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Ingestive behavior of Angus yearling steers in natural grassland subjected to fertilization and over sown of temperate species

Denise Adelaide Gomes Elejalde[1], Carlos Nabinger[2], Eduardo Tonet Ferreira[2], Aline Kellermann de Freitas[2], Regis Luis Missio[1], Taíse Robinson Kunrath[3], Thais Devincenzi[4], Raquel Rolim Cardoso[2], Cassiano Eduardo Pinto[5], Marcelo Fett Pinto[2], Viviane Borba Ferrari[6]

[1]Federal Technological University of Paraná/UTFPR, Pato Branco, PR, Brasil
[2]Federal University of Rio Grande do Sul/UFRGS, Porto Alegre, RS, Brasil
[3]Institute of Zootechnics of the Government of the State of São Paulo, Nova Odessa, SP, Brasil
[4]National Institute for Agricultural Research/INIA, Tacuarembó, Uruguay
[5]Santa Catarina Agricultural Research and Rural Extension Company/EPAGRI, Lages, SC, Brasil
[6]University of São Paulo, Pirassununga, SP, Brasil

***Corresponding author: denise.elejalde@gmail.com**

Abstract

The objective was to evaluate the ingestive behavior of Angus yearling steers grazing natural grasslands of Southern Brazil, submitted or not to the application of fertilizers: NG= natural grassland; FNG= fertilized natural grassland, and FONG= fertilized natural grassland improved with the over sown of temperate forage species. Three Angus yearling steers and a variable number of put-and-take animals were used per experimental unit, to maintain a forage allowance of 13 kg of dry matter/100 kg of body weight. Ingestive behavior of tester animals was visually assessed in four seasons of the year through instantaneous records of activity every ten minutes during the daytime period. There was no effect of pasture treatments on ingestive behavior. An interaction between seasons and periods of the day was observed for daily grazing and rumination time (P <0.05). The grazing activities were clustered at the beginning and the end of the day in summer, autumn and winter, while in spring it was similar in the 1st three quarters of the day, with higher activity in the period close to sunset. The animals spent more time grazing in the spring despite the better quality of forage in this season. Regardless of the season, longer residence and grazing time were found in water foci areas. We conclude that grazing time on natural pastures is influenced by forage mass and forage allowance, and bite rate is influenced by the chemical composition of the sward.

Keywords: bite rate, forage accumulation rate, grazing time, green forage mass, *Lolium multiflorum*, rumination time.
Abbreviations: BR_ Bite Rate; DGT_ Diurnal grazing time; DM_ Duration of meals; DMI_ Duration of meal intervals; DRT_ Diurnal rumination time; DTO_ Diurnal time in other activities; FA_ Forage allowance; FAR_ Forage accumulation rate; FNG_ fertilized natural grassland; FM_ Forage mass; FONG_ Fertilized natural grassland improved with over sown of temperate forage species; HAR_ Herbage accumulation rate; IT_ Inter-tussock; IVDOM_ *in vitro* digestibility of organic matter; NFC_ Non-fibrous carbohydrate; NG_ Natural grassland; NM_ Number of meals; NMI_ Number of meal intervals; SH_ Sward height.

Introduction

Natural grasslands are a complex issue due to their huge floristic diversity. The grasslands of Rio Grande do Sul, Southern Brazil, have about 600 species of *Asteraceae*, 150 legumes and 400-523 species of grasses (Boldrini, 1997; Longui-Wagner, 2003), as well as species of *Cyperaceae* and *Juncaceae* (among others) that are highly consumed, regardless of forage allowance (Thurow et al., 2009). This vast richness of this pastoral ecosystem is unique, and a result of edaphic, climatic, geographic, and anthropic effects. Human interventions, such as fertilization and the introduction of temperate species, modify the pastoral environment. For example, Gomes et al. (2002) found that liming and fertilization of natural grassland of Southern Brazil increased the relative frequency of 23 species. C4 species predominate in these natural grasslands. Hence, another common intervention associated with fertilization is to over sown temperate pastures, such as Italian ryegrass, clovers, and birdsfoot trefoil. The consequence is an increase in floristic complexity and a challenge for grazing management.

