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Ingestive behavior of hoggets given different types of supplement on ryegrass pasture

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ABSTRACT. The ingestive behavior of hoggets was assessed under intermittent grazing method with three days of paddock occupation. These animals remained exclusively on Italian ryegrass (*Lolium multiflorum* Lam) pasture or on ryegrass pasture and receiving 1.2% of DM in relation to body weight of rice paddy, corn grain or whole rice bran as a supplement during the vegetative, pre-flowering and flowering phenological stages of ryegrass. The experimental design was a randomized split-split plots wherein the types of supplement were considered as main plot, phenological stages as subplot and the days of occupation as sub-subplots. The hoggets grazed for a longer time when kept exclusively on ryegrass pasture. The hoggets grazed for less time in the vegetative stage of ryegrass and on the third day of paddock occupation. Feeding behavior of hoggets is changed when supplementation is provided in different phenological stages of the grass and days of paddock occupation.

Keywords: rice bran, rice grain, corn grain, bite rate, grazing time.

Comportamento ingestivo de borregas recebendo diferentes tipos de suplemento em pastagem de azevém

RESUMO. Em método intermitente de pastejo, com três dias de ocupação dos piquetes, foi avaliado o comportamento ingestivo de borregas. Esses animais permaneceram em pastagem exclusiva de azevém (*Lolium multiflorum* Lam.) ou em pastagem de azevém recebendo 1,2% de MS em relação ao peso corporal de grão de arroz em casca, grão de milho moído ou farelo de arroz integral como suplemento durante os estádios fenológicos vegetativo, pré-florescimento e florescimento do azevém. O delineamento experimental foi o inteiramente casualizado em parcelas sub-subdivididas, sendo considerados os tipos de suplemento como parcelas principais, os estádios fenológicos como subparcelas e os dias de ocupação como sub-subparcelas. As borregas pastejaram por maior tempo quando permaneceram exclusivamente em azevém. As borregas pastejaram por menor tempo no estádio vegetativo do azevém e no terceiro dia de ocupação dos piquetes. O comportamento ingestivo de borregas é alterado quando é fornecido suplemento nos diferentes estádios fenológicos do pasto e nos dias de ocupação dos piquetes.

Palavras-chave: farelo de arroz, grão de arroz, grão de milho, taxa de bocados, tempo de pastejo.

Introduction

The diurnal grazing pattern of herbivores involves decisions such as the timing and the frequency of meals and the distribution of grazing periods (GREGORINI, 2012). The formation of pastoral environments that optimize feed intake influences the pattern of grazing and favors animal performance. In ryegrass (*Lolium multiflorum* Lam.), as well as in other forage species, the intermittent grazing method can change the relationship of herbivore with the pasture by means of changes occurring in the structure of the canopy. In this method, these changes are abrupt, occur in short time, interfering with the behavioral patterns of choice, location and intake of pasture by the animal, whose knowledge is important to establish pasture management practices (ZANINE et al., 2007).

The canopy structure determines the easiness with which the grazing animal takes the forage (POMPEU et al., 2009). In the intermittent grazing method, possible reductions in the forage intake rate and increased grazing time can occur every paddock occupation day, when the canopy becomes more heterogeneous, with a consequent increase in selectivity by the herbivore (STOBBS, 1973).

The provision of supplements for grazing animals can also change ingestive behavior, either stimulating or reducing forage intake, because different

types of supplement cause different changes in behavioral habits of herbivores (POMPEU et al., 2009). These changes are mainly related to the ruminal digestion rate of carbohydrates in the supplement. This can modify the way that animals select the pasture and, consequently, the ingestive behavior (ZEOULA et al., 2004). Besides that, supplemented animals spend less time grazing and the bite rate is lower (JOCHIMS et al., 2010), with increased efficiency of taking nutrients from pasture (KRYSL; HESS, 1993).

Annual grasses, such as ryegrass, gradually reduce its quality during phenological development (PONTES et al., 2003). In these different pasture conditions, animals can use different strategies in the search of food, adapting the ingestive behavior to ensure high quality of ingested material even at the end of the crop cycle (PEDROSO et al., 2004). Additionally, the plant canopy structure is modified by the intensity and frequency of defoliation and can also modify the behavior pattern of herbivores, since the canopy changes the time searching and collecting food by animals (TREVISAN et al., 2004).

