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FORAGING BEHAVIOUR OF SHEEP AT PASTURE WITH DIFFERENT TYPES OF VEGETATION IN A PADDOCK [1]

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Foraging behaviour of sheep at pasture with different types of vegetation in a paddock

This experiment was designed to study the foraging behaviour of ewes on a pasture with paddocks with three different types of vegetation, herbaceous (n = 3), woody (n = 2), and semi open (n = 1). Forty sheep were bred on a farm in the Karst region of Slovenia. Ten sheep were focally observed during day light (5 a.m.–9 p.m.). Ewes were observed for 2 days in each paddock with one rotation, so 12 days in total. Grazing time, circadian rhythm of grazing, drinking frequency, and frequency of salt consumption were the observed behaviours. On average, ewes grazed for 10.5 hours a day (mean ± SD = 626.2 ± 47.2 min), with a significant difference between individual variation ($P < 0.001$). Sheep grazed the most in herbaceous paddocks ($P < 0.001$), with lower yet similar levels observed in woody and semi open paddock. The frequency of drinking and salt consumption was low. Individual grazing sheep would drink slightly less than once per day, while consuming salt on average 1.25 times per day. Drinking frequency was the highest in the semi open paddock with some trees and bushes, whereas salt consumption was most frequently observed in the woody paddocks.

Key words: sheep / animal behaviour / ethology / grazing / pastures / paddocks / vegetation / Karst / drinking / salt consumption / Slovenia

Obnašanje ovc na kraškem pašniku z različno vegetacijo

Poskus je bil zastavljen z namenom proučiti obnašanje ovc na pašniku s čredinkami, v katerih so obstajale tri različne vrste vegetacije: travna ruša (n = 3), gozdna (n = 2) in delno zaraščena z drevesi in grmovjem (n = 1). Trop 40 ovc se je pasel na kmetiji na kraškem svetu v Sloveniji. Deset individualnih ovc je bilo direktno opazovanih v času dnevne osvetlitve (od 5. do 21. ure). Ovce so bile opazovane 2 zaporedna dneva v posamezni čredinki z eno ponovitvijo, torej skupaj 12 dni. Opazovana je bila dolžina zauživanja zelinja (+ listje iz grmovja in dreves), dnevni ritem zauživanja travne ruša, pogostost pitja in zauživanja soli. Na dan so se ovce pasle povprečno 10,5 ur (povprečje ± SD = 626,2 ± 47,2 min), vendar so bile značilne razlike med ovcami ($P < 0,001$). Najdaljši čas za pašo so ovce imele v čredinkah s travno rušo ($P < 0,001$). Podoben čas paše je bil opazovan v gozdnih čredinkah in pol odprti čredinki. Pogostost pitja in zauživanja soli je bila nizka. Živali so pile malo manj kot enkrat na dan, medtem ko so zaužile sol 1,25 krat na dan. Pogostost pitja je bila največja v pol odprti čredinki, kjer so bila prisotna tudi drevesa in grmovje, medtem ko je bila največja pogostost zauživanja soli v gozdnih čredinkah.

Ključne besede: ovce / obnašanje živali / etologija / paša / pašniki / čredinke / vegetacija / Kras / pitje / zauživanje soli / Slovenija

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1 INTRODUCTION

Small ruminant social environment varies widely from very intensive feeding with no grazing opportunities to more extensive grazing areas with high grazing opportunities. Behavioural constraints are different and more diversified at pasture than indoors. As the human population becomes more aware of the quality of food, maximising forage utilisation through grazing is an increasingly important tool in animal production. Allowing the animals to perform more natural behaviour while being outside in the open can also improve their welfare (Špinka, 2006).

In Slovenia, sheep production is the most widespread form of extensive animal production. In Karst, western part of Slovenia that occupies almost half of the territory (SURS, 2002), 85% of the countries sheep and goats are reared (SURS, 2002). This area is difficult to cultivate by agricultural machinery and is classified as inappropriate for agricultural production. In 1998, between 120.000 and 150.000 ha of agricultural land in the Karst region was abandoned and overgrown with shrubs, trees, and brushwood (Cunder, 1998). Woody plants are a common component of the overgrowth. However, small ruminants can keep the pastures and farm land clear of ingrown woods through their capacity to graze. Small ruminants can also contribute to the safeguarding of agricultural functions, like care and preservation of the landscape, through maintaining grasslands and preventing land from bush encroachment and fires.

