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Performance supplementation and ingestive behavior of sheep finished in continuous pasture in the period of water restriction

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ABSTRACT. The objective was to evaluate the performance and ingestive behavior of grazing sheep in the finishing stage, with supplementation in the period of water restriction. Fifteen male crossbred sheep were used in continuous pasture in Massai grass and supplied supplement formulated with 18% of crude protein in three levels (0.0; 0.3 and 0.6% of body weight), individually. Bromatological and fodder production analyses were performed, as well as foliar mass production, stem mass and senescent material mass. The performance and ingestive behavior of the animals were evaluated. The design was in four randomized blocks for the variables measured in the fodder. For the biometry, weight gain and behavior variables measured in the animals, the design was entirely randomized with five repetitions. The total forage mass production was 5512.41 kg ha^{-1}, with 6.58% of crude protein, 79 38% of neutral detergent fiber and with 65% of foliar mass. The total weight gain and daily weight gain were higher in animals that received a supplement of 0.6% of body weight. In general, the animals grazed more in the morning period and the supplemented ones destined more time for rumination and leisure than the ones not supplemented.

Keywords: massai; deferral; nutrition; ruminants.

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Introduction

Management practices in sheep farming should seek sustainability of production based on regional conditions (climate, soil, precipitation), animal category and intensification of the system (Garcia & Pinheiro, 2018). According to Sampaio et al. (2016), the use of pastures is the main source of food used in the production system of sheep and other ruminants, so it is important to be aware of climate changes during the year, as well as the productive changes of the plant. In production systems that use only pasture as a source of food, there may be an imbalance between the nutritional quality of the fodder and the demands of the animals during the year, which may reduce the productive potential (Adami et al., 2013).

The region of the state of Tocantins shows a pronounced seasonality throughout the months of the year, with a reduction in rainfall (below 1 mm day^{-1}) between June and August and intensification of rainfall indices between December and February (9 and 12 mm day^{-1}) (Souza et al., 2016). With this, the system of raising sheep on pasture tends to be influenced by the lower availability of food during the dry season of the year, making it necessary to seek strategies such as supplementation in order to ensure the sustainability of production. According to Silva Sobrinho (2018), supplementation in the production of grazing sheep is necessary even to obtain acceptable levels of performance.

Sheep are able to adapt to the most diverse environmental conditions, obtaining information on the behavior of the sheep species in different forms of management helps in the adjustments to optimize productivity, animal welfare and identify appropriate pastoral environments (Moreira et al., 2018). The ingestive behavior of the animal is influenced by the availability and diet composition and may be impaired by the period with low availability of food (Monteiro et al., 2019).

Based on this information, the objective was to evaluate the performance and ingestive behavior of sheep in continuous pasture in the finishing phase, with supplementation of 0.0; 0.3 and 0.6% of body weight in the period of water restriction.

Material and methods

Characterization of the experimental area

The experiment was conducted at the School of Veterinary Medicine and Zootechny of the Federal University of Tocantins – EMVZ/UFT, Campus de Araguaína, Tocantins. The procedures used in this experiment were approved by the Ethics Committee on the Use of Animals of the Federal University of Tocantins under process number 23101.002369/2014-28. The experiment was conducted during the dry season. The climatological data collected at the meteorological station 82596, located at the EMVZ/UFT campus (Latitude: -7.103778°, Longitude: -48.20133°, Altitude: 231.85 meters) regarding the months of execution of the experiment in the year 2017, in the city of Araguaína/TO, are presented in Table 1.

Table 1. Average, maximum and minimum temperatures, average relative humidity (RH), average insolation and precipitation from June to August of the year 2017, obtained from the meteorological station Araguaína-A021 in Araguaína/TO (Instituto Nacional de Meteorologia [INMET], 2020).

Months	Temperature (°C)			RH	Insolation	Precipitation
	Average	Max	Min	(%)	(h)	(mm)
June	24.8	35.3	16.8	68.1	235.3	69.8
July	25.3	34.8	13.8	59.9	277.3	0
August	25.4	38.0	17.7	57.4	296.2	6.0

Implementation of the experiment

The experiment was installed in an area already formed of Massai grass (*Megathyrsus maximus* x *M. infestum* cv Massai) in a typic Ortic Quartzarenic Neosol (Empresa Brasileira de Pesquisa Agropecuária [Embrapa], 2013) located in the sheep sector of EMVZ/UFT. The experimental design was used entirely randomized for the analyses measured in the animals (behavior, biometry and weight of the animals) and in complete blocks randomized for the variables measured in the forage, distributed in the experimental area with four repetitions.

