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The sulla (*Hedysarum coronarium* L.) as a complement of a grass-based farming system: Effect of time allowance of sulla pasture upon intake and performance of dairy ewes

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SUMMARY – The effect of time allowance of sulla pasture on intake and performance of lactating sheep was studied during spring using 64 Sarda ewes. Four groups were allowed to graze plots of annual ryegrass (*Lolium rigidum*, S0), sulla (*Hedysarum coronarium*, S24), or sub-plots of the above species. In this case, after morning milking, the groups were allocated for 3 hours (S3) or 6 hours (S6) to sulla and the rest of the day to ryegrass sub-plots. The herbage intake, measured by the n-alkane method, was undifferentiated between groups in April, while both forages were at a growing stage. In contrast, differences were evident in May (reproductive stage of forages) when herbage intake was higher in all sulla fed groups as compared with S0 (P < 0.06). A similar response was shown by the intake of digestible dry matter (DM) and milk yield. Milk urea was linearly related to dietary crude protein (CP) (P < 0.001). To conclude, a time allowance on sulla of 3 h daily enhances intake and performance of dairy sheep grazing ryegrass-based pastures during late spring.

Key words: Sulla, grazing, intake, sheep, alkanes, milk urea.

***RESUME –** "Le sainfoin d'Espagne (*Hedysarum coronarium *L.) comme complément de systèmes d'élevage basés sur l'utilisation de graminées : Effets des différents temps de séjour au pâturage sur l'ingestion et les performances des brebis laitières". Quatre lots de brebis sardes pâturaient, respectivement le ray-grass annuel (S0), le sainfoin d'Espagne (S24) ou des sous-parcelles des deux espèces. Dans ces derniers cas, les deux lots, après la traite du matin, étaient conduits au pâturage sur des parcelles de sainfoin pendant 3 (S3) ou 6 heures (S6) tandis que le reste du jour, elles restaient sur le ray-grass. L'ingestion d'herbe, mesurée avec la méthode des alcanes, n'a pas été différente dans les lots en avril (fourrages en stade végétatif). Dans le mois de mai (stade reproductif des fourrages), au contraire, l'ingestion d'herbe a été plus haute dans les lots qui pâturaient le sainfoin (P < 0,06). On a trouvé une réponse similaire sur l'ingestion de matière sèche (MS) digestible et sur la production de lait. L'urée dans le lait a été en relation linéaire avec les matières azotées totales (MAT) dans le régime (P < 0,001). En conclusion, un pâturage complémentaire du sainfoin de 3 heures par jour, augmente l'ingestion et les performances de brebis laitières au printemps.*

***Mots-clés :** Sainfoin d'Espagne, pâturage, ingestion, ovin, alcanes, urée dans le lait.*

Introduction

In the arable non-irrigated Sardinian areas, dairy sheep farming is mainly based on grazed cereals and semi-natural pastures, among which the self-reseeding annual ryegrass (*Lolium rigidum* Gaudin). This forage can persist for several years, providing satisfactory biomass yields (Franca *et al*., 1996; Sitzia *et al*., 1996). The sulla (*Hedysarum coronarium* L.), a short-lived perennial legume, can successfully complement the annual ryegrass, due to the maintenance of a high quality of the herbage on offer throughout whole spring as compared to the annual ryegrass (Molle *et al*., 1998). A time allowance on sulla pasture for 6 hours daily in sheep basically fed on annual ryegrass resulted in better performance than grazing a pure ryegrass sward. On the other hand, combining the species in a spatial mixture brought about a trend towards sulla overgrazing (Molle *et al*., 2000). The aim of this study was to assess the effect of different time allowances on sulla pasture on intake and performance of milked ewes, basically fed on annual ryegrass.

