

Hygienic quality of goat's milk

Bacteriological quality of raw goat's milk in Greece

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Summary — Although the production of goat's milk in Greece is significant, the conditions under which this milk is produced are generally unsatisfactory. The large number of dairy farmers, the small herd size, the wide dispersal of milk producers all over the country, the topography, the climatic conditions, the poor stabling conditions as well as, in many cases, the absence of roads, water supplies and electricity, constitute the main problems. The bacteriological quality of goat's milk produced in Greece is not always satisfactory. It usually has high microorganism counts, including pathogens, high somatic cell counts and low pH. A program is currently being implemented to improve the quality of goat's milk. Milk is classified into quality grades on the basis of which the price is determined. To assess quality, the bacteriological quality of raw milk, the presence of antibiotics in milk and its chemical composition are taken into consideration.

goat's milk / microbiological quality / production conditions / Greece

Résumé — La qualité microbiologique du lait cru de chèvre en Grèce. La production du lait de chèvre en Grèce est importante, mais les conditions d'élevage ne sont pas satisfaisantes. Le grand nombre de producteurs, le petit nombre d'animaux par troupeau et leur dispersion sur tout le territoire, les conditions climatiques, les pauvres conditions d'élevage, l'état des routes, l'eau et l'électricité, sont les problèmes les plus importants. La qualité microbiologique du lait de chèvre produit en Grèce n'est pas satisfaisante non plus. Souvent il contient un grand nombre de micro-organismes dont certains sont pathogènes avec aussi un grand nombre de cellules somatiques, et un pH bas. Pour améliorer cette qualité, un programme de paiement du lait en fonction de sa qualité hygiénique et biologique et de sa composition a été mis en place.

lait de chèvre / qualité microbiologique / conditions d'élevage / Grèce

INTRODUCTION

Greece is a country with a significant production of goat's milk. According to FAO data (1987), goat's milk production in Greece in 1986 rose to 400 000 tons, which accounts for 5.2% of total world,

24.8% European and 28.1% EEC member states goat's milk production. As a goat's milk producing country, Greece occupies the 7th position in the world and is 2nd of the European and EEC countries. More recent data show a higher goat's milk production for Greece, ie 649 000 tons for

1990 (Department of Statistics, Greek Ministry of Agriculture, 1993; personal communication).

The main characteristic of Greek goat husbandry is that the majority of the goat population — ≈ 80% — consists of small-sized indigenous breeds, animals without any genetical improvement with a low milk production (Hatjiminaoglou *et al*, 1985). These animals are mainly kept in flocks (82%), and mostly in mountainous (50%) and semi-mountainous (33%) regions of average fertility, where the best way to exploit the ground terrain is to use it as natural grazing land. The goat farms are mostly small (77% with 1–9 animals; 17% with 10–99 animals and only 6% with > 99 animals) distributed throughout the country (Greek National Statistics Service, 1991a,b).

RAW GOAT'S MILK PRODUCTION CONDITIONS

Goat's milk is produced in Greece under quite difficult conditions. The large number of dairy farmers, the small herd size, the low milk yield per animal, the wide dispersal of milk producers, the topography of the country, the climatic conditions, the poor stabling conditions and the absence in many cases of roads, water supplies and electricity, constitute the main problems.

The chemical composition of goat's milk in Greece varies (Anifantakis and Kandarakis, 1981; Veinoglou *et al*, 1982; Voutsinas *et al*, 1990; Simos *et al*, 1991) but compared with the milk produced in other countries, it could be considered as being rich in fat, proteins and total solids (Juarez and Ramos, 1986).

Goat's milk is produced in Greece on a seasonal basis. Most of it is produced from February to July, with maximum yield in

May. More than 70% is used raw or pasteurized for the manufacture of different types of traditional cheeses, usually mixed with ewe's milk. The rest is used for home consumption by farmers, or for butter production.

Milking is carried out twice a day except at the end of lactation period when it takes place only once.

