EFFECTS OF NUTRITION ON EWES' MILK QUALITY

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Summary

Control of milk composition is of importance in dairy ewes because milk is mostly used for cheese making. Besides numerous factors that alter milk composition, knowledge on the effects of nutrition is useful for it concerns both yield and milk content. Furthermore, modification of nutrition is a powerful and short-term means of altering milk composition. Global effects of nutrition are to be separated from specific effects of some nutrients, for they may be combined in order to finely control milk composition. Level of nutrition is a main factor affecting milk yield and milk composition in dairy ruminants : *i.e.* milk yield increases with level of nutrition and vice versa, but effects on milk composition are less clear. Milk fat content is in general negatively correlated to energy balance, whereas with protein content the correlation is positive. In consequence, in most cases, a high level of nutrition in dairy sheep will depress fat content and slightly increase milk protein content. On the other hand, an increase in dietary protein supply will increase milk protein yield, if the ewe has not reached its potential yield, but this response is not associated to changes in milk protein content. An easy means of increasing energy supply is to use high quantities of concentrate. As a result of rumen acidosis, this may directly depress milk fat and protein content and secondarily change energy partitioning from milk to body fat depots. The use of specific nutrients such as protected fat, or amino acids appears to be of interest as a mean of improving milk fat and/or protein content in dairy ewes. Limited experience is, however available, nowadays and advantages or drawbacks are not fully known.

In the practical conditions of dairy flock management the effects of nutrition are often hidden in the complexity of numerous factors that are also known to alter milk composition. Therefore, as a within-group individual nutritional status is unknown, the global response in term of bulk milk composition is difficult to predict. This leads to the notion of group-feeding strategies that include the variety of animal response to feeding treatments.

Introduction

Like for other dairy ruminants, dairy ewe lactation curves, both in terms of milk yield and milk composition, are conditioned by main factors including breed, stage of lactation, milking system and feeding (Flamant and Morand-Fehr, 1982; Treacher 1983, 1989; Bocquier and Caja, 1993; Caja and Bocquier, 1998). In addition it must be remembered that milk yield and milk composition (fat, protein, casein and serum proteins, but not lactose) are negatively correlated (Barillet and Boichard, 1987; Molina and Gallego, 1994; Fuertes et al., 1998). This phenomenon generally appears as a result of improved management practices. As a consequence it requires to find a balance between practices that will increase milk yield and those which increase the milk content ; the financial income being the result of a combination of prices related to both the volume and its quality.

As ewe's milk is mainly used for cheese making, it is of importance to pay attention to fat and protein contents because these parameters, which are routinely measured, can precisely predict cheese yield (Pellegrini et al., 1997). In fact, the main dairy sheep breeder's objectives are: 1) increase of the total milk dry matter output (cheese quantity), 2) a year round stabilization of the milk content, and 3) control of a high fat:protein ratio in order to ensure an adequate fatness of cheese for manufacturing processes and ripening properties. Hence, the primary and long-term objective of the breeder is to improve its ewes' dairy merit both in milk yield and milk composition. Like in the Lacaune breed the objective on maintaining milk composition only came after a successful improvement of milk yield (Barillet et al., 1993). Other objectives can also include criterions such as milkability and mammary morphology (Marie et al., 1999). Ewe dairy merits are widely differing between breeds. Large differences in both milk yield, milk composition and in kinetics during the whole lactation have been reported. They are however confounded with the large variety of production system (Casu et al., 1983; Fernández et al., 1983; Gallego et al., 1983, 1994; Labussière et al., 1983; Caja, 1994; Bocquier and Caja, 1993; Fuertes et al., 1998). In particular, most dairy sheep production systems include a short lamb-suckling period (3-5 weeks length) and, after weaning, a long milking period (4-8 months), but 'suckling-and-milking' can occur simultaneously during the first 2 months of lactation in some breeds (Caja and Such, 1991; Sheath et al., 1995). In regard with ewe milk composition, the lowest values in fat, protein and casein are observed during this 'suckling-and-milking' period (Gargouri et al., 1993 ; Bocquier et al., 1999 ; McKusick et al., 1999) or immediately after weaning, raising afterwards with lactation stage. Slopes of the increasing curves of milk content are mainly conditioned by the breed and level of production (Bocquier and Caja, 1993). Whatever the influence of the above factors, feeding of the ewe modulates both the volume and the composition of milk.