The area was divided into 12 paddocks of 301 m^2, four for each treatment. At the end of the rainy season, in the penultimate week of May, a uniform cut was made 15 cm from the ground, with a costal brush cutter. Considering that the pasture would be continuous and that the animals would enter the paddock as soon as they pastured the previous paddock, the uniformization was performed in the first paddocks of each treatment, and for the other paddocks every four days to avoid that all reached the defined heights at the same time. At the time of the entrance (pre-grazing) of the animals in the paddocks, the height of the pasture should be 35 cm and the removal of the animals (post-grazing) when it was 15 cm.

Two days after the uniforming cut, the area was fertilized using 76.00 kg ha^{-1} of N, 14.63 kg ha^{-1} of P_2O_5 and 30.38 kg ha^{-1} of K_2O, using urea, single superphosphate and potassium chloride as sources, respectively. The amount of fertilizer for the experimental period was calculated for 250 kg ha^{-1}.$year^{-1}$ of N, 50 kg ha^{-1} $year^{-1}$ of P_2O_5 and 100 kg ha^{-1}.$year^{-1}$ of K_2O, considering seven months of rainy season in the year. The animals entered the area in the first week of the following month, the pasture was 45 cm high, being pasture applied the continuous stocking method until the height of 15 cm.

Fifteen sheep, castrated males, Santa Inês x crossbred sheep were used with an average weight of 32 kg ± (4). The sheep were identified with numbered earrings, they were weighed, then dewormed and finally distributed among the three treatments (supplementation levels), being five repetitions (animals) per treatment. Initially the animals were adapted to the diets for six days. The experiment was composed of three treatments, being three levels of concentrated supplementation (0.0; 0.3 and 0.6% of Body Weight - BW,) and four experimental blocks. The continuous stocking method was adopted, using a stocking rate of 4 UA ha^{-1}, previously defined, during the adaptation period, from the number of animals necessary to reduce the fodder mass based on the heights and considering animals exclusively in pasture.

Concentrated feed was formulated for 18% crude protein, the composition of the concentrated diet and the averages of weight provided for each treatment are presented in Table 2. Independent of the treatment the animals had free access to water and mineral mixture Matsuda® Sheep Top Line (135 to 150 g kg^{-1} Ca, 65 g kg^{-1} P, 107 g kg^{-1} Na, 12 g kg^{-1} S, 30 g kg^{-1} CP, 100 g kg^{-1} TDN).

The concentrated food was provided individually in the early morning before the animals were taken to the pasture. The individual amount of concentrate was calculated based on the weight of each animal, and weighings were done each week to adjust the amount of diet. The sheep were kept on the pasture during the day, between 7am and 6pm. After this period, they were taken to separate stalls by treatment in order to avoid predator attacks during the night.

Table 2. Composition of the concentrated supplement and average amount of concentrate supplied for the different levels of supplementation.

Composition	
Ingredients	Proportion (%)
Grinded corn	62.00
Soybean meal	34.03
Bicalcium phosphate	2.11
Mineral salt	1.29
Limestone	0.57
Quantity supplied	
Supplementation (% of body weight)	Concentrated (kg)
0.0	0
0.3	0.104
0.6	0.195

Canopy height

The height of the fodder canopy was controlled during the pasture every two days, taking 20 measurements at random points on each paddock with a ruler graduated in centimeters, from the base of the tiller, close to the ground, to the midpoint of the highest leaves in the canopy.

Structural and bromatological composition of the fodder

An area representative of the height of each paddock was chosen and two samples were collected, both pre-grazing and post-grazing, close to the ground, to obtain the fodder mass, using a square of 0.5 m^2 of area (0.5 x 1 m) and packed in plastic bags. The determination of the green mass production (GMP) was made from the weighing of the collected samples. One of the samples was used to separate and measure the fractions of leaf blade dry mass (LBDM), stem dry mass (SDM) and senescent material dry mass (SMDM). The second sample collected was used to measure the total dry mass (TDM). For these measurements the samples were taken to a forced air vent oven at 55°C for 72h. The volumetric density of fodder (FD) was obtained by dividing the TDM by the actual height, the leaf: stem ratio (L/S) by dividing the LBDM by the SDM and the leaf: senescent material ratio (L/SM) by dividing the LBDM by the SMDM. The available forage (AF) was given by the difference between the amount of TDM and dry mass when the height of the forage reached 15 cm. The forage offer (FO) was determined by dividing the available fodder mass per day by 100 kg body weight.

