DOI: 10.526/cab.v14i3.23613

BEHAVIORAL PARAMETERS OF CULL COWS GRAZING MILLET OR SUDAN GRASS

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ABSTRACT

The objective of this study was to evaluate the behavioral parameters and strategies of displacement and feeding of cull cows grazing millet or Sudan grass. The treatments consisted of: pearl millet (*Pennisetum americanum* (L.) Leeke) or Sudan grass (*Sorghum bicolor* cv. sudanense). Both treatments were submitted to continuous grazing by cull cows over 63 experimental days subdivided into three periods. We used 20 Charolais x Nellore cull cows, at the average age of 8 years and average weight of 445 kg. The animals were divided into 10 paddocks, five paddocks were used for each treatment comprising two cows. The behavioral assessments were carried out for 24 hours straight. The experimental design was completely randomized with two treatments and three periods. The grazing time of cows showed interaction (P = 0.0035) between treatment and period, and the shortest time was for the activity in the first period on pearl millet (504 minutes) compared to the second period of that same treatment (587 minutes) and the third period on Sudan grass pasture (535 minutes). The times of rumination and leisure were similar between treatments; however, the leisure time decreased and rumination increased with time periods. The forage species did not affect the variables related to the strategies of displacement and feeding. With the advancement of cycle pastures, the number of steps per minute, stations per minute and per day decreased while the bite rate and the number of bites per day increased. The behavioral parameters of cull cows grazing Sudan grass or millet are similar; however, the advancement of the vegetative cycle of these species provides changes in the behavioral pattern of the animals.

KEYWORDS: bite rate; displacement strategies; grasses; grazing time; *Pennisetum*; *Sorghum*.

PARÂMETROS COMPORTAMENTAIS DE VACAS DE DESCARTE EM PASTAGENS DE MILHETO OU CAPIM SUDÃO

RESUMO

Objetivou-se com este estudo avaliar os parâmetros comportamentais e as estratégias de deslocamento e alimentação de vacas de descarte em pastagens de milheto ou capim sudão. Os tratamentos consistiram em: pastagem de milheto (*Pennisetum americanum* (L.) Leeke) ou pastagem de capim sudão (*Sorghum bicolor* cv. sudanense). ambos tratamentos submetidos ao pastejo contínuo de vacas de descarte. ao longo de 63 dias experimentais. subdividido em três períodos. Foram utilizadas 20 vacas de descarte cruza Charolês x Nelore. de idade média de 8 anos e peso vivo médio inicial de 445 kg. Os animais foram distribuídos em 10 piquetes. sendo utilizados cinco piquetes para cada tratamento comportando duas vacas. As avaliações comportamentais

foram realizadas durante 24 horas ininterruptas. O delineamento experimental foi inteiramente casualizado com 2 tratamentos e 3 períodos de avaliação. O tempo de pastejo das vacas apresentou interação (P=0.0035) entre tratamento e período. sendo o menor tempo destinado à atividade no primeiro período na pastagem de milheto (504 minutos) comparado com o segundo período desse mesmo tratamento (587 minutos) e terceiro período nas pastagens de capim sudão (535 minutos). Os tempos de ruminação e ócio foram semelhantes entre os tratamentos; no entanto. o de ócio diminuiu e o de ruminação aumentou com o avanço dos períodos. As espécies de forrageiras não influenciaram as variáveis relacionadas às estratégias de deslocamento e alimentação. Com o avanço do ciclo das pastagens. o número de passos por minuto. estações por minuto e por dia diminuíram enquanto a taxa de bocado e número de bocados por dia aumentaram. Os parâmetros comportamentais de vacas de descarte em pastagens de milheto ou capim sudão são similares; no entanto. o avanço do ciclo vegetativo dessas espécies proporciona modificações no padrão comportamental dos animais.

PALAVRAS-CHAVE: estratégias de deslocamento; gramíneas; *Pennisetum*; *Sorghum*; taxa de bocado; tempo de pastejo.

INTRODUCTION

Recent decades have witnessed significant increases in studies on behavioral evaluations of beef cattle on different grazing systems and on a wide variety of grass species. These studies have enabled great progress in understanding the performance responses of animals due to management or choice of grass species for grazing (KONDO, 2011).