Materials and methods

The experiment was undertaken in 1998 at Bonassai research station (NW Sardinia 41°N latitude, mean annual rainfall 547 mm) and lasted from March 13 to May 26. The pasture consisted of four plots (7500 m^2 each), one of pure annual ryegrass (ecotype Nurra) (plot L), one of pure sulla (cv. Grimaldi) (S) and two other plots each including 3750 m^2 of annual ryegrass and 3750 m^2 of sulla (plots S3 and S6). Each plot was split into equal-sized sub-plots. All plots were established in October 1997. On March 12, 64 mature Sarda ewes at the 3rd month of lactation were blocked by body weight (BW, mean ± SE, 45.68 ± 0.67 kg), body condition score (BCS, 2.56 ± 0.02), and milk yield (MY, 1211 ± 34 g/d) into four groups of 16 ewes. After morning milking the groups were allocated for *ca.* 24 h daily (milking periods excluded) to sub-plots of annual ryegrass (group L), sulla (group S) or both the above specie. In this case allocation times were 3 h (group S3) or 6 h on sulla (group S6) and the rest of daytime on the ryegrass. The plots were rotationally grazed; grazing period lasted 14 d throughout. The ewes were machine-milked at 07:30 h and 14:30 h.

Herbage mass was measured before and after grazing using the enclosure cage method (six 1 × 0.5 m^2 quadrates per sub-plots). The intake of DM (DMI) and the *in vivo* DM digestibility (DMD) were assessed on two occasions (April 6-10 and May 4-8) on 8 ewes per group by the n-alkane method as described by Molle *et al*. (1998). Hand-plucked samples (n = 3 per sub-plot) were taken during the intake measurement periods. Herbage samples were freeze-dried and subsampled for measuring dry matter (DM), crude protein (CP) and fibre [neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL)] and CP fractions, non-protein nitrogen (NPN), buffer soluble protein (BSP) and acid detergent insoluble nitrogen (ADIN; Licitra *et al*., 1996). Moreover water-soluble carbohydrates (WSC), tannic phenolics (TP) by Folin-Ciocalteu and *in vitro* DM digestibility (IVDMD) by pepsine-cellulase method were determined. BCS and BW were assessed at the beginning and the end of the experiment. Individual MY was measured weekly. Milk samples were assayed for fat, protein (N*6.38) (infra-red) and urea (differential pH). Data on herbage chemical composition, pooled by forage species, were analysed by one-way ANOVA. Results on DMI, DMD, diet composition, MY and milk composition were analysed by GLM, using the time allowance on sulla as fixed effect. Means were separated by *t* test for multiple comparisons.

Results and discussion

Herbage mass at the end of each grazing period was above the minimum threshold regarded as limiting sheep intake (Penning, 1986; Fig. 1).

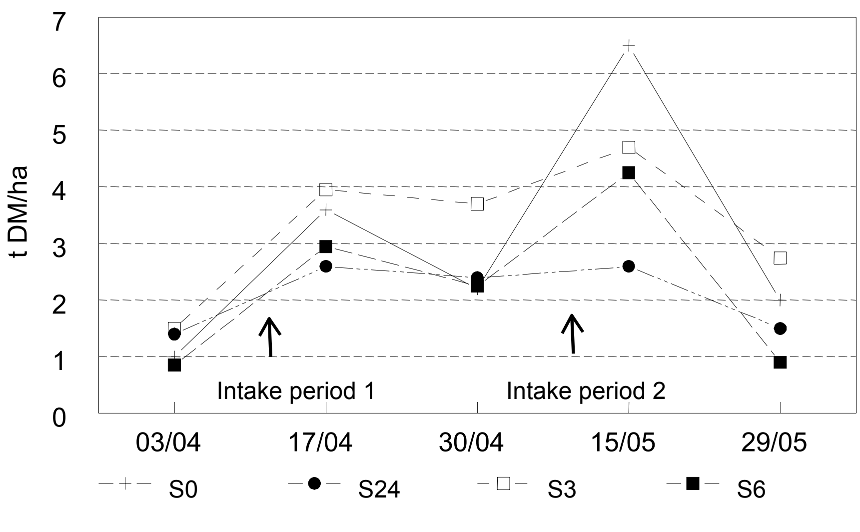

Fig. 1. Average biomass availability at the end of each grazing period.

In both April and May, sulla showed higher CP, ADL, TP and lower WSC, NDF and ADF than ryegrass (Table 1).