The samples for bromatological analysis were taken using the simulated grazing technique, then ground in a Willey-type mill with a 1 mm sieve and the dry matter (DM), organic matter (OM), crude protein (CP), ethereal extract (EE) and mineral matter (MM), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined according to Silva and Queiroz (2002). The total digestible nutrient contents (TDN) were calculated by the equation for green fodder described by Cappelle, Valadares Filho and Silva (2001): TDN = -2.49 + 1.0167DIVMO, where DIVMO is the in vitro digestibility of organic matter (%).

Animal performance

Five repetitions (animals) were used to evaluate the performance of the animals. The initial body weight (InitialBW) and the final body weight (FinalBW) of the animals were obtained by weighing every 7 days of evaluation, with previous fasting of 12h. The FinalBW was related to the last weighing, the weight gain (WG) calculated by the difference between the FinalBW and InitalBW and the average daily weight gain (ADWG) per animal and treatment was obtained by dividing the WG by the days of evaluation of the experiment.

On the same days of weighing the animals the biometric measurements were made according to Menezes et al. (2007): croup height (CH), withers height (WH), croup width (CW), chest width (CW), thoracic perimeter (TP) and body length (BL), being the measurements made by the same evaluator, CH and WH were obtained with the aid of a pachymeter and the other biometric measurements made with the aid of a tape measure. The body condition score (BCS) was also made by the same evaluator, visually and by touching the animal's croup on a scale from 1 to 5 ± 0.5, where 1 was attributed to the very thin animal and 5 to the very fat animal (Mourad, Fehr, & Hervier, 1989).

The ingestive behavior of the animal was performed at the entrance and exit of the pasture animals in the second and fourth blocks, adding four days of observation. The observations were made during 12h (6 to 18h), which was the time the animals stayed on the pasture, by four trained observers. The animals were painted with yellow and black spray paint depending on the color of the animal to facilitate visualization by the evaluators. The variables were measured individually in the animals, every ten minutes, being recorded the pasture, rumination and other activities. The observations were extrapolated to min.day^{-1}. These observations were grouped in three periods of the day, 6 to 10h, 10 to 14h and 14 to 18h, adding 720 min. of evaluation.

Statistical analysis

The design was in random blocks with four blocks for the variables measured in the fodder. For the biometry and weight gain variables measured in the animals, the design was entirely randomized with five repetitions (animals), and for the behavior analysis an unfolding was performed where the same design was adopted, but with repeated analysis in time within the periods of the day. Statistical analyses were performed through the Statistical Analysis System [SAS] (1995), initially performing the analyses of the assumption of normality (Shapiro-Wilk) and homoscedasticity (Levene). Analysis of variance was performed and the means were submitted to the Tukey test, being considered as significant probability values below 5% ($p < 0.05$).

Results and discussion

The bromatological composition of Massai grass was the same for all treatments during the experimental period and are described in Table 3.

Table 3. Bromatological composition of *Megathyrsus maximus* x *M. infestum* cv Massai in the water restriction period of the year.

(%) da DM	Average
Dry matter	25.89
Organic matter	18.44
Crude protein	6.58
Ethereal extract	3.51
Mineral matter	6.19
Neutral detergent fiber	79.38
Acid detergent fiber	41.03
Total digestible nutrients	53.74
Non nitrogenated extracts	43.66
Total carbohydrates	83.69
Non-fibrous carbohydrates	4.27

DM = dry matter.

The crude protein content was less than 7% which, according to Van Soest (1994), is the minimum necessary to stimulate the consumption of fodder and for fermentation to occur in an adequate way in the ruminal environment. Gurgel et al. (2017) observed even lower values (5.5%) in Massai grass in times of water restriction, according to these authors this makes the supplementation necessary for a better productive performance. Silva et al. (2017) evaluating doses of up to 100 kg ha^{-1} and 50 kg ha^{-1} of N and P_2O_5 respectively, in the same area of Massai grass where this experiment was carried out, found CP values of 7.06% in the water period, close to the 7.03% observed by Costa et al. (2017) in Massai grass in dry and rainy periods and fertilized with 200 kg ha^{-1} of N.