In heterogeneous pastures, where the animal has the opportunity to express higher levels of selectivity, the most palatable plants may have a higher frequency and/or intensity of defoliation (Stuth, 1991). According to Modesto et al. (2004), the grazing animal is influenced by many factors that can affect herbage intake. Selective grazing can compensate for low quality forage allowance, allowing the intake of more nutritive plant parts. However, the selective behavior entails an increase in the grazing time (Santana Jr. et al., 2010), which may limit the daily herbage intake. According to Gonçalves et al. (2009), both cattle and sheep

try to maximize herbage intake and reduce energy expenditure by minimizing displacement in the grazing site.
The effects of the complexity of natural grasslands on ingestive behavior are not completely understood. Investigate how and what animals select in this environment is important for the development of management strategies to support animal production and its feasibility on natural grasslands. Therefore, the aim of this study was to evaluate the ingestive behavior of steers grazing the typical natural grassland of the region of Campanha, Rio Grande do Sul, submitted to fertilization and introduction of temperate species.

Results and Discussion

Diurnal grazing time and bite rate

No interaction between season and treatment (P>0.05) was observed for any behavioral activity, which shows that animals adjust their behavior according to the conditions presented to them. In all treatments, animals kept a similar repertoire of activities (P>0.05). Only the diurnal grazing time (DGT) and bite rate showed significant seasoning differences (Table 3).
The rumination time represented 20.7 ± 5.4% of daytime activities, other activities representing 13.1 ± 7.0%. The animals performed 3.7 ± 0.9 meals with a duration of 155 ± 50.4 minutes at a rate of 46.8 bites/minute. The interval between meals was 116.3 ± 90.5 minutes. The daily grazing time was within the normal range of 9 hours. Hodgson et al. (1994) argue that the grazing time is usually eight hours, reaching up to 16 hours in extreme situations. According to Poppi et al. (1987), grazing time rarely exceeds 12 to 13 hours. Beyond that, it can interfere in rumination activity and other behavioral requirements. Thurow et al. (2009), studying levels of forage allowance on steers grazing natural grassland, reported 70% of diurnal grazing, which represents 10 hours of grazing. Prates et al. (1995) observed 75.4% of diurnal and 24.6% of nocturnal grazing, corresponding respectively to 7.15 and 2.27 hours for steers grazing native improved grassland.
The animals spent more time grazing in spring than in summer (Table 3), other seasons being intermediate. Generally, animals behaving increases in grazing time also experience higher bite rates. Both mechanisms are typical of animals trying to increase herbage intake, which was observed in this study. For Elejalde et al. (2005), the variation in bite rate is used to compensate for structural changes in the pasture, being negatively correlated with sward height and leaf:stem ratio. Ungar et al. (1991) and Gonçalves et al. (2009) stated that higher bite rates indicate smaller bite masses being gathered by the grazing animal. However, there was no correlation (P>0.05) between sward height and bite rate in this study. Unlike the homogeneous area evaluated by Gonçalves et al. (2009), the structure of the sward evaluated in this study was heterogeneous.
The variation of DGT and bite rate between the seasons is probably related to the species composition, as well as the diet selected by the animals. The crude protein (CP) was positively correlated (r=0.52, *P*=0.0011) with the bite rate, while the neutral detergent fiber (NDF) was negatively correlated (r=-0.59, *P*=0.0002). Therefore, the animals search to meet their energy requirements, either through adjustments in the repertoire of activities or through higher grazing selectivity.
Mature cattle under restrictive grazing conditions performs about 65 bites/min (Delagarde et al., 2001), and about half in favorable grazing conditions. In this study, the grazing conditions were intermediate since the animals performed 46.8 bites/min. Pardo et al. (2003) observed that calves in natural grasslands performed 50 bites/min, which is similar to our observations. Approximately 84 ± 17% of the bite rate assessments were observed in the inter-tussock (IT) stratum, demonstrating the preference of grazing animals by young leaves, with lower fiber content. This preference for IT stratum and avoidance of tussock less palatable species (Bremm et al., 2012) generates a mosaic structure, which in turn affects displacement patterns and forage searching (Gonçalves et al., 2009). The increase of the IT stratum height is a linear response of a decreasing grazing time (Thurrow et al., 2009, Pinto et al., 2007).

