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in

Molina Alcaide E. (ed.), Ben Salem H. (ed.), Biala K. (ed.), Morand-Fehr P. (ed.).  
Sustainable grazing, nutritional utilization and quality of sheep and goat products

Zaragoza : CIHEAM

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 67

2005

pages 201-204

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=6600043>

To cite this article / Pour citer cet article

Claps S., Rubino R., Fedele V., Morone G., Di Trana A. **Effect of concentrate supplementation on milk production, chemical features and milk volatile compounds in grazing goats.** In : Molina Alcaide E. (ed.), Ben Salem H. (ed.), Biala K. (ed.), Morand-Fehr P. (ed.). *Sustainable grazing, nutritional utilization and quality of sheep and goat products* . Zaragoza : CIHEAM, 2005. p. 201-204 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 67)



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# Effect of concentrate supplementation on milk production, chemical features and milk volatile compounds in grazing goats

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**SUMMARY** – The aim of this study was to evaluate the possibility to increase, through concentrate supplementation, milk production in a traditional grazing goat system without worsening milk quality. The study was carried out at the Bella farm of the Istituto Sperimentale per la Zootecnia, located in the Basilicata region, Southern Italy. Forty-five lactating Siriana goats were divided into three homogeneous groups: (i) G, grazing for 8 hours/day; (ii) GRD, grazing plus 600 g/day of rapidly degradable concentrate; and (iii) GNRD, grazing plus 600 g/day of slowly degradable concentrate. A native, exclusively herbaceous pasture, in a Basilicata region valley was used. In winter, spring and summer, pasture botanical composition was evaluated as reported by Fedele *et al.* (this issue). Milk production was recorded monthly. Physical-chemical analyses and volatile organic compounds (VOC) determination were performed on three cumulative milking samples, collected for each season in every group. Supplemented grazing groups showed significantly higher levels ( $P < 0.05$ ) of milk production (295.7 kg in GRD and 276.7 kg in GNRD) than not supplemented groups (248.6 kg), but no significant difference in the chemical characteristics was found. The widest variations in milk VOC content were observed during grazing seasons. In relation to grazing season, the concentrate supplementation involved a different effect. During winter and spring, the highest sesquiterpenes content was observed in unsupplemented group (1993 ng/l in G group vs 1127 ng/l in GRD and 988 ng/l in GNRD). During summer, the highest values were found in the supplemented group (24,586 ng/l in GRD and 20,968 ng/l in GNRD vs 14,041 ng/l in group G). The VOC content, in winter and spring, was related to herbage intake, while in summer plants selected by animals play a main role. In summer, an essential difference emerged concerning the browsed parts. The animals of supplemented groups, particularly GRD, had selected especially flowers. These results showed that it is possible to increase milk production in traditional feeding systems by concentrate supplementation without worsening milk aroma. Moreover, season and type of concentrate play a main role.