The aim of the present paper is to focus on the known effects of nutrition on milk composition of the dairy ewe (see review of Bocquier and Caja 1993, Bencini and Pulina 1997; Caja and Bocquier, 1998), because results obtained in dairy cattle and goat may not be successfully extrapolated to the dairy ewe. In addition, as dairy ewes are mostly fed in large flocks, it is necessary to briefly analyze the effect the flock structure (including days in milk and parity) on the bulk milk composition (Fraysse et al. 1996) and its consequences for feeding strategies of dairy ewes. We artificially separated the global effects of nutrition from the effects of specific nutrients that may be effective for the manipulation of milk composition of ewe.

Effects of level of nutrition

Energy supply and milk composition : Level of nutrition, mainly referred as level of energy or of feed intake, is a main positive factor affecting milk yield and milk composition in dairy ruminants. Hence, a steeped curve with an early and high peak milk is observed with a high nutrient supply during the early lactation period. Conversely, nutrient shortage during pregnancy and early lactation lead to a low and late peak milk yield. Effects of nutrition on milk composition are less clear because of interactions with the natural evolution of milk composition and through indirect effects of nutrition on milk volume (called dilution effect). Furthermore, in the middle and at the end of lactation, changes in nutrition mainly affect the persistency and/or the body reserves reconstitution, this is why limited effects are generally observed on milk yield or composition (Bocquier and Caja, 1993). Due to the respective variability of milk fat and protein content, the possibilities of altering milk composition by feeding are higher for fat than for protein and/or casein contents (Sutton and Morant 1989).

The specific effects of the level of nutrition on milk composition in dairy ewes are only partially known as recently reviewed by Caja and Bocquier (1998). In this sense, only few experiments are based in individual feeding of dairy ewes during the milking period and results obtained in suckling ewes are also taken into account to obtain reliable conclusions. Available references on the effects of different levels of nutrition in lactating ewes are summarized in Table 1.

Table 1. Ranges of variation on milk yield and composition induced by the level of nutrition in lactating ewes.

		Diet		Milk		
Lactation period and reference	Breed	Energy (UFL/d)[1]	Protein (gPDI/d)[2]	Yield (l/d)	Fat (g/l)	Protein (g/l)
Suckling:						
Robinson et al. (1974)	Cheviot	2.14-2.27	188-265	2.4-3.1	76-74	54-50
Cowan et al. (1981)	FxD	1.78-2.77	214-317	2.2-3.3	83-74	55-52
Cowan et al. (1981)	FxD	2.28-2.33	241-277	3.3-3.5	84-92	53-56
González et al. (1984)	FxD	1.66-2.36	183-260	2.3-2.6	90	50-52
“ “	“	“	212-302	2.3-2.7	90	52-54
“ “	“	“	239-339	2.5-3.1	90	53-54
Geenty & Sykes (1986)	Dorset	1.99-2.00	146	2.4-2.5	76	40-39
“ “	“	1.51-2.42	138-170	2.0-2.7	79-69	40-39
Pérez-Oguez et al. (1994)	Manch.	1.36-1.49	143-162	1.4-1.5	88-84	49
Milking:						
Treacher (1971)	Dorset	1.06-2.18	107-221	1.2-1.5	83-68	46-52
Bocquier et al. (1985)	FxSxL	0.87-0.95	113-122	1.0	35-52	32
Geenty & Sykes (1986)	Dorset	1.83	124	1.7	71	47
“ “	“	1.69-2.10	132-158	1.5-2.0	71-65	53
Pérez-Oguez et al. (1994)	Manch.	1.41-1.50	147-164	0.6	92-99	57-58

FxD= Finnish landrace x Dorset horn; FxSxL= Finnish x Sardinian x Lacaune; Manch.= Manchega.
[1]UFL : 1.7 NEL ; total requirements : 0.033 UFL/BW$^{0.75}$ + 0.7 UFL/l of milk : [2]PDI : Protein Digestible at the level of Intestine ; Total requirements : 2.5 g /BW$^{0.75}$ + 80 g/l (Bocquier et al, 1987b).