Diurnal rumination time and meals

The diurnal rumination time (DRT) did not differ among seasons, indicating animals harvested forage of similar quality. Confortin et al. (2010) made the same inference studying the ingestive behavior of supplemented lambs grazing pearl millet (*Pennisetum glaucum* L.). Rumination time determines the maximum grazing time, given by the relationship between the forage intake and forage digestion rates (Searle et al., 2007). Another reason to agree with Confortin et al. (2010) was the absence of correlation of DRT with sward characteristics and chemical composition of forage apparently consumed by animals presented in Elejalde et al. (2012). According to Van Soest (1994), the physical and chemical properties of the diet influence the rumination activity, which would be proportional to the forage cell wall content.
The seasons did not affect the number of meals and meal intervals as well as the meal and meal interval duration. The meal intervals showed correlations with DRT (r=0.56, *P*=0.0004) and herbage mass (r=0.58, *P*=0.0002) (Elejalde et al., 2012). In this study, the animals had three diurnal meals, lasting 2.6 hours on the average and 2-hour intervals between meals. High meal duration denotes forage restriction, where the animal tries to compensate for the intake requirements through longer meals. According to Mezzalira (2009), animals in higher forage allowance increase the number of meals and decrease the duration of each meal. Thus, this condition leads to shorter meals which can last only 40 minutes, and a greater number of meals reaching 6-8 meals leading the animal to satiety (Carvalho & Moraes, 2005).
The duration of meals and intervals can be explained by the assessment used. Mezzalira et al. (2009) stated that when the objective is specifically to describe meal dynamics, it is essential to adopt intervals of five minutes between visual observations. The longer the observation interval, the higher is the overestimation of meal duration. They also stated that a 10-minute interval overestimates in 20 minutes the meal duration compared to 5-minute. This difference in records could have contributed to the lack of responses that we observed.
Table 4 shows the effect of periods of day and seasons on the time percentage of each period used for DGT and DRT. There was an interaction between periods of the day and seasons for DGT and DRT (Table 4).
The animals concentrated their grazing at the beginning and the end of the day in summer, autumn, and winter. In spring it was similar in the first three periods and at the end of the day, the animals grazed for a longer time (Table 4). Van Rees & Hutson (1983) and Hodgson et al. (1994) found that animals grazed more intensely in the cooler hours of the

day, which are early in the morning and at the end of the afternoon. The DGT did not differ between seasons in the 1st, 2nd, and 4th period of the day. In summer and autumn, the animals grazed for less time in the 3rd period of the day. Penning et al. (1991) reported preferential consumption about four hours before sunset, relating this to the saccharose content in leaves of grasses at this period of the day. Studying the enzyme activity of sucrose catabolism in *Hymenaea courbaril* L. throughout the day, Molle et al. (2009) found that the carbohydrate concentration remains low throughout the day and increases only at the end of the day (6 p.m.). The authors noticed a peak of no hydrolysis enzyme activity, which would allow for an increase in sucrose concentration in the metaphyll observed between 6:00 p.m. and 0h00. In summer and autumn, the animals expressed rumination time in the 2nd and 3rd periods of the day. Since grazing and rumination are mutually exclusive activities, the animals probably ruminated for longer in these periods due to the intensity of sunlight and warm temperatures recorded (summer 27.0 and 34.6 º C; autumn 18.2 and 24.5 º C, respectively for summer and autumn). Thus, the animals sought to refuge under shade (Table 6) and ruminate during these more harsh periods, allocating grazing activities to the beginning and the end of the day, as evidenced by the literature (e.g., Van Rees & Hutson, 1983; Hodgson et al. 1994). In winter and spring, the animals allocated rumination time more evenly between the first three periods of the day, ruminating a shorter time at the end of the day. The DRT did not differ between seasons in the 2nd and 4th period of the day (P>0.05). During the winter and spring, animals ruminated for longer in the 2nd period and less in the 4th period of the day. In this study, the animals ruminated 2.7 hours during the day, so most of the ruminating must have occurred at night. The rumination activity in mature animals takes around eight hours a day variating between four and nine hours, divided into 15 to 20 periods (Fraser, 1980; Van Soest, 1994) and mainly observed at the night (Bremm et al., 2005), although after each grazing period a short period of rumination is observed.

