Influence of organic systems on milk yield and quality of Cilentana goats

Bovera F., Piccolo G., Calabrò S., Cutrignelli M.I., Zicarelli F., Infascelli F.

in

Priolo A. (ed.), Biondi L. (ed.), Ben Salem H. (ed.), Morand-Fehr P. (ed.).
Advanced nutrition and feeding strategies to improve sheep and goat

Zaragoza : CIHEAM
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 74

2007
pages 83-87

Influence of organic systems on milk yield and quality of Cilentana goats

F. Bovera, G. Piccolo, S. Calabrò, M.I. Cutrignelli, F. Zicarelli and F. Infascelli
University of Naples, Department of Scienze Zootecniche e Ispezione degli Alimenti,
via F. Delpino, 1, 80137 Naples, Italy

SUMMARY – Forty-five multiparous pregnant Cilentana goats were equally divided into three groups. The first two groups (A and B), grazing natural pasture from 08:00 to 16:00 hours, received, respectively, the commercial concentrate (CP 18.0%, UFL, 1.03/kg DM) normally used on the farm where the trial was carried out and another (CP 17.0%, UFL 1.10/kg DM) made up only of raw materials from organic farming. The third group (C) received the same concentrate as group A but, during the whole trial period, was housed in a stall where it received alfalfa hay *ad libitum* as forage. The concentrates were fed at 200, 300 and 400 g/head/d, respectively 45, 30 and 15 days before parturition (beginning of February); then the quantities were increased up to 800 g/head/d. Once the kids were sold, two months after parturition, the milk yield was monitored monthly until the dry season for a total of 5 months. At each control, individual milk samples from the two daily milkings were analysed for protein, fat, lactose, casein and non-protein nitrogen contents. The milk yield did not statistically differ among the groups. However, group B, fed "organic" concentrate, showed higher milk yields than group A, which were fed non-organic concentrate, and overlapped yields in comparison to group C, housed in stalls (1432.7 *vs* 1418.1 g/d *vs* 1337.2 g/d, respectively for groups B, C and A). As regards milk chemical composition, the grazing groups showed significantly higher fat percentages (4.45 and 4.60 *vs* 3.79%, respectively for groups A, B and C; $P<0.01$), probably due to high roughage intake due to more intensive physical activity. The other chemical parameters showed no significant differences. Our results showed that the organic breeding of Cilentana goats did not induce a performance decrease: indeed, it can improve product yield in light of the exclusive use of goat milk for cheese making.

Keywords: Organic system, Cilentana goat, milk yield, quality.

RESUME – *"Influence des systèmes de production biologique sur la quantité et la qualité du lait de chèvres Cilentana". Quarante-cinq chèvres multipares Cilentana en gestation ont été distribuées en trois groupes égaux. Les deux premiers groupes (A et B), sur pâturage naturel de 08:00 à 16:00 h, ont reçu respectivement le concentré commercial (CP 18,0%, UFL, 1,03/kg matière sèche) qui était normalement utilisé à la ferme où a été mené l'essai, et un autre aliment (PB 17,0%, UFL 1,10/kg matière sèche) composé uniquement de matières premières provenant de l'agriculture biologique. Le troisième groupe (C) a reçu le même concentré que le groupe A sauf que, durant toute la période de l'essai, les animaux étaient en stabulation et recevaient du foin de luzerne à volonté comme fourrage. Les concentrés étaient distribués à raison de 200, 300 et 400 g/tête/j, respectivement 45, 30 et 15 jours avant la parturition (début février) ; ensuite les quantités augmentaient jusqu'à 800 g/tête/j. Après la vente des chevreaux, deux mois après la parturition, la quantité de lait était suivie mensuellement jusqu'à la saison sèche pendant un total de 5 mois. A chaque contrôle, on analysait les échantillons individuels de lait provenant des deux traites journalières pour connaître les teneurs en protéine, matière grasse, lactose, caséine et azote non protéique. La qualité du lait ne différait pas statistiquement entre les groupes. Cependant, le groupe B, recevant un concentré "bio", a montré des quantités de lait supérieures à celles du groupe A, qui recevait un concentré non "bio", et avec des quantités semblables à celles du groupe C en stabulation (1432,7* vs *1418,1 g/j* vs *1337,2 g/j, respectivement pour les groupes B, C et A). Concernant la composition chimique du lait, les groupes en pâturage ont montré des pourcentages significativement supérieurs en matière grasse (4,45 et 4,60* vs *3,79 %, respectivement pour les groupes A, B et C; P<0,01), probablement dû à la forte ingestion de fourrage en raison d'une activité physique plus intense. Les autres paramètres chimiques n'ont pas montré de différences significatives. Nos résultats indiquent que la conduite en "bio" des chèvres Cilentana n'a pas induit de baisse des performances : en fait, ceci peut améliorer le rendement productif étant donné que le lait de chèvre est exclusivement utilisé pour la fabrication fromagère.*

