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in

Ledin I. (ed.), Morand-Fehr P. (ed.).
Sheep and goat nutrition: Intake, digestion, quality of products and rangelands

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 52

2000
pages 187-192

Intake and performance of dairy ewes grazing Mediterranean forages either as pure or mixed swards

G. Molle, M. Sitzia, M. Decandia, N. Fois, G. Scanu and S. Ligios
Istituto Zootecnico e Caseario per la Sardegna, 07040 Olmedo, Italy

SUMMARY – The feeding values of the self-reseeding annual ryegrass (*Lolium rigidum* Gaudin), and the short-lived legume sulla (*Hedysarum coronarium* L.), were assessed in the years of seeding (R1) and self-seeding (R2) for the former, in years one (S1) and two (S2) for the latter and in the year of seeding for space (SM) and time (TM) mixtures of them using six groups of grazing Sarda milk ewes. The main objective was to identify the complementary nutritive patterns of the pastures for sheep milk production. S1 contained a high content of annual ryegrass as weed (28%). Digestible dry matter intake was higher ($P < 0.001$) in S2, TM and SM than in R2 with the other groups being intermediate. Crude protein intake was higher for sulla treatments and for R1 compared with R2 ($P < 0.001$). Contents of sulla in the diet were similar for S1 (66%) and SM (73%) compared with 20% for TM. Sulla increased ($P < 0.01$) ewe milk yield and improved body fat recovery as assessed by D_2O dilution. Only R2 ewes showed depletion of body protein ($P < 0.05$). There is scope to integrate these species in ewes' diets and TM appears better in terms of pasture management and animal performance.

Key words: Alkanes, body composition, D_2O, digestibility, intake, sulla, ray grass, ewe, pasture.

RESUME – *"Quantités ingérées et performances de brebis laitières pâturant des fourrages méditerranéens cultivés seuls ou en association". La valeur alimentaire d'un ray-grass annuel (*Lolium rigidum *Gaudin) et du sainfoin d'Espagne (*Hedysarum coronarium *L.) a été évaluée en comparant six lots de brebis Sardes. Celles-ci pâturaient respectivement : le ray-grass ou le sainfoin l'année du semis (R1 et S1) ou l'année après celle du semis (R2 et S2) ; un "mélange spatial" (SM) ou un "mélange temporaire" (TM) des deux espèces exploitées l'année de leur semis. Dans la parcelle S1 était présent, outre le sainfoin, le ray-grass comme adventice (28%). La quantité de matière sèche digestible ingérée a été plus élevée pour les brebis S2, TM et SM par rapport à celles R2, les autres lots étant intermédiaires. L'ingestion de protéine brute a été plus élevée pour les brebis dont la ration contenait du sainfoin et en R1 par rapport à R2 (P < 0,001). La composition de la ration a été similaire entre S1 et SM (66% et 73% de sainfoin) tandis que la proportion de sainfoin était seulement de 20% en TM. La production laitière a été plus élevée pour les brebis dont la ration contenait du sainfoin (P < 0,01). L'estimation de la composition corporelle à l'aide de la* D_2O *montre que ces brebis ont eu aussi une plus forte tendance à reconstituer les lipides corporels. Les brebis R2 ont été les seules qui ont montré une diminution des protéines corporelles (P < 0,05). En conclusion : (i) il y a des avantages dans l'incorporation des deux fourrages dans la ration des brebis ; et (ii) TM donne les résultats les plus encourageants autant pour la gestion des prairies que pour les performances animales.*

Mots-clés : *Alcanes, composition corporelle,* D_2O*, digestibilité, ingestion, sainfoin d'Espagne, ray-grass, brebis, pâturage.*

Introduction

The self-reseeding annual ryegrass (*Lolium rigidum* Gaudin) and the short-lived legume sulla (*Hedysarum coronarium* L.) are regarded amongst the most interesting forages for dairy sheep farming in Sardinia (Fois *et al.*, 1996). In particular the annual ryegrass is featured by a good persistence (Sitzia *et al.*, 1996) and satisfactory carrying capacity as well as high feeding value during the autumn-winter period (Molle *et al.*, 1998). The sulla shows some complementary characteristics, yielding a high amount of palatable herbage during spring (Molle *et al.*, 1998). Due to these reasons there is scope for studying the effect of integrating these forage species in the diet of dairy ewes. The main aim of this experiment was to assess during spring the feeding value of these species in the first and second year after pasture establishment, as unique or mixed diet components. The effect of these treatments on milk yield and body composition were also evaluated.

