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Effect of polyethylene glycol on browsing behaviour and performance of late lactating goats

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SUMMARY – The effect of polyethylene glycol (PEG), an antitannic substance, on feeding behaviour, intake and milk production of Sarda goats at the end of lactation, was evaluated. Twenty goats were allowed to browse for 7 hours daily on 5 ha shrubland. The goats were allotted to two groups of ten: PS receiving 50 g/day of PEG 4000 MW, and PU, receiving no PEG supplementation. Feeding behaviour and feed intake were studied by direct observation, using the bite-count method. *In vivo* digestibility of dry matter and crude protein was assessed using C_{36} alkane as external marker. The time spent grazing was similar in the two groups. The average intake at pasture tended to be higher in PS than PU (1366 vs 1187 g DM/head/day, NS). The percentage of the species eaten by the goats was different in the two groups: the PEG supplemented goats ate more tanniferous species like *Pistacia lentiscus* L. whereas the control goats selected more herbaceous species. Goats from the PS group had higher *in vivo* crude protein digestibility, compared with PU (0.53 vs 0.40, P $\leq$ 0.01). Milk yield (755 vs 645 ml, P 0.01) and milk urea content (19.76 vs 16.46 mg/100 ml, P 0.01) were higher in PS goats. To conclude, when a goat diet consists mainly of species rich in tannins, PEG alleviates their negative effect on protein digestion.

Key words: Goats, tannins, polyethylene glycol, feeding behaviour, Mediterranean shrubland.

RESUME – *"Effet du polyéthylène-glycol sur le comportement alimentaire et les performances de chèvres en fin de lactation". On a étudié l'effet de la supplémentation avec du polyéthylène-glycol (PEG) sur le comportement alimentaire, l'ingestion et la production de lait de 20 chèvres sardes en fin de lactation qui pâturaient pendant sept heures/jour sur une surface arbustive et arborée de 5 ha. Dix chèvres (PS) ont reçu 50 g/jour de PEG 4000 PM, et dix (PU) n'en ont pas reçu. Le comportement alimentaire et l'ingestion des chèvres ont été estimés par observation directe des coups de dents. La digestibilité* in vivo *de la matière sèche et de la matière azotée totale a été mesurée par un marqueur externe (alcane C_{36}). Le comportement alimentaire des deux groupes a été le même. L'ingestion moyenne au pâturage (1366 vs 1187 g MS/tête/jour, NS) tend à augmenter avec le PEG. Les chèvres du lot PS ont ingéré plus d'espèces riches en tannins (*Pistacia lentiscus *L.*) alors que celles du lot PU ont ingéré plus d'espèces herbacées. La digestibilité de la matière azotée totale a été plus haute dans les chèvres du lot PS (0,53 vs 0,40, P 0,01). La production de lait (755 vs 645 ml, P 0,01) et sa concentration en urée (19,76 vs 16,46 mg/dl, P 0,01) étaient plus élevées chez les chèvres PS. En conclusion, dans des parcours avec des espèces particulièrement riches en tannins, le PEG contribue à limiter leurs effets négatifs sur la digestion des protéines.*

Mots-clés : *Chèvre, tannin, polyéthylène-glycol, comportement alimentaire, parcours méditerranéen.*

Introduction

Most Mediterranean goats are fed on shrubland. Many woody species are characterised by a low to medium level of crude protein and high tannin content that reduce the intake, and mainly the digestibility of these plants (Robbins *et al*., 1987; Silanikove *et al*., 1994, 1996). Polyethylene glycol (PEG) is considered an effective anti-tannic substance due to its ability to prevent binding between condensed tannins and proteins (Badran and Jones, 1965). Previous work at our laboratory showed that PEG can markedly improve protein digestibility in Sarda goats, fed with lentisk (*Pistacia lentiscus* L.) (Decandia *et al.,* 1995). The aim of this work was to evaluate the effect of PEG supplementation on feeding behaviour, intake and performance of Sarda goats browsing a Mediterranean shrubland.