Mots-clés : *Système biologique, chèvres Cilentana, quantité de lait, qualité du lait.*

Introduction

In 2003 for the second consecutive year in Italy, a decrease in the number of organic farms was

recorded even if Italy is still ranked first in Europe and third in the world for the number of farms converted or under conversion (IFOAM, 2005). Regarding livestock production, the "organic" standard (EC Reg. 1804/99, transposed into effect in Italy under DM 04.08.2000, integrated by DM 29.03.2001) entails compliance with many regulations and practices to be adopted by farmers. First, regulations prohibit breeding without land, stipulate the access of animals to pasture and also envisage limitations regarding animal nutrition. Among the most important: the use of dry matter from roughage has to make up at least 60% of total dry matter intake; it is possible to use at most 15% of dry matter intake from non-organic feeds; the use of extraction meals is prohibited. In light of this, organic breeding appears very interesting in goats, in particular where animals are raised from native genetic types, adapted to pasture in marginal pedo-climatic areas. For such livestock, despite the numerous studies conducted (Duranti *et al*., 1993; Piccolo *et al*., 1998), little is known regarding their productive potential while much has been written about the chemical-nutritional characteristics of the milk, used almost exclusively for production of fresh and stored cheese and ricotta. The small size of fat globules and the higher content of short and medium-chain fatty acid (Jennes, 1980; Chandan *et al*., 1992), that increase intestinal absorption (Hacelaf *et al*., 1993) are lending goat milk gradually increasing interest in the scientific community as food for early infancy or as an alternative to cow milk in humans who find it hard to digest the latter. For about ten years our Department has carried out studies on the effect of different feeding plans on milk yield and quality of a population of Cilentana goats raised in the province of Salerno with the traditional extensive system. The aim of our paper was to evaluate the effect of exclusively organic nutrition on the productive performance of these animals. Moreover, it seems interesting to ascertain whether the organic system, in comparison with the intensive breeding system that includes no pasture, can penalize milk yield and quality.

Materials and methods

The trial was carried out in the Province of Salerno (Italy) on a farm where Cilentana goats were raised to pasture. Forty-five pluriparous goats were used, equally divided into three groups (A, B and C) with the same number of lambings and similar milk yield in the previous lactation. The first two groups (A and B) were led daily to pasture (consisting in coppice and scrubland) from 08:00 to 16:00 and were given a diet supplement, respectively, of a commercial concentrate normally used on the farm and another made up only of raw materials from organic farming. The third group (C) was fed the same concentrate as group A but was housed during the trial in stalls where it was fed, as roughage, an alfalfa hay *ad libitum*. The concentrates were administered at 200, 300 and 400 g/head/d respectively 45, 30 and 15 days before the presumed date of lambing, identified by an ultrasonographic method. After lambing (occurring for all animals in the first ten days of February 2004) the concentrate quantity was gradually increased up to 800 g/head/die. The maximum level was established in order to remain, in particular for the animals raised under organic nutrition, in the limit of 40% of dry matter intake supplied by concentrate feeds. Indeed, as the average live weight of the goats was about 57 kg, and given that grazing goats are attributed (Rubino, 1996) a voluntary intake of 3.5% of live weight, 800 g represent 40% of the presumed diet consumed by animals. Samples of concentrates used in the trial and of the alfalfa hay were analysed for chemical-nutritional characteristics (AOAC, 1990; INRA, 1988).