In Brazil, many grass species of warm season are sold in order to meet the requirements of different production systems. Among these species, millet and Sudan grass have been used for feeding beef cattle. While the millet is widely explored in continuous grazing systems, with productive features that consolidate it as forage with large production potential (RESTLE et al., 2002; PILAU & LOBATO. 2008), Sudan grass is recommended for the formation of hybrid sorghum intended to rotational grazing systems (TAMELE, 2009) and cutting systems (GONTIJO et al., 2008). However, this species has been used in continuous grazing systems in Rio Grande do Sul, in areas where millet was traditionally explored. The advancement of Sudan grass in these areas is a result of high resistance of the species to water déficits, which notoriously has been occurring in some regions of the state during summer.

Although there is a wide variety of options for warm season forages with exploration potential in beef cattle production, the volume of scientific information on the behavior of cull cows regarding most of these grasses is scarce. According to SBRISSIA (2004), conceptual changes in research of the study of warm season forages are necessary and lie on the understanding of the systemic and dynamic character of the pasture ecosystem, so that the set of elements involved and their interactions are considered whenever possible.

Characteristics of warm season pastures, as the grass species used on production systems (ZANINE et al.. 2006) and the conditions related to the development stage and the plant architecture, reflect significantly in animal behavior. According to HODGSON (1990). these characteristics determine different strategies of displacement and diet selection of beef cattle under continuous grazing, which will reflect in their performances. BAGGIO et al. (2009) demonstrated that the behavior of grazing animals is an important indicator of pasture conditions, which directly makes this information an important tool for guiding management and simultaneously meets the demands of society in relation to animal welfare.

Therefore, the present study aimed to analyze the behavioral parameters and the displacement strategies of beef cows grazing Sudan grass or pearl millet.

MATERIAL AND METHODS

The experiment was developed in the Sector of Beef Cattle Production, Animal Science Department, Universidade Federal de Santa Maria. We used an experimental area of 15 ha, divided into 12 paddocks. The treatments were as follows: Millet – animals kept on continuous grazing on pearl millet pasture; and Sudan – animals kept on continuous grazing on Sudan grass pasture. Continuous grazing with variable capacity was the method used.

For the evaluation of behavioral paramenters, we used 20 Charolais x Nellore cull cows. In the beginning of the experimente, the animals presented mean live weight of 445 kg and

average age of 8 years.

For maintaining forage mass, animals were used as regulators, when necessarry. Forage mass (FM) was estimated by means of the visual estimation technique with double sampling (WILM et al., 1944), in the beginning of the grazing period and every 10 days, with 20 visual estimates and five cuts. A sample was withdrawn from each cut and, subsequently, it was homogenized and divided into two sub-samples, one of them for determining the partially dry matter content of the pasture (PDM), and the other one for manually separating structural and botanical componentes of the pasture. After botanical separation and drying of strucutral componentes of the pasture, we determined the percentage participation of leaf blades, stems, dead matter of the studied species and unwanted species. From the leaves and stem proportion we determined the leaf:stem ratio. To determine forage supply (FS). we calculated the ration of available FM by the animal weight, expressed as kg of DM/100kg of live weight/day (SOLLENBERGER et al., 2005). Green blades supply (GBS) was determined by the product of FS by the leaf blades percentage of the FM.

The evaluations of the behavioral parameters were obtained in three periods, with assessments on February 10th, 2011 (1-21), March 3rd, 2011 (22-42) and March 22nd, 2011 (43-63), taken during 24 uninterrupted hours. The experimental design was completely randomized with measures repeated in time in a 2 x 3 factorial arrangement (two treatments and three periods), with 10 replicates (animals).

The activities were recorded by trained evaluators (one evaluator for four cows), every 10 minutes, identifying the activites of grazing (G), leisure (L) or rumination (R), with the aid of a cronometer and led lanterns for nighttime

Grazing time was considered the period during which the animal searched for forage with small displacements; rumination time was considered the period in which the animal was not grazing but was chewing the food bolus regurgitated; leisure was considered the period in which the animal was not grazing or chewing. but social activities and water intake might be included.

The bite rate (BR) was determined during grazing activities, taking as much as possible of the bite rate activity, during the 24-hour evaluation with the aid of cronometers. For determining the bite rate, we considered the time spent by the animal to carry out 20 bites and then corrected it to one minute. During grazing activities, we also recorded the time and number of steps the cows needed to go through ten feeding stations. Each feeding station was identified when the animal was grazing, without moving the forelimbs, although head movements were possible.

The variables were calculated as follows: number of steps per feeding station (No. steps/st) = by the ratio of the average number of steps per station by 10; number of stations per minute (No. st/min) = 60*10/(average time to go throught ten stations); number of daily stations (No. stations/day) by the product of grazing time by No. st/min; number of steps per minute (No. steps/min) by the product of No. steps/st by No. st/min; number of steps per day (No. steps/day) by the product of grazing time by No. steps/min; bite rate per day (No. bites/day) by the product of the BR by the grazing time.

