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Small ruminant milk. Technological aspects: Storage and processing

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ABSTRACT - Small ruminants milk is very important in the Mediterranean region. In certain countries, sheep and goat milk production is more important than cow's. This milk is almost exclusively processed into cheese. Its composition is quite variable according to management and feeding systems, milking techniques, care on the part of the farmer, not to mention factors which are strictly linked to the animal: breed, lactation stage... This paper studies the main problems concerning refrigeration storage, transportation and processing. A non negligible increase of demand is very likely to occur, which could considerably enlarge in the region. To respond to this demand it is necessary to reinforce training and technological aid to farmers, to control the main diseases, to introduce new processing technologies and especially to pass legislation that allows to protect the cheese types produced in the Mediterranean region.
Key words: Sheep, goats, cheese, stockage, collecting, technology.

RESUME - «Aspects technologiques du lait de petits ruminants: stockage et transformation». Le lait de petits ruminants revêt une importance très grande dans la région méditerranéenne. Dans certains pays, la production de lait de brebis et de chèvre est plus importante que celle de vache. Ce lait est quasi exclusivement valorisé sous forme de fromage. Sa composition s'avère très variable en fonction notamment des systèmes d'élevage et d'alimentation, des techniques de traite, des soins prodigués par l'éleveur, sans compter les facteurs strictement liés à l'animal: race, stade de lactation... Les principaux problèmes de stockage avec réfrigération, de transport et de transformation sont étudiés. Il existe très vraisemblablement une possibilité non négligible d'augmentation de la demande qui pourrait être considérablement accrue dans la région. Pour répondre à cette demande, il est nécessaire de renforcer la formation et l'aide technique aux éleveurs, de contrôler les principales maladies, d'introduire de nouvelles techniques de transformation et surtout de mettre en oeuvre une législation permettant de protéger les types de fromage produit dans la région méditerranéenne.
***Mots-clés:** Ovins, caprins, fromage, stockage, collecte, législation, technologie.*

Introduction

The small ruminants farmed in the Mediterranean countries are sheep and goats, and dairy breeds are widespread among the many breeds of these animals found in this area. In some countries the production of ewe and goat milk is of considerable importance compared to that of cow milk. Table 1 shows cow, ewe and goat milk production in the Mediterranean countries. It may be seen that, overall, ewe and goat milk are respectively 7.4 % and 3.9 % that of cow milk. However, it may also be noted that in Greece the production of ewe milk almost equals that of cow milk, in Libya and Syria it is 2/3 and in Cyprus and Turkey 1/3 that of cow milk.

It is also interesting to note the changes there have been compared to the three-year period 1979-81. With the exception of Israel, ewe milk production has tended to increase slowly in almost all the countries. The same is not true for goat milk, the production of which has remained almost unchanged, though with a tendency towards a decrease in the three major producing countries (Turkey, France and Greece).

Ewe milk is used almost exclusively for the production of cheese (including whey cheeses) and to a lesser extent for yogurt. Goat milk is partly consumed as such, but is mainly used for cheese-making and the production of yogurt.

The other dairy products such as cream, butter and ghee, or the fermented products such as leben, laban, oggtt and khoa are much less important and will not therefore be discussed in this report.

When considering ewe and goat milk, the most striking aspect is the enormous variability in its chemical, physical and microbiological characteristics, which obviously have a major effect on its technological characteristics and hence on the products deriving from it. There are a great many reasons for these differences, and the following may be remembered:

a) The farming system, environmental conditions and type of feeding.

b) The system of milking, storage and collection of the milk.

c) The conditions of hygiene of the farm equipment, the farm workers and the farm overall.

d) The breeds, level of production, lactation stage, health and individuality of the animals.

e) The processing technologies used (temperature, starters, rennet).