Grazing is defined as the time spent each day in grazing activity, that is, prehension and mastication (Woodward, 1997). It is well documented that sheep and goats show selective grazing and select for a high quality, nutritionally balanced diet. Grazing duration and rhythm is often related to specific forage characteristics (Baumont *et al.*, 2000) due to different dietary choices (Morand-Fehr, 2003). This is partly the reason for keeping sheep and goats together at pasture. They have different preferences for feeds and the area is therefore more intensely grazed. At pasture, two main grazing periods usually occur at sunrise and sunset, which are also the preferred drinking times in both sheep (Rook and Penning, 1991) and goats (Rossi and Scharrer, 1992). However, drinking frequency can differ greatly between individuals, partly as a result of differences in social hierarchies (Milinski and Parker, 1991) and space availability around the drinking troughs (Ehrlenbruch *et al.*, 2010).

In a heterogeneous environment, the management of the grazing circuit has become an important factor. An understanding of sheep behaviour in a complex environment is therefore essential for optimizing the management of sheep and goat flocks in unfavourable areas, such as the Karst region in Slovenia. Studying more feeding behaviour of ruminants may provide a firm knowledge on ethological traits of animals and a better understanding of how to achieve a good economical production, good animal welfare, and at the same time preserve the semi open landscape as best as possible.

The aim of the study was to investigate how forage characteristics and type of vegetation influence foraging behaviour during sheep grazing. Sheep were observed at three different types of vegetation in a paddock in the Karst region of Slovenia.

2 MATERIAL AND METHODS

2.1 MATERIAL

The experiment was carried out during the summer time on a farm in the hilly Karst region of Slovenia called Vremščica (altitude of 900 – 1000 m a.s.l.). Two days before the onset of an experimental procedure, 40 ewes of Istrian Pramenka and 10 goats cross breeds were mixed and released into the same foraging area in order to get familiar with each other. The animals were reared on that farm and thus used to the area. The animals were of similar age to prevent any effects of age on different flocking behaviour and handling responses (Hargreaves and Hutson, 1997). The area was fenced and for the purpose of the experiment divided into 6 paddocks of similar size (approx. 400 m^2). The shape of paddocks depended on the structure of the ground and the type of vegetation. There were 3 paddocks covered with only grass sward (herbaceous paddock), 1 partly covered with trees and bushes (semi open paddock) and 2 fully overgrown paddocks with hazel and beech trees (woody paddock) (Fig. 1). Thus, 50 animals were grazing in six paddocks with three different types of vegetation for a period of 6 weeks. Animals stayed at the pasture for 24 hours. At each paddock there was one drinking trough and one wooden trough with salt. Therefore, animals had the possibility to both feed and drink. The average ambient temperature during the observation period of 12 days was 14.1 °C, ranging from 9.2 °C to 18.5 °C.

2.2 METHODS

2.2.1 BEHAVIOURAL OBSERVATIONS

For the purpose of this experiment ten young sheep were directly observed during foraging in the flock of 50 animals. Each of the 10 ewes was marked with a different combination of stripes on the back using red, black,

a) b) c)

Figure 1: *Paddock with three different types of vegetation (a: herbaceous paddock, b: semi open paddock with some trees and bushes, c: woody paddock).*
Slika 1: *Čredinke z različno vegetacijo (a: travnata čredinka, b: delno zaraščena čredinka z grmovjem in drevesi, c: gozdna čredinka).*

or green water resistant colour spray. The observations lasted 12 days during a 6 week period, with six interrupted intervals each lasting two consecutive days. Animals were 5 or 6 days at a paddock, depending on the feeds availability, and afterwards moved to another paddock. During the experiment the animals were rotated between all 6 paddocks in such a way that they were observed twice at the same paddock. Two observers, situated on a raised platform, began to observe the animals two days after moving the sheep into a paddock. Animals were observed inside (woody paddock) or outside the paddock (herbaceous paddock, semi open paddock). When observed outside, observers sat in a caravan 300 m distanced from the pasture, using binoculars. Before the observations started in the woody paddocks, the observers had spent 2 days at the pasture together with the sheep, so that the animals got used to their presence. The observers always wore the same working coat that was familiar to the animals. Observers started with the observations on the third day after moving the animals into a specific paddock. Observations started at 5 a.m. and finished at 9 p.m. Only one observer per time was observing the animals, 2 hours in a row, and then the observers were changed. Daily observation time was 16 hours. Activities of an individual sheep were scored on sheets of paper. Recordings were made for the following foraging activities:

- grazing (duration, daily rhythm),
- drinking water,
- salt consumption.

