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Effect of roughage level and source in diets on the risk of reversing fat and protein percentages in goat milk

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SUMMARY – In France, for several years, reversions of fat and protein percentages have appeared in milks of intensively fed goats from 4-5 months to 7-8 months of lactation. Values of protein percentages are higher than fat percentages; which has unfavourable effects on cheese quality. Consequently we tried to assess the dietary effects on the percentage reversion risks. Two fibre sources, lucerne hay or dehydrated unground blocks were compared at a low and high roughage/concentrate ratios (R/C) in a 2 x 2 factorial experiment carried out in a Latin square design during 4 periods of 4 weeks. Thirty two Saanen and Alpine goats in the 3rd month of lactation were allotted in 4 groups balanced in milk yield and composition. The mixed complete diet was composed with lucerne hay (A) or deshydrated lucerne blocks (D) at 60% (H) or 30% (L) total DM, beet pulp silage (20% H or 35% L) and concentrates (soya oilmeal and barley 20% H or 35% L). The level of dry matter intake was not significantly different (2.95, 2.94, 2.88, 2.99 kg DM/d respectively for AH, AL, DH, DL diets) but the intake of net energy was higher in AL and DL diets than in AH and DH diets. The milk yield was significantly higher in L diets limited in roughages (3.48 kg milk/d for L diets vs 3.10 kg milk/d for H diets). The type of lucerne had no effect on milk yield. Fat percentage tended to be lower in L diets than H diets; D lucerne significantly decreased fat percentage only with L diets. D diets tended to increase protein percentages. The reversions of fat and protein percentages were significantly more frequent in L diets than in H diets, and unsignificantly in D than in A diets. In conclusion, the R/C ratio is more efficient to provoke reversions of fat and protein percentages in high yielding dairy goats than the physical presentation of lucerne when goats were received a diet rich in roughages but the effect of physical presentation tends to be higher when the F/C ratio is low.

Key words: Dairy goat, composition of milk, forage/concentrate ratio, type of roughage.

RESUME – "Effet du niveau et de la source de fourrage dans le régime sur le risque d'inversions des taux butyreux et protéiques dans le lait de chèvre". En France depuis plusieurs années, des inversions des taux butyreux (TB) et taux protéique (TP) sont apparues dans les laits de chèvres alimentées intensivement entre 4-5 et 7-8 mois de lactation. Le TP est supérieur au TB ; ce qui a un effet défavorable à la qualité du fromage. En conséquence, nous avons testé l'effet de facteurs nutritionnels sur les risques d'inversion dans cette expérience. Deux sources de fibres : le foin de luzerne et des blocs de luzerne déshydratée non broyée ont été comparées à bas (L) et haut (H) rapport Fourrage/Concentré (F/C) dans une expérience factorielle (2 x 2) conduite selon un dispositif de carré latin pendant 4 périodes de 4 semaines. Trente deux chèvres Saanen et Alpine en 3^e mois de lactation sont réparties en 4 lots équilibrés en production et composition du lait. Les rations complètes distribuées sont composées de foin de luzerne (A) ou de blocs de luzerne déshydratée (D) à 60% (H) ou 30% (L) de la matière sèche totale, d'ensilage de pulpes de betterave (20% H ou 35% L) et de concentré (tourteau de soja et orge 20% H et 35% L). Le niveau d'ingestion n'est pas significativement différent (2,95, 2,94, 2,88, 2,99 kg DM/d respectivement pour les régimes AH, AL, DH, DL) mais l'ingestion d'énergie nette est supérieure avec les régimes AL et DL. La production laitière est significativement supérieure avec les régimes L limités en fourrages (3,48 vs 3,10 kg lait/j pour les régimes H). Le type de luzerne n'a pas d'effet sur la production laitière. Le TB tend à être plus bas avec les régimes L. La luzerne D diminue significativement le TB seulement avec les régimes L. Les régimes D tendent à diminuer un peu le TP. Les inversions TB/TP sont significativement plus fréquentes avec les régimes L et de façon non significative avec les régimes D par rapport aux régimes A. En conclusion, le rapport F/C est plus efficace pour inverser les TB/TP chez les chèvres hautes productrices que la présentation physique du fourrage quand le rapport F/C est élevé mais l'effet et la présentation physique est plus net que le rapport F/C est bas.