All variables were submitted to normality test by the Shapiro-Wilk test, and the following transformations were performed when necessary: No. steps between stations (1/(x)); No. steps/min (log (x)); No. st/min (log (x)); No. st/day (log (x)); number of bites/day (log (x)). Later variance analyzes and F test were performed 5% significance, using PROC MIXED (mixed models).

MIXED was used due to the nature of the repeated measures of the data (sequentially in time). This procedure provides higher ratings of covariance matrices types to be selected. The lowest AIC value was used as the information criterion for the best variance structure. Means between treatments were submitted to analysis of variance and Student "t" test at the 5% significance, using "LSMEANS". The effects of the cause of main variation (type and period) were detected as well as the interactions between them. Data analyzes were performed with the aid of the statistical package SAS version 8.01.

Tables 1 and 2 display the values observed for the productive characteristics on pasture in relation to the treatments and periods of evaluation.

Table1 – Productive characteristics of pearl millet and Sudan grass pastures

Variables	Treatments	
	Pearl Millet	Sudan Grass
DM (g/kg of GM)	222.0	233.9
CP (g/ kg de DM)	136.1	130.6
NDF (g/ kg de DM)	523.4	505.7
Forage Mass (kg of DM/ha)	1606.93	1617.47
Forage Supply (kg of DM /100kg of LW)	9.42	8.29
GBS (kg of DM /100kg of LW)	2.79	2.43
Leaf:stem relation	0.76	0.78
Indesirable species (g/kg de MS)	483.81	455.89

Table 2 – Productive characteristics of peral millet and Sudan grass pastures in relation to the evaluation periods

Variables	Periods (days)			
	1º-21º	22º-42º	43º-63º	Mean
DM (g/kg of GM)	215.6	216.5	250.4	227.5
CP (g/ kg de DM)	170.4	129.6	100.1	133.4
NDF (g/ kg de DM)	488.1	490.1	565.4	514.5
Forage Mass (kg of DM/ha)	1514.6	1748.8	1568.7	1610.7
Forage Supply (kg of DM /100kg of LW)	9.23	8.11	9.21	8.85
GBS (kg of DM /100kg of LW)	3.63	1.98	2.23	2.61
Leaf:stem relation	1.15	0.58	0.57	0.77

The following mathematical model was used for analysis of variance:

$$Y_{ijk} = \mu + T_i + R_k (T_i) + P_j + (TP)_{ij} + e_{ijk}$$

Given: Y_{ijk} is the dependent variable; μ, the measure of all the observations; T_i, the effect of the i-th dietary treatment; R_k (T_i), the effect of the k-th repetition within the i-th treatment (error a); P_j, the effect of the j-th period; $(TP)_{ij}$, the interaction between the i-th treatment and the j-th period; and e_{ijk}, the overall experimental error (error b).

RESULTS AND DISCUSSION

There was an interaction between the treatment and the period for grazing activity (Table 3). The animals showed shorter times for grazing activity during the first period of behavioral assessment on pearl millet pasture compared to the second period of the same treatment and the third period of Sudan grass treatment. The other comparisons of means, regardless of time or treatment, showed similar grazing activity time.

Table 3 – Grazing time of cull cows in finishing phase on continuous grazing on pearl millet or Sudan grass pastures

Treatments	Grazing time (minutes/day)			Mean	Standard error	Probabilidty
	Period (days)					
	1º-21º	22º-42º	43º-63º			Treat. x Per.
Pearl Millet	504[b]	587[a]	578[ab]	557	25.24	0.0395
Sudan	566[ab]	559[ab]	648[a]	591		
Mean	535	573	613			

Lowercase letters differ between lines and columns by "t" test at 5% significance.

The increase in grazing time of cows was expected to compensate the reductions in food quality and availability on pastures with the advancement of the vegetative cycle, due to the process of grass lignification, which reduces the availability and therefore the accessibility to leaf blades, confirmed by negative correlations of the variables grazing time and green blade supply and the leaf:stem ratio (r= -0.32; P=0.0127 e r= -0.38; P=0.030, respectively). According to WOODWARD (1997), as the ability of diet selection by the animals decreases, the bite rate and grazing time increase, as a compensatory mechanism of the reductions in bite size.