Grazing was recorded every 5 min during 16 hours of observation using instantaneous sampling. The number of drinking and salt consumption bouts was scored within the same time period but using continuous sampling.

2.2.2. STATISTICAL ANALYSIS

We prepared data with Microsoft Excel for Windows and analysed them using statistical package SAS/STAT (SAS, 2008). The general linear model (GLM) was used to determine the effects of normally distributed data. The daily values of data were tested for normality. All the tests were two-tailed and the significant level was set at P≤0.05. Data for grazing was normally distributed and the model shown in equation [1] was developed using three fixed effects and an independent variable. The effect of breed had been tested but later omitted from the model as it described only 0.000126% of the variability.

$$y_{ijk} = \mu + P_i + D_j + A_k + b_i(t_{ijkl} - \bar{t}) + e_{ijk}, \quad (1)$$

where P_i is the effect of paddock ($_i$ = 1–6), D_j is the effect of day ($_j$ = 1–2), A_k is the effect of animal ($_k$ = 1–10), $b_i(t_{ijkl} - \bar{t})$ is the effect of averaged daily temperature, and e_{ijk} is a random error.

In the case of other activities, drinking frequency and salt intake, data were not normally distributed even after transformation. The number of drinking and salt consumption bouts was very low; therefore, these behaviours are presented in a descriptive manner only.

3 RESULTS

3.1 GRAZING

Sheep were free at pasture for 24 hours and it was observed that during the afternoon heat sheep moved into the shade, if available. This suggests shade should be made available to animals in pastures. At pasture, sheep could develop their own foraging strategy. They spent on average 10.5 hours grazing during light hours (mean ± SD = 626.2 ± 47.2 min). The maximum duration of graz-

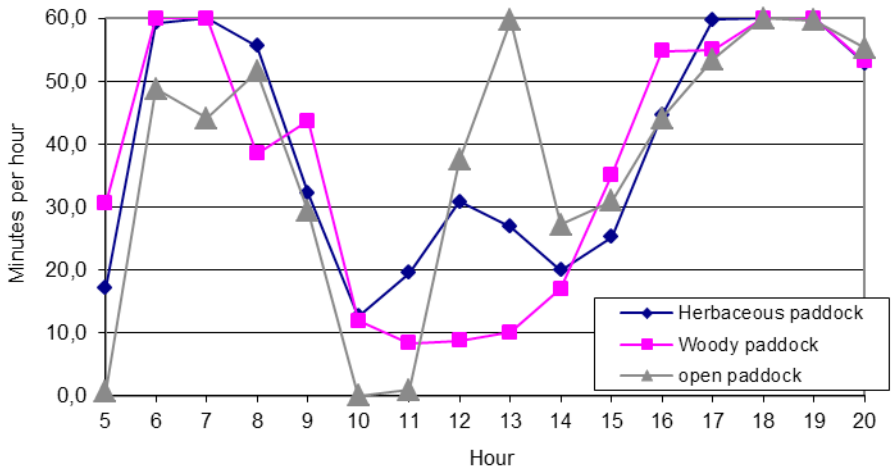

Figure 2: *Daily grazing rhythm at herbaceous paddock, woody, and semi open paddock with some trees and bushes.*
Slika 2: *Dnevni ritem paše v travni čredinki, gozdni čredinki in delno zaraščeni čredinki z grmovjem in drevesi.*

ing per day was a bit less than 12 hours (713.3 min). The similar duration of grazing was observed in the study of Lynch *et al.* (1992). They reported 8–9 hours of grazing a day with a maximum of around 13 hours when the feed supply was limited. This means that the broad diversity of feeds in our study motivated ewes to graze. The beginning of the grazing was synchronous in our study. If one animal started to graze, it was followed by the others. Such behaviour is species specific, and with sheep being social animals, they tend to be synchronous in their starting of grazing bouts (Champion *et al.*, 1994).