Materials and methods

The experiment was carried out at the "Bonassai" research farm (33 m a.s.l., mean annual rainfall 569 mm) from March 24 to April 29, 1997. Six experimental plots were compared on a flat, calcareous soil. Each consisted of two 3750 m^2 sub-plots of annual ryegrass (cv. Nurra) in the year of seeding (R1) or in the year of self-reseeding (R2); sulla (cv. Grimaldi) of one (S1) or two years (S2); a "space mixture" (SM, 50% sulla and 50% ryegrass by area on adjacent strips) and a "time mixture" (TM, 50% sulla and 50% ryegrass by area, time allowance on sulla: 6 hours daily from 8:30 to 14:30). Both mixtures included ryegrass and sulla in the year of seeding.

Seventy-two lactating and twelve dry, non-pregnant mature Sarda ewes, equally managed in the pre-experimental month, were blocked the former for body weight (BW) and previous milk yield (MY) and the latter for BW, and were divided into six groups, randomly allotted to the experimental plots. The groups were allowed to graze all day long without receiving any supplement. The duration of each grazing period for each sub-plot was 14 days. The ewes were machine-milked twice daily at 08:00 and 15:00. Herbage mass and its composition (1 x 0.5 m^2, n = 6-8 per sub-plot) were measured at the beginning and the end of each grazing period. Diet composition, herbage dry matter intake (DMI) and *in vivo* dry matter digestibility (DMD) were assessed once (9-18 April) on 6 lactating ewes per group, using the n-alkanes method as described by Molle *et al.* (1998). Herbage of each species on offer was hand-plucked during the faeces sampling period. All faeces and herbage samples were freeze-dried and subsamples were analysed for n-alkane determination. Herbage samples were also analysed to measure crude protein (CP), neutral detergent fibre (NDF), acid detergent lignin (ADL), total and tannic polyphenols (PP) using the Folin-Ciocalteu method (Cabiddu *et al.*, this volume).

Diet composition as a proportion of the sown species in the diet of each ewe, was assessed using as discriminating criterion the ratio between C_{29} and C_{31} in the herbage and in the faeces, the latter corrected by the recovery rate of the alkanes reported by Dove *et al*. (1989). The calculation was performed using the least square optimisation procedure (Dove and Moore, 1995). The estimate of DMD was performed using C_{36} as external marker corrected by its faecal recovery (0.947). Milk yield, milk fat, protein and urea were measured at the beginning and the end of the trial and then fortnightly throughout. Body weight and body composition were measured at the beginning and the end of the experiment. Body composition was evaluated using the deuterium oxide (D_2O) method only for the ewes whose D_2O diffusion space fell within the range observed in a previous validation experiment (Ligios *et al.*, 1995). The effect of treatments on the variables under study was assessed by ANOVA or ANCOVA, using pre-experimental measurements as covariate when appropriate. Treatment means were separated using t-tests for pre-planned comparisons.

Results and discussion

Herbage mass on offer was relatively high in all plots through the trial (Table 1). Post grazing herbage mass was relatively high and never fell below 1.3 t DM/ha.

Post-grazing mass of sulla in SM tended to be lower ($P < 0.08$) than in TM: 0.35 and 0.53 t DM/ha (SM) vs 1.57 and 1.78 t DM/ha (TM), in grazing period 1 and 2, respectively. The sub-plots of sulla in S1 and TM were featured by a high percentage of weeds, mainly annual ryegrass (Table 1). R2 showed higher tiller density ($P < 0.001$) and tended to higher amount of heads per hectare than R1 at the end of the experiment (0.75 vs 0.60 t DM/ha, respectively). The composition of the herbage selected during the intake measurement period in each sub-plot is represented in Table 2. It is noteworthy that the diet of ewes grazing sulla included more CP, ADL and total PP and less NDF than the diet of pure ryegrass-grazing ewes. An extremely low CP was found in R2-grazing diet.

The DMI was higher in S2 than S1, R1 and R2 treatments (Table 3). The mixtures were intermediate. The DMI of S2 per unit of metabolic weight, resulted as high (142 g DM/kg $LW^{0.75}$) as previously found, in terms of organic matter (OM) by Terrill *et al.* (1992) in sulla-grazing mutton sheep (132 g OM/kg $LW^{0.75}$).The difference in DMI between S2 and S1 can be partially explained, besides the diet composition (see below), by a greater amount of leaves on offer at the beginning of the grazing period 2 (2.40 vs 1.91 t DM/ha, respectively, NS). The crude protein intake (CPI) was the highest in S2 and the lowest in R2. The DMD tended to decrease from ryegrass to sulla and from first to second year in both forages.