Vegetation areas visited

Table 5 shows the residence of animals in the vegetation areas of natural grassland under fertilization and over sown with temperate species. There were no interactions between treatments and seasons for vegetation areas visited by animals (*P*>0.05). The seasons did not affect the residence and grazing time in different vegetation areas (P>0.05). The treatments influenced the grazing time under shade (*P*<0.05). There were differences between vegetation areas for residence time and grazing time (Table 5). The relationship between residence time and grazing time on vegetation areas was 73.6, 74.7, 34.0, and 51.5% for Wet Lowland, Drained Lowland + Slope, Shade, and Top, respectively.

The animals grazed during 69% of the daytime in the natural grassland treatment (NG). Animals grazing fertilized natural grassland (FNG) and the same improved with fertilization and over sown of temperate species (FONG) remained grazing during 67.6% and 60.5% of the period, respectively. Animals in NG remained under shade for 45.6% of the whole period, while the animals of FNG and FONG grazed 17.6 and 32.9% of the time under shade (Table 5). It is known that animals seek shade during the hottest hours of the day (Bennett et al., 1985). However, Paranhos Costa & Cromberg (1997) reported the need for shade as circumstantial, so a general rule of when and how offering shade to animals is difficult to address. For example, Possa (1989) found differences among breeds, among animals within a breed, and between days of observation, which led to significant variation in the intensity and distribution of shade use. In Angus breed, 35.8% of the time that animals were under shade occurred before 10:00 a.m. and after 2:00 p.m., out of the hottest period of the day. Nellore breed animals in the same periods spent even more time under shade (66.6%). Paranhos da Costa & Cromberg (1997) observed Nellore, Gir, and Caracu breeds in high shade availability areas (12%) and reported a wide variation in the search of shade (occupying from 3.77% to 39.9% of total time).

Table 6 shows the percentage of diurnal grazing time in different periods of the day. The distribution of DGT in different areas of vegetation in different periods of the day showed no interactions with seasons and treatments (*P*>0.05). Animals sought shade during most of the day, even in times of low solar radiation.

Differences between periods of the day for grazing time in the Wet Lowland and Drained Lowland + Slope were observed (Table 6). The water in lowland area would enable the animal the opportunity to distribute the grazing time more evenly. In the Drained lowland + Slope this activity was concentrated at sunrise and sunset. Beede & Collier (1986) reported water as one of the most important nutrients, particularly for animals raised in warm climates, as it has an effect on thermal comfort by direct cooling.