Goat's milk delivered to dairies for processing constitutes ≈ 40% of the country's total production and is delivered as follows:

- by the farmers themselves, once or twice a day depending on the ambient temperature. This means of transport concerns a limited quantity of milk produced on farms located near the dairy units;

- evening milk is stored on the farms in cans at ambient temperature till the following morning when the dairy unit collects it together with the morning milk. During periods of high temperatures, collection is usually performed twice a day, *ie* both morning and evening. In both cases the milk cans are collected either from the dairy farms or from certain collection points where more farmers take their milk;

- the milk is transported by the farmers to a collection center once or twice a day depending on the period of the year, where it is cold-stored in tanks, usually at 3–4°C. The milk is collected from these centers by the dairies once a day or every 2 days and is transported by isothermic tankers to the dairy unit;

- milk is stored in small cooling tanks located on farms at temperatures ≈ 3–4°C. It is usually collected by the dairy unit once a day, or every 2 days. This system of collection concerns large farms and is only applied to a limited extent.

In spite of the fact that there are no accurate data concerning the percentage of goat's milk stored in cooling tanks before delivery to the dairies, the amount is esti-

mated to be quite low, and not > 5% of total milk production. Nevertheless, there is marked effort in this direction in an attempt to significantly increase this percentage.

QUALITY OF RAW MILK

The quality of raw goat's milk is difficult to estimate with certainty due to the limited data on the subject. The results of a study carried out by the Agricultural University of Athens Dairy Laboratory under the author's supervision on the milk produced in 3 regions of Greece, namely Epirus, the Peloponnese and Crete have been presented. They refer to the methylene blue test reduction time, somatic cell counts and milk pH.

Methylene blue reduction time

Based on the fact that a strong relationship exists between goat's milk methylene blue reduction time and total bacterial counts, $r = -0.923$ (Samaras and Kehagias, 1987), the methylene blue reduction test appears a useful indication for the assessment of the bacteriological quality of goat's milk. 1 158 raw goat's milk samples taken during lactation from the above-mentioned regions, were therefore examined using the methylene blue reduction test. From an analysis of the results it was found that only a small percentage of the samples, *ie* $\approx 28\%$, had a reduction time > 3 h, corresponding to high quality raw milk. A relatively significant percentage, *ie* $\approx 33\%$, had a reduction time of 1 h or less, corresponding to low quality raw milk, and a percentage of the samples had reduction time of between 1 and 3 h, corresponding to intermediate quality (fig 1). A similar picture was presented when the samples were examined separately for each of the 3 regions. It is to be noted that in the case of

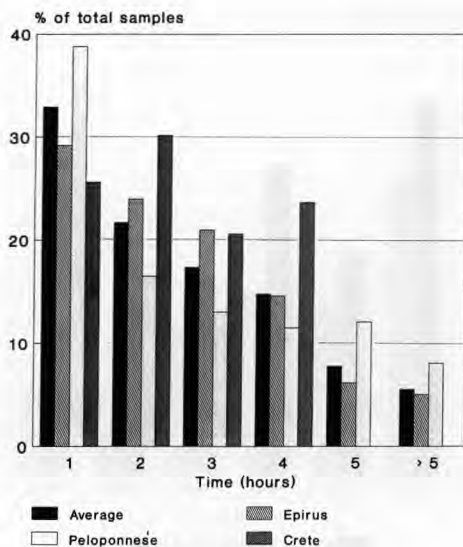


Fig 1. Distribution of methylene blue reduction time of goat's milk samples from different regions of Greece. NB: in the case of Crete, samples with a reduction time of > 3 h are grouped in the same class.

Distribution des temps de réduction du bleu de méthylène du lait de chèvre de différentes régions de Grèce. Dans le cas de la Crète, les échantillons ayant un temps de réduction de plus de 3 h ont été regroupés dans la même classe.

Crete, samples with a reduction time of > 3 h were grouped in the same class.

When the results were analyzed of samples taken from the regions of Epirus and the Peloponnese per month (fig 2), it could be seen that milk quality was higher during winter than in the spring, mainly because of changes in the environmental temperature.