After sale of the kids (second half of April) and up to the dry season for a total of 5 months, milk yield was recorded monthly. At each control, representative milk samples from the two daily milkings were transported to our Department's laboratories to analyse protein, fat and lactose contents with the infrared method using Milko Scan 133B (FIL-IDF, 1996) standardised for goat milk, and non-protein nitrogen (NPN) and casein according to the methods proposed by the ASPA Commission (1995).

The results of the yield characteristics were analysed by ANOVA using SAS (2000) according to the model: $Y_{ijk} = \mu + G_i + C_j + GC_{ij} + \varepsilon_{ijk}$ where Y is the single observation, μ is general mean, G is the group effect (i = A, B or C), C is the control effect (j = 1,…5), GC is the interaction between the two considered effects, and ε is the error. The "intra-effect" comparison among the means was performed with the Tukey test (SAS, 2000).

Results and discussion

Table 1 shows chemical-nutritional characteristics of the two concentrates and the alfalfa hay used

in the trial. The concentrate made up with raw material from organic farming showed, as a function of chemical composition, a slightly higher nutritive value than the concentrate administered to other two groups (1.10 *vs* 1.03 UFL/kg DM).

Table 1. Chemical characteristics of concentrates and alfalfa hay used during the trial

	Dry matter (%)	Ash (%DM)	Crude protein (%DM)	Ether extract (%DM)	Crude fibre (%DM)	UFL/kg DM (%DM)
No-Bio Conc.	87.0	8.0	18.0	3.0	9.0	1.03
Bio Conc.	87.0	6.1	17.0	5.0	6.8	1.10
Alfalfa hay	88.0	7.5	16.0	1.7	24.8	0.65

As regards alfalfa hay, the purpose of using it in stall conditions was to make the diets as isoproteic as possible. Indeed, previous studies (Infascelli *et al*., 1998; Cutrignelli *et al*., 2000) on the same genetic type of goats raised to pasture in the same study area, ascertained that during the highest vegetative stage (April and May) the protein content of the grass intake by goats was about 16%.

Average milk production during the five months of milking (Table 2) did not statistically differ among the three groups, even if group B, fed the organic concentrate and led to pasture showed a higher milk production than the other two groups (1432.7 *vs* 1418.1 g/d *vs* 1337.2 g/d, respectively for groups B, C and A). In terms of milk chemical composition (Table 2), the grazing groups showed significantly higher fat percentages than group C (4.45 and 4.60 vs. 3.79%, respectively for groups A, B and C; P<0.01).

Table 2. Milk yield and quality of groups during the trial

	Milk production (g/head/d)	Protein (%)	Fat (%)	Lactose (%)	Casein (%)	NPN (%)
Group Effect (GE)						
A	1337.2	3.53	4.45^{A}	4.59^{B}	2.78	0.23
B	1432.7	3.58	4.60^{A}	4.58^{B}	2.82	0.22
C	1418.1	3.64	3.79^{B}	4.67^{A}	2.80	0.22
Control Effect (CE)						
1	2043.7^{A}	3.28^{C}	4.23^{B}	4.76^{A}	2.62^{B}	0.21^{B}
2	1703.3^{B}	3.50^{BC}	4.50^{A}	4.74^{A}	2.71^{B}	0.20^{B}
3	1367.8^{C}	3.55^{B}	3.97^{C}	4.60^{B}	2.74^{B}	0.26^{A}
4	1154.6^{C}	3.44^{BC}	4.18^{B}	4.53^{BC}	2.75^{B}	0.19^{B}
5	710.8^{D}	4.14^{A}	4.52^{A}	4.43^{C}	3.20^{A}	0.26^{A}
Significance						
GE	NS	NS	**	**	NS	NS
CE	**	**	**	**	**	**
Interaction	NS	NS	NS	*	NS	**
SEM	10.47×10^{4}	0.14	0.39	0.12	0.12	0.002

A, B and **: P <0.01.
*: P <0.05.
NS: non-significant.

Our results agree with those recorded by Ramanzin *et al*. (1997) in milking cows and, more recently, by Soryal *et al*. (2004) in Alpina goats. Although in our case it is not possible to measure the voluntary dry matter intake from roughage, in particular for grazing animals, we can assume that

groups A and B consume more roughage, probably due to the low palatability of legumes for goats (Malechek and Provenza, 1981) and to the more intensive physical activity due to pasture.

