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Effect of polyethylene glycol on feeding behaviour of dairy goats browsing on bushland with different herbage cover

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SUMMARY – The effects of polyethylene glycol (PEG) on feeding behaviour, intake and milk production of 36 Sarda goats, at the end of lactation, browsing on a lentisk-based bushland with different herbage cover were studied. The goats were allotted to two groups that browsed 7 hours daily on 2 plots characterised by different cover proportions of woody and herbaceous species. These proportions were 90 vs 10% in one plot (W, low herbage cover) and 70 vs 30% in the other plot (H, high herbage cover). Each group was divided into two subgroups: one fed with 50 g/day of PEG 4000 MW (PS) and the other receiving no PEG supplementation (PU). The feeding behaviour was different between groups; H-goats had a higher grazing time, expressed as percentage of total observation time, than the counterparts (64 vs 58%, $P < 0.05$). The intake was not affected by the treatments. The percentage of the species eaten by the goats was different in the two groups: H-goats ate more herbaceous and less woody species than W-goats. In each group the PEG tended to affect the botanical composition of the diet. As a matter of fact PS ate more tanniniferous species than PU ($P = 0.12$). The different percentage of herbage cover as well as the PEG affected milk yield and composition. The average milk production was 473, 591, 540 and 589 ml respectively in W-PU, W-PS, H-PU and H-PS sub-groups with significant effect of herbage-cover × PEG interaction ($P < 0.05$). The milk urea was affected by herbage cover ($P < 0.001$) and PEG supplementation ($P < 0.001$). The effect of PEG is strictly dependent on pasture composition. Its efficacy as antitannic supplement is higher when the pasture is characterised by high proportion of tanniniferous species.

Key words: Tannins, PEG, intake, diet selection, Mediterranean bushland.

RESUME – *"Effet du polyéthylène-glycol sur le comportement alimentaire des chèvres laitières au pâturage sur parcours avec différentes proportions de couverture herbacée". On a étudié l'effet du polyéthylène-glycol (PEG) sur le comportement alimentaire, l'ingestion et la production de lait de 36 chèvres sardes en fin de lactation au pâturage sur parcours avec différentes proportions de couverture herbacée. Les chèvres ont été partagées en deux lots qui pâturaient pendant 7 heures/jour sur 2 parcours avec différentes proportions de couverture arborée et herbacée. Ces proportions étaient de 90 vs 10% dans un plot (W, basse couverture d'herbe) et 70 vs 30% dans l'autre (H, haute couverture d'herbe). Chaque lot a été partagé en deux sous-lots : un (PS) recevait 50 g/jour de PEG (PM 4000) et l'autre (PU) ne recevait pas de PEG. Le comportement alimentaire des lots a été différent, l'activité de pâturage en pourcentage a été plus intense dans le lot H (64 vs 58%, $P < 0,05$). Le PEG n'a pas affecté le comportement alimentaire. Aucune différence significative n'a été observée pour l'ingestion moyenne au pâturage ; tandis que la composition botanique a été différente. Les chèvres du lot H ingéraient plus d'espèces herbacées et moins d'espèces ligneuses que celles du lot W. Les chèvres qui recevaient le PEG ont montré une tendance à ingérer plus d'espèces riches en tannins. La production de lait a été de 473, 591, 540 et 589 ml respectivement dans les lots W-PU, W-PS, H-PU et H-PS avec effet significatif de l'interaction couverture herbacée × PEG ($P < 0,05$). La concentration en urée du lait a été affectée soit par la couverture herbacée ($P < 0,001$), soit par le PEG ($P < 0,001$). L'effet du PEG est strictement lié à la composition du pâturage. En effet son efficacité est plus grande quand la proportion d'espèces riches en tannins dans le pâturage est élevée.*

Mots-clés : *Tannins, PEG, ingestion, sélection de l'ingéré, parcours méditerranéen.*

Introduction

The goat ability to select pasture species or part of plants with high nutritive value is well known. In particular goats browsing on bushlands search plants with relatively low tannin and high crude protein (CP) percentages, like many herbaceous species and some woody species (Cabiddu *et al.*, 2000; Decandia *et al.*, 2000b).

When the percentage of low-tannin species is high, tannic compounds do not negatively affect goat nutrition; on the contrary, a marked decrease in *in vivo* digestibility of CP and to a lesser extent of dry matter (DM) can occur (Silanikove *et al.*, 1996; Decandia *et al.*, 2000a,b). In that case, a depression of animal intake and performance can also be detected.