Existence of significant correlation between same milk components in successive controls (fat: r= +0.5; protein: r= +0.7 ; Barillet and Boichard, 1987) suggest that effects of nutrition at early stage of lactation may have carry-over effects on milk composition during the milking period. Direct evidence of such effects are however lacking (Fraysse et al., 1996), even if it is obvious that it is of interest to optimize nutrition during early lactation because milk yield regularly declines.

In most dairy sheep breeds fed *ad libitum* good quality forages, the energy balance reaches the equilibrium within few weeks after weaning (Caja, 1994 ; Bocquier et al., 1995) as a consequence of the evolution of voluntary intake (Bocquier et al., 1987a, 1997; Pérez-Oguez et al., 1994, 1995; Caja et al., 1997) and milk yield. This may not be the case when using large amounts of concentrate that induce a decline in forage consumption (Bocquier et al., 1983) or with too poor quality forages. Milk fat content is negatively correlated (r=-0.87; P<0.05) to energy balance (-1 UFL/d=+12.2 g/l milk fat), this relationship being established (Bocquier and Caja, 1993) from available references of suckling and milking ewes in a wide range of net energy balance (-1.5 to +1.5 UFL/d) and milk yield (0.6 to 3.5 l/d). Consequently, in most cases, a high level of nutrition of dairy ewes will reduce milk fat percentage. In comparison with fat content, and in agreement with cow and goat conclusions, the response of ewe milk protein content follows a positive relationship (r=+0.64; P<0.05 ; Bocquier and Caja, 1993) with a lower and flatter slope. As a consequence a high level of nutrition of dairy ewes generally produce moderate increase in milk protein and casein percentages. This was also demonstrated in both dairy goats (Flamant and Morand-Fehr, 1982) and cows (DePeters and Cant, 1992).

Effects of undernutrition : Grazing dairy ewes in typical extensive or semi-intensive systems of the Mediterranean area are periodically subjected to undernutrition, in relation to seasonal changes in forages or by-products availability (Caballero et al., 1992; Sheath et al., 1995). Moreover, in intensive large flocks of dairy ewes, even when food supply is theoretically sufficient, stage of lactation and competition for food between ewes often lead to some individual underfeeding situations, specially in the case of most productive ewes in early lactation (or rearing twins or triplets) which have higher nutrient requirements (Bocquier et al., 1995). Negative energy balance produced by undernutrition will result in a decrease in milk yield and protein content and in an increase in milk fat, in agreement with values shown in Table 1. Slope of regression between milk yield and fat percentage (-6.3 g/l) estimated by Bocquier and Caja (1993) from available data is higher than observed in the Lacaune population (-4.9 g/l ; Barillet and Boichard, 1987) indicating that not only dilution-concentration effects are involved in this increase of fat percentage. Increase of blood free fatty acids, as a consequence of body fat mobilization, is an important reason for observed high milk fat percentage.

While undernutrition is mostly physiological at the onset of lactation, its effects during middle- or late-lactation are not well documented, neither in dairy ewes (Bocquier and Caja, 1993) nor in cattle (Coulon and Rémond, 1991). During this period, a severe and chronic undernutrition of dairy ewes reduced strongly the milk yield (-31%) and increased milk fat content in +9.6g/l (+16%), while protein content of milk was unchanged (Agus and Bocquier, 1995).

Effects of over-feeding : Over-nutrition is also consequence of group feeding and its is considered as a normal way to restore body reserves in the middle or late lactation. High levels of intake during lactation are achieved when ensuring that ewes can have high quality diets during early lactation i.e. before weaning (Pérez-Oguez et al., 1994, 1995). As a general trend, when the energy supply is increased, milk protein content tends to increase slightly and fat content tends to decrease, as described before. The expected increment in milk protein content by increasing the level of nutrition during the milking period are very low as indicated in Table 1 and (Bocquier and Caja, 1993). Variations of milk content are lower than during the suckling period as a consequence of differences in amplitudes of energy balance.

It should be stressed that, in practical conditions of dairy flock management and as a consequence of group feeding practices, the observed global effects of level of nutrition (over or under-nutrition) are normally hidden inside the feeding treatments and are mainly due to high yielding ewes. Individual intake of forage and concentrate can differ according to feed intake capacity. In these conditions a careful interpretation of data is recommended.