Besides quantitative characteristics, the qualitative characteristics, such as crude protein (CP) and neutral detergent fiber (NDF) content, can also affect the ingestive behavior of the animals (MANZANO et al.. 2007). BRÂNCIO et al. (2003) observed no correlation between grazing time of steers and quantitative traits of three cultivars of *Panicum maximum*, managed under rotational grazing; however, the authors found negative correlations between qualitative characteristics of pastures, as lignin content in the beginning of the grazing period and at the end of the pasture cycle, and crude protein and digestibility. In this study, grazing time was negatively correlated with CP content of pasture (r = -0.29, P = 0.0238), showing no correlation with NDF (r = 0.15, P = 0.2614).

Rumination and leisure times did not differ significantly between the types of pasture used in finishing cull cows (Table 4). This behavior was expected, since the productive and nutritive characteristics of the pastures were also similar for each grass species (Table 1).

Table 4 – Rumination or leisure time (minutes/day) of cull cows in finishing phase on pearl millet and Sudan grass pastures

Variables	Treatments		Standard error	P
	Pearl Millet	Sudan Grass		
Rumination	305	318	12.28	0.4526
Leisure	578	531	2.86	0.1079

Regarding evaluations of rumination and leisure times in function of evaluation periods, we verified changes in the advancement of the pasture cycle (Table 5). As discussed earlier, quantitative and qualitative characteristics of pastures increased the grazing time of the animals with the advancement of the evaluation periods. This trend increased rumination time (242, 295 and 389 minutes), and decreased leisure time (662, 565 and 435 minutes) (P <0.0001). The NDF content of pasture correlated positively with rumination time (r = 0.47, P <0.0001) and negatively with leisure time (r = -0.42, P = 0.0008). This behavior, although expected, is not desired since an increase in rumination time along with grazing time results in higher energy consumption.

Table 5 - Rumination or leisure time (minutes/day) of cull cows in finishing phase in relation to evaluation periods

Variables	Periods (days)				Standard	
	1º-21º	22º-42º	43º-63º	Mean	Error	Probability
Rumination	242^{c}	301^{b}	392^{a}	312	18.12	<0.0001
Leisure	663^{a}	566^{b}	435^{c}	555	24.57	<0.0001

Uppercase letters differ in the lines by "t" test at 5% significance.

The use of pearl millet and Sudan grass did not alter the number of feeding stations (8.69 and 8.17 per minute, respectively) and the bite rate (36.82 and 35.88 minutes, respectively) (Table 6).

The similarities between quantitative and qualitative characteristics of pastures, as well as the performance of the cows in function of the treatments (PACHECO, 2013) also apply to the variables related to behavioral parameters. Botanical composition of pastures (ARNOLD & DUDZINSKY, 1967), vegetative stage (HODGSON, 1990), and leaves availability and accessibility (ROGUET et al., 1998) are among the main characteristics that affect the feeding strategies of cattle in continuous grazing. When these characteristics show similarities the also extend to the grazing behavior (HODGSON, 1990). BRÂNCIO et al. (2003) observed similarities in feeding behavior of cattle according to the cultivar of grass species *Panicum maximum* Jacq., used for grazing, and also found few differences in the variable bite rate during four evaluation periods (June, September, November and March). AURELIO et al., (2007) found that structural changes in the pastures of Tifton 85 *(Cynodon dactylon* x *C.nlemfuensis)* or dwarf elephant grass *(Pennisetum purpureum* cv.Mott) determine changes in the number of feeding stations per minute for dairy cows; however, these differences did not extend to the number of bites per minute.

The number of steps per minute, number of stations per minute and number of stations per day were higher in the first period of evaluation (8.8, 10.9 and 4780, respectively) compared to the second (6.1, 8.0 and 3445, respectively) and third evaluation periods (5.2, 6.4 and 3176, respectively) (Table 7). These variables were similar in the last two periods. The number of steps between feeding stations (1.24, 1.30 and 1.27) was similar (P = 0.8578) among the evaluation periods.

Table 6 – Displacement and consumption strategies of cull cows in the finishing phase on Sudan grass or pearl millet pastures

Variables	Treatments		Standard error	P
	Pearl Millet	Sudan Grass		
No. steps /minute	6.61	6.76	0.47	0.9070
No. steps between stations	1.32	1.23	0.06	0.2992
No. stations /minute	8.69	8.17	0.74	0.6706
No. stations /day	3626	3975	296.33	0.4732
Bite rate /minute	36.82	35.88	1.53	0.6698
Bite rate /day	20820	21426	1036	0.6174

The trends observed for the number of steps between the feeding stations and the number of feeding stations/min do not support what is reported in the literature. In the present study, blades supply and the relation leaf:stem were higher in the first evaluation period, followed by drastic reductions in subsequent periods (Table 2). This behavior would lead to a greater number of steps between feeding stations (PALHANO et al., 2006; TEIXEIRA et al., 2010) and of feeding stations visited (PALHANO et al., 2006; BAGGIO et al., 2009).