This study evaluated the ingestive behavior of hoggets under intermittent grazing exclusively on ryegrass pasture or when given different supplements. This behavior was also assessed in the days of paddock occupation (1-3) and in the stages of pasture growth (vegetative, pre-flowering and flowering). In the phenological stages was evaluated the intensity and frequency of defoliation.

Material and methods

The experiment was conducted from July to October 2011, at the Department of Animal Science, Federal University of Santa Maria, located in the Central Depression of Rio Grande do Sul State. The climate is humid subtropical, according to the Köppen classification. The soil is classified as paleudalf (EMBRAPA, 2006).

The experimental area consisted of five paddocks of 0.13 ha and a further contiguous area of 0.35 ha. The pasture was sown in May 2011, with broadcast seeding and fertilizer application of 200 kg ha^{-1} of 5-20-20 fertilizer (N-P-K). Top dressing fertilization was performed with 123 kg ha^{-1} nitrogen (N) as urea, in seven applications, the first held in June 6th, and the others at intervals of 15 days.

The ingestive behavior of hoggets was assessed when exclusively on ryegrass pasture (*Lolium multiflorum* Lam.) and on ryegrass pasture plus daily 1.2% DM in relation to body weight (BW) of paddy rice grain (7.9% crude protein (CP), 88.5% of in situ dry matter digestibility (ISDMD), 25.9% neutral detergent fiber (NDF) and 90.4% dry matter (DM)); ground corn grain (8.7% CP, 96.2% of ISDMD, 16.3% NDF and 89.7% DM) or whole rice bran (13.8% CP, 84.6% ISDMD, 25.8% NDF and 92% DM) as a supplement. This assessment was performed in three phenological stages of ryegrass (vegetative, pre-flowering and flowering) and during the three-day occupation of the paddocks. The intensity and frequency of ryegrass defoliation were also evaluated in the same three phenological stages.

The grazing method was intermittent and the interval between grazings was estimated to correspond to the thermal sum required for the emergence of 1.5 ryegrass leaf, with an phyllochron estimated at 125 day-degrees (CONFORTIN et al., 2010). The thermal sum (TS) was calculated by the equation: $TS = \sum (Tmd) - 5^{o}C$, in which Tmd are the mean daily temperatures of the period and five is the base temperature for growth of ryegrass. Each paddock was occupied for three days. The occupation days plus grazing interval constituted a grazing cycle. Experimental animals were Suffolk hoggets with initial age and body weight (BW) of 10 months and 45.6 ± 4.4 kg, respectively. Four test-animals were used for each type of supplement and a variable number of regulator animals. The stocking rate was adjusted predicting the disappearance of 50% of existing biomass at the entry of animals to the paddocks.

The experimental animals, regardless of the type of supplement given, occupied the same area for grazing. Every day at 14 hours, hoggets were placed in individual cages to receive the supplements that were available to the animals for one hour. After that time, the leftovers were collected for determination of individual consumption.

The forage mass (kg DM ha^{-1}) was determined by visual estimation with double sampling, with 20 visual estimates and five harvests, performed in each paddock on the first and third days of grazing. The material from the cuts was homogenized for manual separation of botanical and structural components. After the botanical separation and drying of the structural components in a forced air circulation oven at 55°C for 72 hours, it was determined the participation in kg DM of leaf blades, stems, dead material and inflorescences. With the proportion of leaf blades and stems we determined the leaf:stem ratio.

The canopy height (cm) was measured daily at 40 fixed points per paddock, and considered as the distance from the ground to the average height of the folding leaves of ryegrass. By the difference in canopy height between occupation days of each paddock, it was calculated the grazing depth (cm). The stocking rate (kg BW ha^{-1}), per grazing cycle was calculated from the sum of the mean weight of

the test-hoggets, with the mean weight of each regulator hogget multiplied by the number of days that they remained in each paddock, divided by the number of days of the grazing cycle. The forage allowance (kg DM 100 kg^{-1} of BW) was calculated by the ratio of the daily DM availability and stocking rate.

To determine the content of crude protein, neutral detergent fiber and *in situ* dry matter digestibility of the forage, samples from the manual simulation of grazing were previously taken to a forced air oven at 55ºC for 72 hours and then ground in a Wiley-type mill.