Naturally, an in-depth description of the above mentioned factors would not be fitting in this paper. We wish only to emphasize that no other farm animals show as great a variability as ewes and goats. The farming systems, for example, range from intensive farms with a high degree of mechanization and adequate feeding to rearing the animals on the poorest of land, and from the use of modern processing technology (ultrafiltration, use of selected starters) to age-old techniques, where the rennet used is obtained from the coagulated milk removed from the stomach of day-old lambs, which is then tied in a cloth and dried for 3-4 days. This is dipped into the milk 3-4 times and the milk is then left for 10-15 minutes to coagulate. The cloth-tied coagulum may be used for roughly a month (1).

The levels of production of ewe and goat milk also vary very greatly throughout the year as the amount of milk available differs widely because of the length of lactation and the seasonability of parturition. This leads to problems in the industrialization and in the marketing of the product, and hence to research into methods of storage for the milk or curd which may help to resolve these difficulties.

Finally, it should be noted that while ewes and goats are often considered together, the milk they produce is very different and consequently the techniques used for making the cheese and other dairy products also vary greatly between the two.

Storage

Many sheep and goats farmers (often the two are farmed together) process the milk on farm and produce for a local market (as well as for consumption by the producer himself). However, the farmer who does not process the milk directly, or does not process it every day, is obviously faced with the problem of storage. The storage system and the equipmet necessary, in increasing order of complitability, may be indicated thus (4):

— Cooling in cold flowing water.

— Refrigeration.

  — Indirect: can refrigeration tanks.

  — Direct: refrigeration tanks with or without heat recovery systems or fast refrigeration.

— Refrigeration of milk after thermization.

— Refrigeration of milk after ultrafiltration and thermization.

The first system may be of some importance only in mountain areas with a steady supply of water; the installations and equipment for utrafiltration are not of pratical interest for sheep and goat farmers, although they have been successfully experimented at an industrial level (13); it may obviously be hoped that milk thermization on the farm, immediatly following milking, will become common practice, but as yet there is little sign of this.

Thus, refrigeration is undoubtedly the most widespread milk storage system and hence we will briefly consider the merits and disadvantages of this system. The main reasons for the spreading of refrigeration, and the consequent collection and transport of the milk in tanks, may be summed up as follows (5):

1. Technical reasons: it is well known that the application of low temperature enables the bacteriological quality of the milk to be maintained until processing.
2. Economic reasons: refrigeration makes it possible to rationalize the collection routes, and hence to reduce transport costs from the farm to the processing plants.
3. Manpower reasons: refrigeration permits, within certain limits, a greater flexibility in working hours both for the farm workers and those employed in the processing factories.
4. Other advantages offered by refrigeration stem from the fact that it enables the energy recovery of the heat extracted from the milk itself during refrigeration; it provides a storage tank which eliminates the difficulties arising from the use of cans and it reduces to a minimum any violent shaking of the milk or contact with the air.

It should, however, be clearly stated that refrigeration is not a technique for improving milk quality, but only a physical process aiming to conserve the original quality of the milk until it is processed. It is thus a serious error to consider refrigeration as a universal solution to all the problems of milk quality on the farm. It should rather be emphasized that milk storage at low temperatures, above all if prolonged, may have negative effects, especially on the organoleptic characteristics of the milk and dairy products, as well as on its yield of cheese. Milk stored in this way undergoes considerable changes as regards its physical, chemical, biochemical and microbiological characteristics involving practically all its components.

From a microbiological point of view, we should remember that psychrotrophic bacteria multiply in refrigerated milk. These bacteria produce very active proteolitic and lipolitic enzymes which have the important property of being thermostable.

The most important consequence of prolonged refrigeration in relation to modifications in milk fat is lipolysis, i. e. the hydrolysis of triglycerides caused by lipases, with an increase of free fatty acids in the milk. Three types of lipolysis are recognized: induced, spontaneous and microbial (7). Induced lipolysis derives from the action of natural

lipase (secreted from the udder) on the milk fat globules once these have been damaged by thermal (eg. cooling) or mechanical shocks (violent shaking, agitation, etc.). Spontaneous lipolysis derives from variations in the composition and original properties of the milk related to the physiological and nutritional status and the health of the animal. Microbial lipolysis derives from the action of the lipases secreted by psychrotrophic microorganisms which make up the essential flora of refrigerated milk. It is thus closely linked to the bacteriological quality of the milk.