Effects of the level of dietary protein supply : Analysis of ewes' references (Bocquier et al., 1987b) indicate a quadratic relationship (r^2=0.97) between protein supply (in g PDI) over maintenance requirements and milk protein yield. Mean estimation of PDI efficiency was of 0.56, which is close to the value (0.59) observed by protein balances (Bocquier et al., 1987). Marginal increase of protein yield as a result of protein increment is almost null above 300 gPDI/d. There is, however, no significant effect of protein (PDI) balance on milk content neither on fat nor on protein in the compiled data by Bocquier and Caja (1993). Effects of dietary protein level on milk production of early lactating ewes are mainly attributed to energy savings as a consequence of an increase in body fat mobilization (Robinson et al., 1974, 1979; Cowan et al., 1981) and utilization (Geenty and Sykes, 1986).

Effects of the interaction between dietary protein and energy were studied by Cannas et al. (1998) in Sarda ewes during mid-milking period and related to milk urea nitrogen. Ewes were fed in pens with whole pelleted diets varying in two energy and four protein levels. Results are summarized in Table 3.

Table 3. Effects of energy and protein content in the diet on milk yield and milk composition in dairy ewes (Cannas et al., 1998).

	Energy[1] level	Crude protein (% DM) 14	16	19	21	Mean
Milk yield (l/d)	L	1.26	1.43	1.50	1.48	1.42
	H	1.16	1.20	1.34	1.34	1.26
Milk fat (g/l)	L	60	57	57	59	58
	H	57	57	54	56	56
Milk true protein (g/l)	L	55	54	53	52	54
	H	57	54	53	54	55
Milk urea N (mg/dl)	L	12.9	17.7	23.4	26.7	19.9
	H	12.2	17.0	22.3	25.8	19.3

[1] : L= 1.55 Mcal EN_L/kgDM (i.e. 0.91 UFL/kgDM), H=1.65 Mcal EN_L/kgDM (i.e. 0.97 UFL/kgDM).

Milk yield tended to increase and milk true protein to decrease with dietary protein level, in agreement with previous conclusions. Milk yield seems to reach a plateau above 19% of crude protein in the diet. Furthermore, energy level reduced significantly both milk yield and milk fat. Milk fat values were low and close to those observed in low fat syndrome, probably as a consequence of pelleted diets and of high content in non structural carbohydrates. True milk protein decreased with dietary protein level but was higher with the high, compared to the low energy diet. Milk urea nitrogen, which is positively correlated with protein in the diet, is better related to protein concentration of the diet (r^2=0.82) than with protein intake (r^2=0.56) giving an effective indicator of N utilization. Milk urea of these ewes varied between 12-27 mg/dl according to protein level, which was lower than measured in cow, and in general agreement whith measures on Lacaune ewes.

Effects of the level or proportion of concentrate in the diet : Effect of concentrate is positively associated with the energy level of the diet as a result of its energy density, and as a consequence milk fat may be depressed and milk protein increased. Furthermore, the use of high proportion of concentrates (>60% of dry matter) in diets may depress, by itself, both the milk fat and protein contents during the first months of lactation (Eyal and Folman, 1978). These effects might be different according to ewe's breed : higher for Awassi (fat: -28 g/l; protein: -2 g/l) than for Assaf ewes (fat: -6 g/l; protein: +1 g/l). Negative effects of concentrates on milk production are attributed to a quick and phasic degradation of non-structural carbohydrates in the rumen, reducing dramatically the rumen pH and altering the amount and composition of microbial protein synthesis and limiting the degradation of structural carbohydrates. These adverse effects of excess concentrate may be partially reversed by use of pH buffers (Hadjipanayiotou, 1988). During full lactation, it is also observed in group-fed ewes that the level of concentrate, if moderately increased, mainly affects the weight and body condition in lactating ewes, whereas bulk milk yield and composition are small or not significantly affected.

