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Effects of polyethylene glycol supplementation on the performances of Cilentana goats grazing woodland and scrubland

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SUMMARY – Thirty pregnant goats grazing in woodland and scrubland were randomly allocated to two equal groups (PEG and control). They were individually given 200, 300 and 400 g of concentrate (19.2% CP and 1.0 Milk Feed Unit, equal to 1700 kcal of net energy for lactation, on DM) 45, 30 and 15 days before the delivery, respectively. 10 g/head/day of PEG mixed with a part of concentrate was offered to the PEG group. After parturition (end of January - beginning of February) the concentrate was gradually increased for both groups up to 500 g/head. After weaning of kids (60 days), individual milk yield was recorded every 30 days with analyses for protein, fat, lactose and urea. *Quercus ilex* and *Pirus amygdaliformis* were the main woody species present in the grazing areas. No differences were found between groups for kid birth weights and daily weight gain (DWG); the PEG supplement affected only milk yield registered after weaning (1210 *vs* 1065 g/day; P<0.01), mainly in spring.

Keywords: PEG supplementation, Cilentana goat, tannins, grazing.

RESUME – *"Effet de la supplémentation en PEG sur les performances de chèvres Cilentana en pâturage sur zones de forêt et broussailles". Trente chèvres en gestation en pâturage sur des forêts et broussailles ont été distribuées au hasard en deux groupes égaux (PEG et témoin). Il leur a été distribué individuellement 200, 300 et 400 g de concentré (19,2% PB et 1,0 UFL, égal à 1700 kcal d'énergie nette pour la lactation, sur MS) à 45, 30 et 15 jours avant la parturition, respectivement. 10 g/tête/jour de PEG mélangés à une partie du concentré furent donnés au groupe PEG. Après la parturition (fin janvier - début février) le concentré fut graduellement augmenté chez les deux groupes jusqu'à 500 g/tête. Après le sevrage des chevreaux (60 jours), la production individuelle de lait fut enregistrée tous les 30 jours, avec analyse de protéines, matière grasse, lactose et urée.* Quercus ilex *et* Pirus amygdaliformis *étaient les principales espèces arbustives présentes dans les zones de pâturage. Il n'a pas été relevé de différences entre les groupes pour le poids à la naissance et le GMQ des chevreaux ; le supplément en PEG a affecté uniquement la production de lait enregistrée après le sevrage (1210* vs *1065 g/jour ; P<0,01), surtout au printemps.*

Mots-clés : *Supplémentation en PEG, chèvre Cilentana, tannins, pâturage.*

Introduction

The majority of natural vegetation in Mediterranean woodlands and scrublands is represented by woody species, whose use as browse by ruminants is restricted by the high content of tannins in foliage (Kumar and Vaithiyanathan, 1990; Leinmuller *et al.,* 1991). Tannins are polyphenolic substances which bind to proteins and may have either adverse or beneficial effects for ruminants, depending on their concentration and structure as well as other factors such as animal species, physiological state of the animal and composition of the diet (Makkar, 2003). The inverse relationship between high tannin level in forage and palatability, voluntary intake, digestibility and nitrogen retention in ruminants is well established (Silanikove *et al.,* 1994; Silanikove *et al*., 1996). Various studies aimed at detoxification (by inactivation or removal of tannins) of woody leaves have been conducted. For this purpose, polyethylene glycol (PEG), a polymer that binds tannins irreversibly over a wide range of pH and reduces the formation of a protein-tannin complex (Jones and Mangan, 1977), has been administered to grazing animals by spraying on leaves in aqueous solution, mixed as dry powder with harvested leaves (Kumar and Vaithiyanathan, 1990), or drenched orally (Pritchard *et al*., 1992; Terrill *et al.,* 1992). A practical application is mixing PEG with a small amount of concentrate and provided to animals once daily (Silanikove *et al.*, 1994; Silanikove *et al*., 1996) before turning them out to graze (Decandia *et al.,* 1998). The present study aimed to evaluate the effect of PEG on the productive traits of "Cilentana" goats, extensively bred in mountainous areas of Cilento (Salerno province, Italy) characterized by woodland and scrubland.