To determine the intensity and frequency of grazing on ryegrass, 20 tillers were tagged with colored plastic wires, distributed over five transects. At each phenological stage, two assessments were performed in a fixed paddock twice a day during the three-day occupation of the paddock. Expanded leaves were measured from their ligules, expanding leaves from the ligule of the last fully expanded leaf, and the measure of senescent leaves considered only the green portion of the leaf blade. The intensity of defoliation was obtained by the following equation:

$$\text{intensity} = [(\text{initial length} - \text{final length})]/\text{initial length}]$$

The value of the defoliation frequency was obtained by the equation:

$$\text{frequency} = \text{number of } \frac{\text{touches}}{\text{number of possible touches x evaluation duration}}$$

The leaf appearance rate (day degrees) was determined by linear regression between the number of leaves produced and thermal sum of the period. The leaf appearance rate is the value of the slope of the regression and phyllochron (day degrees) is its inverse value.

Measures of time spent grazing, ruminating and in other activities were performed by direct visual observation of two test-hoggets belonging to each food system (defined by the type of supplement) for 12 hours daylight in a fixed paddock during the three days of occupation and on two occasions per phenological stage. At these times, the activity with highest occurrence was registered at the end of the ten-minute interval. The activities recorded were expressed as total daytime (diurnal hours or min.), time per hour (min. $hour^{-1}$) and as time per period of morning and afternoon (min. $period^{-1}$). The bite rate (bites $min.^{-1}$) was calculated concomitantly with observations of grazing activity with the maximum possible number of records, using stopwatch, as the time required for the animals to perform 20 bites.

Ingestive behavior variables were analyzed following the structure of sub-subplots in a completely randomized design, with types of supplement as main plot, phenological stages as subplot, and days of occupation as sub-subplots, and animals as repetition.

The intensity and frequency of defoliation were analyzed in a completely randomized design with two replications, the phenological stages were considered as treatments and grazing cycles as repetition.

For comparing grazing activities during the morning and afternoon, data were analyzed in a split plot completely randomized design, considering as main plot the types of supplements, the phenological stages or days of paddock occupation, and periods of morning or afternoon as sub-plots.

Data were subjected to normality test, correlation and regression analysis and analysis of variance by the General Linear Model (GLM) procedure. When detected differences, means were compared by Tukey test at 5% probability. The analyses were performed using Statistical Analysis System 9.2.

Results and discussion

The meteorological data for the months of the study period show that the mean observed temperatures (16.4°C) are similar to historical means for that period, while the observed rainfall and radiation were below historical values (169.3 mm and 174.9 hours), with values of 136.6 mm and 169.6 hours, respectively.

The mean thermal sum during the grazing interval was 147.8 ± 37.1°C, corresponding to 1.2 times the ryegrass phyllochron, calculated by Confortin et al. (2010). The mean forage disappearance was 50% of the canopy height (18.5 ± 2.9 cm), equivalent to 58.3 kg DM per each centimeter lowered in this height. The daily supplement intake by hoggets was 0.76, 1.00 and 1.12% dry matter in relation to body weight (BW) for rice bran, paddy rice and ground corn, respectively. The difference in consumption for the types of supplements was probably due to the different physical forms thereof. This consumption was limited by the low density of rice bran and perhaps by the lower palatability of paddy rice. The corn grain, more palatable, was consumed in greater amounts when available for a limited time. In conditions where the supplement is supplied without time limitation to be consumed, animals adjust their behavior by increasing the frequency of return to the trough and fractionating the consumption of the supplement offered (BREMM et al., 2008).

There was no interaction ($p > 0.05$) supplement type × phenological stage, supplement type × days of paddock occupation and phenological stage × days of paddock occupation for the variables grazing time, rumination time, time to other activities, bite rate and grazing depth.

Grazing time was different ($p < 0.05$) between the types of supplement, phenological stages and days of paddock occupation (Table 1). The supplemented hoggets showed grazing time 17.3% lower than those exclusively on ryegrass pasture. The restriction of the grazing in the period that animals received the supplement was equivalent to 8.3% of the grazing time of hoggets solely on pasture. The reduction in grazing time, beyond this management measure, then, corresponded to 8.9%. This reduction may be due to a likely increase in the efficiency of forage intake by hoggets that received supplement. According to Krysl and Hess (1993), supplemented cattle may decrease energy costs in grazing activity without reducing the consumption of organic matter of the forage. Also Moreno et al. (2008) observed that the diurnal grazing time was reduced by 16.4% by hoggets grazing on Italian ryegrass receiving 1.0% DM in relation to the BW of corn meal as a supplement.

