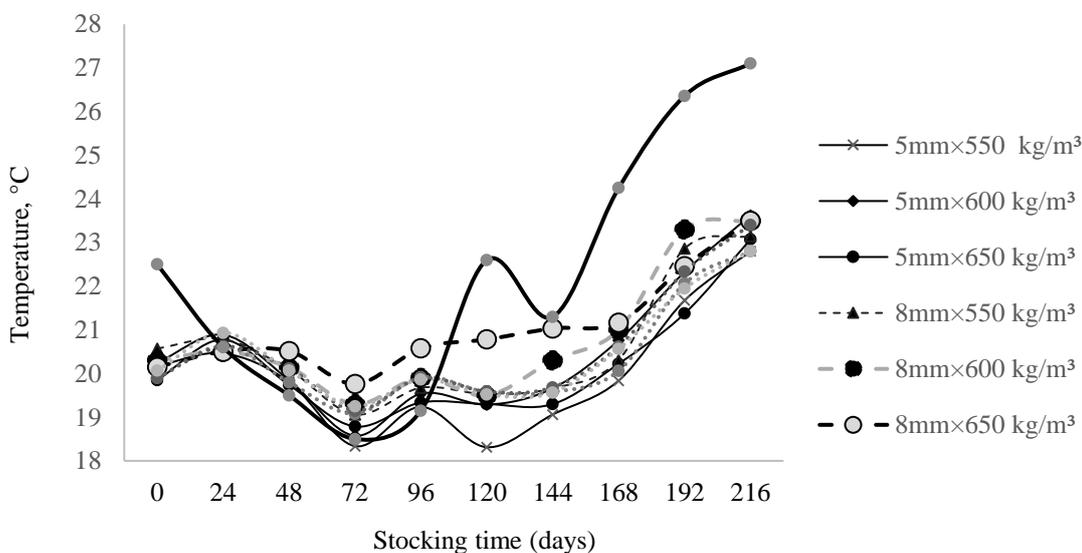


Figure 2. Temperatures of silages (°C) during the exposure period (h) to oxygen. SEM = 0.21; $P < 0.01$ for interaction between the theoretical particle size x density x time.

The fact that numerically the treatment with smaller theoretical particle size and greater compacting density (5mm and 650kg/m³), in certain periods, presented higher internal temperature of the ensiled mass in relation to the others is noteworthy. This may be a result of the greater efficiency in compacting, greater

expulsion of residual air, better anaerobic fermentation and greater preservation of the nutritional value of the ensiled mass, with smaller losses of soluble composts (Loures *et al.*, 2003; Neumann *et al.*, 2005; Amaral *et al.*, 2007).

CONCLUSIONS

Silage with low compacting density (550kg/m³) and processing with theoretical particle size of 12mm reduce the effluent loss. The nutritional value of the silage of Paiaguás grass in general is not influenced by the theoretical particle size and density of silage. Different particle sizes and compacting densities do not alter the aerobic stability of the silages of Paiaguás grass.

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