Consequences of group-feeding on nutritional strategies : The dairy sheep allowances were established for an individual ewe or a group of ewes with similar performances and they do not take into account differences between animals, *i.e*. variability within the group of ewes to be fed (Bocquier and Caja, 1993; Bocquier et al., 1995). If possible, ewes should be allocated into homogeneous groups according to their characteristics (physiological status, prolificacy, stage of lactation, milk yield or suckling litter size and body condition score). When this allocation is, however, not possible and ewes performance are widely spread, it is an usual practice to supply more feed than the average recommended allowances of the group. In Lacaune dairy ewes for instance, the main aim of feeding strategies is to give a diet that is adequate for ewes that make the most important contribution to total milk production; these ewes are those which produce about 10% more milk than the group average. Therefore, the energy supply for such group of ewe is calculated for an individual milk production that is 10% above the actual mean milk yield. The protein supply is generally calculated for a milk production that is 30% over the mean milk yield. This is because of marginal responses both in milk yield and in protein content, although the excess of dietary protein induces waste of protein especially for the low producing ewes of the group. Few comparative trials of group-feeding strategies have been done in dairy ewes. In this aim, an experiment was conducted (Bocquier et al., 1995) to compare the effect of two strategies of group-feeding. In this aim two similar groups of Lacaune dairy sheep (96 ewes each) were either fed altogether (all levels of milk yield confounded) or after separation in two subgroups according to milk yield (high and low). Total milk yield and milk composition were identical in both groups, but 'low-milk yield' subgroup showed a higher increase in body weight and body condition score at the end of the experi ment. Most of the beneficial effects of group feeding are obtained on the saving of concentrates, with dairy performances generally maintained or slightly improved.

On the other hand, at a given time, the main factor of milk yield variability in a flock comes from lambing dispersion and direct effects of feeding on milk composition are hidden by the heterogeneity of performance. Studies that have been conducted in France (Roquefort and Pyrenees) to measure the impact of within flock lambing kinetics on annual milk production and its composition (Fraysse et al., 1996) allow to take this factor into account for indirect comparisons of flock performances.

Effects of specific nutrients on ewe's milk composition:

Effects of fat supplements : The interest of fat supplements in the diets of dairy sheep has increased in the past years as a result of the availability of new preparation of fat as food for ruminants and of favorable results obtained in dairy cows. Available information on dairy ewe is however limited and we specially focus on calcium soaps of long chain fatty acids (CSFA). The effect of protected fat on ewe milk production and composition has been reviewed by Casals and Caja (1993) and Chilliard and Bocquier (1993) and main results referred to milking period of dairy sheep are summarized in Table 4.

Table 4. Effects of calcium soap of long chain fatty acids on milk production of Manchega dairy sheep during milking.

Lactation period and reference	Basal diet	Lipid (g/d)	Yield (%)	Fat (g/l)	Protein (g/l)
Casals et al. (1989, 1992a, 1999)	Grazing	0	0.75	79	62
	"	160[1]	0.78	97	56
	Gr.+ Protein suppl.	0	0.73	85	64
	"	160[1]	0.69	100	59
Casals et al. (1991, 1992b)	Grazing	0	0.74	74	60
	"	40[1]	0.83	82	59
	"	80[1]	0.70	94	60
	"	120[1]	0.74	89	55
	"	160[1]	0.71	94	56
Font et al. (unpublished)	Grazing	0	0.51	99	65
	"	72[1]	0.53	105	61
Cuartero et al. (1992)	Grazing	0	0.45	92	-
	"	75[1]	0.46	104	-
Gargouri et al. (1995)	Grazing	0[2]	0.94	82	67
	"	72[1,2]	1.00	84	63
Gargouri (1997)	Grazing	0	0.92	74	63
	"	96[1]	0.83	83	61
Pérez Alba et al. (1997)	Oat-vetch hay	0	1.40	65	51
		166[3]	1.56	68	49

[1]: Calcium soaps of palm oil; [2]: Including 2% of animal fat and 3% of whole soybean seed in both concentrates; [3]: Calcium soaps of olive oil.