Somatic cell counts (scc)

The distribution of somatic cell measurements determined by the Fossomatic me-

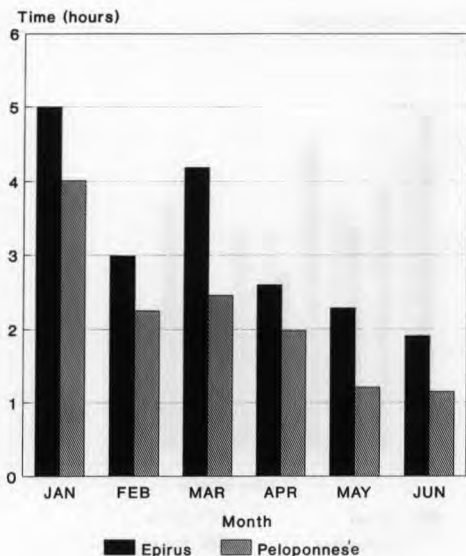


Fig 2. Evolution of mean methylene blue reduction time during the lactation period in goat's milk samples from different regions of Greece.

Évolution au cours de la lactation des temps moyens de réduction du bleu de méthylène du lait de chèvre de différentes régions de Grèce.

thod on raw goat's milk samples from the regions of Epirus and the Peloponnese during the lactation period has been presented in figure 3. It can be seen from this figure that the majority of the milk samples (65%) had an average of $> 10^6$ scc/ml, indicating poor hygienic conditions of the goat udder. Only 10% of the samples had $< 5 \times 10^5$ scc/ml. It can also be concluded from examination of this figure that there were no significant differences in the 2 regions regarding the above.

When the somatic cell counts of milk samples taken during the lactation period — January till June — were examined (fig 4) a steady increase was found in somatic cell counts during the lactation period, *ie* 9.9×10^5 scc/ml at the beginning, reaching

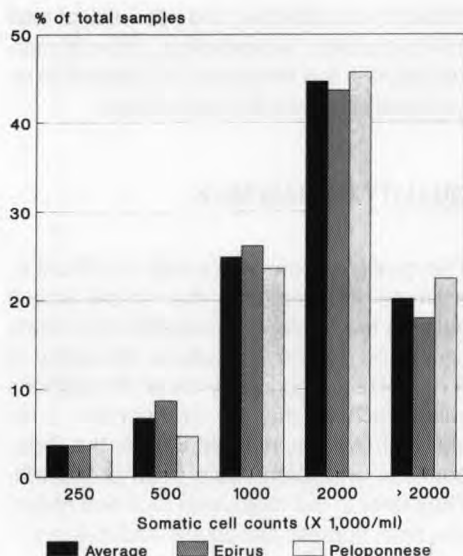


Fig 3. Distribution of somatic cell counts in goat's milk samples from different regions of Greece.

Distribution du nombre de cellules somatiques du lait de chèvre de différentes régions de Grèce.

up to 1.9×10^6 scc/ml towards the end of the lactation period.

Raw milk pH

The distribution of pH in the samples from the regions of Epirus and the Peloponnese on average and for each region separately have been presented in figure 5. From these results it can be concluded that a rather high percentage of the milk samples examined (23%) had a pH < 6.50 , which was mainly attributed to the poor hygienic conditions at the stages of milk production and handling. The majority of milk samples (69%) had a pH of 5.51–5.70.

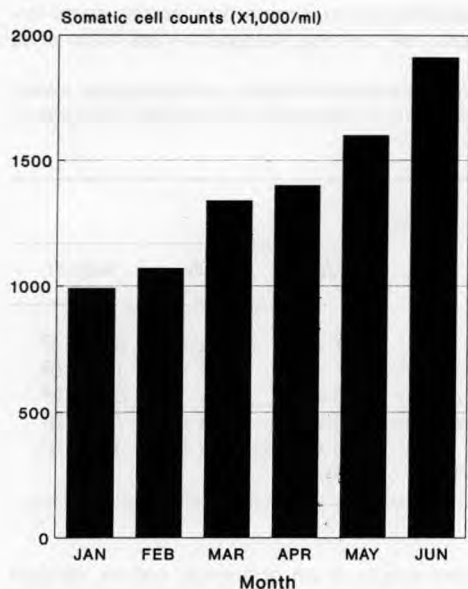


Fig 4. Evolution of mean somatic cell counts during the lactation period in goat's milk samples from Greece.