Multiple regressions

Multiple regressions were performed (Table 7) to verify which sward variables and chemical composition (Elejalde et al., 2012) would better explain the ingestive behavior of grazing steers. The DGT was best explained by the forage allowance (FA) and forage accumulation rate (FAR), which explained 81% of this activity. The FAR expresses fresh biomass, whereas FA expresses the amount of forage that is available for selection. Hence, the combined variables suggest the availability of young green leaves determining DGT. Pinto et al. (2007) reported grazing time being more dependent on the sward height of the inter-tussock stratum than forage allowance and forage mass, indicating that the effect of sward height could not prevail depending on the range of forage mass presented to the grazing animals. In fact, Trindade et al. (2012) noticed that regardless of forage allowance and the season, the lowest values of grazing time were associated with sward structures with forage mass between 1,400 and 2,200 kg DM/ha and sward height between 8 and 13 cm. In this study, there was an interaction between seasons and treatments for forage mass and pasture height (Elejalde et al., 2012). The forage allowance was 14.6% of body weight (*P*>0.05), corresponding to sward heights of 13.2; 8.5; 10.3; 8.7 cm and forage masses of 2,357; 1,371; 1,346 and 1,179 kg DM/ha, respectively for summer, autumn, winter, and spring. According to Table 3, the lowest percentages of DGT occurred in the summer, within the range of forage mass and sward height similar to those observed by Trindade et al. (2012). The variables that composed the model and explained 91% of the activity were: bite rate (BR), forage mass (FM), diurnal time of other activities (DTO), non-fibrous carbohydrates (NFC), sward height (SH), and percentage of bite rate in the upper stratum (ES). The sward height has an important effect on the accessibility of forage to the animals, so very low swards may restrict intake by forage capture constraints.

Table 1. Temperature recorded near the experiment on the days of ingestive behavior evaluation.

Climate data	Seasons			
	Summer (10/01)	Autumn (19/04)	Winter (15/08)	Spring (29/10)
Maximum temperature (T ºC)	37.8	28.9	18.9	26.9
Minimum temperature (T ºC)	20.4	15.6	12.4	17.7
Average temperature (T ºC)	29.1	22.3	15.7	22.3

INMET - Automatic Station of Quaraí – RS.

Table 2. Percentage of vegetation areas in the experimental units and locations where sampling units were fixed.

Block	ExperimentalUnit[1]	Percentage of each vegetation area		
		Drained lowland + Slope (A1)	Wet Lowland (A2)	Top (A3)
1	NG	75%	15%	10%
	FNG	80%	15%	5%
	FONG	90%	10%	2%
2	NG	80%	20%	-
	FNG	65%	35%	-
	FONG	75%	25%	-
3	NG	75%	25%	-
	FNG	80%	20%	-
	FONG	85%	15%	-

[1]NG= natural grassland; FNG= fertilized natural grassland and FONG= fertilized natural grassland improved with over sown of temperate forage species.

Table 3. Percentage of daily grazing time and bite rate as function of seasons.

Varibles	Seasons				
	Summer	Autumn	Winter	Spring	P
DGT (%)[1]	60.7 B	63.2 AB	66.7 AB	72.5 A	0.0318
BR (bites/min)[2]	41.8 B	44.9 AB	50.6 A	49.8 A	0.0477

Means followed by different letters in line differ by Student test (P<0.05). [1]Diurnal grazing time; [2]Bite Rate.

Table 4. Periods of day and seasons effect on percentage time of each period used for diurnal grazing time (DGT) and diurnal rumination time (DRT) of steers in natural pasture under fertilization and over sown with temperate species.

Periods	Seasons			
	Summer	Autumn	Winter	Spring
DGT (%)[1]				
6:50 to 10:00	80.2 A a	83.2 A a	69.7 AB a	69.7 B a
10:10 to 13:00	48.5 B a	57.2 B a	50.8 B a	64.9 B a
13:10 to 16:00	28.4 B bc	16.2 C c	50.3 B ab	59.3 B a
16:10 to 19:00	79.1 A a	84.6 A a	81.7 A a	91.6 A a
DRT (%)[2]				
6:50 to 10:00	2.9 B b	4.7 C b	19.2 A a	17.2 AB a
10:10 to 13:00	37.5 A a	32.1 B a	27.8 A a	30.6 A a
13:10 to 16:00	46.5 A ab	57.0 A a	26.6 A b	25.3 AB b
16:10 to 19:00	11.7 B a	6.2 C a	6.1 B a	8.9 B a

Means followed by same capital letters, in column, and lowercase letters, in line, do not differ by Student test at 5% significance. [1]($P = 0.0347$); [2] ($P = 0.0028$).