The values of acid detergent fiber (ADF) and neutral detergent fiber (NDF) were close to those obtained by Cardoso et al. (2019) (38.4 and 77.9% of DM) and Silva et al. (2017) (80.04 and 45.39% of DM) in the same area of Massai grass in the rainy season. The same occurred for TDN levels close to 50.15% obtained by Cardoso et al. (2019).

The production and structure of the pasture did not present difference for the evaluated treatments, indicating that the management adopted in the pasture was the same in the used area. Managing Massai grass height at 35.58 cm, the dry mass production was 5512.41 kg ha^{-1} (Table 4), a value lower than the forage mass production obtained in this same area in the water period (6600 kg ha^{-1}) with similar management and fertilization height (Cardoso et al., 2019), which was expected due to the low precipitation of this time (Table 1). However, the value of forage mass was higher than the 2694 kg ha^{-1} found by Gurgel et al. (2017) working with Massai grass with 95% light interception in the water restriction period of the year and the 3971 kg ha^{-1} observed by Emerenciano Neto et al. (2016) in Massai grass fertilized with urea (150 kg ha^{-1} of N) and use of irrigation in the months without rainfall.

Table 4. Mean canopy height, total dry mass available (TDM), leaf blade dry mass (LBDM), stem dry mass (SDM), senescent material dry mass (SMDM), leaf: stem ratio (L/S), leaf: senescent material ratio (L/SM), forage density (FD), available forage (AF), forage offer (FO) of *Megathyrsus maximus x M. infestum* cv Massai and the average days in sheep pasture in the water restriction season.

Pre-grazing			
Variables	Values	Pr > F	CV (%)
Canopy height (cm)ns	35.58	0.7211	5.02
TDM (kg ha^{-1}) ns	5512.41	0.2372	20.13
LBDM (kg ha^{-1}) ns	3594.80	0.3444	25.21
SDM (kg ha^{-1}) ns	323.6	0.7674	21.13
SMDM (kg ha^{-1}) ns	1734.15	0.5554	18.35
L/S ns	12.04	0.9854	23.47
L/SM ns	2.44	0.4688	21.29
FD (kg.cm^{-1} ha^{-1}) ns	157.14	0.2372	20.17
AF (kg) ns	3203.13	0.3611	7.89
FO (%)ns	6.65	0.3864	18.96
Days in pasture ns	5	0.7939	20.55
Post-grazing			
Variables	Values	Pr > F	CV (%)
Canopy height (cm)ns	13.67	0.9642	11.04
TDM (kg ha^{-1}) ns	2296.88	0.9878	18.24
LBDM (kg ha^{-1}) ns	906.81	0.8696	23.76
SDM (kg ha^{-1}) ns	204.42	0.5916	19.26
SMDM (kg ha^{-1}) ns	1185.88	0.1761	21.56
L/S ns	4.43	0.1051	20.87
L/SM ns	0.76	0.9264	22.36
FD (kg.cm^{-1} ha^{-1}) ns	153.13	0.9878	21.56

ns = not significant by F test; Pr > F = probability; CV%= coefficient of variation.

The available forage mass was 3203.13 kg ha^{-1} and the forage supply 6.65% with the grass being pastured between the canopy heights of 35.58 and 13.67 cm, close to the values obtained with the management being done at the same heights during the rainy season (Cardoso et al., 2019), this demonstrates that the adequate management carried out in the waters influences the mass of forage available in the months of low rainfall.

The pasture showed considerably higher leaf production in relation to that of stem and senescent material, which can also be observed by the L/S and L/SM ratios. The L/S ratio is close to the 12.64 observed by Emerenciano Neto et al. (2016), which can be attributed to the management of pasture fertilization in the previous rainy season and to the low elongation characteristic of Massai grass (Gurgel et al., 2017).

As can be seen in Figure 1, the proportion of leaves in the pre-pasture was 65% while only 6% of the structural composition of Massai grass is composed of stalks and 29% of senescent material.

