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Sheep grazing on native pasture alone or with forage peanut

Abstract – The objective of this work was to evaluate the effect of forage peanut (*Arachis pintoi*) supplementation on the forage intake and rumination behavior of Corriedale sheep grazing on a native grassland environment. Two treatments were compared: grazing on native pasture alone or with ad libitum access to forage peanut. In both, forage allowance was set to 12% body weight. Although total daily grazing duration did not differ significantly between treatments, access to forage peanut reduced the time the sheep spent grazing in the morning and ruminating. Free access to forage peanut significantly alters the grazing patterns of Corriedale sheep on native pasture and enhances their performance (weight gain) by optimizing energy allocation toward production.

Index terms: *Arachis pintoi*, natural pasture, rumination, sheep feeding.

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Pastejo de ovinos em pastagem nativa exclusiva ou com amendoim forrageiro

Resumo – O objetivo deste trabalho foi avaliar o efeito da suplementação com amendoim forrageiro (*Arachis pintoi*) nos comportamentos de ingestão de forragem e de ruminação de ovinos Corriedale em ambiente de campo nativo. Foram comparados dois tratamentos: pastejo em campo nativo exclusivo ou com acesso ad libitum ao amendoim forrageiro. Em ambos, a oferta de forragem foi ajustada para 12% do peso corporal. Apesar de a duração total do pastejo diurno não diferir significativamente entre os tratamentos, o acesso ao amendoim forrageiro reduziu o tempo gasto pelas ovelhas com pastejo matinal e ruminação. O livre acesso ao amendoim forrageiro altera significativamente o padrão de pastejo de ovinos Corriedale em pastagem nativa e melhora seu desempenho (ganho de peso) ao otimizar a alocação de energia para produção.

Termos para indexação: *Arachis pintoi*, pastagem natural, ruminação, alimentação de ovinos.

Introduction

Native grasslands in the Pampa biome present a marked seasonal productivity, with high forage yields in spring but a lower production and frequent overgrazing in winter (Wróbel et al., 2023; Roberti et al., 2024). This variability indicates that the native pasture alone rarely provides an adequate year-round nutrition or productivity for grazing animals to reach their full productive potential (Barbero et al., 2021).

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Diversifying forages in grazing systems is a key strategy to offset the nutritional and productive limitations often occurring in natural pastures during certain periods of the year. When included, tropical legumes are known to increase protein supply in the animal's ingested diet (Alonzo et al., 2017; Nunes et al., 2020). These plants not only fix nitrogen in the soil, but also provide a high-protein and low-fiber forage (Muir et al., 2025). In this scenario, animals can select a diet with an improved nutritional value, which positively influences their ingestive behavior (Pedroso et al., 2004). These findings are important considering animal performance is dependent on forage intake, which is affected by feeding behavior (Paula et al., 2010).

Pedroso et al. (2004) found that small ruminants show a high behavioral flexibility, represented by their capability to consume diverse native plant diets. This enables them to adapt to heterogeneous native grasslands by altering forage harvest and ingestion mechanisms to maintain a consistent nutrient supply in different environments. Animals with access to a better quality pasture (Dias-Silva & Abdalla Filho, 2021), for example, tend to consume less forage due to its higher fiber content (Glienke et al., 2016).

To date, different forages have been used for animal feeding. Although forage peanut (*Arachis pintoi* Krapov. & W.C.Greg.) is a promising alternative, there is still a lack of information on its effective management and utilization, particularly regarding its integration to and management within native grassland-based animal production systems (Costa et al., 2020). This combination of pasture management and livestock grazing is essential to better understand animal behavior (Schmitz et al., 2023). The hypothesis here is that incorporating forage peanut into native grassland grazing systems will modify animal intake patterns, decreasing time spent grazing and ruminating, consequently increasing idle periods.

The objective of this work was to evaluate the effect of forage peanut supplementation on the forage intake and rumination behavior of Corriedale sheep grazing on a native grassland environment.