From the above it clearly emerges that the lipolysis of refrigerated milk is more intense the greater the alterations to the fat globule and the longer the storage period. Whereas cow milk lipolysis has been studied in depth (there are three voluminous documents by International Dairy Federation) much less research has been done on goat milk (6, 9, 16) and hardly any, it would seen, on ewe milk. Furthermore, it should be noted that the studies on goat milk were carried out on high yielding dairy goat breeds above all in France and Norway. The less productive breeds produce milk with a very different chemical composition (the fat content is much higher) which therefore has a different susceptibility to lipolysis. For further details on goat milk lipolysis we recommend Chilliard's excellent review (6) and in this paper we will emphasize only the following points:

1. Strong lipolysis has a negative effect on the organoleptic characteristics of milk and its derivatives, giving rise to a rancid or soapy flavour (as with cow milk). It should be remembered that the taste of goat milk, which is noticeable also in its derivatives, is clearly affected by the free fatty acid content, especially those with 6 to 10 atoms of C (16). It is well known that, at the same level of lipolysis, in the milk of sheep and goat, off-flavours are enhanced due to the higher amounts of short-chain free fatty acids.
2. The lipases of certain psychrotrophic bacteria are resistent to high heat treatment and thus even though they do not give apparent lipolysis in raw milk, they can negatively influence the quality of ripened products.
3) Numerous factors contribute to enhance lipolysis in ewe and goat milk such as:

   — The high initial bacterial load of the milk.

   — The high number of somatic cells (lipolysis tends to increase with the number of somatic cells and it is known that in ewe and goat milk the number is high, independently of the presence of mastitis).

   — The lenght of storage (often the milk is collected every 6 milkings).

   — Excessive agitation.

On the basis of the causes of lipolysis, the means for limiting it appear clear:

a) Limitation of the initial microbial load, improving the overall conditions of hygiene on the farm and especially those of milking.

b) Rapid cooling of milk after milking with collection after a maximum of every 4 milkings.

c) Early thermization treatment of the milk (immediately after milking).

This last techique is still seldom used even on cow farms. It would thus seem unlikely that it will be applied to ewe and goat milk for quite sometime. It would however be the fastest and most efficient method of limiting lipolysis as it reduces both psychrotrophic multiplication and the activity of the natural lipase of milk.

Low-temperature storage also has considerable effects on the colloidal phase of the milk (3). As regards casein, there is a partial solubilization of the components, especially beta-casein which tends to separate from the micelles. This fact obviusly leads to reduced cheese yield. If one considers that beta-casein accounts for a third of the total casein in cow milk, half that in ewe milk, and three-quarters that in goat milk (table 2) it follows that considerable drops in yield could occur in the processing of small ruminant milk.

As far as the mineral compounds are concerned, the temperature influences the balance between the soluble and colloidal forms. An increase in the content of soluble inorganic calcium and phosphorus is observed in refrigerated milk. These changes give rise to a decrease in micelle diameter. At the same time a rise in the hydratation degree of the casein micelles occurs. This double phenomenon leads to greater stability of the micelles which is clearly evident during cheese-making from the way the milk reacts to the rennet. The coagulation time increases and the coagulum is less compact, more fragile and consequently more difficult to process mechanically. This fact is particularly evident in high yielding dairy goat. To our knowledge, there are no experimental data on ewe and goat milk proteolysis. It has been shown for cow milk that beta and alfa s2-casein are the most sensitive to plasmin (17). The action of plasmin continues throughout storage. The porteolysis of the milk due to both the plasmin and the proteinases of the psychrotrophic bacteria provokes losses of soluble nitrogen in the whey and reduced cheese yied. Nevertheless, it should be noted that these modifications are partly reversible using calcium chloride an enriching the milk with proteins.