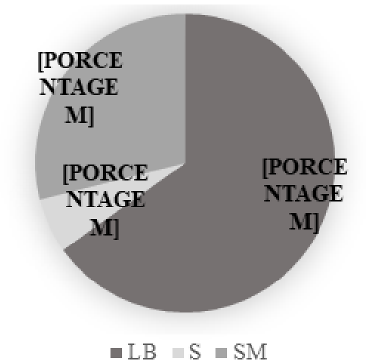

Figure 1. Proportions of leaf blade (LB), stem (S) and senescent material (SM) of *Megathyrsus maximus* x *M. infestum* cv Massai.

The greater participation of leaves reflects in the more selective and preferential consumption of sheep by this part of the plant in relation to the stem, for being more adequate to its requirements (Carvalho et al., 2015). According to Moreira et al. (2018), the higher proportion of leaves reduces the time of capture of food contributing to the higher intake of pasture.

The animals' body measurements were not influenced by supplementation levels up to 0.6% of body weight (Table 5). These measures are dependent on several characteristics besides diet, such as race, species, management and others and therefore the differences and similarities found tend to be conflicting (Araújo et al., 2015).

Table 5. Dry mass production (DMP), initial body weight (InitialBW) and final body weight (FinalBW) measurements, total weight gain (WG) and daily average (ADWG), biometric measurements of body length (BL), thoracic perimeter (TP), croup width (CW), breast width (BW), withers height (WH) and garure height (GH) and body condition score (BCS) of sheep in Massai grass pasture (*Megathyrsus maximus x M. infestum)* in the period of water restriction, submitted to different levels of supplementation.

Variables	Supplementation (% of body weight)			Pr > F	CV (%)
	0	0,3	0,6		
DMP (kg ha^{-1})	2980	3000	2995	0.0783	21.03
InitialBW (kg)	38.0	37.3	34.3	0.6272	17.2
FinalBW (kg)	38.5	39.7	38.5	0.9413	16.4
WG (kg)	0.460 b	2.460 ab	4.200 a	0.0030	56.4
ADWG (kg)	0.018 b	0.09 ab	0.162 a	0.0030	56.4
BL (cm)	48.2	46.4	49.4	0.2265	5.4
TP (cm)	96.2	93.2	91.4	0.7431	10.5
CW (cm)	16.4	15.6	16.0	0.8404	13.3
BW (cm)	20.4	21.0	22.8	0.3434	12.0
WH (cm)	69.0	69.8	69.4	0.9350	4.9
GH (cm)	69.4	70.8	71.0	0.6016	3.8
BCS	2	2	2	0.6912	20.6

Averages followed by different letters on the line differed statistically at 5% probability (Pr > F). CV(%) = coefficient of variation.

The total weight gain (WG) and the daily average weight gain (ADWG) were higher in the animals supplemented with 0.6% of the body weight, not differing statistically from the treatment with supplementation with 0.3% of the body weight. Kieling, Teixeira, Pivato, Viero, and Cruz (2006) observed increases in the ADWG of lambs with the increase in the level of concentrate and attributes this to the higher nutritional intake obtained by these animals due to supplementation. Gurgel et al. (2017) observed ADWG ranging from 0.045 to 0.159 kg in sheep grazing Massai grass in the water restriction period of the year, being the smallest gain observed when there was no monthly precipitation and the largest gain in the month in which the precipitation was 126 mm, a value higher than that recorded throughout the experimental period (75.8 mm) of this work.

The daily average weight gain of the supplemented animals at 0.6% of body weight was 0.162 kg despite being in the finishing phase, when the gain is not as accentuated as in the initial phases of growth, while the non-supplemented animals had the lowest weight gain (0.018 kg). Even if the gain of the non-supplemented animals was lower, it is important to note that the positive gain of these animals at this time of the year, with a low protein content, was something positive, because the lack of supplementation in the period of water restriction, when deficient nutrients in the forage must be supplied, can even reduce performance (Reis, Ruggieri, Casagrande, & Páscoa, 2009).

The supplementation with concentrate in the rearing and finishing phase reduces the animals slaughter time, this is essential to increase the enjoyment rate and the capital turnover of the property, Souza et al. (2010) correlates the best performance of sheep to pasture supplemented with the highest nutritional intake and resistance of these animals.