Table 1. Ingestive behavior variables of hoggets according to the type of supplement, phenological stage, and days of paddock occupation.

	Activities (minutes)		
	Grazing	Rumination	Other activities
Type of supplement			
Ryegrass	436.4a	103.3a	180.3c
Corn grain	359.8b	108.3a	251.8ab
Rice grain	341.6b	97.8a	280.6a
Whole rice bran	380.5b	100.8a	238.6b
P*	0.0002	0.7610	<0.0001
RSD[1]	11.2	7.6	11.2
Phenological stage			
Vegetative	334.8b	107.1a	278.1a
Pre-flowering	396.7a	95.0a	228.3b
Flowering	407.3a	105.6a	207.1b
P*	0.0002	0.3520	<0.0001
RSD[1]	10.0	5.4	10.1
Occupation			
Day 1	398.0a	99.6a	222.4b
Day 2	356.2b	103.9a	259.8a
Day 3	384.6ab	104.2a	231.3b
P*	0.0182	0.8404	0.0088
DPR[1]	10.8	5.4	10.8

*Probability; [1]residual standard deviation.

The reduction in grazing time of the supplemented hoggets compared with those exclusively grazing (Figure 1A) occurred mainly in the morning ($p < 0.05$). This may be related to the behavioral adaptation of animals, in the expectation of the daily supply of supplement at 2 p.m.

Throughout the day, the grazing time was higher in pre-flowering and flowering stages ($p < 0.05$; Figure 1B). The reduction ($p < 0.05$) of 34.1% (598.8 kg leaf blades ha^{-1}) in the leaf blades mass that occurred from the vegetative to the other phenological stages, according to Baggio et al. (2008), reduced the quality of the available forage, increasing the demand of hoggets for leaf blades and, consequently, increasing the grazing time. Animals develop distinct grazing strategies according to changes in the pastoral environment. The hoggets consumed forage with lower ($p < 0.05$) content of neutral detergent fiber (NDF) in the vegetative stage (47.2%) compared with the stages of pre-flowering and flowering (55.2%). The lowest proportion of NDF coupled with the linear downward trend of digestibility of the apparently consumed forage ($\hat{Y} = 98.17 - 0.27x$; $r^2 = 79.96\%$; $p < 0.0001$), indicate a higher consumption of leaf blades in the vegetative stage of the grass. Probably, the combination of these factors was responsible for a 16.4% increase in grazing time in the stages of pre-flowering and flowering in relation to the vegetative stage of the ryegrass.

The grazing time (Figure 1C) was longer ($p < 0.05$) on the first day of occupation, soon after the exchange of paddocks, on average 6.6 daytime hours. When animals enter a new area, part of the time spent on grazing involves the recognition of the area (KRYSL; HESS, 1993), which may have been the responsible for the longer grazing time of hoggets during the beginning of each new occupation of paddock. From the first to the second day of occupation, grazing time was reduced ($p < 0.05$) by 10.5%, especially in the early morning hours (Figure 1C). On the third occupation day, grazing time was intermediate, showing that it was not changed by reduction ($p < 0.05$) in the leaf: stem ration in this same day. Baumont et al. (2004) studied the ingestive behavior of sheep and observed that in periods before the exchange of paddocks, the animals became waiting, seeming reluctant to spend more time and energy selecting small quantities of leaf blades available.

The time spent on grazing throughout the day (Figure 1), for the types of supplement (A), phenological stages (B) and days of occupation (C) is greater ($p < 0.05$) in the afternoon, with more pronounced peaks from 16 hours. Periods of more severe grazing in late afternoon were also observed by Baggio et al. (2008) in Italian ryegrass intercropped with black oat. The peak of grazing activity at dusk seems to be an adaptive feeding strategy to maximize daily energy acquisition. This behavior provides steady release of nutrients during the night (GREGORINI, 2012), since the periods before the sunset coincide with the highest values of nonstructural carbohydrates and DM content in plants (BARBOSA et al., 2010).