Milk storage can also be assured by freezing, and this technique has been experimented for ewe and goat milk. It is however obvius that freezing of fluid milk is not of interest as cheese accounts for only a small proportion of the weight of milk, and thus the storage of large quantities of milk is not always justifiable technically nor economically (15). The freezing of curds, or of retentate from ultrafiltration is a technique which has been widely experimented from the technical point of view, especially for cow milk. The freezing of ewe milk is employed on an industrial scale and then generally used in the production of mixed cheeses with very good results.

Transport

The milk stored on the farm must obviously be

transported to the dairy plant. Transport has an enormous influence as regards maintaining the bacteriological quality of the milk. Sometimes, milk obtained in good conditions of hygiene and thereafter conserved adequately up until the moment of collection, turns out to be of poor quality at the moment of processing. The reasons for this may be summed as follows:

— Mixing of refrigerated and non-refrigerated milk in the tanks.

— Excessively high temperature in the tanks at the time of collection.

— Over-lengthy storage on the farm.

— Loading of very bad quality milk, even in small quantities, into the tanks.

— Inadequate cleaning and disinfection of the tanks.

— Over-lengthy collection routes.

— Anomalous temperature increase in the tanks.

— Inadequate storage of the milk at the dairy plant.

The problems connected with milk collection have been dicussed in other papers. We wish only to stress the importance it has within the context of milk processing.

Processing

Although the techniques of ewe and goat milk processing have progressed considerably over the last 20 years, they are often still at the level of family or small-scale operations. While there are some exceptions, this is generally the case in all the countries of the Mediterranean basin, where sheep and goats are predominantly farmed for milk production and where there therefore exists an ancient and set tradition of cheese-making from ewe and goat milk.

The processing of small ruminant milk shows great variation. The factors noted at the beginning, which modify the quantitative and qualitative characteristics of the milk, represent a series of negative aspects which lead to great variability in milk production from one year to another and considerable irregularity within the same year. Certainly, the situation will improve in the future, but this improvement will only come about slowly. It may thus be expected that ewe and goat milk processing will retain a certain degree of its farm craft nature, however this should not be considered altogether negative. Advantage could be taken of this characteristic of the processing of ewe and goat milk by placing the emphasis on the traditional, wholesome and original nature of dairy products produced in this way, when marketing them, as today's consumer appears sensitive to such aspects. We are in complete agreement with this point of view as expressed by Ledda (14).

Ewe milk

To have an idea of the great variety of ewe cheese, you need only consider that from a preliminary poll carried out for IDF (10) it results that in the 13 Mediterranean countries which replied to the questionnaire more than 100 types of ewe cheese are produced (table 3). There are thus many different techniques of cheese-making and all kinds of cheese: fresh, soft-body, pressed, veined and hard (cooked or uncooked), ricotta.

We think it is more suitable to consider here the problems of production, organization and marketing linked to milk processing rather than the technical and scientific aspects of it. Although exact data are not available we can state that the most of the sheep farmers of the mediterranean countries process the milk directly on the farm. This is due to different reasons:

a) Milk storage or collection is not possible and therefore its transformation (into cheese or yogurt) becomes a necessity.

b) The social and economic conditions of many mediterranean countries mean that the income the farmer gets from the sale of cheese and ricotta is higher than that he could receive by selling the milk.

Generally, farm-produced cheese goes to the local market. Thus there are no problems in placing the product and the producer's income is satisfactory. In certain areas in which ricotta is part of the culinary tradition the farmer may have a considerable income from this by-product.

From our experience (which is obviously limited to Italy, but we believe that the conditions here reflect those of many other mediterranean countries) there are four main problems facing these farmers: animal health problems (especially those related to zoonotic diseases); problems connected with the bacteriological quality of the milk; problems linked to cheese ripening and problems connected with ensuring a constant supply to the market.