Table 1. Features of the pastures on offer to Sarda ewes grazing either sulla (S1 and S2), annual ryegrass (R1 and R2), a space mixture (SM, 50% of either species by area) or a time mixture (TM, succession of grazing periods during daytime: sulla 814 h, the rest ryegrass). Means ± SE; n = 6, pure swards or n = 4, SM and TM

Treatment (species)	Herbage mass (t DM/ha)	Weeds (% DM)	Leaves† (t DM/ha)	Tillers-growing points† (no./m^2)
S1	2.6 ± 0.3	27.6 ± 3.9	1.8 ± 0.2	21 ± 10
S2	3.5 ± 0.3	9.5 ± 1.8	1.7 ± 0.2	627 ± 82
SM (sulla)	2.1 ± 0.3	12.3 ± 5.1	1.7 ± 0.3	56 ± 28
SM (ryeg.)	2.7 ± 0.4	10.7 ± 4.2	1.1 ± 0.2	1208 ± 183
TM (sulla)	2.9 ± 0.3	28.4 ± 4.3	1.9 ± 0.3	16 ± 4
TM (ryeg.)	3.9 ± 0.3	1.8 ± 0.6	1.8 ± 0.1	2318 ± 380
R1	4.0 ± 0.4	3.7 ± 1.4	1.6 ± 0.1	1834 ± 109
R2	4.1 ± 0.3	0.3 ± 0.1	1.7 ± 0.1	6458 ± 380

†Means refer to the pre-grazing composition of the sown species.

Table 2. Chemical composition of the herbage selected by Sarda ewes grazing sulla (S1 and S2), annual ryegrass (R1 and R2), a space mixture (SM) or a time mixture (TM). Means and SED (SE of the difference) (n = 3 per species)

Treatment (species)	DM (g/kg)	CP (g/kg DM)	NDF (g/kg DM)	ADL (g/kg DM)	Total PP† (g/kg DM)	Tannic PP†† (g/kg DM)
S1	232^{b}	204^{b}	215^{b}	39^{c}	52^{ab}	40^{a}
S2†††	154^{c}	255^{a}	296^{b}	84^{a}	54^{a}	20^{bc}
SM (sulla)	173^{c}	250^{a}	239^{b}	53^{b}	40^{b}	26^{b}
TM (sulla)	232^{b}	202^{b}	224^{b}	36^{c}	40^{b}	29^{ab}
SM (ryeg.)	332^{a}	145^{c}	456^{a}	11^{d}	14^{c}	4^{c}
TM (ryeg.)	266^{b}	150^{c}	450^{a}	11^{d}	14^{c}	3^{c}
R1	246^{b}	166^{c}	434^{a}	9^{d}	17^{c}	5^{bc}
R2	291^{ab}	107^{d}	454^{a}	9^{d}	15^{c}	3^{c}
Mean	249	179	351	27	29	18
SED	17	11	14	1	2	1

†Total polyphenols.

††Tannic polyphenols.

†††N = 1.

a,b,c,dMeans within columns followed by different letters are significantly different ($P < 0.05$).

Tannic PP can be involved in the reduction of sulla DMD (Stienezen *et al.*, 1996). However, the lower DMD in S2 compared to S1 cannot be explained by the proportion of tannic PP in the diet (Table 2) or by its amount whereas the ADL level (Table 2) and the high rate of rumen outflow played probably a major role. The low DMD measured in R2-ewes probably stems from a CP deficit in their diets.

In terms of DDMI, the best results were performed by the mixtures and S2, and the worst by R2; S1 and R1 showed intermediate results.

The diet composition of S1 was undifferentiated by that of SM, whereas S2-grazing ewes had practically just sulla in their diets. On the contrary, sulla in TM diets averaged 20%. This low figure agrees with the afore mentioned post-grazing results and can be explained by the higher probabilty in TM than SM of encountering ryegrass patches in the sulla subplots (see weed % in Table 1). Another reason could be a reduction of the intake rate due to the increase in temperatures and radiation up to midday that could have hampered sulla consumption more in TM than SM-ewes.

Table 3. Intake of dry matter (DMI), crude protein (CPI), *in vivo* DM digestibility (DMD), digestible dry matter intake (DDMI) and diet composition as proportion of sown species in the diet of Sarda ewes grazing sulla (S1 and S2), annual ryegrass (R1 and R2), a space mixture (SM) or a time mixture (TM). Means and SED (SE of the difference); n = 6 per treatment

Treatment	DMI (g DM)	CPI (g CP)	DMD (g/kg DM)	DDMI (g DDM)	Ryegrass (% DMI)	Sulla (% DMI)
S1	1795[b]	344[c]	667[b]	1205[ab]	34.1[b]	65.9[b]
S2	2385[a]	597[a]	610[c]	1460[a]	5.4[a]	94.6[a]
SM	2091[ab]	464[b]	686[ab]	1442[a]	27.2[b]	72.8[b]
TM	1979[ab]	319[c]	708[a]	1407[a]	79.6[c]	20.4[c]
R1	1812[b]	302[c]	705[a]	1274[ab]	100.0[d]	0.0[d]
R2	1525[b]	164[d]	613[c]	937[b]	100.0[d]	0.0[d]
Mean	1943	370	667	1298	56.49	43.51
SED	101	36	12	73	9.0	9.0

[a,b,c,d]Means within columns followed by different letters are significantly different (P < 0.05).