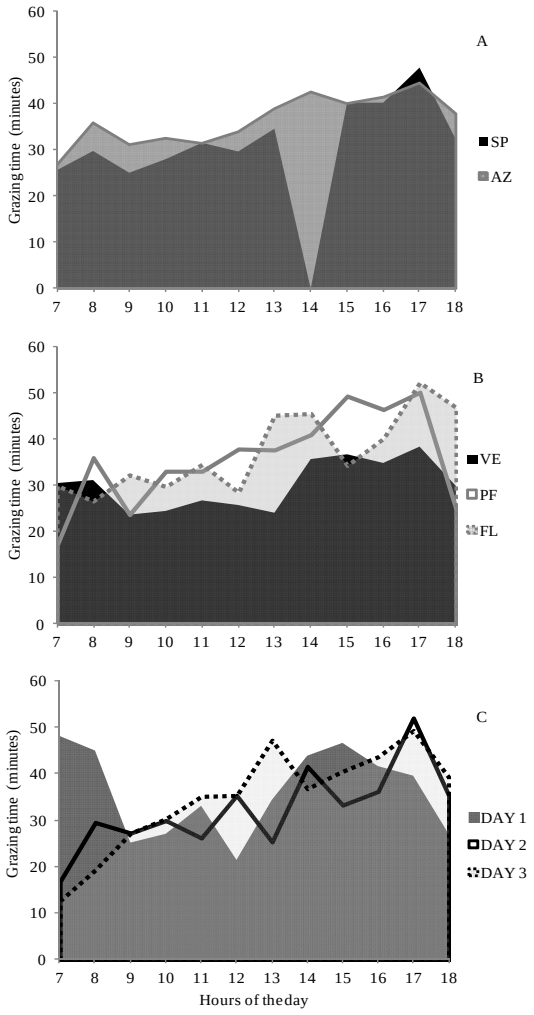

Figure 1. Distribution of the grazing time of hoggets during the evaluation time when received supplement (SP) or not (AZ-ryegrass), the phenological stages (VE-vegetative; PF- pre-flowering and FL-flowering) and days of paddock occupation (1, 2 and 3).

The rumination time was similar ($p > 0.05$) between hoggets receiving different treatments, between the phenological stages and the days of paddock occupation, with a mean of 103 ± 38 min. daytime (Table 1), corresponding to 1.7 hours, which is 14.2% of total hours evaluated. The 14.6% increase in NDF ($p < 0.05$) in the forage as grazed from the vegetative stage (47.2%) to the other stages was not sufficient to alter the diurnal behavior of rumination of the hoggets. In accordance with Carvalho et al. (2006), the increase in the amount of dietary fiber increases the time spent in the rumination. Nevertheless, the lack of effect of the supplement, phenological stages and occupation days on rumination time may be due to the low diurnal occurrence of this activity, once rumination occurs predominantly at night (BARBOSA et al., 2010).

The time spent on other activities was different ($p < 0.05$) when the animals received different types of supplement, in the phenological stages and days of occupation (Table 1). The time spent on other activities by the hoggets that received paddy rice as a supplement was longer ($p < 0.05$) by 14.9% compared to those that received whole rice bran as a supplement. The hoggets that received ground corn grain as a supplement spent the same time on other activities ($p > 0.05$) than the other animals that received supplements. The animals that remained exclusively on ryegrass pasture allocated 35.7, 28.4 and 24.4% less time on other activities compared with those receiving paddy rice, ground corn and rice bran, respectively. As the supply of nutrients to animals that received no supplement comes exclusively from forage, it was expected a longer grazing time for these animals, thus remaining less time to perform other activities. Less time spent on other activities in non-supplemented animals was also observed by Silva et al. (2011).

The daytime spent on other activities was 21.7% longer ($p < 0.05$) in the vegetative stage of ryegrass and 12.7% longer ($p < 0.05$) on the second day of paddock occupation. In other phenological stages and occupation days, the time spent on other activities was similar ($p > 0.05$; Table 1).

Since the activities of ingestive behavior are mutually exclusive, the most time spent on other activities by the hoggets, in the vegetative stage and on the second day of paddock occupation, may have occurred due to shorter grazing time in this same phenological stage and day of occupation.

The bite rate was different ($p < 0.05$) between hoggets that received different types of supplement and between phenological stages of ryegrass. The hoggets that received whole rice bran and paddy rice performed, on average, 53 bites $min.^{-1}$, 7.2% higher than the bite rate of animals that received corn grain and those exclusively on ryegrass pasture. Information about the effect of supplement use on the bite rate is lacking. According to Bremm et al. (2008), the increase in bite rate is a mechanism to maintain the forage intake rate when there are variations on pasture, which provide smaller mass of bites. Camargo et al. (2009) verified that for sheep, the phenological stage of pasture has higher interference with bite rate than the use of supplements.