In contrast IVDMD was higher in ryegrass in April but the reverse was true in May when both forages were at a reproductive stage. Interestingly the current data on sulla, while confirming the results by Terril *et al*. (1992) about the high non-structural carbohydrates (NSC) to NDF ratio in spring (April in our case), show that 80-50% of NSC consists of insoluble carbohydrates (estimated as difference between NSC and WSC). It is also noticeable that, similarly to carbohydrate, readily fermentable nitrogen fractions (NPN in May and BSP) tended to be lower in sulla than ryegrass while ADIN showed an opposite trend.

Table 1. Chemical composition of the herbage selected in April (period 1) and May (period 2). Data are means pooled by species; n = 9 per each forage species

Item	Period 1 (April)			Period 2 (May)		
	Ryegrass	Sulla	P<	Ryegrass	Sulla	P<
DM (%)	18.04	16.17	NS	21.53	16.71	***
CP (% DM)	20.83	26.70	***	14.27	25.53	***
NPN × 6.25 (% CP)	9.01	9.27	NS	17.77	10.12	***
BSP (% CP)	33.00	13.41	***	16.27	9.43	*
ADIN × 6.25 (% CP)	22.30	26.76	NS	6.22	31.39	***
WSC (% DM)	9.78	6.92	**	9.67	7.54	*
NSC† (% DM)	24.75	33.88	***	20.32	20.32	NS
NDF (% DM)	40.30	25.87	***	55.49	41.47	***
ADF (% DM)	20.96	14.63	***	30.16	26.13	**
ADL (% DM)	0.76	4.42	***	2.67	12.67	***
TP (% DM)	1.28	2.25	***	0.53	3.04	***
IVDMD (%)	87.35	78.79	***	66.18	74.20	***

†Calculated as follows: NSC (% DM) = 100 − Ash (% DM) − NDF (% DM) − CP (% DM) − EE (% DM).
*P < 0.05, **P < 0.01, ***P < 0.001, NS = P > 0.05.

In April, total herbage DMI was undifferentiated between groups (Table 2). Due to the presence of some annual ryegrass as weed in sulla plots, some intake of ryegrass was detectable also in S24 group. The digestibility decreased along with the time allowance on sulla (P < 0.001) but total digestible DMI (DDMI) was not affected by the treatments. In May total herbage intake tended to be higher in sulla-fed sheep than in pure ryegrass-fed counterparts (P < 0.06). The percentage of sulla in the diet increased linearly with the time allowance on sulla (P < 0.001) but the intake of sulla did not differ between S3 and S6. DMD increased with the time on sulla and this resulted in higher intake of digestible DM (DDMI) in all sulla fed groups (P < 0.2 for the comparison between S6 and S0).

Table 2. Voluntary intake, *in vivo* digestibility and intake of digestible DM (DDMI) of annual ryegrass (L) and sulla (S) grazed by dairy ewes with a time allowance on sulla of 0 (S0), 3 (S3), 6 (S6) and 24 h daily (S24). Least square means, n† = 8 per group

	Intake of L (g DM)	Intake of S (g DM)	Total intake (g DM)	*In vivo* digestibility (% DM)	DDMI (g DM)
Period 1 (April)					
S0	2177a	0a	2177	75.43a	1642
S3	1442b	303b	1745	73.64a	1290
S6	1264b	600c	1864	73.59a	1373
S24	263c	1670d	1933	66.48b	1296
P<	***	***	NS	***	NS
Period 2 (May)					
S0	1213a	0a	1213	55.90a	678a
S3	1172a	547b	1719	65.12b	1126b
S6	795b	650b	1445	60.92b	883ab
S24	178c	1668c	1846	64.76b	1195b
P<	***	***	0.06	**	*

†n = 7 in group S3.
a,b,c,dMeans in column within period with different letter differ at P < 0.05.
*P < 0.05, **P < 0.01, ***P < 0.001, NS = P > 0.05.