Material and methods

The trial was carried out on a farm located at 800 m a.s.l. where goats are hand-milked twice daily, deliveries are concentrated between the end of January and the beginning of February and kids are weaned at 60 days of age. Thirty pregnant goats were randomly allocated into two equal groups (PEG and C - control), 45 days before the presumed date of delivery (estimated by ultrasonography). Both groups grazed on 20 ha from 08:00 to 16:00 hours and were confined at nights. Each goat from both groups was given 200, 300 and 400 g of concentrate (19.2% CP in the DM; 1.0 Milk Feed Unit/kg DM, equal to 1700 kcal of net energy for lactation, INRA, 1978) 45, 30 and 15 days before delivery, respectively. Ten g/head/day of PEG 4000 mixed with a part of concentrate (100 g) was offered before grazing to the PEG group. After parturition, the concentrate was gradually increased for both groups to 500 g/head, but the PEG supplement was unchanged. Samples of woody species and concentrate were monthly analysed for: dry matter (DM), crude protein (CP), ether extract (EE) (ASPA, 1980); NDF, ADF and ADL (Van Soest *et al*., 1991) and the nutritive value was calculated according to INRA (1978).

Kids suckled the goats until weaning (60 days) and they were weighed at birth and at 60 days old; daily weight gain (DWG, g/d) over 60 days was calculated. Only after weaning, individual milk yield was recorded each 30 days, for a total of 5 sampling (until the end of lactation). Each time individual milk samples (obtained by mixing the production of the two daily milkings) were analysed for protein, fat and lactose (near infra-red method) and urea by instruments working in differential pH-metry. The effect of PEG was tested by the GLM PROC of SAS (2000); in the case of milk yield the sampling effect was also tested.

Results and discussion

Quercus ilex and *Pirus amygdaliformis* were the main woody species present in the areas of the trial. Both have an average condensed tannin content, which in the case of *Quercus ilex* could highly change in function of the season (3.64 *vs* 8.06, in spring and summer respectively; Cabiddu *et al.*, 1998). Other species present were *Carpinus betulus, Hedera helix, Myrtus communis*. The herbaceous vegetation was scarce.

The chemical composition and nutritive value of the leaves from the main woody species browsed by goats, by season, and of concentrate is reported in Table 1. Interestingly, both *Quercus ilex* and *Pirus amygdaliformis,* showed little change in chemical composition from spring to summer. Our results agree with those reported by Cabiddu *et al.* (1998), who however found lower ADL content in *Quercus ilex* (16.2% and 15.2%, in spring and summer respectively).

Table 1. Chemical composition (% DM) and nutritive value of leaves from the main woody species and concentrate given to goats

	Quercus ilex		*Pirus amygdaliformis*		Concentrate
	Spring	Summer	Spring	Summer	
DM	52.1	53.3	37.5	39.3	87.0
CP	10.0	8.6	11.2	10.6	19.2
EE	1.7	1.7	1.9	1.7	3.6
NDF	58.9	59.8	41.3	40.6	32.2
ADF	42.4	42.8	23.6	22.8	14.9
ADL	18.1	18.3	11.8	11.6	1.1
Ash	4.8	4.8	7.2	7.3	7.4
MFU/kg DM[†]	0.54	0.53	0.72	0.69	1.0

[†]MFU: milk feed unit (1700 kcal of net energy for lactation; INRA, 1978).

There were no differences in kid birth weights and DWG from Control and PEG treated goats

(Table 2), suggesting no influence of PEG in the dry period and in the first two months of lactation (suckling period). Our results are contrary to those of Gilboa *et al.* (2000) who found birth weight and DWG significantly higher for kids whose mothers received 10 g/day of PEG in their diet. However, in that trial one of the main woody species grazed was *Pistacia lentiscus,* which has a higher condensed tannin content (on average 21% DM, Cabiddu *et al.*, 1998), so the influence of PEG should have been more evident due to the higher intake of tannins. On the other hand, Silanikove *et al.* (1996) found that to improve DM intake, DWG and organic matter digestibility, supplementation of 10 g/day of PEG was sufficient when goats were fed leaves of *Quercus calliprinos*, and *Ceratonia siliqua*, while 20g/d were required with diets comprising mainly *Pistacia lentiscus*. In a trial carried out on Comisana lambs fed, from 45 days of age, a diet containing 56% of *Ceratonia siliqua* (carob) pulp, Priolo *et al.* (2000) found significantly ($P<0.05$) higher growth rates in group given 40 g of PEG per kilogram of diet compared to the control. Priolo *et al.* (2002) subsequently studied the possibility of reducing the PEG given to lambs fed the same diet, and found significantly lower DWG in animals receiving 10 g of PEG/kg of diet compared to those whose diet was supplemented with 40 g of PEG.