Évolution au cours de la lactation du nombre moyen de cellules somatiques du lait de chèvre.

A clear difference is observed when the 2 regions are compared as far as the ratio of the samples with low pH is concerned. In the case of the Peloponnese, 33% of the samples had a pH < 6.50, whereas in the Epirus samples the percentage was 15%. This was mainly attributed to the differences in the frequency of collection and climatic conditions.

MILK MICROFLORA

The main bacterial groups of non-clinical goat's milk samples have been studied by Kalogridou-Vassiliadou *et al* (1991). The total viable counts and staphylococci, micrococci and streptococci counts increased significantly during May, June and July

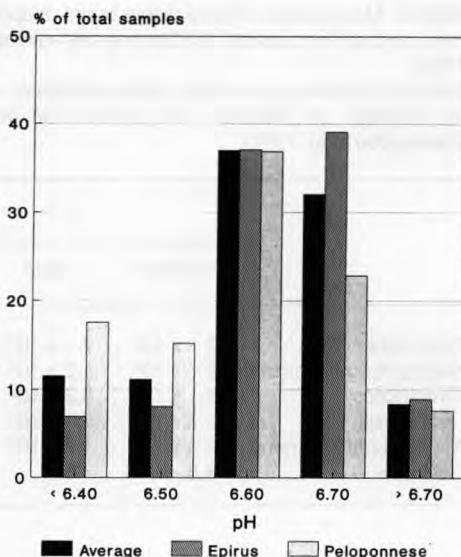


Fig 5. Distribution of pH of goat's milk samples from different regions of Greece.

Distribution du pH du lait de chèvre de différentes régions de Grèce.

while the coliform and aerobic spore former counts increased during March and April (table 1). Differences in the bacterial groups were observed between goats and months throughout the lactation period.

The presence of mastitis-related pathogens was determined by the procedure of Kalogridou-Vassiliadou (1991). It was found that 65% of the samples examined contained infective organisms which mainly comprised staphylococci (59%) and bacilli (30%), as well as coliforms, micrococci, streptococci, corynebacteria and *Pseudomonas*. Among staphylococcal isolates, *S aureus*, *S epidermidis*, *S capitis*, *S hyicus* subsp *hyicus* and *S intermedius* were more frequent than the other species. Among bacillus isolates, *B coagulans* and *B licheniformis* were the most frequent.

Table 1. Mean values of total viable count, staphylococci/micrococci, streptococci, aerobic spore formers and coliform counts (CFU/ml) in non-clinical goat's milk samples (Kalogridou-Vassiliadou *et al*, 1991).

*Valeurs moyennes de la flore totale revivifiable, staphylocoques/microcoques, streptocoques, sporulés aérobies et coliformes (UFC/ml) du lait de chèvre avec mammite non clinique (Kalogridou-Vassiliadou *et al*, 1991).*

	Months					
	March	April	May	June	July	August
Total viable count	7 x 10 ²	7 x 10 ²	2 x 10 ³	2.7 x 10 ³	4.8 x 10 ³	6.8 x 10 ²
Staphylococci/micrococci	2 x 10 ²	1.2 x 10 ²	7.3 x 10 ²	8 x 10 ²	9 x 10 ²	1.5 x 10 ²
Streptococci	1 x 10 ³	6.2 x 10 ²	1.7 x 10 ³	2.5 x 10 ³	1.7 x 10 ³	5 x 10 ²
Lactobacilli	2.7 x 10 ²	5.1 x 10 ²	1.2 x 10 ³	1.1 x 10 ³	2.3 x 10 ²	7.8 x 10 ¹
Aerobic spore formers	1.3 x 10 ³	1.2 x 10 ²	3 x 10 ¹	4.4 x 10 ¹	4.2 x 10 ¹	3 x 10 ¹
Coliforms	4.8	3.8	4.4	0.4	1.8	1.2