A higher bite rate was observed during the pre-flowering stage (52.9 bites $min.^{-1}$), intermediate rate in the flowering stage (51.3 bites $min.^{-1}$) and lower rate in the vegetative stage (49.1 bits $min.^{-1}$). In early development stage of ryegrass, hoggets consumed more digestible forage

($\hat{Y} = 98.17 - 0.27x$; $r^2 = 79.96\%$; $p < 0.0001$), with lower NDF content (47.2%), allowing faster collection of nutrients resulting in less frequent and larger bites during the vegetative stage. The bite rate was positively correlated with grazing time ($p = 0.0417$; $r = 0.48$) which was also lower in the vegetative stage. In the stages of pre-flowering and flowering, characterized by early and complete formation of the reproductive organs of the plant, respectively, the grazing time was 16.4% longer ($p < 0.05$) than at the vegetative stage. At the pre-flowering, the highest bite rate registered may be attributed to the probable change in selectivity of animals in response to the increase in grazing time and reduction ($p < 0.05$) by 35.2% in the leaf:stem ratio observed from the vegetative stage, of 3.69, to the pre-flowering stage. In the flowering stage, the leaf: stem ratio further reduced (64.0%; $p < 0.05$) interfering with the selection of leaf blades by hoggets. This, along with the grazing time similar ($p > 0.05$) to the pre-flowering stage, may indicate that the hoggets, instead of increasing the number of bites in the flowering stage, optimized the collection of leaf blades in the chosen grazing sites, with less expenditure of energy searching for new leaves, almost nonexistent at that stage.

The bite rate was not affected ($p > 0.05$) during the days of paddock occupation, averaging 51.1 ± 4.7 bites $min.^{-1}$, indicating that the reduction in the proportion of leaf blades, over the days of occupation, was not sufficient to change this component of ingestive behavior.

The grazing depth was similar ($p > 0.05$) between the phenological stages of the grass with a mean of 3.1 ± 1.6 cm, but it was different ($p < 0.05$) between the occupation days, averaging 5.6 cm for the first day and 1.9 cm for the other days, which were not different to each other ($p > 0.05$). The leaf: stem ratio decreased ($p < 0.05$) 61.0% from the first to the third day of paddock occupation, which was 1.3. Thus, the stems would have worked as a barrier, leading the hoggets to perform shallower bites on the third day of occupation. The depth of bites, along with canopy height, are the main variables that influence the bite mass, as stated by Hodgson et al. (1997). Also according to these authors, the bites should be as deep as possible, because these bites result in greater bite mass, instantaneous consumption and, consequently, higher daily intake of forage.

The mean values of frequency of defoliation in return time to the same tiller, of expanding leaf blades (1.1 ± 0.1), expanded leaves (1.6 ± 0.1) and total (1.3 ± 0.2) were similar ($p > 0.05$) between the phenological stages of ryegrass. Considering the frequency of complete defoliation of leaf blades, the animals returned, on average, three times to the same tiller during the days of paddock occupation, indicating that hoggets explored 230% of the area available during the three-day occupation. When compared the frequencies of defoliation, of expanding and expanded leaf blades, it was observed that the return time was 31.5% longer ($p < 0.05$) for expanded leaf blades. The frequency of defoliation of expanding leaves was positively correlated with the leaf appearance rate ($p = 0.0550$; $r = 0.87$). The higher the leaf appearance rate the larger the proportion of expanding leaves available for grazing. Due to their location, these leaf blades are preferably consumed by grazing animals, which explains the shorter return time of expanding leaves compared with that of expanded leaf blades.

The mean grazing intensity, regardless of the type of leaf blade, corresponded to 74.1% ($p > 0.05$) in all phenological stages. Once the lambs returned three times to the same tiller during each occupation of paddocks, the intensity of defoliation was 32.5% higher than the 50.0% reported by Mazzanti and Lemaire (1994) who also claimed that the proportion of leaf length removed is relatively constant.

Conclusion

The daytime grazing is shorter when the hoggets receive supplements, regardless of the type of supplement. The longer grazing time is observed in animals exclusively on ryegrass in the pre-flowering and flowering stages, and on the first two days of paddock occupation. The daytime behavior of rumination in hoggets is not altered by supplementation, phenological stages of the grass and neither by days of paddock occupation. The frequency and intensity of defoliation are constant with the progress of the ryegrass cycle.

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