By health problems we refer especially to brucellosis. It should be remembered that farm-produced cheeses are almost always produced from raw milk and that Brucella is still present in many farms in the Mediterranean area. It is true that the Brucella is killed in the ripening process; it is however equally true that the modern consumer prefers only slightly mature and moderately salty cheeses and that it is in the interest of the farmer to sell the cheese produced as early as possible: less weight loss, lower investment for ripening equipment and lower passive interest.

Naturally, a number of other pathogenic bacteria may be present in cheese made from raw milk: Salmonellae, Staphylococcus aureus, Escherichia coli, Coxiella burnetti and the emerging Yersinia enterocolitica, Campylobacter jejuni and Listeria monocytogenes.

It is well known that sheep farming often operates under very difficult conditions because of the lack of adequate structures both for rearing the animals and processing the products as well as inadequate technical know how on the part of the farmer, etc. Thus, the milk frequently contains a high initial microbial load. Recent research carried out in Spain (15) on the bacteriological quality of ewe milk

concludes that there is high risk of early blowing in manchego cheese made from raw ewe milk. We believe that poor hygienic quality of ewe milk is, unfortunately, a widespread phenomenon. In an attempt to limit the negative effects caused by a high bacterial load the sheep farmer tends to add excessive amounts of salt. It should also be observed that the highest bacterial load obviously coincides with the hottest months, while the farmer often has no suitable areas available for the ripening of the cheese; the quality of the cheese produced is therefore poor and it is too salty. These cheeses will obviously be little appreciated by the consumer, both because of the taste and because current advice on diet suggests the use of little salt in an attempt to decrease the incidence of hypertension and subsequent occurrence of cardiovascular disease (cheeses with low-sodium content may already be found on the market). The considerations discussed above, concerning the salt content, are particulary pertinent to those countries having a temperate climate. The importance of having suitable rooms available for cheese maturation should be stressed. In our experience the cost of the equipment necessary for controlling the ripening environment is made up by the reduction in cheese weight-loss alone.

Another negative aspect arises from the fac that sheep cheese production on the farm is not constant throughout the year. Given the seasonal nature of lambing, it follows that milk production is also seasonal. The de-seasonalization of lambing, through induced oestrus using hormonal substances, often gives unsatisfactory results. The selection of ewes for year-round oestral cycle requires a great deal of time. The freezing of acid curd has been experimented with good results on goat milk, but obviously it can only be put into practice at an industrial level and certainly not by sheep farmers who process the milk directly. Moreover, it should be remembered that freezing of the curd has negative effects on the organoleptic characteristics of the cheese. A partial solution could be the production of mixed cheeses. A second system of ewe milk processing, which may be defined as industrial, has developed and is developing in areas where greater quantities of ewe milk are produced and where it is therefore possible to have large concentrations of milk for processing. These dairy plants naturally adopt the latest processing technologies and it is possible to produce cheeses which totally satisfy the requirements of the consumer. In our opinion, the consumer wants three things from a cheese: that it is wholesome, that its flavour is typical and pleasing and that its charasteristics do not change with time. Industrially produced cheeses are obviously safe from the point of view of health, as the milk is heat-treated. HTST pasteurization (72.5 ° C for 15 sec.) does not influence the organoleptic characteristics of ewe milk, as assessed by a taste panel (19). The typical flavour of the product is ensured by using natural starters and by avoiding drastic treatment which could alter the characteristics of the milk. The use of a standard commercial rennet can ensure that the organoleptic characteristics remain constant with time. In our opinion, it is important to maintain the characteristic taste, the wholesomeness and the originality of ewe cheese, qualities which can be lost if the milk is pasteurized at high temperatures and commercial starters are used. If ewe milk is treated thus there is a risk that the cheese produced will be very similar to that obtained with cow milk. The ideal solution could be thermization of the milk (63 °-65 °C), which is presently used i. e. in the production of Pecorino Romano (14), where it has given a considerable improvement in quality. In fact thermization represents a good compromise between a strong attack on the microbial load, such as is produced by pasteurization at relatively high temperatures, and the dangerous survival of anti-cheese-making flora when no treatment is undertaken. Thermization associated with the use of a natural starter enables the typical characteristics of the cheese to be maintained, which derive from the microflora of the production and milk processing environment and, at the same time, to avoid the occurrence of abnormal fermentation.