First references (Pérez Hernández et al., 1986) in suckling ewes tried to improve lamb growth with contradictory results, but most clear response was obtained in the improvement of milk fat content in dairy ewes. Lactational (suckling and milking periods) effects of CSFA included in the concentrate fed to Manchega dairy ewes grazing in semi-intensive conditions have been reported mainly by Casals et al. (1989, 1991, 1992ab, 1999), Cuartero et al. (1992), Gargouri et al. (1995), Pérez Alba et al. (1997) and Osuna et al. (1998). The last authors compared the use of oilseeds vs CSFA and Lacaune vs Manchega dairy ewes in indoors conditions. Although total milk yield was unaffected in all experiments, dietary CSFA significantly increased the milk contents of fat and solids, in most cases, and decreased slightly milk protein content in overall lactation. Responses varied according to CSFA dose and lactation stage. Apparent efficiency of CSFA transfer to milk was higher in suckling than in milking ewes, and optimum intakes to maximize milk fat production were close to 120 and 70 g CSFA/ewe/day, in suckling and milking respectively. The depressive effect of CSFA on milk protein increased with time after lambing, and optimum intake of CSFA that maximized milk protein production were the same as for milk fat. Milk casein also decreased with CSFA but casein content as percentage of milk protein was unchanged in all cases. Fatty acids profile in milk and cheese was changed with a strong increase in palmitic (C16:0) and oleic (C18:1) acids and a decrease in the C6 to C14 acids (Gargouri et al., 1995; Pérez Alba et al., 1997), but differences in fatty acids profile were non significant after the ripening of cheeses. Change in fatty acids profile of milk was dependent on CSFA profile (Gargouri et al., 1995; Pérez Alba et al., 1997). Special care must be taken in relation to changes in lipolysis rate or organoleptic characteristics after modification of fatty acid composition in cheese.

More recently Osuna et al. (1998) studied the effects of feeding whole oilseeds, to partially replace calcium soaps of fatty acids, on dairy ewes intake and milk production and composition. In this aim Manchega and Lacaune dairy ewes were used in mid-milking period to determine the lactational effects of supplementing diets with fat coming from palm oil CSFA (5.5%) or from a mixture of CSFA (2.5%) and whole cottonseed (11%) or CSFA (2.5%) and whole sunflower seeds (4%). Diets were isonitrogenous (16%CP) and were offered as a total mixed ration (71% forage: 29% concentrate) where fat supplements were included. Ether extract increased from 2.5% in control to 7% in fat supplemented. Results are summarized in Table 5.

Table 5. Effects of feeding whole oilseeds and Calcium soaps of fatty acids on milk production and composition of Manchega and Lacaune dairy ewes during mid milking.

Item	Breed[1]	Control	CSFA[2]	CSFA+WCS[3]	CSFA+SFS[4]
Milk yield (l/d)	M	0.8	0.8	1.0	0.8
	L	1.7	1.7	1.5	1.7
Milk fat (g/l)	M	74	95	95	90
	L	61	77	82	70
Milk protein (g/l)	M	63	60	64	62
	L	55	55	58	55

[1]: M= Manchega, L= Lacaune; [2]: CSFA= Calcium soaps of fatty acids; [3]: WCS= Whole cotton seed; [4]: SFS= Sunflower seed.

Due to the dietary fat, intake tended to decrease, milk fat percentage and yield were increased, and casein content was reduced. Milk yield was not affected by treatments and no interactions were found between breed and fat supplementation, in spite of the respective differences ($P<0.01$) between Manchega and Lacaune dairy ewes in milk yield (0.9 and 1.6 l/d), and fat (8.8 and 7.2%) and protein (6.2 and 5.6%) percentages, respectively in the control diet. A significant effect was detected on milk casein as percentage of total protein that decreased as response to lipid supplementation.

Effects of protein supplements: Studies on the use of low degradable protein supplements, protected proteins or protected amino acids in milk production of sheep are very limited and most of the references were obtained from suckling ewes, altering the practical significance of data of milk composition. In addition, in some cases the results are not significant or contradictory. In regard to low degradability protein supplements Robinson et al. (1979), Cowan et al. (1981), Penning and Treacher (1981), González et al. (1982), Hadjipanayiotou (1988, 1992) and Penning et al. (1988), and most recently Purroy and Jaime (1995), showed increases in milk yield during early lactation when included or substituted a degradable protein by fishmeal (60-140 g/d) as in lactating ewes. Milk composition was, however unchanged in most cases and only significantly improved in the trials of Penning et al. (1988) and Purroy and Jaime (1995), when compared to soybean and fishmeal in suckling ewes. These last authors reported significant increases in milk protein (+2.9 g/l, +6.2%) but not in milk yield, probably as a consequence of the reduction of undernutrition (70-80% of energy requirements) applied in the experiment. Robinson et al. (1979) also found a slight increase ($P<0.10$) in milk protein in ewes fed fishmeal, when compared with those fed soybean or peanuts protein supplements. Effects of fishmeal are attributed to an increase in the amount and profile of amino acids absorbed in the small intestine and that are available for milk synthesis.