**Key words:** Goat, concentrate supplementation, milk production, VOC content.

**RESUME** – "Effet de la nature de la complémentation sur la production laitière, les caractéristiques chimiques et la teneur en composés volatils du lait de chèvres au pâturage". L'objectif de cette expérience était d'étudier l'influence de la complémentation des chèvres sur parcours par un concentré rapidement dégradé ou lentement dégradé sur la production laitière, les caractéristiques chimiques et la teneur en composés volatils du lait. L'expérience a été réalisée à Bella, Istituto Sperimentale per la Zootecnia, dans la région Basilicate (Sud de l'Italie). Trois lots de quinze chèvres (Derivata di Siria) chacun ont été utilisés. Les animaux ont été soumis aux régimes alimentaires suivants : (i) lot P – pâturage pendant 8 heures/jour ; (ii) lot PRD – pâturage plus 600 g/j de concentré rapidement dégradé ; et (iii) lot PNR – pâturage plus 600 g/j de concentré lentement dégradé. La composition botanique du pâturage a été déterminée par la méthode de Fedele et al. (ce volume). La production de lait a été mesurée chaque mois. Les analyses physico-chimiques et la teneur en composés volatils du lait ont été déterminées sur trois échantillons collectés au cours de chaque saison et pour chaque groupe d'animaux. Les chèvres recevant du concentré ont produit plus de lait ( $P < 0,05$ ) que celles n'ayant pas été supplémentées (295,7 kg PRD et 276,7 kg PNR contre 248,6 kg pour le lot P). Cependant, la composition chimique du lait a été la même entre les trois groupes de chèvres. Une importante variation de la quantité de lait produite et de sa teneur en composés volatils a été constatée entre les saisons de pâturage. En effet, en hiver et au printemps la concentration de sesquiterpènes la plus élevée a été observée avec le lait issu des chèvres du groupe P (1993 ng/l contre 1127 ng/l pour le lot PRD et 988 ng/l pour le lot PNR). En revanche, une tendance inverse a été constatée avec la saison estivale (24 586 ng/l pour le lot PRD et 20 968 ng/l pour le lot PNR contre 14 041 ng/l pour le lot P). Les résultats montrent que la teneur en composés volatils, au cours de l'hiver et au printemps, varie en fonction de l'ingestion d'herbe. Cependant, en été, elle varie en fonction du stade végétatif des plantes consommées. Les chèvres recevant du concentré (PRD et PNR) ont notablement sélectionné au niveau des plantes disponibles l'apex et les parties renfermant des fleurs. Il ressort de ce travail que, dans les systèmes traditionnels, la complémentation des chèvres au pâturage par des concentrés permet d'augmenter la production laitière sans modifier de manière importante les caractéristiques aromatiques du lait. Cependant, l'effet de la saison et de la nature du concentré sur la production et la qualité du lait a été important.

**Mots-clés :** Chèvre, complémentation de l'aliment concentré, production laitière, composés volatils.

## Introduction

The grazing system is predominant practice in Southern Italy, as well as in all Mediterranean area. Several traditional dairy products are made from milk of grazing animals not receiving concentrate supplementation. Decisions about this supplementation, as quality and quantity, are more difficult in grazing than in housed systems just because herbage intake as quality and quantity is unknown. For grazing goats, the choice is further complicated, in comparison to other ruminants, because of the pronounced selective behaviour of this species. Therefore, diet composition of goat varies considerably with pasture composition (Fedele *et al.*, 1993).

The greatest effect on milk quality and production could be obtained by finding concentrates that better interact with the nutritive characteristics of selected herbage.

The effect of feeding system, in particular the use of pasture, on milk properties has been studied (Bugaud *et al.*, 2000; Verdier-Metz *et al.*, 2000), but there is a lack of information on the effect of type and level of concentrate on milk and cheese aromatic characteristics. A study was planned to investigate the influence of two concentrate sources of mixed grains – rapidly and slowly degradable – on milk production, chemical features and milk volatile compounds in grazing goats. The main goal of this work was to evaluate the possibility to increase, by concentrate supplementation, milk production in traditional grazing goat system without worsening the milk quality.

## Materials and methods

The study was carried out at the Bella farm of Istituto Sperimentale per la Zootecnia, located in Basilicata region, Southern Italy. Forty-five lactating Siriana goats were divided into three homogeneous groups:

- (i) G – grazing for 8 hours/day.
- (ii) GRD – grazing plus 600 g/day of rapidly degradable concentrate (barley and chickpeas – ratio 60/40).
- (iii) GNRD – grazing plus 600g/day of slowly degradable concentrate (maize and broad beans – ratio 80/20).

The native pasture, exclusively herbaceous, was divided into six paddocks; each group alternatively grazed two paddocks. The botanical composition of pasture was evaluated during each season. In winter and spring the vegetation was dominated by grasses (75-85% and 55-65%, respectively), in summer by forbs (50-55%).