The activities of pasture, rumination, leisure, salt consumption and water consumption can be observed in Figure 2.

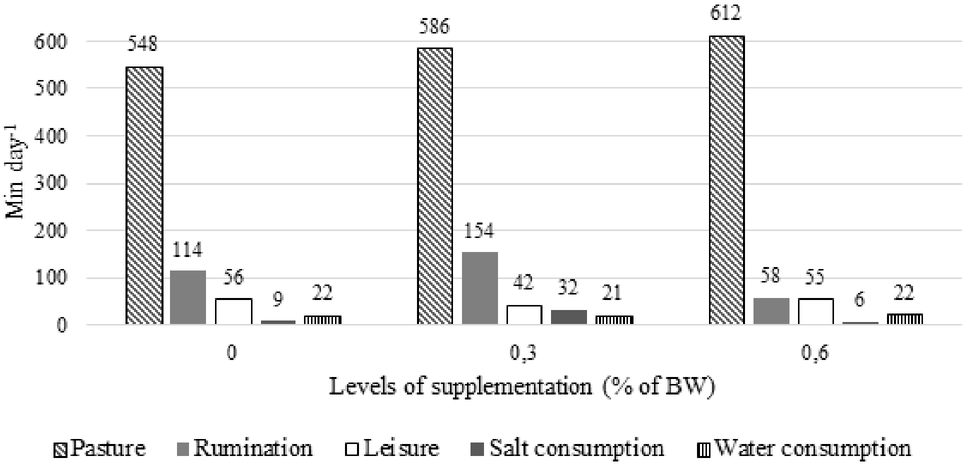

Figure 2. Activities observed, at min.day^{-1}, in the behavior of grazing sheep fed with different levels of supplementation in % of body weight – BW.

The grazing times varied from 548 to 612 min day^{-1}, probably due to the good availability of fodder mass and because the animals were already familiar with the environment, but were less than 720 min day^{-1}, time that, according to Moreira et al. (2018), if exceeded can interfere with rumination time. Anyway, cud-chewing time tends to be reduced with the increase of grazing activity, but it also tends to be influenced by the fiber contents of the diet.

Sousa Segundo, Santos, Souza, Silva, and Souza (2016) observing the behavior of supplemented sheep during 12h of the day, found that rumination occupied about 4.5h of this time. Pazdiora et al. (2019) observed cuddling time of 6.10h in sheep fed with Tifton grass presenting 65.4% of ADF and 12% of CP, the animals in the present study presented lower times but the evaluations performed only at the time of pasture (6:00-18:00) disregarded the time used for this activity during the night. Monteiro et al. (2019) observed longer time of rumination between 20 and 08h while the feeding periods were higher during the day.

The animals devoted little time to idle activity, this activity, as well as rumination, tends to be more frequent during the nocturnal period. According to Sousa Segundo et al. (2016) this activity is not desirable, being unproductive because it does not represent consumption or rumination of dry matter in the food.

Besides factors such as climate, quality, structure and supply of the diet, the grazing time can also influence the ingestive behavior of sheep. There was interaction between the treatments and the periods of the day in the results of pasture, rumination, leisure, salt consumption and water consumption (Table 6).

Table 6. Ingestive behavior of sheep in Massai grass pasture (*Megathyrsus maximus* x *M. infestum*) in the period of water restriction submitted to different levels of supplementation.

Supplement (% de BW)	Period 6:00-10:00	Period 10:00-15:00	Period 15:00-18:00	Averages	Pr > F S	Pr > F P	Pr > F S x P	CV (%)
Pastures (min day^{-1})								
0	238 Aa	207 Ba	103 Bb	183	0.0389	< .0001	0.0001	26.88
0,3	238 Aa	210 Bb	137 ABc	195				
0,6	229 Aa	229 Aa	154 Ab	204				
Averages	235	216	131					
Rumination (min day^{-1})								
0	0,0 Ab	68 Ba	46 Aa	38	0.0017	< .0001	0.0024	25.61
0,3	0,0 Ac	125 Aa	29 Ab	51				
0,6	0,0 Ac	43 Ba	15 Bb	19				
Averages	0	79	30					
Idle (min day^{-1})								
0	2 Bb	25 Ba	29 Aa	19	0.2088	< .0001	0.0002	41.37
0,3	1 Bc	27 ABa	14 Bb	14				
0,6	15 Ab	28 Aa	12 Bb	18				
Averages	6,08	27	18					
Consuming mineral salt (min day^{-1})								
0	3 Aa	3 Ba	3 Aa	3	0.0756	0.0017	0.0058	38.54
0,3	4 Ab	28 Aa	0,0 Ab	11				
0,6	2 Aa	3 Ba	1 Aa	2				
Averages	3	11	1					
Consuming water (min day^{-1})								
0	7	9	5	7	1.0000	0.0034	1.0000	55.84
0,3	7	9	5	7				
0,6	7	9	5	7				
Averages	7 ab	9 a	5 b					