Materials and methods

Twenty mature Sarda goats at 150-170 days after parturition, were allowed to browse on a 5 ha shrubland for 7 hours/day. The goats were allotted to two homogeneous groups. One group was fed

in the morning with a PEG-based supplement (PS, 50 g/day of polyethylene glycol, PEG molecular weight of 4000, mixed in 50 g of beet pulp); the other group received no PEG supplementation (PU). In the evening all the goats were supplemented with 200 g/head of ryegrass hay and either 100 (PS) or 150 (PU) g/head of commercial concentrate (16% of crude protein). The goats were machine-milked twice daily. Data on vegetation were collected from a 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). The feeding behaviour was studied once a week by the direct observation of biting (Bourbouze, 1980) and the intake was measured by hand plucking of the vegetation (Meuret *et al.*, 1985). The forage samples were analysed for dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignen (ADL) (Goering and Van Soest, 1970) and condensed tannins (CT) by the Folin-Ciocalteu solution as described by Cabiddu *et al.* (this volume). *In vivo* digestibility of dry matter and crude protein were assessed using the alkane C36 as external marker corrected by its recovery rate (Dove, 1989). Body weight and body score were measured at the start and the end of the trial. Milk yield and composition (fat, N*6.38 and urea by a differential pH-meter) were measured individually once a week. The effect of PEG was tested by ANOVA.

Results

On the basis of permanent transect results, *P. lentiscus* was the main species with a specific contribution above 55%. The feeding behaviour was similar in the two groups, the grazing time expressed as percentage of total observation time was 57% and 53%, in PS and PU, respectively.

The percentage of the species eaten by the goats was different in the two groups: the PEG supplemented goats ate more tanniferous species like *P. lentiscus* whereas the control goats selected mainly herbaceous species (Table 1).

Table 1. Contact specific contribution (CSC) of different species in the shrubland and botanical composition of the diet of goats either supplemented (PS) or unsupplemented (PU) with PEG (least square means)

Species	CSC (%)	Diet composition (% DM intake)	
		PS	PU
Herbaceous species	15.5	11.0	21.0
Chamaerops humilis L.	1.0	15.0	5.3
Lonicera implexa Aiton	<1.0	2.3[a]	6.8[b]
Myrtus communis L.	3.5	5.2	3.3
Pistacia lentiscus L.	57.5	23.7[a]	11.2[b]
Rhamnus alaternus L.	<1.0	4.2	3.2
Rubia peregrina L.	2.1	3.3	8.8
Rubus ulmifolius Schott.	<1.0	10.3	12.0
Smilax aspera L.	1.7	1.8	4.2
Quercus ilex L. *Q. suber* L.	5.9	11.8	11.3
Others species	11.4	12.0	12.0

[a,b]Values for diet composition in the same row with different letters differ significantly (P 0.05).

The chemical composition of different species grazed or browsed by the goats is shown in Table 2. The percentage of crude protein is very low in almost all species, at the exception of *Rubus ulmifolius* Schott. and the *Rhamnus alaternus* L. whereas the level of condensed tannins is particularly high in *P. lentiscus*. As a consequence, the PS goats ingested diets richer in condensed tannins.

The average DM intake at pasture was similar between groups (1366 PS and 1187 g DM PU) (Fig. 1). *In vivo* DM digestibility did not differ between groups: 0.56 and 0.54 for PS and PU, respectively. Goats in the PS group hadhigher *in vivo* CP digestibility (0.53 vs 0.40, P ≤ 0.01). Body weight

decreased in all goats without any effect for PEG. However,PEG supplementation was associated with small gain in body condition (+0.16±0.05 vs –0.06±0.05 $P \leq 0.05$ in PS and PU, respectively). Milk yield and urea content were higher in PS goats: 755 vs 645 ml, $P \leq 0.01$; and 19.76 vs 16.46 mg/dl, $P \leq 0.01$ in PS (Fig. 2). No differences were found in the milk fat and protein percentage (5.67±0.13 and 3.31±0.06 vs 5.44±0.13 and 3.46±0.06, respectively in PS and PU).