In winter, spring and summer the pasture composition was evaluated as reported by Fedele *et al.* (this issue).

Milk production was recorded monthly. Physical-chemical parameters and volatile organic compounds (VOC) were analysed on three cumulative milk samples, collected in each season and each group.

The milk aroma was determined by a modified headspace technique. One hundred ml of milk was flushed with pure helium and VOC released were collected into adsorption traps filled with graphitic sorbents until a quantitative extraction was achieved.

VOC were analysed by HRGC-MS after thermal desorption of traps performed at 250°C. The separation was carried out on a capillary column (50 m × 0.32 mm ID) internally coated with a non-polar silicon phase. VOC were identified on the basis of their mass spectra. Selected ions were used to quantify overlapping peaks or those present at trace levels.

The data recorded for the chemical-physical parameters were analysed by GLM procedure (SAS, 1988).

## Results and discussion

The milk production and chemical features are reported in Table 1. Milk production was higher in supplemented grazing groups than in unsupplemented one ( $P < 0.05$ ) (295.7 kg GRD and 276.7 kg GNRD vs 248.6 kg G). Not significant difference was observed in chemical-physical characteristics.

Table 1. Milk production and quality in different feeding systems (means  $\pm$  SD)

Groups	Parameters <sup>†</sup>					
	Milk prod. (kg)	DM (%)	CP (%)	Fat (%)	Lactose (%)	NPN (%) ( $\times 100$ )
G	248.6b	12.2	3.3	3.7	4.5	4.0
GRD	295.7a	12.4	3.1	3.8	4.8	4.2
GNRD	276.7a	11.9	3.1	3.6	4.5	3.9
Group effect	*	n.s.	n.s.	n.s.	n.s.	n.s.

<sup>†</sup>DM: dry matter; CP: crude protein; NPN: no-protein nitrogen.

<sup>a,b</sup>In columns are different  $P < 0.05$ .

\* $P < 0.05$ ; n.s.: no significant.

This result agreed with previous studies of Claps *et al.* (1994) and Fedele *et al.* (2000), who showed that concentrate supplementation improved milk production, had no effect on the chemical composition of milk.

The content of mono and sesquiterpenes in goat milk (Table 2) showed a great variability of VOC composition among groups and seasons. During the winter and spring, the highest monoterpenes content was observed in G group, but in GRD group exhibited the highest content in summer.

Table 2. Goat milk mono and sesquiterpenes composition (means  $\pm$  SD)

Groups	Seasons		
	Winter	Spring	Summer
Monoterpenes (ng/l)			
G	1899 $\pm$ 190	243 $\pm$ 173	1730 $\pm$ 1771
GRD	1192 $\pm$ 175	201 $\pm$ 216	2077 $\pm$ 1645
GNRD	785 $\pm$ 138	130 $\pm$ 103	1429 $\pm$ 1512
Sesquiterpenes (ng/l)			
G	2397 $\pm$ 2961	1609 $\pm$ 645	14041 $\pm$ 3455
GRD	1124 $\pm$ 534	1130 $\pm$ 800	24586 $\pm$ 23000
GNRD	724 $\pm$ 80	1252 $\pm$ 158	20698 $\pm$ 16717

The same pattern was observed for the sesquiterpenes content. In winter, sesquiterpenes content in G group were 113% higher than GRD and 231% higher than GNRD. In spring, the differences between the same groups decreased at 42 and 28%, respectively. The highest level of sesquiterpenes was detected in GRD group during the summer, and it increased of 70 and 19% compared with G and GNRD groups.

In winter and spring, the highest content of mono and sesquiterpenes found in G group, may be related to high herbage intake in these seasons. Indeed, in winter the dry matter (DM) intake by G group was higher than by GRD (210 g/day). The DM intake by GNRD group averaged 150 g/day. Furthermore, in spring, DM intake of G group was higher than in supplemented groups. G group ingested 220 g DM/day and 210 g DM/day more than GRD and GNRD, respectively.