The circadian rhythm of grazing was significantly different during the day (Fig. 2). Grazing was the most intense in the morning with the peak between 6–8 a.m. when animals would spend from 45–60 min per hour grazing, whereas in the afternoons between 6–7 p.m., animals would graze during the entire observational period. After 5 p.m., the amount of time grazing increased with animals spending more than 50% of their time on that activity. This trend was also reported by Shinde *et al.* (1997) where grazing was generally observed at any time of day or night, but was most intensive in the morning and late afternoon until dusk. Lynch *et al.* (1992) explained that in continental areas grazing activity is concentrated to 4 hours after dawn and in the last 4 hours around sunset, but can easily start before dawn and extend long into the dark.

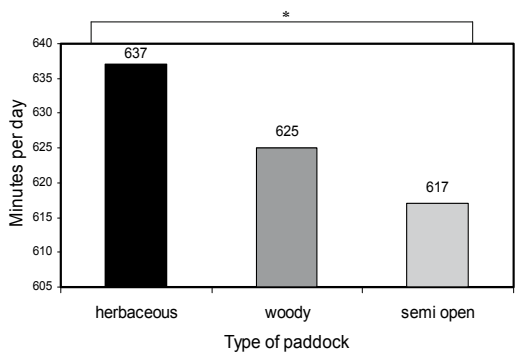

Figure 3: *Grazing time in different types of paddock. Difference between bars:* $F_{2,60} = 5.23$; $*P < 0.001$.
Slika 3: *Čas paše v različnih vrstah čredink. Razlika med stolpci:* $F_{2,60} = 5,23$; $*P < 0.001$.

As shown in Fig. 3, we found significant differences in the grazing duration in different types of paddock ($P < 0.001$). Sheep spent the most time grazing at the herbaceous paddock whereas at the woody and semi open paddock the grazing was reduced to a similar level. This means that soil (grass) and aerial (woody) feeding behaviour differed. According to Vidrih *et al.* (1996) and Baumont *et al.* (2000), differences in herbage composition between types of paddock can affect grazing duration, and may explain the differences observed in our study. There was an additional effect of the individual on grazing duration ($P < 0.001$; Fig. 4). The variation in the average grazing duration over the 12 observed days ranged between 592 and 662 min.

The temperature did not significantly affect the grazing time ($P > 0.1$), but it affected the circadian rhythm of grazing ($P < 0.05$; Fig. 5). When temperature was below 15.4 °C, sheep grazed more during 9 a.m. and 4 p.m. than when above 15.4 °C. This is a predictable result since ruminants tend to avoid grazing during the hottest part of the day and thus reduce their daily grazing time. To avoid thermal stress ruminants find shade and spend more time resting (Shinde *et al.*, 1997).

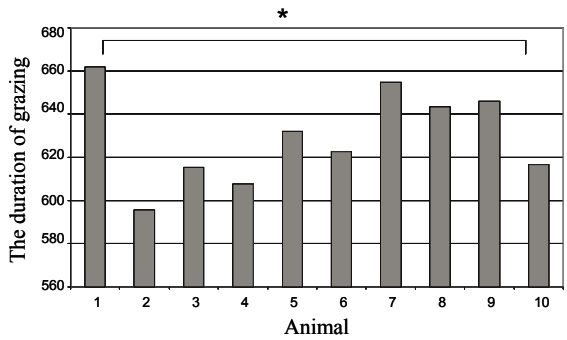

Figure 4: *The average grazing time of an individual sheep. Difference between bars:* $F_{9,60} = 4.58$; *$P < 0.001$.
Slika 4: *Povprečen čas paše za posamezno žival. Razlika med stolpci:* $F_{9,60} = 4{,}58$; *$P < 0.001$.

On the first observed day, sheep spent less time grazing compared to the second day ($F_{1,60} = 122.33$; $P < 0.001$; Table 1). Sheep thus showed different foraging strategies between days due to shortages in herbage availability during the second day. This is based on the conclusions of Baumont *et al.* (2000), where it is suggested that one of the limiting factors of grazing is the herbage availability and growth stage of vegetation.