Whichever the reasons, this result tends to fit in the model of herbivore selection at pasture by Newman *et al.* (1995). It predicts that lactating ewes at the beginning of a grazing day would exhibit, during c. 40 min, a 100% preference for a legume (clover) followed by a 100% preference for a grass (perennial ryegrass) lasting c. 6 hrs. Then a mixed legume-grass meal, covering most of the remaining grazing day, should occur. According to this model, the ewes grazing sulla in the morning TM were partially hampered to exert their relative preference for the legume in the second part of the grazing day due to the time-allowance restriction.

Average milk yield was higher in the ewes containing sulla in their diets without difference between pure or mixed diets (Table 4). On the contrary, the fat percentage was higher in the pure ryegrass diets. The protein content was lower in TM as compared with R2; the other groups behaved as intermediate. Milk urea concentration tended to parallel CP intake, being the upper and lower utmosts S2 and R2, respectively. Pure sward responses in this study agree with previous results (Molle *et al.*, 1998).

Table 4. Milk yield (MY) and milk composition in Sarda ewes grazing sulla (S1 and S2), annual ryegrass (R1 and R2), a space mixture (SM) or a time mixture (TM). Means and SED (SE of the difference); n = 12 per treatment

Treatment	MY (ml/day)	Fat (%)	Protein (%)	Urea (mg/100 ml)
S1†	1218[a]	5.88[a]	6.02[ab]	38.49[b]
S2	1184[a]	5.86[a]	6.01[ab]	43.54[a]
SM	1146[a]	5.48[a]	5.99[ab]	35.32[b]
TM	1202[a]	5.65[a]	5.83[b]	36.44[b]
R1	931[b]	6.52[b]	5.99[ab]	31.50[c]
R2	798[c]	6.15[b]	6.20[a]	18.37[d]
Mean	1078	5.92	6.01	33.88
SED	39	0.13	0.08	1.55

†N = 11.
[a,b,c,d]Means within column followed by different letters are significantly different (P < 0.05).

Body weight and body composition results are shown in Table 5. There was an increase of BW and lipid reserves that was maximum in TM. The lowest fat accretion was found in the ewes grazing R1.

Also protein content showed a slight positive trend in all groups with the exception for R2 that depleted some protein reserve, confirming a CP undernutrition state.

Table 5. Body weight (BW) and body composition at the beginning of the trial and their changes in Sarda ewes grazing sulla (S1 and S2), annual ryegrass (R1 and R2), a space mixture (SM) or a time mixture (TM). Means and SED (SE of the difference)

Treatment (n)	BW (kg)	BW change (kg)	Lipid (kg)	Lipid change (kg)	Protein (kg)	Protein change (kg)
S1 (10)	41.83	1.76[b]	5.13	2.11[bc]	5.52	0.04[a]
S2 (9)	42.30	2.65[ab]	4.73	2.81[ab]	5.60	0.09[a]
SM (11)	41.53	2.81[ab]	5.14	3.28[ab]	5.49	0.07[a]
TM (10)	41.29	3.32[a]	4.27	3.80[a]	5.53	0.09[a]
R1 (12)	41.48	1.33[bc]	5.72	0.88[c]	5.44	0.08[a]
R2 (11)	42.53	0.37[c]	5.06	2.03[bc]	5.60	-0.11[b]
Mean (63)	41.80	2.00	5.04	2.43	5.53	0.04
SED	0.75	0.31	0.43	0.31	0.06	0.02

[a,b,c]Means within columns followed by different letters are significantly different ($P < 0.05$).

Conclusions

Sulla improves the diet of dairy sheep grazing grasses during spring by increasing DDMI and CPI as compared with ryegrass and, particularly with the self-reseeded ryegrass R2. Hence it enhances sheep milk yield and, in the meantime, improves fat and protein reserve recovery.

The "time mixture" tested in this trial allows milk performance and body reserve recovery as good as the "space mixture" but shows the great advantage of decreasing the risk of sulla overgrazing. Further research is needed to better explore the management of these forage species within pastoral farming-systems.

Acknowledgements

This research was partially funded by the EU (INTERREG funds). The authors gratefully thank D. Dettori, S. Furesi, G. Meloni and S. Piconi for the technical assistance and A. Cabiddu, M. Delrio, M.A. Sanna and S. Porcu for carrying on the chemical analysis.

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