Table 5. Permanence of animals in the vegetation areas of natural grassland under fertilization and over sown with temperate species.

Treatments[1]	Vegetation areas			
	Wet Lowland	Drained Lowland + Slope	Shade	Top
	Percentage of permanence time in the vegetation areas [2]			
NG	25.9	39.8	22.6	11.7
FNG	36.2	39.2	15.3	9.3
FONG	39.0	43.6	8.8	8.6
Mean	33.7 A	40.8 A	15.6 B	9.9 B
	Percentage of grazing time in the vegetation areas [3]			
NG	20.5	32.5	10.3 a	5.7
FNG	27.6	31.5	2.7 b	5.8
FONG	26.2	27.7	2.9 b	3.7
Mean	24.8 A	30.5 A	5.3 B	5.1B

Means followed by different capital letters in the line differ by Student test at 5% significance.
[1]NG= natural grassland; FNG= fertilized natural grassland and FONG= fertilized natural grassland improved with the over sown of temperate forage species.
[2]$P = 0.0017$; [3]$P < 0.0001$

Table 6. Percentage of diurnal grazing time of animals in the vegetation areas of natural grassland in different periods of the day.

Periods	Vegetation areas			
	Wet lowland[1]	Drained lowland + Slope[2]	Shade	Top
Percentage of diurnal grazing time in vegetation areas				
6:50 a.m. to 10:00 a.m.	31.6 A	30.9 AB	2.9	4.4
10:10 a.m. to 1:00 p.m.	21.9 AB	23.8 B	6.6	1.3
1:10 p.m. to 4:00 p.m.	15.4 B	17.0 B	7.0	0.1
4:10 p.m. to 7:00 p.m.	31.0 A	45.5 A	4.9	1.4

Means followed by different letters in column differ by Student test (P<0.05). [1]P= 0.0339, [2]P = 0.0022.

Table 7. Selected variables by multiple regression model for ingestive behavior: sward characteristics x chemical composition.

Variables[1]	Parcial R²	Model R²	P value
Diurnal grazing time[2]			
FA	0.64	0.64	<0.0001
FAR	0.16	0.81	<0.0001
Diurnal rumination time[3]			
BR	0.48	0.48	<0.0001
FM	0.12	0.59	0.0043
DTO	0.10	0.70	0.0022
NFC	0.14	0.84	<0.0001
SH	0.04	0.88	0.0045
TS	0.03	0.91	0.0039
Diurnal time in other activities[4]			
FM	0.34	0.34	0.0002
Bite rate[5]			
DRT	0.48	0.48	<0.0001
DTO	0.06	0.54	0.0417
NFC	0.15	0.69	0.0004
FAR	0.16	0.85	<0.0001
IVDOM	0.03	0.88	0.0159

[1]FA= forage allowance; FAR= Forage accumulation rate; BR= Bite Rate; FM= forage mass; DTO= Diurnal time in other activities; NFC= Non-fibrous carbohydrate; SH= sward height; TS= Tussock stratum; DRT= diurnal rumination time; IVDOM= *in vitro* digestibility of organic matter.
Regression model: [2]GT= 3.49 – 0.0908 FAR + 0.0088 FA [3]DRT= 212.58 + 1.8015 FM – 4.3186 SH + 10.1086 NFC – 1.3774 BR – 1.1063 DTO – 0.9621 TS [4]DTO= 85.5182 + 0.5018 FM
[5]BR= - 21.4646 + 1.3739 FAR – 6.8490 IVDOM + 7.9141 NFC – 0.6030 DRT – 0.6606 DTO