Materials and Methods

The study was carried out in January and February of 2018 within the coastal physiographic region of the Pampa biome in Southern Brazil (31º52'00"S, 52º21'24"W, at 13.24 m above sea level). The soil in the area was categorized as a Podzólico Vermelho-Amarelo eutrófico (Cunha & Silveira, 1996), equivalent to an Alfi-Ultisol transition (Soil Survey Staff, 2022). According to Köppen, the local climate is Cfa, humid temperate with hot summers. The project was approved by the Ethics Committee on Animal Use of Universidade Federal de Pelotas (under process number 50405097), located in the municipality of Pelotas, in the state of Rio Grande do Sul.

Two different pasture areas were used for the experiment. The first was a typical native pasture, representative of the region's natural grasslands, where species from the genera *Paspalum* sp., *Andropogon* sp., and *Axonopus* sp. predominated. The second was an adjacent pasture of the Amaillo forage peanut cultivar. Both areas received 150 kg ha^{-1} diammonium phosphate (N-P-K 18-46-00) as top dressing in November 2017, were kept resting until the beginning of the study, and offered sun shelters for the animals.

Two treatments evaluated were: grazing on a native pasture alone or with unrestricted access to an adjacent area with forage peanut. The implemented method was continuous grazing with a variable animal load. Four 18-month-old test sheep of the Corriedale lineage were kept under each treatment, and a fluctuating number of put-and-take animals were used to adjust precisely the animal load. Forage allowance was fixed at 12 kg dry matter per 100 kg body weight.

Forage quality and quantity were determined through pasture mass, height, and bromatological traits (Table 1). The chemical analysis was used to determine the contents of crude protein, neutral detergent fiber (NDF), acid detergent fiber, acid detergent lignin, and mineral matter, based on the methodology adapted from Silva & Queiroz (2002).

To quantify animal productivity, mean daily gain was calculated from pre- and post-experimental weighing. Ingestive behavior was registered from sunrise to sunset on days 16 (January 24), 18 (January 26), and 42 (February 20) of the experiment through

direct visual recording of animal activity every 10 min (Jamieson & Hodgson, 1979). The observed activities included: grazing, defined as the act of selecting and consuming forage (head down, ingesting food); rumination, chewing movements performed without active forage intake, usually following grazing; and idle, resting periods without either grazing or rumination. Grazing and rumination sessions of approximately 4 min were filmed at close range.

Bite rate and mericic chewing were assessed using focal sampling. Bite rate was determined by timing 20-bite intervals (Hodgson, 1982), and total daily bites were calculated by multiplying this rate by individual grazing duration. Mericic chewing was measured as the time and number of movements per bolus, and total daily mericic chews were obtained from the product of chews per bolus and daily rumination time. The total number of ruminated bolus was calculated by dividing daily rumination time by the time spent per bolus. All observations were conducted non-invasively to avoid disturbing the animals' natural behavior.

The data were subjected to the descriptive analysis to examine dispersion and consistency and to graphical analyses to facilitate visualization. After data inspection, normality was checked using Shapiro-Wilk's test, at a 95% significance level. Variables that did not present a normal distribution were transformed to log10(x) to stabilize variance.

The data were analyzed using the mixed model procedure (PROC MIXED) to implement the maximum likelihood restricted method (REML) as an unbiased variance estimation technique. Given the small sample size, a corrected Akaike information criterion value was used as decision rule to avoid overfitting and select the best correlation pattern. The compound symmetry, unstructured, and autoregressive of first order matrices were tested. Treatments were considered as fixed effect and evaluation dates as random effect, as shown in the following equation:

$$Y_{ijk} = \mu + \alpha_i + d_j + \varepsilon_{ijk}$$

where Y_{ijk} is the animal's response to treatment i on date j in repetition k; μ is the overall mean; α_i is the fixed effect of treatment i; d_j is the random effect of date j; and ε_{ijk} is the error associated with handling i, on date j and repetition k.

Means were compared by the F-test (α=0.05). Pearson correlation coefficients were also estimated (Steel et al., 1997), specifically between the studied continuous variables of ingestive behavior (rumination, grazing, and idle), at a 95% significance level. The SAS OnDemand for Academics software (SAS Institute Inc., Cary, NC, USA) was used.