In previous experiments Decandia *et al.* (2000a,b) found that a dose of 50 g/head/day of polyethylene glycol (PEG) while neutralizing tannins, affects the botanical composition of goat diet. PEG supplemented goats ingest more tanniniferous and less herbaceous species than unsupplemented counterparts. In the mean while these goats showed better CP digestibility and performance than control group. With the aim to study the optimum condition for using PEG as tannin-binding agent, we undertook an experiment to evaluate the effect of PEG on feeding behaviour, intake and performance of Sarda goats browsing on a lentisk-based bushland with different herbage cover.

Materials and methods

The experiment was carried out at the beginning of summer with thirty-six goats at the end of lactation (42.7 ± 0.3 kg BW). The goats supplemented with ryegrass hay (200 g/head/day) and commercial concentrate (200 g/head/day), were allotted to 2 homogeneous groups. The groups browsed for 7 hours a day on 2 experimental bushland (2.7 ha) characterised by a different cover proportion of woody and herbaceous species. The first plot (H-high herbage cover) had 30% of herbage and 70% of woody vegetation cover; the second (W-low herbage cover) had 10% of herbaceous and 90% of woody species cover. Both groups, machine milked twice a day, were divided in 2 subgroups: one received 50 g/head/day of PEG 4000 (PS) and the other received no PEG supplementation (PU).

The percentage of herbage cover was measured on the basis of an aerial photo of the bushland. Botanical composition of pasture was determined from 100 points permanent transect and expressed as the ratio between the number of contacts for each species and the total number of contacts percent (CSC) (Daget and Poissonet, 1969). Body weight (BW) and body condition score (BCS) of animals were measured at the beginning and at the end of the experiment. Milk yield and milk composition (fat, N*6.38, and urea by differential pH-meter) were measured once a week. Feeding behaviour was studied once a week by the direct observation of biting as detailed by Kababya *et al.* (1998), and the intake was measured by hand plucking of the vegetation (Meuret *et al*., 1985). Forage samples were freeze-dried and analysed to determine DM, organic matter (OM), CP, neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL) and tannic phenols (TP) by Folin-Ciocalteu method, using catechin as standard (Martillotti *et al*., 1987).

The effect of herbage-woody proportion, PEG supplementation and their interaction was tested by analysis of variance. Treatments means were separated by the *t*-test.

Results and discussion

The woody vegetation in the bushland comprised species like *Pistacia lentiscus* L., *Quercus* spp. and *Myrtus communis* L. with CSC of 62.27, 4.86 and 3.16%, respectively. The chemical composition of main species is shown in Table 1.

All the species, herbaceous included, had low CP content. The TP level was higher in *Pistacia lentiscus* particularly in the young leaves. In fact, as already observed by Provenza and Malechek (1983), tannin concentration, in the same species, changes according to physiological stage and growth conditions.

The feeding behaviour was different between groups; H-goats had a higher grazing time, expressed as percentage of total observation time, than W-goats (64 vs 58%, $P < 0.05$). No effect of PEG on feeding behaviour was detected. DM intake at pasture was affected neither by cover proportion nor PEG supplementation (Table 2).

Table 1. Chemical composition (% DM) of main species in the bushland (n = 1)

Species	DM (%)	CP	NDF	ADF	ADL	TP
Herbaceous species	75.09	8.56	62.05	35.17	5.82	1.00
Chamaerops humilis L.	48.91	9.51	59.27	36.62	7.65	4.30
Myrtus communis L.	40.67	8.29	34.52	22.47	9.93	13.25
Quercus ilex L.	50.99	8.84	61.38	41.64	16.69	4.93
Quercus suber L.	42.73	11.37	54.13	36.16	13.71	8.82
Rhamnus alaternus L.	39.16	11.87	24.41	15.07	5.90	4.78
Rubus ulmifolius Schott.	40.85	11.26	40.71	21.57	6.41	7.89
Smilax aspera L.	29.20	9.76	47.60	30.96	12.67	3.85
Pistacia lentiscus L.						
New leaves	38.67	10.37	36.62	31.65	15.41	17.33
Old leaves	52.95	7.54	40.53	30.95	16.68	15.11
Overshadowed leaves	41.24	10.35	40.23	30.04	16.03	14.41

Table 2. Effect of herbage/woody proportion (H/W), PEG supplementation and their interaction on DM intake and chemical composition (% DM) of goat diet at pasture. Least square means

	Treatments				Probability level		
	H-PU	H-PS	W-PU	W-PS	H/W	PEG	H/W*PEG
Intake (g DM/day)	1479	1531	1479	1559	NS	NS	NS
CP (% DM)	9.33	9.33	9.67	9.83	0.05	NS	NS
NDF (% DM)	51.83	47.67	49.00	49.00	NS	NS	NS
ADF (% DM)	33.67	32.33	32.50	32.67	NS	NS	NS
ADL (% DM)	11.00b	12.00b	12.50a	12.67a	*	NS	NS
TP (% DM)	6.17	8.50	7.83	7.67	NS	0.11	0.07

[a,b]Means in rows with different letters differ significantly.
*P < 0.05, **P < 0.01, ***P < 0.001, NS >0.15.