Table 2. Kid body weight (kg) and average daily gain (g/day)

	PEG	Control
Birth weight (kg)	3.45 ± 0.73	3.49 ± 0.52
Weight at 60 days old (kg)	13.3 ± 1.04	13.3 ± 1.41
DWG (g/d)	164.0 ± 46.3	163.0 ± 43.4

Average milk yield (Table 3), calculated on the 5 milk sampling effected after weaning, was significantly higher in group PEG than in C (1209.7 *vs* 1064.7 g/day; $P<0.01$) but milk fat, protein, lactose and urea were unaffected by the treatment. Gilboa *et al.* (2000), supplementing the diet with 10 g/day of PEG, found no effect of PEG treatment in milk yield and milk fat, protein and lactose in Mamber goats, while in Damascus x Anglo-Nubian goats the PEG supplementation resulted in 0.5 kg higher daily milk yield after parturition, an advantage which increased to 0.8 kg ($P<0.001$) at the peak of lactation. In our study the milk yield significantly ($P<0.01$) differed between groups only at the first two sampling effected after weaning (Fig.1). Decandia *et al*. (2000) in Sarda goats at the end of lactation, grazing on Mediterranean scrubland, recorded significant increases in milk yield and also in milk urea on supplementing the diet with 50 g of PEG.

Table 3. Milk yield and chemical characteristics

	Yield (g/d)	Fat (%)	Protein (%)	Lactose (%)	Urea (mg/dl)
Treatment effect					
PEG	1209.7	4.49	3.70	4.37	29.0
Control	1064.7	4.46	3.66	4.38	28.3
Sampling effect					
1	1444.2	4.38	3.21	4.59	31.6
2	1528.3	4.55	3.55	4.55	32.8
3	1208.7	3.96	3.33	4.37	26.7
4	1130.0	4.26	3.41	4.22	23.7
5	375.0	5.24	4.92	4.15	26.8
Significance					
T	**	NS	NS	NS	NS
S	**	**	**	**	**
TxS	NS	NS	NS	NS	**
Variance of error					
	33940.6	0.348	0.351	0.0036	25.77

*P<0.05; **P<0.01; NS: not significant.
1, 2, 3, 4, 5: sampling; T: treatment; S: sampling; TxS: interaction treatment x sampling.

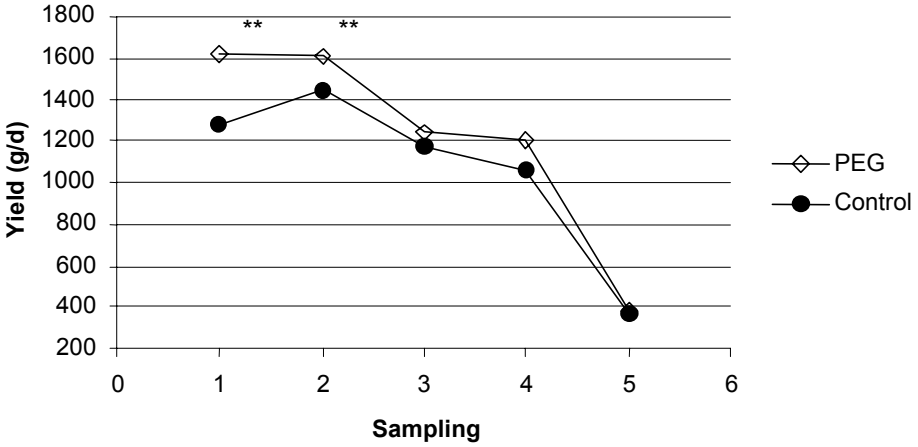

Fig. 1. Milk yield as function of sampling (**P<0.01).

In present trial, the PEG effect on milk yield was higher in spring, although the tannin content in *Quercus ilex* increases in summer (Cabiddu *et al.*, 1998). The responses will have been affected by the different nutritional demands for lactation, and intakes of woody species were probably higher in spring than summer.

Conclusions

The results of this study confirm the suitability of 10g/day PEG supplementation to the diet of goats browsing in Mediterranean woodland: tannin-binding effected by the PEG improves the CP availability and consequently increases milk yields. Moreover, PEG does not reduce milk protein or fat percentage, which may be useful for cheese manufacturing.

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References

ASPA (1980). Commissione valutazione alimenti. Valutazione degli alimenti di interesse zootecnico. Analisi chimica. *Zoot. Nutr. Anim.*, 6: 19-34.