Results and Discussion

The native pasture showed consistent productive and nutritional traits alone or when supplemented with forage peanut, despite the higher crude protein content of the legume (Table 1). Initial sheep body weight was similar across both treatments (Table 2), but final sheep weight differed significantly, being higher for animals with free access to forage peanut. For these sheep, the average daily gain was 139 g, leading to a significantly higher final weight ($p = 0.0094$). However, although the animals grazing exclusively on the native pasture had a negative average daily gain, their final body weight ($p = 0.4163$) was not significantly altered.

Table 1. Means for canopy height (CH), forage mass (FM), and bromatological traits of the native pasture alone or supplemented with forage peanut (*Arachis pintoi*).

Treatment[(1)]	Area	CH (cm)	FM (kg ha^{-1})	Bromatological traits[(2)]				
				CP (%)	NDF (%)	ADF (%)	ADL (%)	MM (%)
NP	NP	9.8	1609.4	9.9	47.9	37.1	8.1	5.6
NP+FP	NP	9.9	1620.7	8.5	48.1	36.8	8.2	5.7
	FP	14.7	2918.0	16.1	42.1	28.7	6.6	6.3

[(1)]NP, native pasture; and FP, forage peanut. [(2)]CP, crude protein; NDF, neutral detergent fiber; ADF, acid detergent fiber; ADL, acid detergent lignin; and MM, mineral matter.

Total grazing duration did not differ significantly between treatments (p = 0.2165), being 492.5 and 556.5 min, respectively, for sheep with and without access to peanut forage (Figure 1). Considering period of the day, grazing duration was longer (p = 0.0359) in the morning for animals on the native pasture alone when compared with those with access to the legume, likely due to forage chemical composition and biomass availability in the area (Table 1). Contrastingly, in the afternoons, grazing duration did not differ between treatments (p = 0.2449). Other factors, such as environmental conditions or general forage availability (Pedroso et al., 2004; Schmitz et al., 2023), may have contributed to a more uniform grazing behavior in both evaluated pasture areas.

Grazing activity throughout the day was more uniform (p = 0.6801) for sheep on the native pasture, totaling 272.7 min in the morning and 283.25 min in the afternoon. On native pasture + legume, more time

Table 2. Standard error of the means and p-values of the F-test (α = 0.05) for initial body weight, final body weight, and daily live weight gain of Corriedale sheep subjected to the treatments native pasture (NP) alone or supplemented with forage peanut (FP) (*Arachis pintoi*).

Trait	Treatment[1]		p-value of trait
	NP+FP	NP	
Initial body weight	35.8 (2.7)	38.7 (2.9)	0.4804
Final body weight	44.1 (3.7)	37.0 (2.0)	0.0117
p-value of treatment	0.0094	0.4163	-
Daily gain	0.139 (0.04)	-0.028 (0.03)	0.0051