Table 2. Crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL) and condensed tannins (CT) indifferent shrubland species and in the diet of the goats supplemented (PS) or unsupplemented (PU) with PEG

	Chemical composition (% of DM)				
	CP	NDF	ADF	ADL	CT
Species					
Herbaceous species	6.6	67.1	33.1	4.2	0.7
Chamaerops humilis L.	9.5	61.9	38.5	7.7	2.3
Lonicera implexa Aiton	6.3	28.1	18.9	8.1	3.2
Myrtus communis L.	7.7	35.1	25.2	9.5	15.0
Pistacia lentiscus L.	9.8	37.2	31.4	22.1	23.4
Rhamnus alaternus L.	11.5	21.4	14.4	5.9	6.5
Rubia peregrina L.	8.3	44.0	32.4	6.9	2.5
Rubus ulmifolius Schott.	11.9	35.4	19.6	6.4	15.3
Smilax aspera L.	9.4	43.6	29.9	14.4	8.3
Quercus ilex L. *Q. suber* L.	9.0	55.3	37.3	14.9	9.4
Goat Diet					
PS	8.7	41.6	27.3	10.9	10.3
PU	8.4	43.3	26.9	9.2	7.7

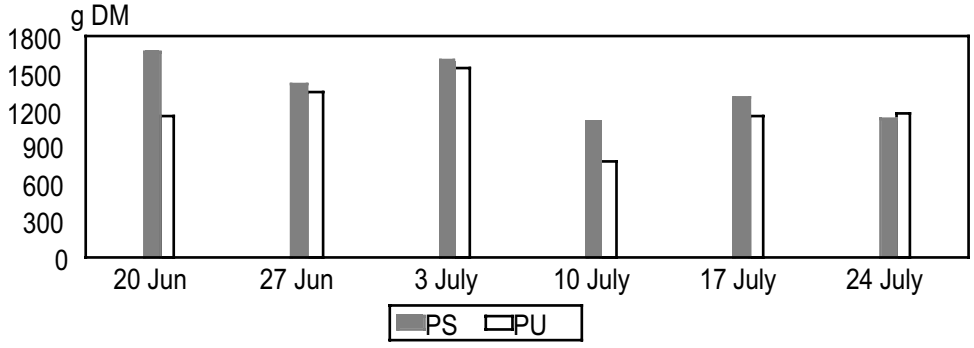

Fig. 1. Intake of herbage and browse in Sarda goats either supplemented (PS) or unsupplemented (PU) with PEG.

Conclusions

In this trial, as in previous studies with browsing goats (Decandia *et al*., 1999), PEG supplementation markedly increased the crude protein digestibility while the dry matter intake was just moderately, if any, affected. Moreover PEG supplementation changed the botanical composition of the diet: the goats ate more tanniferous species, like *P. lentiscus,* usually refused. The ability of polyethylene glycol to alleviate negative effects of tannins on protein utilisation and consequently, milk yield, is confirmed.

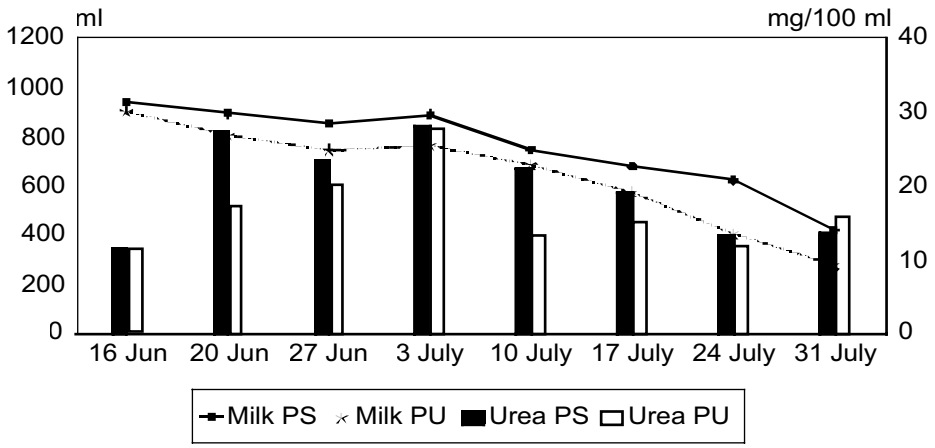

Fig. 2. Milk yield and milk urea (mg/100 ml) in Sarda goats either supplemented (PS) or unsupplemented (PU) with PEG.

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