The botanical composition of the diet showed differences between groups. H ingested more herbaceous species and less woody species (*Quercus* and *Rubus* spp.) than W (Table 3). The total lentisk intake was not affected by H/W proportion, but W-goats searched more overshadowed leaves than the counterparts. PEG supplementation showed a tendency to raise lentisk intake mainly in the H plot (P = 0.09). In W plot PEG supplemented goats tended to select more overshadowed lentisk for its lower tannin level. This confirms the effect of PEG on goat selection (Decandia *et al*., 2000a,b; Titus *et al*., 2001).

Chemical composition of goat diet is characterised by different CP, ADL and TP content (Table 2). H-goats had diet with lower TP level than W-goats, because of the scarce quality of herbaceous species. The ADL percentage was higher in W-goats, confirming the results obtained from Papachristou and Nastis (1993) in similar conditions. The level of tannins in the diet instead tended to be affected by PEG, in the H group. In this group, as already observed (Decandia *et al*., 2000a,b), if herbaceous species are available, PU goats browsing high-tannin vegetation select preferably species with low tannin level.

Live weight and BCS (not shown) slightly increased in all groups without any significant difference. Milk yield, milk protein and urea were higher in H than W goats (Table 4) probably because of the higher CP availability due to the presence of herbaceous species usually characterised by low acid detergent insoluble crude protein (ADI-CP) and tannin level as compared to woody species (Cabiddu *et al*., 2000).

Table 3. Effect of herbage/woody proportion (H/W), PEG supplementation and their interaction on botanical composition of goat's diet (% total intake) at pasture. Least square means

Species	Treatments				Probability level		
	H-PU	H-PS	W-PU	W-PS	H/W	PEG	H/W*PEG
Herbaceous species	28.16a	19.13a	8.99b	8.54b	**	NS	NS
Chamaerops humilis L.	9.64	6.92	7.74	6.85	NS	NS	NS
Myrtus communis L.	5.30	5.14	6.74	5.05	NS	NS	NS
Quercus spp.	9.16b	10.11b	28.54a	30.54a	***	NS	NS
Rhamnus alaternus L.	3.55	2.83	2.82	4.35	NS	NS	NS
Rubus ulmifolius Schott.	1.99	2.43	8.11	4.67	0.11	NS	NS
Smilax aspera L.	8.49	7.86	5.43	8.18	NS	NS	NS
Pistacia lentiscus L.							
Total	20.22	37.33	22.57	21.63	NS	0.12	0.09
New leaves	3.56ab	6.55a	1.27b	2.02b	*	0.16	NS
Old leaves	15.50ab	28.67a	9.75b	13.00b	*	0.11	NS
Overshadowed leaves	1.15b	2.11b	11.54a	6.61ab	*	NS	NS
Other species	13.47	8.23	9.03	10.17	NS	NS	NS

[a,b]Means in rows with different letters differ significantly.
*P < 0.05, **P < 0.01, ***P < 0.001, NS >0.15.

Table 4. Effect of herbage/woody proportion (H/W), PEG supplementation and their interaction on milk yield and milk composition of goats. Least square means

	Treatments				Probability level		
	H-PU	H-PS	W-PU	W-PS	H/W	PEG	H/W*PEG
Milk yield (ml/h/day)	541b	589a	473c	591a	0.05	***	*
Protein (%)	3.37a	3.31ab	3.25bc	3.22c	***	NS	NS
Fat (%)	5.72	5.54	5.61	5.44	NS	0.06	NS
Urea (%)	17.58c	23.71a	14.24d	20.54b	***	***	NS

[a,b,c,d]Means in rows with different letters differ significantly.
*P < 0.05, **P < 0.01, ***P < 0.001, NS >0.15.

The interaction H/W*PEG was significant for milk yield; actually the effect of PEG was bigger in W-goats (Table 4). The increase of milk yield supplementing with PEG goats browsing on bushlands, confirms previous results (Decandia *et al*., 2000a,b; Gilboa *et al*., 2000). The fat content tended to be reduced by PEG supplementation. In contrast PEG markedly raised milk urea.

Conclusion

The effect of PEG is strictly dependent on pasture composition and on goat possibility to select plants and part of plants with low to moderate tannin level. The efficacy of PEG as anti-tannic supplement is higher when pasture is characterised by high proportion of tanniniferous species. In these conditions goats are forced to consume tannins and PEG supplementation improves their performance mainly as a consequence of a better protein utilisation.

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