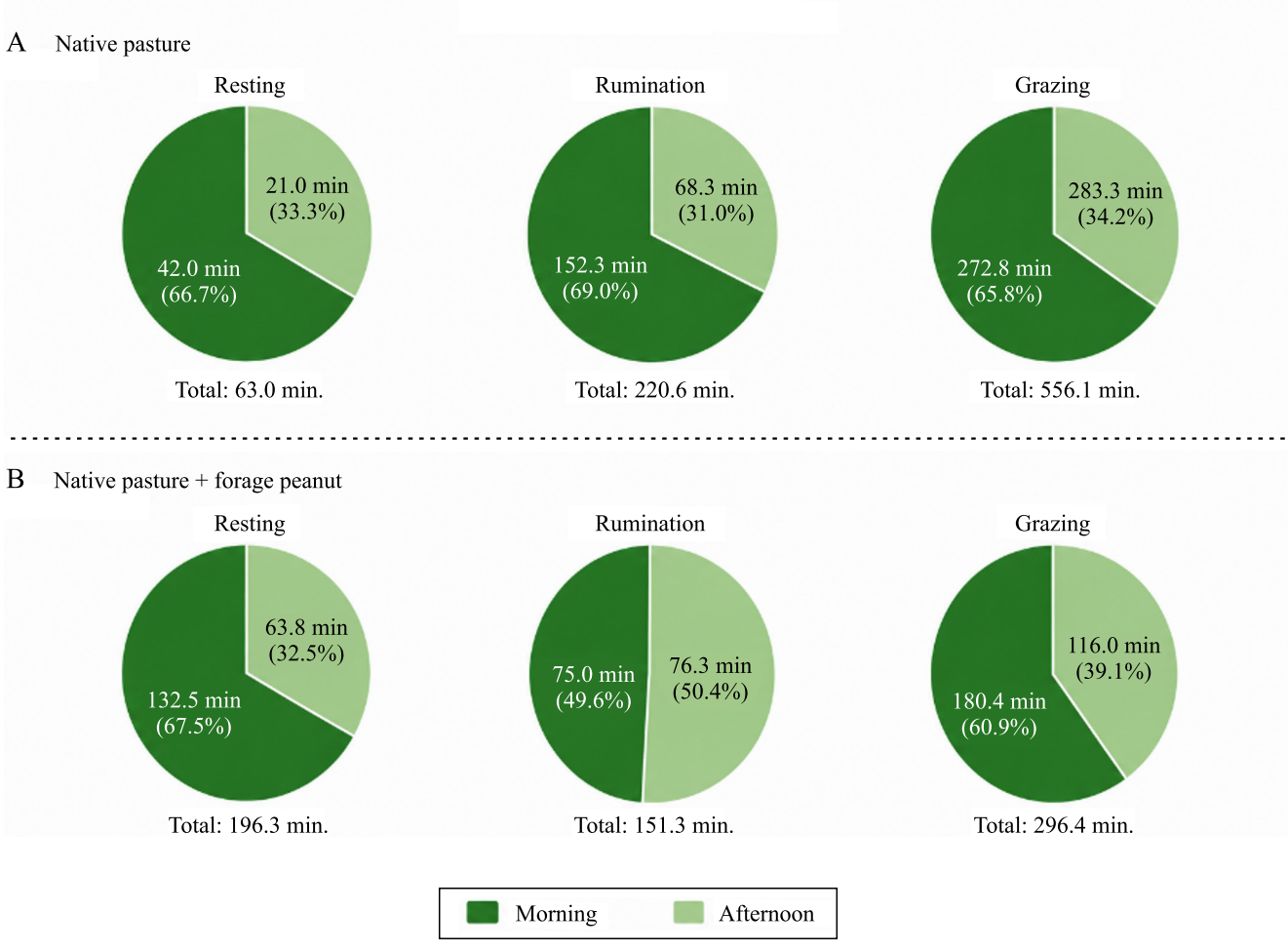

Figure 1. Time spent on grazing, rumination, and resting (idle) by Corriedale sheep during the morning and afternoon under two treatments: A, native pasture alone (A); and B, supplemented with forage peanut (*Arachis pintoi*).

was spent grazing in the afternoon than in the morning ($p = 0.0002$), i.e., 291.2 and 201.5 min, respectively.

For native pasture alone, grazing time was notably longer in the afternoon (116 min) than in the morning (17.7 min). However, in the treatment with native pasture + forage peanut (Figure 1), sheep spent more time grazing on the legume, both in the morning (180.4 min) and afternoon (178.4 min). These differences, particularly the shorter time grazing on native pasture in the morning, suggest a preference for forage peanut, especially earlier in the day. A similar pattern was observed in the afternoon when sheep were more active at 6 p.m. on native pasture + forage peanut (Table 2). This dietary adjustment is critical for maintaining ruminal homeostasis, facilitating sustained satiety overnight, and improving overall digestive efficiency. Therefore, although sheep graze at daytime hours (Molle et al., 2022), they are prone to consume fibrous plant species in late afternoon (Dias-Silva & Abdalla Filho, 2021), seemingly to optimize ruminal fill during the night.