In winter and spring, the botanical composition of the diet selected by the three groups was similar. In summer, the highest content of sesquiterpenes was obtained in the milk of the animals supplemented with rapidly degradable concentrate (GRD). This phenomenon could not be ascribed to the effect of herbage intake, but probably to the plants selected by animals. In fact, the herbage intake of GDR was lower 32 and 6% than G and GNRD groups and composed by a higher percentage of *Cichorium intibus*, *Crepis* sp. and *Rumex* sp.

A relevant difference emerged about the parts browsed. Animals in the supplemented groups, and particularly GRD, selected especially flowers which are rich on sesquiterpenes (Schantz and Ek, 1971).

The highest presence in the summer pasture of dicotyledones could explain with reference to Buchin *et al.* (1999) the high content of sesquiterpenes observed in the milk.

## Conclusion

We showed that it is possible to increase milk production in traditional feeding systems through concentrate supplementation without worsening milk aroma. Season had great effect on milk quality. Only in summer, milk VOC content reached very significant values. The rapidly degradable concentrate seemed to interact better with herbage intake characteristic. Both concentrates had similar effects on milk production. The relationship between the terpenes in milk and the botanical composition of pasture confirmed the results obtained from others authors (Mariaca *et al.*, 1997; Bugaud *et al.*, 2000).

## References

- Buchin, S., Martin, B., Dupont, D., Bornard, A. and Achilleos, C. (1999). Influence of the composition of Alpine highland pasture on the chemical, rheological and sensory properties of cheese. *J. Dairy Res.*, 66: 579-588.
- Bugaud, C., Bornard, A., Hauwuy, A., Martin, B., Salmon, J.C., Tessier, L. and Buchin, S. (2000). Relation entre la composition botanique des végétations de montagne et leur composition en composés volatils. *Fourrages*, 162: 141-155.
- Claps, S., Rubino, R., Cogliandro, E. and Fedele, V. (1994). Fabbisogni alimentari e nutritivi, comportamento alimentare e produzione di latte di capre allevate al pascolo con differenti integrazioni alimentari. In: *Atti 10e Giornata Scientifica "Miglioramento dell'Efficienza Produttiva degli Ovini e dei Caprini"*, Bella (Italy), 24 November 1994, pp. S2-2.1-2.16.
- Fedele, V., Pizzillo, M., Claps, S., Morand-Fehr, P. and Rubino, R. (1993). Grazing behaviour, diet selection and intake of goats in intensive pasture in southern Italy. *Small Ruminant Res.*, 11: 305-322.
- Fedele, V., Signorelli, F., Brancaleoni, E., Ciccio, P. and Claps, S. (2000). Effect of concentrate grain source and herbage intake on physical-chemical features and milk aroma in grazing goats. In: *7th International Conference on Goats*, Tours (France), 15-18 May 2000, pp. 152-154.
- Mariaca, R.G., Berger, T.F.H., Gauch, R., Imhof, M.I., Jeangros, B. and Bosset, J.O. (1997). Occurrence of volatile mono and sesquiterpenoids in highland and lowland plant species as possible precursors for flavour compounds in milk and dairy products. *J. Agr. Food Chem.*, 45: 4423-4434.
- SAS (1988). *SAS Users' Guide*. SAS Institute, Cary, USA.
- Schantz, V.M. and Ek, B.S. (1971). Ueber die Bildung von ätherischem Oel in Kummel, *Carum carvi* L. (About the formation of essential oil in caraway, *Carum carvi* L.). *Sci. Pharm*, 39: 82-101.
- Verdier-Metz, I., Coulon, J.B., Pradel, P., Viallon, C., Albouy, H. and Berdagué, J.L. (2000). Effect of the botanical composition of hay and casein genetic variants on the chemical and sensory characteristics of ripened saint-nectaire type cheeses. *Lait*, 80: 361-370.