Cabiddu, A., Decandia, M., Stizia, M. and Molle, G. (1998). A note on the chemical composition and tannin content of some Mediterranean shrubs browsed by Sarda goats. In: *Proceedings of the FAO/CIHEAM Meeting on the Nutrition of Sheep and Goats*, Grignon (France), 3-5 September 1998, pp. 175-178.

Decandia, M., Molle, G., Stizia, M., Cabiddu, A., Ruiu, A., Pampiro, F. and Pintus, A. (1998). Effect of polyethylene glycol on browsing behaviour and performance of late lactating goats. In: *Proceedings of the FAO/CIHEAM Meeting on the Nutrition of Sheep and Goats*, Grignon (France), 3-5 September 1998, pp. 147-150.

Decandia, M., Stizia, M., Cabiddu, A., Kababya, D. and Molle, G. (2000). The use of polyethylene glycol to reduce the anti-nutritional effects of tannins in goats fed woody species. *Small Rum. Res.*, 38: 157-164.

Gilboa, N., Perevolotsky, A., Landau, S., Nitsan, Z. and Silanikove, N. (2000). Increasing productivity in goats grazing Mediterranean woodland and scrubland by supplementation of polyethylene glycol. *Small Rum. Res.*, 38: 183-190.

INRA (1978). *Alimentation des ruminants*. Ed. INRA, Paris, France.

Jones, W.T. and Mangan, J.L. (1977). Complexes of the condensed tannins of sainfoin (*Onobrychis viciifolia*) with fraction 1 leaf protein and with submaxillary mucoprotein, and their reversal by polyethylene glycol and pH. *J. Sci. Food Agric.*, 28: 126-130.

Kumar, R. and Vaithiyanathan, S. (1990). Occurrence, nutritional significance and effect on animal productivity of tannins in tree leaves. *Anim. Feed Sci. Technol.*, 30: 21-38.

Leinmuller, E., Steingass, I. and Menke, K.H. (1991). Tannins in ruminant feedstuffs. *Anim. Res*., 321: 1-56.

Makkar, H.P.S. (2003). Effects and fate of tannins in ruminant animals, adaptation to tannins, and strategies to overcome detrimental effects of feeding tannin-rich feeds. *Small Rum. Res.*, 49: 241-256.

Priolo, A., Waghorn, G.C., Lanza, M., Biondi, I. and Pennisi, P. (2000). Polyethylene glycol as a means for reducing the impact of condensed tannins in carob pulp: Effects on lamb growth performance and meat quality . *J. Anim. Sci.*, 78: 810-816.

Priolo, A., Lanza, M., Bella, M., Pennisi, P., Fasone, V. and Biondi, L. (2002). Reducing the impact of condensed tannins in a diet based on carob pulp using two levels of polyethylene glycol: Lamb growth, digestion and meat quality. *Anim. Res.*, 51: 305-313.

Pritchard, P.H., Marin, P.R. and O'Rourke, P.K. (1992). The role of condensed tannins in the nutritional value of mulga (*Acacia anaeura*) for sheep. *Aust. J. Agric. Sci.*, 57: 1739-1756.

SAS (2000). *SAS/STAT® Software: Changes and Enhancements through Release 8.1.* SAS Institute Inc., Cary, NC, USA.

Silanikove, N., Nitsan, Z. and Perevolotsky, A. (1994). Effect of polyethylene glycol supplementation on intake and digestion of tannin-containing leaves (*Ceratonia siliqua*) by sheep. *J. Agric. Food Chem.*, 42: 2844-2847.

Silanikove, N., Gilboa, N., Nir, I., Perevolotsky, A. and Nitsan, Z. (1996). Effect of a daily supplementation of polyethylene glycol on intake and digestion of tannin-containing leaves (*Quercus calliprinos, Pistacia lentiscus* and *Ceratonia siliqua*) by goats. *J. Agric. Food Chem.*, 44: 199-205.

Terrill, T.H., Douglas, G.B., Foote, A.G., Purchas R.W., Wilson, G.F. and Barry, T.N. (1992). Effect of condensed tannins upon body growth and rumen metabolism in sheep grazing Sulla (*Hedysarum coronarium*) and perennial pasture. *J. Agric. Sci*., 119: 265-274.

Van Soest, P.J., Robertson, J.B. and Lewis, B.A. (1991). Methods for dietary fiber, neutral detergent fiber, and no starch polysaccharides in relation to animal nutrition. *J. Dairy Sci.*, 74: 3583-3598.