On the other hand, very high swards may restrict intake by longer time spent to bite formation (Carvalho et al. 2001). This positive relationship between sward height/forage allowance and bite mass/intake is known as the functional response (Hodgson, 1990). Gonçalves et al. (2009) observed that beyond a sward height of 11.4 cm, the bite depth of heifers grazing natural grasslands was not able to compensate for the low density in the upper stratum.
The DTO explained 10% of DRT. The lower the bite rate, as a percentage of bites in tussocks, the longer was the DRT, composing 51% of the explanation of this activity. For DTO, the only explanatory variable was green forage that explained 34% of the activity. The bite rate was 88% explained by the DRT, DTO, non-fibrous carbohydrates (NFC), herbage accumulation rate (HAR), and *in vitro* digestibility of organic matter (IVDOM). The decrease in time of other activities and rumination explained 54% of the bite rate. The increase in forage accumulation represents an increase of preferred fresh forage because it has a higher content of rapid degradation carbohydrates that may increase the bite rate, as shown by the regression model. The decrease in IVDOM caused an increase in bite rate.

Materials and Methods

Location, soil and climatic characteristics and establishment management

The experiment was performed in Cantagalo Farm, located in the city of Quaraí, physiographic region Campaign of Rio Grande do Sul, Brazil (30º16'12.51" South, 55º 50'50.71" W). According to Köeppen classification, the climate is mesothermal, subtropical type, Cfa 2 class. Table 1 shows the temperature recorded close to the experiment on days of ingestive behavior evaluation. The soil is classified as Orthic Vertisol Ebony Chernosol (Embrapa, 2006), with the following characteristics: pH 5.5, 7.1% organic matter, 5.8 mg/dm³ of phosphorus, 104 mg/dm³ potassium, 81.6% saturation of bases, and the absence of Al. According to Boldrini et al. (2010), the natural grassland of the region of Campanha of Rio Grande do Sul has a predominance of C4 species. However, C3 species are better represented in this region than in other regions of Southern Brazil.
On April 4th, 2007, FNG treatment was applied with 200 kg of diammonium phosphate per ha (DAP: 18-45-00) and in September 200 kg/ha of urea (45-00-00) was applied. The FONG treatment received the same levels of fertilization in the same periods of FNG treatment, adding the over sown with temperate species in line during the first fertilization. The species used were *Lolium multiflorum* Lam, *Lotus corniculatus* cv. St. Gabriel and *Trifolium repens* cv. Lucero with seeding densities of 30, 8 and 3 kg/ha of seeds, respectively. The animals started grazing on July 7th, 2007. In 2008, the experimental units were mowed (February 15th to 27th), being performed the application of 100 kg/ha of DAP in April, totaling 144 kg/ha of N, and 135 kg/ha of P_2O_5 and performed the over sown of ryegrass (20 kg/ha of seeds). The animals remained in continuous stocking with put-and-take stocking to maintain the daily forage allowance of around 13 kg of dry matter /100 kg of body weight (BW), as recommended by Maraschin (2001). Angus breed yearling

steers were used, with nine months old and average of 233 kg BW, being four test animals per experimental unit and a variable number of put-and-take animals, according to Mott & Lucas (1952).

Areas with distinct vegetation inside the experimental units were chosen for the allocation of fixed sampling frames for the phytosociological assessment. In the area named as "drained lowland + slope" there was predominance of *Andropogon lateralis* (25.7%), *Lolium multiflorum* (5%), *Paspalum vaginatum* (4.2%) and *Paspalum pauciciliatum* (3.4%). In "Wet Lowland" there was predominance of *Andropogon lateralis* (20.2%), *Eleocharis dunensis* (4.4%), *Eleocharis viridans* (3.5%), and *Lolium multiflorum* (3.2%). In the area classified as "Top" there was predominance of *Piptochaetium montevidense* (14.2%), *Paspalum notatum* (11.7%), *Stenachaenium campestre* (8.6%), and *Andropogon lateralis* (6.9%). The percentages express the average coverage of species during the seasons. The vegetation measurements were conducted in summer, winter, and spring, in the months of January, August, and October 2008, respectively. During the evaluations of ingestive behavior, the evaluators while recording the animal activity also assessed which area of vegetation they were at that moment. Besides the predetermined areas to study the vegetation (Table 2), and just concerning ingestive behavior, we included the area "Shadow" to characterize a foci area.