As for other milk chemical characteristics, statistically significant differences were recorded for lactose content (4.59 and 4.58 *vs* 4.67%, respectively for groups A, B and C; $P<0.01$). The percentages of casein and non-protein nitrogen did not statistically differ among the groups even if, expressing the two parameters as percentages of total protein, some differences could be noted: grazing groups showed higher casein values (78.75 and 78.77 *vs* 76.92%, respectively for groups A, B and C), while "organic" group showed the lowest content of NPN (6.98 *vs* 7.36 and 7.42%, respectively for groups B, A and C). Non-protein nitrogen values were on average lower than those reported for animals of selected breeds and highlight the optimal aptitude to cheese production of milk from Cilentana goat: Piccolo *et al.* (1998) showed that NPN levels have a negative effect both on curd formation and consistency.

On the basis of analytical data the average cheese yields were calculated for the three groups using the equation suggested by Alais (1984) for Camembert cheese: yield = 0.327 × g of protein + 0.09 × g of fat. The cheese yield of the milk produced by the group raised in stall conditions was the lowest, while the best results were obtained from the milk produced by group B (15.55 *vs* 15.85 *vs* 15.31%, respectively for groups A, B and C).

As expected, during milking, milk production decreased even if it was at the 5th control (8th month of lactation) on average higher than 700 g/head/d, while protein and fat percentages increased gradually. For the latter parameter, it is worth studying the trend of fat content in milk by milking month (Fig. 1). The grazing groups showed higher values at the first two productive controls (April and May) than the two subsequent controls; on the contrary, the fat content of milk produced by group C increased gradually during milking. For all groups in June and July (controls 3 and 4) the lowest fat contents were recorded, due to climatic condition that depressed fat synthesis (Loewenstein *et al*., 1984). In any case, our results are in agreement with Guo *et al*. (2001) and Soryal *et al*. (2004). At the last control, finally, in the three groups the highest fat content was recorded.

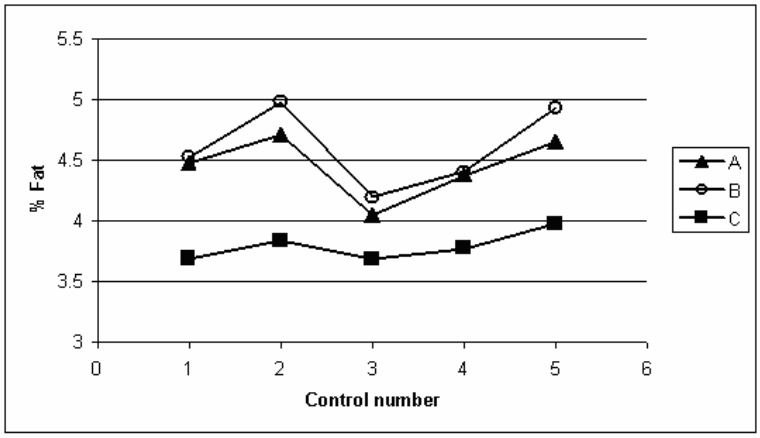

Fig. 1. Trend of fat percentage by group.

Conclusions

The results showed that Cilentana goat can be raised under organic conditions, making milk yields similar to those recorded in animals kept in stalls and fed alfalfa hay *ad libitum*. Our results are of considerable interest given that the diets of the three groups were very similar in terms of protein and energy supplies, while energy consumption differed greatly in animals grazing in steeply-sloping mountain areas. Moreover, fat content was significantly higher in grazing groups, a fact of considerable interest as goat milk is almost exclusively used for cheese production. This is another valid reason to justify the increasing interest in the breeding of Cilentana goat that, due to centuries-old adaptation to marginal habitats, ensures the use of otherwise underused feed resources.

Research is being undertaken in our Department to determine the fatty acid composition of milk, with particular attention to conjugated linoleic acid (CLA). Indeed, the plant species at pasture could positively affect the fatty acid composition.

Acknowledgments

Research supported by CRAA, scientist in charge: Prof. F. Infascelli.