The preference for the legume can be attributed to its higher amount of soluble fibers, low lignin content, and high digestibility (Woodmartin et al., 2024), particularly of its upper stratum often formed by over 65% leaves (Kröning et al., 2019). Other authors concluded that the legume was more appealing, especially in early afternoon, due to its higher carbohydrate content, particularly in its leaves, resulting from the daytime photosynthetic process (Champion et al., 1994; Hardy et al., 2023).

A benefit of the extended grazing time in the area with the legume was the optimization of nutrient intake by the animals (Costa et al., 2018), followed by an increase in their daily weight gain (Table 2). However, this higher grazing intensity could lead to excessive defoliation and subsequent biomass reduction in forage peanut and to an underutilization and overall quality decline in the less preferred native pasture. This indicates that implementing a mechanism to regulate grazing on forage peanut is essential to mitigate potential overgrazing and to maintain pasture sustainability.

Grazing start and distribution varied between treatments (Figure 2). In the morning, sheep on native pasture started grazing after 8 a.m., with a higher intensity at 9 a.m. and 12 p.m. In comparison, when the animals had access to forage peanut, they began grazing as early as 7 a.m., with an initial preference for the legume. Rutter (2006) observed that sheep and cattle had a 70% preference for a white clover (*Trifolium repens* L.) pasture, probably associated to their diet's carbon-to-nitrogen ratio.

Grazing duration had a strong negative correlation with animal idle time ($r = -0.6735$; $p<0.05$), meaning that an increased grazing activity reduced the resting period. Contrastingly, no significant correlation was observed between grazing and rumination time ($r = 0.0695$; $p>0.05$), although rumination time was negatively correlated with idle time ($r = -0.7642$; $p<0.01$). These findings were expected as the higher physiological demands of grazing or rumination tightened the daily time budget in sheep behavior, resulting in a reduced resting time. The total time available for active grazing is naturally restricted since livestock must allocate significant portions of their daily schedule to essential activities such as rumination, water intake, and social interactions (Smith et al., 2021; Pollock et al., 2022).

Total rumination time was higher in the treatment with native pasture alone (220.6 min) when compared with native pasture + forage peanut (151.3 min), each 26.3 and 18% of the daytime period, respectively (Figure 1). The time spent ruminating was reduced in the afternoon in native pasture alone, but was distributed equally throughout the day when the legume was included. During the day, the amount of time spent in rumination was related to the content and physical characteristics of the NDF in the ingested diet. The sheep with access to forage peanut, for example, spent a shorter time grazing on native pasture (Figure 2), which consequently affected NDF intake and total time spent ruminating. In another study, the highest rumination activity was recorded between 5 a.m. and 8 a.m. (Rego et al., 2017).

Idle time varied significantly between treatments (Figure 1). Total resting time was 63 min in the pasture alone ($p = 0.0039$), lower than the 196.3 min with forage peanut, suggesting a lower daily energy expenditure by sheep. In terms of period of the day, idle time was also longer in the treatment with the legume both in the morning ($p = 0.0178$) and afternoon ($p = 0.0058$). Despite this difference, the two evaluated treatments showed a similar pattern of a longer idle time in the morning. This suggests that the higher fiber content of the native forage increased the demand for rumination while maintaining grazing duration, which was associated with less time available for idle behavior.