These results as a whole confirm the high intake and digestibility of sulla, even during flowering stage when the quality of annual ryegrass markedly decays (Molle *et al*., 1998, 2000). According to Douglas *et al*. (1999) this could be related to the high palatability of sulla as compared to ryegrass stems. As a matter of fact in May, sulla stems (n = 1 sample per plant component) showed an IVDMD close to that of leaves (73 vs 76%, respectively) while in ryegrass the corresponding IVDMD values were 62 and 80%, respectively. Moreover sulla stems contained more WSC and less TP than sulla leaves (18 vs 14% DM and 0.9 vs 1.9% DM, respectively).

The improvement of nutrient status of sheep was not linearly related to the time allowance on sulla since S3 tended to higher DDMI than S6. This could partially be explained by a trend towards a higher DM availability in S3 than S6 plots (Fig. 1). Another possible reason is the feeding behaviour of sheep grazing sulla. Recent results of our laboratory point out that grazing time in milked ewes allotted on sulla for 6 h daily (i.e. managed as S6) averages around 3 hours (G. Molle, pers. comm.). It is probable that grazing time in S3 and S6 was not so much differentiated and this is consistent with their similar intake of sulla. The relatively low palatability of sulla when offered as pure pasture can be in relationship with its TP content (Silanikove *et al*., 1997).

The ewes allowed on sulla pasture all day long increased their BW more than the counterparts: 5.12 (S24) vs 0.69 (S6), 0.18 (S3) and 1.78 kg (S0), P < 0.001. This was also evident in terms of BCS [0.20 (S24) vs 0.06 (S6), 0.07 (S3) and 0.02 BCS units (S0), P < 0.05 between S24 and S0 or S6 and P < 0.06 for the comparison between S24 and S3].

In April, MY and milk composition was not affected by the time allowance on sulla with the exception of milk urea (Table 3). In May sulla pasture exerted a clear raising effect on milk yield. In this period a positive linear relationship was found between time on sulla and urea (P < 0.001). Results on MY were similar to previous data (Molle *et al*., 1998, 2000) for S24 and S6 as compared to S0. In contrast, the lack of difference between S6 and S3 for milk performance, in keeping with nutrient intake profile, is a novel outcome. Pooling all individual data, milk urea was found linearly correlated with CP intake (P < 0.001, not shown) and dietary CP level: milk urea (mg/dl) = 1.31 $\times$ CP (DM %) + 13.43; R^2 = 0.31; P < 0.001. Strict linear relationships with higher slopes were found by Cannas *et al*. (1998) pooling average data from high-concentrates non-tannic diets. TP play a role in depressing blood and milk urea as a consequence of binding dietary proteins (Stienezen *et al*., 1996; Decandia *et al*., 2000). However other factors such as the synchronization of the rate of N and energy release in the rumen cannot be ruled out (Sinclair *et al*., 1993).

Table 3. Milk yield and milk composition of dairy ewes grazing annual ryegrass (L) and sulla (S) with a time allowance on sulla pasture of 0 (S0), 3 (S3), 6 (S6) and 24 h daily (S24). Least square means, n = 16 per group

	Milk yield (g)	Fat (%)	Protein (%)	Lactose (%)	Urea (mg/dl)
Period 1 (April)†					
S0	1213	5.75	5.71	4.25	39.9a
S3	1317	6.21	5.90	4.24	43.4b
S6	1307	5.74	5.85	4.24	50.5d
S24	1489	5.87	5.84	4.24	47.2c
P<	NS	NS	NS	NS	***
Period 2 (May)††					
S0	615c	6.65	5.88	4.40	27.8a
S3	848b	6.46	5.81	4.53	35.3b
S6	791bc	6.32	5.98	4.62	38.2c
S24	1122a	6.65	6.00	4.75	41.4d
P<	***	NS	NS	NS	***

†From March 24 to April 27.
††From April 28 to May 26.
[a,b,c,d]Means in column within period with different letter differ at P < 0.05.
***P < 0.001, NS = P > 0.05.

Conclusion

To conclude sulla pasture confirms its efficacy for improving intake of nutrients and performance of dairy sheep grazing ryegrass-based pastures during spring. In particular these benefits become evident when annual ryegrass feeding value begins to decay. In these conditions the allocation of sulla pasture for 3 hours daily results in higher intake and dairy performance than a pure ryegrass-based diet.

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