According to BAGGIO et al. (2009), the permanence time at a feeding station is related to forage abundance, so that the greater the forage supply at the feeding station, the longer the permanence time. These authors added that, although there were no differences for the number of steps, they verified that the variable was negatively correlated with forage supply (r = -0.57; P = 0.0033). This strategy allows the animal to better assess the food environment available, providing more time for search of better grazing sites (ROGUET et al., 1998). A possible explanation for the similarity in the number of steps between feeding stations and the reduction in the number of steps and feeding stations/minute with the advencement of the evaluation period, in this study, is the increase in the participation of the invasive species Alexander grass (*Urochloa plantaginea*), which showed greater participation in the botanical composition of unwanted species in the pasture (PACHECO, 2013), and the decrease of leaf blades supply.

Possibly, the changes in the botanical composition of pastures reflected in reductions in bite depth and volume due to growth habit of Alexander grass (caespitose prostate) (PACHECO, 2013) and the reduced leaf participation in the structural composition of the pastures. This caused the animals to compensate reduction in bite volume by increasing the bite rate (Table 7), affecting the time spent searching better grazing stations due to the need to maintain the level of forage intake, since the selection opportunities in this situation were limited. REGO et al. (2006) demonstrated that the instantaneous intake rate on warm season grazing is enhanced by the greater grass height; however, the authors suggested that the bite characteristics are affected by the pasture structure. These authors demonstrated that legume exclusive pastures, with different growth habits, increase the bite rate and shorten bite manipulation time, while grazing on warm season grass exclusive pastures increases intake per bite. The correlation coefficients between the number of steps per minute and unwanted species, leaf blade supply and leaf:stem ratio showed the following values: r = -0.45 (P = 0.0003); r = 0.25 (P = 0.06) and r = 0.23 (P = 0.08), respectively, while the correlations regarding the number of stations per minute were r = -0.39 (P = 0.0021); r = 0.29 (0.0233) and r = 0.29 (P = 0.0228), respectively.

Table 7 – Displacement and consumption strategies of cull cows in the finishing phase in relation to evaluation periods

Variables	Periods (days)			Mean	Standard error	P
	1º-21º	22º-42º	43º-63º			
No. steps /minute	8.8[a]	6.1[b]	5.2[b]	6.7	0.50	<0.0001
No. steps between stations	1.24	1.30	1.27	1.27	0.07	0.8413
No. stations /minute	10.9[a]	8.0[b]	6.4[b]	8.43	1.17	0.0005
No. stations /day	4780[a]	3445[b]	3176[b]	3800	344	0.0097
Bite rate /minute	26.08[c]	35.56[b]	47.41[a]	36.35	1.43	<0.0001
Bite rate /day	13791[c]	20507[b]	29070[a]	21123	1073.33	<0.0001

Lowercase letters differ in the lines by "t" test at 5% significance.

The bite rate per minute (26.08; 35.56 and 47.41) and the number of bites per day (13,791; 20,507 and 29,070) increased (P <0.0001) with the advancement of periods. The lowest values of bite rate in the first period can be associated with the increased availability of leaf canopies in pastures. TEIXEIRA et al. (2011) showed that, in pastures with plenty of forage, the bite rate can be reduced since the animal can increase the bite depth and volume and therefore decrease the bite rate.

With the advancement of periods and consequent reduction in leaf blades supply, and possible reduction in the bite volume, there was a gradual increase in bite rate, so that this strategy would act as a compensatory activity to a possible reduction in bite volume, aiming at maintaining the level of forage intake, as discussed previously. This behavior explained by a negative correlation between bite rate/minute (r = -0.28 and P = 0.029; r = -0.36 and P = 0.0048, respectively) and bite rate/day (r = -0.32 and P = 0.0116; r = -0.43 and P = 0.0006, respectively) with leaf blades supply and leaf:stem ratio. However, it is noteworthy that the strategy of increasing the number of bites per minute to compensate the reduction in bite volume results in increased energy waste per unit of dry matter intake (UNGAR et al., 1991). A larger bite volume is more advantageous to the animal due to lower energy waste per kg of DM intake.

CONCLUSION

The use of pearl millet or Sudan grass pastures does not alter behavioral parameters and displacement and feeding strategies of cull cows. However, the vegetative cycle changes feedind and intake strategies, which, in turn, are closely associated with the productive characteristics of the pastures.

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Protocolado em: 09 abr 2013 Aceito em: 04 jun 2013