3.2 DRINKING

Animals had free access to water. On the basis of visual observations, it can be stated that ewes approached the water trough very suddenly and they would always run towards it. It was observed that when one or two animals started to approach the watering point, the other animals followed. According to this, we support the conclusion that drinking behaviour by sheep is socially facilitated (Forkman, 1996) and a synchronised behaviour (Rook and Penning, 1991), with similar findings in Vidrih *et al.* (1996). As all the animals arrived at the drinking source at approximately the same time, competition for water was most probably high (Ehrlenbruch *et al.*, 2010). When sheep are housed indoors, an increased number of ewes per nipple drinker may lead to an increase in total drinking time and number of displacements (Bøe, 1998).

Table 1: *Differences in the grazing duration between 2 observed days (variables are given as mean min ± SD)*
Preglednica 1: *Razlike med časom paše v dveh opazovanih dneh (spremenljivke so podane kot min ± SD)*

	Day			
Behaviour	1	2	F-value	P-value
Grazing time	589.25 ± 33.75	663.1 ± 23.99	122.33	< 0.001

On some days some ewes were not observed to drink during the observational period. However, Lynch *et al.* (1992) concluded that during summer sheep should drink at least once a day, otherwise they tend to reduce grazing time in the heat and increase grazing at night or early in the morning when dew is on the grass. According to our results, it can be concluded that in the case of a small flock of grazing sheep, enough space for drinking water should be available at the pasture, so that the

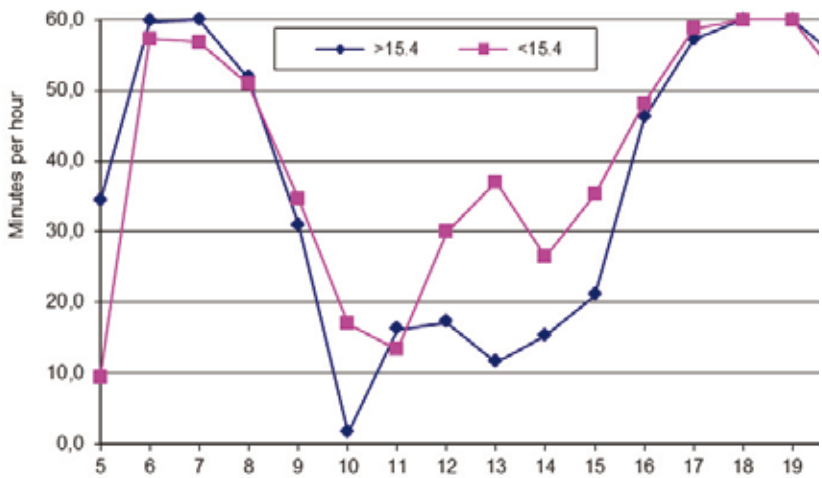

Figure 5: *Grazing rhythm at temperatures above and below the average daily temperature. Difference between the lines:* $F_{1,60} = 4.08$; $P < 0.05$.
Slika 5: *Pašni ritem nad in pod povprečno dnevno temperaturo. Razlika med nad in pod povprečno dnevno temperaturo:* $F_{1,60} = 4.08$; $P < 0.05$.

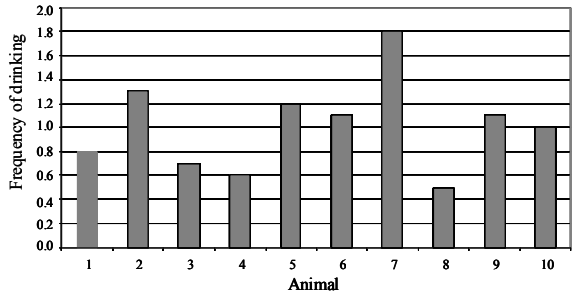

Figure 6: *Frequency of drinking of an individual sheep.*
Slika 6: *Pogostnost pitja pri posamezni ovci.*

majority of animals have access to the water at the same time.

The drinking frequency was low during the observation period (Table 2). The average drinking frequency during this time was 0.99 per animal. The maximum number of drinking bouts per observation period was two. The animals drank the most frequently in the morning between 8 a.m. and 9 a.m., and between 3 p.m. and 7 p.m. in the afternoon. The water usage differed between the types of paddock. Sheep drank the most in the semi open paddock, but in the herbaceous and the woody paddock the frequency was lower, yet the same