Between the two levels of processing, farm-based and industrial, there is a third system of ewe milk processing which should become even more important in the future. We are referring to processing in small-sized dairy plants which process limited amounts of milk supplied by a small number of farmers. There are many factors which lead us to believe that the number of these small-sized plants will increase over the next few years. Of these we note:

1. The number of farmers processing the milk on the farm is tending to decrease, trough slowly. The main reason for this is the insufficient number of farm-workers, often young people leave the family farm and a salaried worker is uneconomic. Another reason could be the fact that the sheep-farmer cannot ensure the conditions (above all sanitary) in the processing areas required by law.

2. The large-sized industrial dairy plants cannot collect milk beyond a certain distance from where they are situated, for reasons of both costs and milk quality, as seen beforehand.

3. A small dairy plant which adopts modern techniques is obviously able to supply a product of high quality, giving greater prestige to both the product itself and the farmers of the area in which it is produced. Clearly, each dairy plant should produce cheese with its own trade-mark.

4. These small plants could be run by the farmers themselves (co-operatives, public companies, etc.) so that some of the profit from the processing returns to the producers.

Aware as we are of the traditional diffidence of sheep-farmers towards any sort of association, and their strong individuality, we realize that this evolution will be slow. However, we believe it could be the only alternative to the closing-down of many sheep-farms.

We also note that for the most difficult areas, prefabricated «ready-for-work» dairy plants are now available (18).

Yogurt may obviously be produced also from ewe milk. This product is of considerable importance in Turkey, Syria, Greece, Cyprus, Iran and Iraq whereas it is not produced in Portugal, Spain or France. In Italy there is a very limited

production of yogurt in Sardinia alone, and this is for family consumption. The excellent reviews of Kehagias (11) and Kurman (12) deal in detail with the technological and nutritional aspects of yogurt produced from ewe and goat milk, so here we will emphasize only that ewe-milk yogurt has a smoother and firmer texture and a higher acceptability than yogurt from cow and goat milk.

Goat milk

Obviously it is difficult to generalize about goat milk processing for an area as large as the Mediterranean as there are many aspects to be considered: the geographical location and hence climatic conditions, farming conditions, religious and cultural factors, the breeds farmed, the type of milk produced and the type of processing, whether small-scale, on the farm or industrial. Moreover, it should be remembered that goat milk is often mixed with the milk of other species (sheep or cows), especially in rural areas where the flocks are usually mixed. Having said this, the products obtained from goat milk processing can be divided as follows:

1. Soft cheese with slow or lactic coagulation.
2. Cheese with fast or rennet coagulation.
3. Ricotta.
4. Yogurt.
5. Fermented milks.

The products obtained with the first of these techniques are perhaps amongst the oldest known to man, as this is a spontaneous process of milk maturation whereby the microbial flora naturally presents changes lactose into lactic acid. The coagulation time varies until a pH of roughly 4.5 is reached, depending on the initial microbial load of the milk and the temperature. This processing technique is common in certain areas of the Mediterranean, especially where the milk is processed directly on the farm, as it requires small outlay for equipment and the milk need not be heated; furthermore, small quantities of milk can be processed at one time. The products are almost all of small or medium size and are usually consumed fresh, or even still containing whey; however, they may be salted on one or more occasions to avoid perishing for considerable lengths of time. Nevertheless, it should be emphasized that although heavy salting ensures against perishing, the flavour and organoleptic characteristics of the products suffer the consequences and thus these are not easily marketable. Soft cheeses differ greatly as regards flavour as often each farmer has unwittingly, and with time, selected lactic microflora which are unique to the place of processing and which therefore give different and distinct flavour, smell and consistency to the cheese. These products go off rapidly and have to be kept at low temperatures (6-8 °C). However, even in the best conditions, their shelf life is extremely limited and they are therefore necessarily sold in areas near the place of production, especially in hot climates.