Use of protected proteins also gave interesting results, but in some cases they are not significant or contradictory. Treatment of protein supplements with formaldehyde must be done at optimum doses (Caja et al., 1977). In this sense, compared the use of soybean, fishmeal and formaldehyde protected soybean in Chios dairy ewes were without significant effects on milk yield and milk composition (Hadjipanayiotou, 1992), even if milk fat and milk protein contents were slightly higher in ewes fed formaldehyde treated soybean. The use of formaldehyde protected soybean in Chios dairy ewes in negative energy balance also did not affect milk yield and composition (Hadjipanayiotou and Photiou, 1995). Industrially protected soybean by mean of lignosulphonate treatment is nowadays available for ruminants. Evaluation of treated vs untreated soybean was done in Manchega dairy ewes fed with poor quality forage at two levels of supplementation with concentrate (Pérez et al., 1994, 1995). Values of effective degradability measured in sacco for treated and untreated soybean used in the experiment were 0.30 and 0.56, respectively. Differences between treatments were not significant, but a significant interaction ($P<0.05$) was observed in the milk yield comparisons between the level of concentrate and degradability of protein. The highest values in milk yield were obtained with the high level of low degradability soybean supplements. Milk composition was unaffected by treatments.

More recently, protected amino acids have been used in lactating ewes to increase milk production during suckling (Lynch et al., 1991; Baldwin et al., 1993) or milking periods (Bocquier et al., 1994). Lynch et al. (1991) studied the supplementation of Methionine (0.11%) and Lysine (0.28%) in two concentrates for suckling ewes of varying levels of protein (10 and 16% crude protein). Obtained results indicated a higher milk yield (+11%) in the ewes fed with the high protein supplemented concentrate, but the difference was not significant. Milk protein was also unaffected by both experimental treatments. The inclusion of protected Methionine (0.2%) in the concentrate produced small (+2%) and non significant increases in milk yield and milk protein as observed by Baldwin et al. (1993) in suckling Dorset ewes. It has been also shown that the milk protein content of milk can be increased by addition of 3 or 6 g/d of protected Methionine at early stage of lactation of milking period in Lacaune ewes (Bocquier et al., 1994) with ewes in positive nutrient balance (117-120% and 120-140% of energy and protein requirements, respectively). The response to Methionine was higher when basal diet was based on silage than on hay, indicating that Methionine content could be the limiting amino acid in this last diet. Milk yield and milk fat content were unaffected by the supplementation.

Conclusions and prospects

Quality of milk can be defined in many different ways according to its final destination and/or to consumer's demands. In the next future, however, at a very limited scale, some dairy ewes may be bred for their milk properties, because it has been demonstrated the feasibility of producing pharmaceuticals in the milk of transgenic animals. For the majority of breeders, the problem is to produce milk at large scale. For them, the changes in the way to produce milk followed a stepped evolution which was allowed by scientific knowledge and technical progress either in the improvement of its production or on the control of the products. The major step was to increase productivity of dairy ewes and to control the health aspects. The second step was imposed by cheese manufacturers : milk is now generally paid on its ability to be transformed into cheese, *i.e.* fat and protein content. Nowadays, there is a wide variety of new objectives that are emerging as a demand of social groups. Among them, "natural" production, animal welfare, perennial land use and waste control are often cited. These objectives appear somewhat confusing because they may be contradictory or they may not be economically adapted to the present context. This is the reason why, breeders defend their products and their income by well-defined new production rules that are collectively chosen. Hence, in France, it is not allowed to treat dairy ewes with genetically engineered substances such as BST. In addition, decisions have been taken in the Roquefort region of France and nowadays the use of some constituents of concentrates are prohibited (ruminal-protected fat or amino-acids) or animal by-products. The use of some others feed are in discussion for they may contain parts of transgenic plants.

Sheep milk producers are mostly located in the Mediterranean area. Their breeding system relies on local sheep breeds that are well-adapted to such an environment with local feed resources together with traditions of cheese making and consumption. They perceive that this is not sufficient and this is why they decided to emphasize the use of local feed that may contribute to the milk quality in order to reinforce the notion of typical cheese.

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