Studied variables

Ingestive behavior measurements were carried out after phytosociological and floristic evaluations. Visual assessments were performed at regular intervals of ten minutes, from sunrise to sunset, according to Hughes & Reid (1951). The observers were previously trained and allocated to each experimental unit using binoculars. The test animals were numbered with aluminum paint on both sides of the thoracic region.

Since daytime varies between the seasons of the year, to compare treatments, the time of each activity was standardized as a percentage of the total time measured. The daily average time measured was 870 minutes on January 10th (summer), 740 minutes on April 19th (autumn), 720 minutes on August 15th (winter), and 830 minutes on October 29th, 2008 (spring). To evaluate the distribution of time spent in different activities throughout the day, the trial was divided in four periods as follows: 6:50 a.m. to 10:00 a.m., 10:10 a.m. to 1:00 p.m., 1:10 p.m. to 4:00 p.m., 4:10 p.m. to 7:00 a.m.

The activities of each animal test were classified as diurnal grazing time (DGT) – searching activity, selection and harvesting of forage, including short periods used to displacement to select the diet (Hancock, 1953); diurnal rumination time (DRT) - the period in which the animal is chewing the bolus returned from the rumen, and diurnal time of other activities (DTO) – a period in which the animal was socially interacting, displacing, resting or drinking water (Forbes, 1988). During the same periods of ingestive behavior evaluation, when the animals were grazing, the bite rate (BR) was recorded, estimated by the time spent by an animal to take 20 bites (Hodgson, 1982).

The number of meals (NM), the duration of meals (DM), the number of meal intervals (NMI) and duration of meal intervals (DMI) were obtained by controlling the grazing time (Penning & Rutter, 2004). The meal was defined as at least 20 consecutive minutes in the grazing process. A minimum break of 20 minutes in the grazing process was considered a meal interval.

Experimental design and statistical analyses

The experimental design was a randomized block due to the prevailing topography (slope, semi-slope and lowland). The experimental area of 49 ha was divided into three blocks and the following treatments were applied with three replicates: NG= natural grassland (control); FNG= fertilized natural grassland, and FONG= fertilized natural grassland improved with over sown of temperate forage species. Once satisfied with the assumptions of normality and homogeneity of variances, data were submitted to analysis of variance (ANOVA) and Pearson correlation at 5% of significance. The analysis of variance was performed using the MIXED procedure (Littel et al., 1996) of statistical software SAS *Statistical Analysis System* v. 8.02 (SAS, 2001), using the seasons as repeated measurements over time according to Gutzwiller & Riffel (2007). The treatment means were compared by Student test (Pdiff) at 5% of significance. Multiple regressions were performed by STEPWISE procedure (SAS, 2001) for variables of ingestive behavior with the chemical composition of the forage apparently consumed (Elejalde et al., 2012) and the pasture characteristics described in Ferreira et al. (2011). The general model concerning the analysis of the variables studied was represented by: $Y_{ijk} = \mu + B_i + T_j + P_k + TP_{jk} + E_{ij}$, where: Y_{ijk}= dependent variables, μ = mean of all observations, B_i = i block effect, T_j= j treatment effect (fertilizer levels), P_k= k period effect (seasons); TP_{jk}= j treatment x k period interaction; E_{ij}= random error associated with each j observation. When the periods and grazing areas were studied, they were included in the model as a factor, as well as their interactions with other factors.

Conclusions

The fertilizer levels applied does not modify the ingestive behavior of steers in natural grasslands of Southern Brazil. The grazing activities are influenced by the seasons, shade, water availability, and species composition. The time spent grazing on natural pastures is influenced by the forage mass and forage allowance. The bite rate is influenced by the chemical composition of the sward and forage accumulation.

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