The fast or rennet coagulation is the method traditionally used worldwide for cheese making. The technique varies little in different geographical areas and with the milk of different species. It is based on the addition of rennet, in amounts that vary according to the type of product desired, to milk heated to temperatures which range from 28 to 42 °C for goat milk or mixed goat-ewe milk. A very wide range of products may be obtained with this technique, differing as regards size, flavour and organoleptic characteristics. The products may be consumed fresh or matured. Salting is essential and is carried out either superficially or by immerging the cheese in brine. The cheeses obtained with rennet coagulation may be ripened for long periods after salting and the hard crust that forms acts as a protective barrier which considerably reduces deterioration and increases handling suitability. These products can be stored at higher temperatures than those needed for lactic curd products and can therefore be more widely sold. These characteristics allow a different approach both to the problem of transport, and hence to the marketing area even in the zone with the worst climatic conditions, and to storage, which can be at selected sites from which the sales network will develop.

Ricotta is a product obtained by processing the whey of rennet curd, which is heated to roughly 85 ° C and then acidified to obtain precipitation. Normally these products are sold in small amounts and they are consumed fresh, thus being only slightly salted.

However, there are some types of ricotta which are consumed after long periods of ripening and which are salted and pressed to keep with time. As mentioned before, these products are obtained from whey processing, but in some areas it is common to add variable amounts of whole goat milk to improve yield. Ricotta is produced for a local market, mainly because of its considerable perishability.

Yogurt is also a very ancient product, that has long been known and appreciated in Eastern Europe but which only became popular over all the mediterranean area in the fifties. Leaving aside small-scale production, goat milk yogurt is a product which has presented many difficulties at an industrial level, some of which remain unresolved and which still affect its success even on the markets of countries where the goat is an important farm animal. The problems are mainly technical as this product is characterized by a highly fragile coagulum, by contrast with that obtained with cow milk, and this is not always acceptable to the consumer. Even vacuum concentration and ultrafiltration techniques with deodorisation, which may succeed in producing a compact coagulum, do not ensure against the occurrence of flavours which are unique to this milk and which are particularly strong in certain periods of the year. The seasonability of production, and the difficulties of milk storage, which would enable yogurt to be available on the market year-round, have affected the development of this sector.

The fermented or acidified milks are products that have different names depending on the production area (Soben, Saban, drinking yogurt). They are obtained from slow, lactic coagulation, considerably conditioned by the temperature used during processing. The coagulation time affects the final flavour of the product, thus giving rise to a whole range

of products which are similar but differ greatly as regards flavour. These products are particularly appreciated and widely consumed in moslem nations, especially in the hotter months of the year and during religious holidays. These fermented milks are sufficiently acidic, ranging from 75 to 85 Dornic, to ensure wholesomeness. Salting is not always carried out, and indeed only certain populations require these products to be salted.

It may be concluded that as far as goat milk processing is concerned, the market for cheeses currently produced with traditional techniques will probably not expand greatly in the future, above all because of the perishability and production difficulties of these products. We believe, however, that both yogurt and the other fermented products may have a growing market, especially in the Near East where these products have always been appreciated. Apart from processing, it should be remembered that goat milk could also be sold for direct consumption. A number of factors lead us to believe that there could indeed be an increase in the milk production for this market (E. E. C. quotas on cow milk, allergies to cow milk, particular dietetic characteristics).