References

Alais, C. (1984). *Scienza del latte*. Ed. Tecniche Nuove.

AOAC (1990). *Official Methods of Analysis*. 15th edn. Association of Official Analytical Chemists, Arlington, Virginia.

ASPA (1995). *Commissione metodologie di valutazione della produzione quanti-qualitativa del latte. Metodi di analisi del latte delle principali specie di interesse zootecnico*. Centro Stampa Università di Perugia, Italy.

Chandan, R.C., Attaie, R. and Shahani, K.M. (1992). Nutritional aspects of goat milk and its products. In: *Proc. V International Goats Conference*, New Delhi (India), 1992, vol. IV(II): 399-420.

Cutrignelli, M.I., Sarubbi, F., Durante, G., Bovera, F. and Infascelli, F. (2000). Influenza del livello energetico e proteico del mangime sulla produzione quanti-qualitativa di latte in capre allevate al pascolo. In: *Proc. XIV SIPAOC National Congress*, Vietri sul Mare (Italy), 18-21 October 2000, pp. 363-369.

Duranti, E., Bosi, G., Casoli, C., Costarelli, S., Lucaroni, A., Morgante, M. and Todini, L. (1993). In: *Proc. IX Congr. Naz. ASPA,* Rome (Italy), 3-7 June 1991, pp. 1019-1027.

FIL-IDF (International Dairy Federation) (1996). *Dictionary of Dairy Terminology*. Second revised edition. Elsevier, Brussels.

Guo, M.R., Dixon, P.H., Park, Y.W., Gilmore, J.A. and Kindstedt, P.S. (2001). Seasonal changes in the chemical composition of commingled goat milk. *J. Dairy Sci*., 84(Suppl. E), pp. E79– E83.

Hacelaf, W.W., Boukherelda, M., Bendouabdellah, M., Coquin, P., Desejeux, J.F., Razafindrakoto, O., Ravelomanana, N., Rasolofo, A., Rakotoarimanana, R.D., Gourgue, P. and Briend A. (1993). Le lait de chèvre peut-il remplacer le lait da vache chez l'enfant malnutri? *Lait*, 73: 601-611.

IFOAM (2005). *The World of Organic Agriculture: Statistics and Emerging Trends*. INFOAM, Bonn, Germany.

Infascelli, F., Sarubbi, F., Calabrò, S., Bovera, F., Durante, G. and Piccolo, V. (1998). Influenza del livello di integrazione alimentare sulla produzione quanti-qualitativa di latte in capre allevate al pascolo. In: *Atti XIII Congr. Naz. SIPAOC*, Palermo (Italy), 16-19 April 1998, pp. 81-83.

INRA (1988). *Alimentation des bovins, ovins et caprins*. Institut National de la Recherche Agronomique, Paris.

Jennes, R. (1980). Composition and characteristics of goat milk. *J. Dairy Sci*., 63: 1605-1630.

Loewenstein, M., Frank, J.L. and Speck, S.J. (1984). Goat cheese. In: *Extension Goat Handbook*. USDA, Washington, DC, 10 pp.

Malechek, J.C. and Provenza, F.D. (1981). Feeding behaviour and nutrition of goats on rangelands. In: *Intern. Symp. "Nutrition et systèmes d'alimentation de la chèvre"*, Tours (France), 12-15 May 1981, INRA-ITOVIC, 1: 411-428.

Piccolo, V., Moniello, G., Infascelli, F. and Cutrignelli, M.I. (1998). Caratteristiche quanti-qualitative del latte e profilo metabolico di una popolazione caprina allevata in provincia di Napoli. *La Selezione Veterinaria*, 1: 1-11.

Ramanzin, M., Bailoni, L., Schiavon, S. and Bittante, G. (1997). Effect of monensin on milk production and efficiency of dairy cows fed two diets differing in forage to concentrate ratio. *J. Dairy Sci*., 80: 1136-1142.

Rubino, R. (1996). *L'Allevamento Caprino*. ASSONAPA, Roma.

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

Soryal, K.A., Zeng, S.S., Min, B.R., Hart, S.P. and Beyene, F.A. (2004). Effect of feeding system on composition of goat milk and yield of Domiati cheese. *Small Rum. Res*., 54: 121-129.