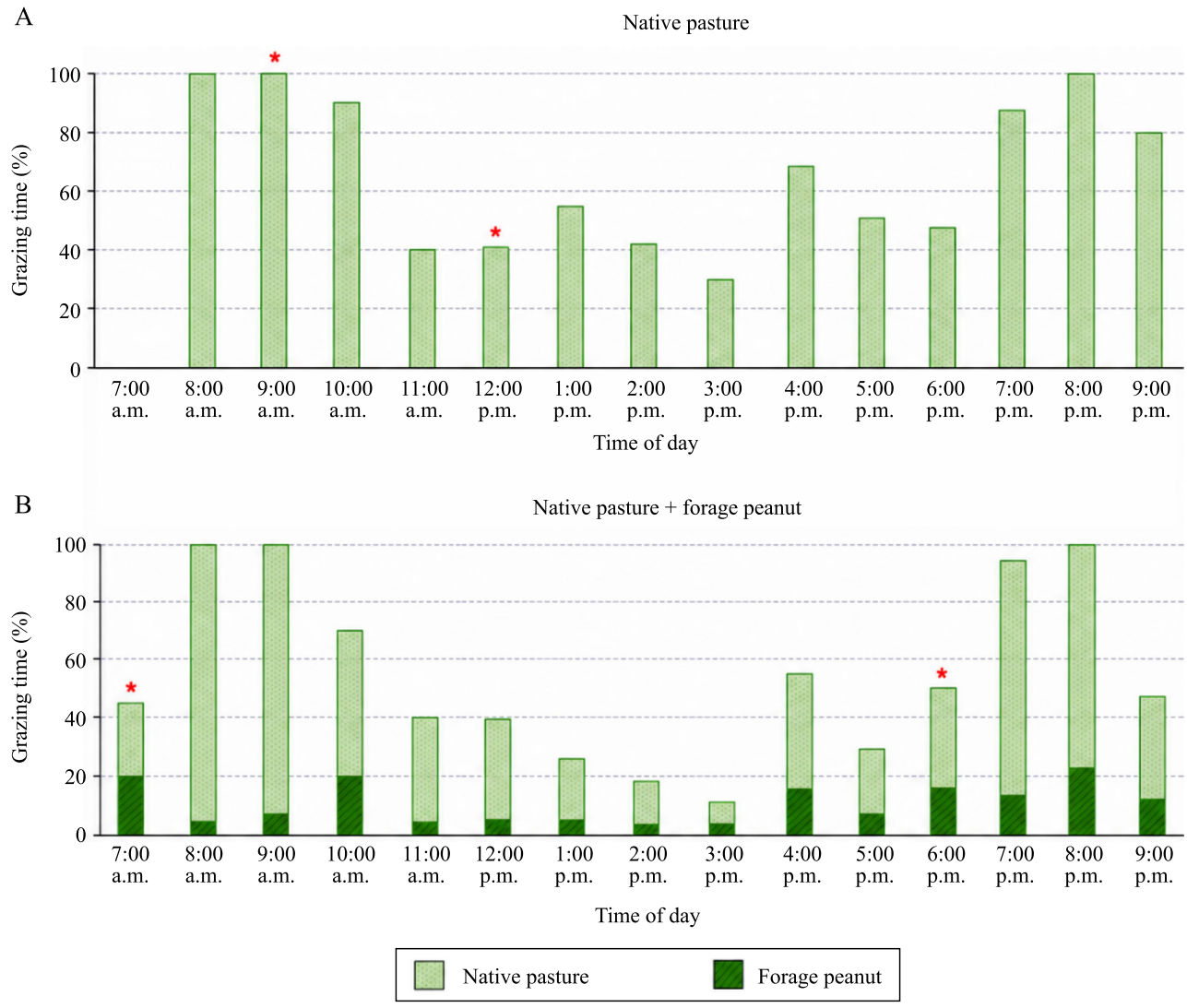

Figure 2. Grazing time in the morning and afternoon of Corriedale sheep under two treatments: A, native pasture alone; and B, supplemented with forage peanut (*Arachis* pintoi). *Significant differences in total grazing time between treatments in the same period of the day by the F-test (α=0.05).

Table 3. Standard error of the means and p-values of the F-test (α=0.05) for intake and digestive behavior of Corriedale sheep subjected to the treatments native pasture alone or supplemented with forage peanut (*Arachis pintoi*).