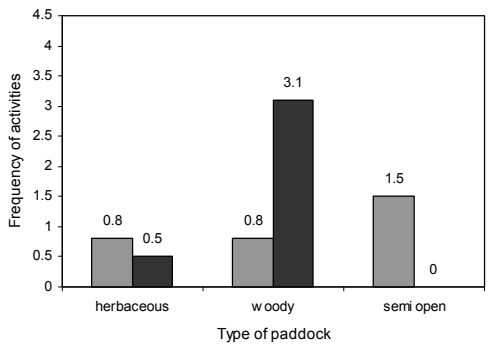

Figure 7: *Frequency of drinking (grey bar) and salt consumption (black bar) in paddock with different types of vegetation.*
Slika 7: *Pogostnost pitja (sivi stolpec) in konzumacija soli (črn stolpec) v čredinkah z različno vegetacijo.*

(Fig. 7). Climate conditions affected drinking behaviour as well. When the temperature was higher, there was a greater need for water. Water usage was different among animals, showing genetic influence on the behaviour expressed. The animal that drank the most often was one of the two ewes that spent the most time grazing. The lowest frequency among ewes was 0.5 and observed by animal 8.

Table 2: *Drinking frequency and salt intake frequency between the observation days*
Preglednica 2: *Pogostnost pitja in konzumacije soli med opazovanimi dnevi*

Observation days	Drinking	Salt intake
1	1.1	0.0
2	1.0	0.1
3	0.9	0.0
4	0.9	0.0
5	1.4	2.2
6	1.4	2.5
7	0.8	1.3
8	0.4	0.5
9	2.1	4.5
10	0.9	3.1
11	0.3	0.3
12	0.7	0.5
Mean	0.99	1.25

3.3 SALT CONSUMPTION

Salt appetite or sodium hunger is a motivational state in which animals seek out and ingest substances containing sodium (Johnson and Thunhorst, 1997). Sheep in our study had access to feed on leaves from bushes and trees. The expected result is that the frequency of salt intake was the highest at the woody paddock, with a lower value for the herbaceous paddock. At the semi open paddock animals were not seen to consume salt during the observation period (Fig. 7). Salt consumption occurred mainly in the morning between 6 a.m. and 8 a.m., and between 5 p.m. and 9 p.m. in the afternoon. The average frequency of salt consumption per day was 1.25 (Table 2). However, individual variation existed between the animals for salt consumption (Fig. 8). This may show that sheep differ in their taste preference of feed found in the environment (Baumont *et al.*, 2000). Vidrih *et al.* (1996) analysed the concentration of particular minerals in the leaves of hazel and beech tree, with leaves containing 0.15–1.17 g so-

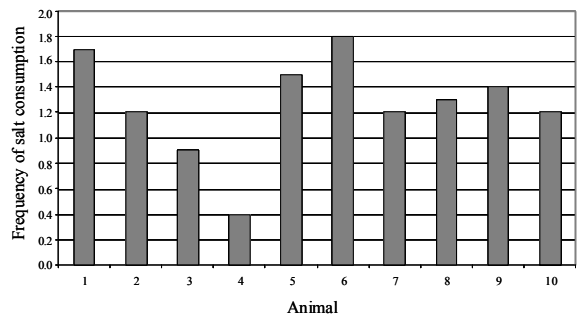

Figure 8: *Frequency of salt consumption of an individual sheep.*
Slika 8: *Pogostnost konzumacije soli pri posamezni ovci.*

dium/kg of dry matter. Sheep weighing less than 50 kg have a nutritional requirement of 1.5 g of sodium in dry matter per day to maintain optimum health (Vidrih *et al.*, 1996). It was observed that animals would chew the bark off trees or wood at the woody paddock. This might be a consequence of the lack of sodium (Kermauner, 1996). However, further study of the nutritional value of forages is required.

4 CONCLUSIONS

For sheep, time spent grazing was on average 10.5 hours per day during the light hours of 5 a.m. to 9 p.m. The type of paddock influenced the grazing duration and daily rhythm. The frequency of water drinking was overall low with animals drinking less than once per day. The highest water usage was recorded at the semi open paddock. It can be concluded that enough space for drinking should be available on the pasture, especially at semi open paddock, since sheep are showing synchronised drinking behaviour. The frequency of salt consumption was the highest at the woody paddock, which can be explained by the lack of sodium in the leaves and branches that are often eaten. It is advised to provide additional sodium, in the form of salt, under such environmental conditions. In conclusion, foraging behaviour under grazing conditions is greatly influenced by differences between individual ewes and forage conditions.

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