Future needs

It should not be forgotten that the Mediterranean countries potentially have a very large market for sheep cheeses. One needs only remember all the countries in which sheep are not milked (North and South America, Japan, Australia, Northern Europe, etc.) International exchange of sheep cheeses (and to a lesser extent goat cheeses) will certainly increase in the future, but this increase is dependent on the supply of a high-quality product by the producing countries. High quality is obviously linked to good management and adequate milk-processing techniques. The problems to be faced in up-dating traditional sheep and goat farming are numerous and difficult. We will list only the most important ones:

1. Technical assistance must be given to the farmers.

This is the first and foremost problem to be resolved. I am sure everyone is aware of the great need sheep and goat farmers have of technical assistance, and of the obvious technical and economic improvements that would result from it.

2. It is necessary to control and eradicate the most important diseases.

The economic and social importance of this aspect goes without saying.

3. The milk must be paid for according to its quality.

This step should obviously be introduced gradually, and more than an economic effect it would have an enormous psychological effect, as the farmer would be obliged to operate with greater attention on the farm.

4. Some technologies such as mechanical milking, on-farm refrigeration and pasteurization must be introduced to improve the hygienic and sanitary quality of the milk and its derivatives.

5. Adequate legislation must be introduced to protect ewe-goat products (both at a national and international level) in the interests of both producer and consumer. We are thinking especially of the regulation of mixed cheeses, packaging and presentation standards for the sheep-goat products which would clearly indicate the area of origin, etc.

6. Further experimentation is necessary on the production, use and marketing of ewe and goat milk and their derivatives.

We would be the first to admit that it is easy to list a series of problems, but much more difficult to resolve them. We all know that there is a long road ahead, but I would like to think that this seminar is a step in the right direction.

Table 1

MILK PRODUCTION IN MEDITERRANEAN COUNTRIES (1,000 MT)

SPECIES	COW	EWE		GOAT		EWE % COW MILK	GOAT % COW MILK
YEAR	1986	1979/81	1986	1979/81	1986		
Algeria	539	158	197	134	164	36.5	30.4
Egypt	965	20	23	8	9	2.4	0.9
Libya	69	38	44	15	17	63.7	24.6
Morocco	850	20	25	27	35	2.9	4.1
Tunisia	300	13	14	13	10	4.7	3.3
Cyprus	75	25	—	37	40	33.3	53.3
Israel	869	21	15	24	22	1.7	2.5
Lebanon	92	14	16	35	42	17.4	45.7
Turkey	3,230	1,142	1,200	623	524	37.2	16.2
Albania	345	42	41	27	31	11.9	9.0
France	33,700	1,040	1,087	464	454	3.2	1.3
Greece	642	585	600	425	400	93.5	62.3
Italy	10,865	606	610	118	130	5.6	1.2
Malta	28	1	1	2	1	3.6	3.6
Portugal	842	83	95	37	41	11.3	4.9
Spain	6,702	211	232	302	360	3.5	5.4
Syria	650	368	450	74	76	69.2	11.7
Yugoslavia	4.600	142	140	—	—	3.0	—
Total or mean	65.363	4.529	4,815	2,365	2,356	7,4	3,9

(F. A. O., 1987)

Table 2

CASEIN FRACTIONS AS % OF TOTAL CASEIN (2)

Casein fractions	Cow milk		Goat milk		Ewe milk	
αS_1	36	45.5	12.6	75.3	15.5	30.2
αS_2	9.5				14.7	
β_1	33		35.9		18.9	47.1
β_2			39.4		28.2	
κ	9.4		8.1		7.3	
γ	6.8		3.9		15.4	

Table 3

CHEESES MADE FROM EWE AND GOAT MILK IN SOME MEDITERRANEAN COUNTRIES (10)

COUNTRY	EWES	GOAT	MIXED
Cyprus	1	—	—
Egypt	1	1	—
France	21	83	22
Greece	2	—	2
Israel	4	—	—
Italy	29	8	7
Morocco	—	1	—
Portugal	5	—	4
Spain	16	5	5
Syria	—	—	4
Tunisia	2	—	—
Turkey	9	—	—
Yugoslavia	13	—	—
	103	98	44

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