Behavior	Treatment[1]			p-value
	NP+FP		NP	
Bite rate (bites per minute)[2]	37.5 (3.6)	33.6 (2.9)	43.3 (3.7)	0.1995
Total number of bites per day	19,641 (563.1)		19,943 (1,127.6)	0.6135
Time per ruminal bolus (s)	30 (3.0)		37.5 (3.9)	0.0032
Mericic chewing per ruminal bolus	60 (4.3)		67.3 (5.4)	0.0039
Ruminal bolus per day	302.5 (21.3)		352.8 (41.7)	0.029
Mericic chewing per day	18,150 (2699.7)		23,743 (2030.1)	0.0093

[1]NP, native pasture; and FP, forage peanut. [2] In the NP + FP treatment, the bite rate was registered separately for each pasture area.

Bite rates and total number of bites per day did not differ significantly between treatments. The bite rate was 43.3 bites per minute on native pasture alone and 37.5 and 33.6 bites per minute for native pasture + forage peanut, respectively (Table 3). Total bites per day were 19,943 for native pasture and 19,641 for native pasture + forage peanut.

A significant difference ($p = 0.032$) was observed in mericic chewing time per ruminal bolus between treatments, being 37.5 s for native pasture alone and 30 s for native pasture + forage peanut. The number of mericic chews per ruminal bolus also differed significantly ($p = 0.0039$), with 67.3 and 60 movements for the native pasture and native pasture + forage peanut treatments. Likewise, the number of ruminal boluses per day varied significantly ($p = 0.029$), being 352.8 and 302.5 for the former and latter treatment, respectively. Consequently, the total daily mericic chews were higher in sheep grazing on native forage (23,743 chews per day) than in those with access to the legume (18,150 chews per day). Considering both treatments, total rumination time directly influenced the overall number of chews, assuming consistent individual chewing movements per bolus.

In the present study, sheep with access to peanut forage showed lower rates of bites and daily mericic chews, probably due to forage chemical composition and biomass availability in the area. Molle et al. (2022) found that cattle, sheep, and horses increased their biting frequency to adapt to a pasture's physical arrangement that could restrict their ability to consume forage. In this line, Jin et al. (2022) concluded that sheep change, not only their grazing behavior to cope with different pasture conditions, but the frequency of their biting and swallowing events. For instance, ruminants will intensify their bite rate and extend their grazing duration in shorter pastures in order to compensate for a reduced bite mass (Dias-Silva & Abdalla, 2021; Tontini et al., 2021), indicating a correlation between bite rate and pasture height. Therefore, if an increased grazing duration and bite rate are insufficient to compensate for a lower forage availability, there will likely be a decrease in overall intake.

Time chewing per ruminal bolus was longer for sheep grazing only on native pasture, probably due to its high NDF content (Table 3). Similarly, when increasing roughage in the diet of Holstein cows, Jiang et al. (2017) registered a longer ruminal bolus handling time. Sauvant et al. (1996) added that forage quality, particularly its cell wall content, directly influenced rumination time and the number of mandibular movements per ruminal bolus. In their study, the latter authors developed a model to estimate sheep chewing activity and ingestion behavior, observing a linear decrease in total chewing time as dietary cell wall components were reduced and nonfibrous carbohydrates increased. These findings indicate that an increased forage fiber requires more mastication, implying in more time spent in rumination and mericic chewing.

Considering the obtained results, the changes observed in sheep ingestion behavior are primarily related to time spent grazing and ruminating, linked to structural differences in the evaluated pastures.

Conclusions

1. Free access to forage peanut (*Arachis pintoi*) significantly alters the grazing patterns of Corriedale sheep on native grassland pasture.

2. Sheep show a strong preference for forage peanut, which accounts for approximately 75% of daytime grazing, particularly in early morning.

3. The preference for forage peanut in mixed systems significantly reduces rumination time.

4. Access to forage peanut enhances sheep performance by optimizing energy allocation toward production.

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Data availability statement

Data available upon request: research data are available from the corresponding author upon reasonable request.

Declaration of use of AI technologies

During the preparation of this work, the authors used ChatGPT (OpenAI) solely to create Figure 1. The authors reviewed the figure and take full responsibility for its content. No generative artificial intelligence tools were used for any other aspect of the study or manuscript preparation.

Conflict of interest statement

The authors declare no conflicts of interest.

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