Averages followed by different lower-case letters in the row and upper-case letters in the column differed statistically at 5% probability (Pr > F). BW = body weight. CV(%) = coefficient of variation. S = level of supplement. P = period.

The time of pasture in the early morning did not differ between treatments, this may be linked to the fact that all animals, regardless of treatment, spend the night only with mineral supplement and water available and therefore seek food in a similar way when placed in the area of pasture Monteiro et al. (2019) found longer feed intake times in the daytime period and according to Lima et al. (2014), the main grazing moments begin at dawn. Usually the pasture activities are interspersed with rumination or idleness periods (Moreira et al., 2018), but because they are stuck in the night period this may have been modified. Due to these and other changes that occur according to sheep management, it is important to define the times at which pasture activity preferably occurs in order to define feeding strategies.

However, even knowing that supplementation can decrease pasture time, it was superior in the animals that received supplementation in the levels of 0.6% of BW in the other periods of the day (10:00-18:00). Sheep in low quality pasture, when supplemented, are able to digest more easily the fiber due to the higher contribution of ammoniacal nitrogen in the rumen and, therefore, available to microorganisms, contributing to the better use of fodder (Carvalho et al., 2019). The reduced pasture quality observed in the period of water restriction added to the additional levels not considered high, probably contributed to this greater utilization of pasture. Souza et al. (2010) observed a substitution effect only using concentrate dose above 0.66% of BW for sheep in irrigated Tifton 85 pasture. The longer grazing time is related to the increase in consumption with the increase in the level of supplementation, which in turn is determinant for better performance (Lima et al., 2014).

The rumination for both treatments was lower in the early morning period, which was expected since the animals spent this period almost exclusively grazing, the behavior of ruminants grazing is characterized by long periods of feeding mainly in the early morning and late afternoon (Siqueira & Fernandes, 2014), decreasing the other activities, such as rumination, in these periods.

In the period between 10:00-15:00, the animals supplemented with 0.3 and 0.6% had more time of rumination and laziness than in the other periods of the day, probably because by reaching more quickly their nutritional requirements they were able to allocate the warmer periods to these activities, while the animals not supplemented remained feeding to supply their needs. According to Silveira et al. (2015), supplemented animals are able to achieve the required levels of nutrient consumption in less time, resulting in increased rumination and idleness activity.

The animals supplemented with concentrate at 0.6% of body weight ruminated less than the others in the evening. The frequency of rumination in sheep, unlike grazing, usually occurs irregularly during the day and night (Lima et al., 2014). The cud chewing time decreased linearly with the increase of the concentrate level in diets (Moreira et al., 2018). This is related to the fact that the rumination time is longer when the diets have higher fiber contents (Pazdiora et al., 2019), although the pasture diet is similar, the higher amount of supplement proportionally reduces the amount of fiber in addition to providing greater nutritional intake to aid ruminal digestion of this plant fraction.

The consumption of mineral salt was similar, being superior only in the treatment with 0.3% of the supplementation body weight in the hottest period of the day. For all animals the water consumption was higher in the hottest period of the day and lower in the late afternoon, and there was no effect of the treatments for this variable, and the results were mainly associated with the higher temperature of the period from 10 to 15h.

Conclusion

Adequate pasture management in the water period prior to the water restriction period results in good dry mass availability at this time of the year, but with reduced nutritional quality. The supplementation in levels of 0.6% of body weight increases the total weight gain and average daily weight gain of the animals in the finishing phase. Sheep on pasture have peaks in the morning (06:00-10:00), while they do not require more time for rumination in the 10:00-15:00 period, and supplemented sheep spend more time for rumination and laziness than unsupplemented sheep.

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