The relation between somatic cell counts and infective status of the goat udder has been studied by Kalogridou-Vassiliadou *et al* (1992). It was found that ≈ 81% of goat udders were infected, minor pathogens — coagulase negative staphylococci, micrococci, bacilli and corynebacteria — being the most frequent isolates (66%). Somatic cell counts of > 10⁶ cells/ml were found in 80% of the milk samples infected by major pathogens and in 45% of the samples infected by minor pathogens.

IMPROVEMENT OF RAW MILK QUALITY

With the aim of improving goat's milk quality in Greece, a program which has been in existence since 1985 is being implemented on a voluntary basis. This program focuses on 3 aspects:

- informing milk producers on subjects related to milk quality;
- quality control of raw milk delivered to dairies;
- incentives to milk producers regarding milk quality improvement. The incentives

are mostly of an economic nature, related to payment of a quality premium to milk producers who deliver good quality milk. These incentives also include the provision of technical and veterinary services, as well as materials — cooling tanks, other means of maintaining animal hygiene, etc.

Evaluation of goat's milk quality takes place every month and is assessed by determination of microbiological quality, detection of antibiotics and estimation of fat content.

According to the regulation in force, every month the milk from each producer is classified into 3 quality grades, *ie* A, B and C, on the basis of the results of all the examinations. A quality premium is provided for A and B grades whereas a basic price is given for the C grade.

The quality control includes the following.

Determination of microbiological quality

The method applied is the methylene blue reduction test. The frequency of analysis is twice per month for each producer. The

final concentration of the pigment is 5 µg/ml milk. The quality grading according to reduction time is as follows: grade A: > 3 h; grade B: 1–3 h; grade C: < 1 h.

Detection of inhibitory substances

The frequency of analysis is once per month for each producer. A variety of tests are used.

Estimation of fat content

The analysis is carried out 4 times per month for each producer. A minimum fat content standard of 4.3% is utilized for classification into quality grades A or B.

Due to the non-compulsory implementation of the quality payment system for goat's milk, the quality examination has not yet been extended to the degree that the country requires.

There is a widespread belief that immediate action should be taken concerning adoption of a series of measures to contribute to an improvement in goat's milk quality. The measures to be taken are as follows:

- sanitary: the extermination of *Brucella melitensis* and the restriction of mastitis should be a priority;
- modernization of goat farms: the setting up of larger units with modern, well-organized premises is of primary importance. Cooling the milk before its delivery to the dairies is also an immediate priority;
- compulsory implementation of the quality payment scheme for all dairy units collecting goat's milk, as well as extension of the price differentiation system to all the producers according to milk quality. The price incentives should be substantial and not limited to insignificant premium prices;

- the establishment and operation of a network of central laboratories to undertake milk quality control, with the necessary substructure and showing credible results.

CONCLUSIONS

Although there is insufficient data on the quality of raw goat's milk produced in Greece, it may be said that it is not always up to standard. This is mainly due to the difficult conditions under which the milk is produced. In order to improve the quality of raw goat's milk a number of measures should be taken. Sanitation of the animal population, improvement of stabling conditions, cooling of milk before delivery to the processing units and implementation of a compulsory quality payment scheme for all the dairy units processing goat's milk, are of primary importance.

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There is a widespread belief that immediate action should be taken concerning adoption of a series of measures to contribute to an improvement in goats' milk quality. The measures to be taken are as follows:

- namely, the examination of goats' milk and the restriction of mastitis should be a priority;
- modernization of goat farms; the setting up of larger units with modern well-organized premises in order to improve hygiene. Cooling the milk before its delivery to the dairies is also an immediate priority;
- compulsory implementation of the daily payment scheme for all dairy units collecting goat's milk, as well as extension of the pasteurization system to all the producers according to milk quality. The price incentives should be substantial and not limited to insignificant premium prices.