Mots-clés : Chèvre laitière, composition du lait, rapport fourrage/concentré, type de fourrage.

Introduction

Usually French consumers consider goat cheeses as gastronomic products which are bought for familial or friendly parties. But since several years, some criticisms have appeared about the quality of

goat cheeses: the cheese paste is granulous and not fine enough; goat cheeses are short of goaty flavours. The consumer observations have become frequent simultaneously with the apparition of reversions of fat and protein percentages in milks of goats flocks in intensive conditions, particularly in mid lactation from 4-5 to 7-8 months of lactation (Morand-Fehr, 1996). The fall of cheese quality would be due to reversions of fat and protein percentages (Danieau, 1998), which can have various causes: incomplete milkings, genetic improvement principally trended to increase protein production, and unbalanced diets in fat and fibrosity (Morand-Fehr, 1996; Morand-Fehr *et al.*, 1998). As in an inquiry (Nourtier, 1997) milk percentages reversions were observed where goat farmers replaced hays by dehydrated roughages, the effects of the forage/concentrate ratio and the physical presentation of roughages were tested in the present experiment.

Material and methods

Thirty two Saanen and Alpine adult goats in the third month of lactation at the beginning of the experiment were allotted in 4 groups of 8 goats balanced on milk production and composition (fat and protein percentages). They were placed in individual crates. The experiment was carried out in a Latin square design and lasted 12 weeks divided in 4 periods of 3 weeks.

All the goats were given mixed diets during all the experiment. Two nutritional factors were tested in 2 x 2 factorial design: roughage/concentrate (R/C) ratios 60/40 (H) and 30/70 (L), two types of roughages lucerne hay of good quality (A) vs dehydrated unground lucerne blocks (D) containing 66% 4 mm and more sized particles. All the diets were composed of lucerne, over-pressed beet pulp silage and concentrates (barley, soya oilmeal, minerals and vitamins) (Table 1); their water content was about 55%. So goats were received *ad libitum*. Individually each experimental diets (AH, AL, DH and DL) during one of the four periods in two daily distributions. The distributed quantities were calculated so that refusals were less than 10%.

Table 1. Composition of experimental diets

	Experimental diets			
	AH	AL	DH	DL
Type of lucerne	Hay	Hay	Deshydrated blocks	Deshydrated blocks
Ratio R/C	60/40	30/70	60/40	30/70
Composition % DM				
Lucerne	60	30	60	30
Beet pulp silage	20	35	20	35
Concentrate (Barley, soya meal)	20	35	20	35

The adaptation of goats to experimental diets lasted 2 weeks. During the 3rd week of each period, a sample of each diet was taken off for chemical analysis to calculate net energy value (UFL/kg DM), the level of intake and milk production were individually measured for 5 days and milk fat and protein percentages of each goat twice.

Results and discussion

The 4 experimental diets were well accepted. The level of dry matter (DM) intake around 3 kg DM goat day (Table 2) was satisfying for goats producing 3-4 kg milk in mid-lactation (Sauvant *et al.*, 1991). The levels of DM intake were not significantly influenced by experimental diets but the net energy intake was significantly higher energy content of the AH and DH diets rich in concentrates. Consequently the milk yield of goats received AL and DL diets was higher because the milk yield depends closely of the net energy intake of goats (Hadjipanyiotou and Morand-Fehr, 1991). The

physical presentation of lucerne had no significant effect on goat milk yield. As shown in Table 3, the fat percentage of goat milk tended to be lower in L diets than diets due to the lower fibrosity of L diets.

Table 2. Effect of R/C ratio and type of lucerne on intake and milk yield of dairy goats

	Experimental diets				Significance of diet effect
	AH Hay	AL Hay	DH Deshydrate d	DL Deshydrate d	
Type of lucerne					
Ratio R/C	60/40	30/70	60/40	30/70	
Level of DM intake (kg/d)	2.95	2.94	2.88	2.99	NS
Level of NE intake (UFL [†] /d)	2.40 ^a	2.80 ^b	2.39 ^a	2.88 ^b	*
Milk yield (kg/d)	3.08 ^a	3.46 ^b	3.12 ^a	3.50 ^b	*

[†]UFL: Feed unit for milk (net energy).

^{a,b}In the same line, the values which have not a same subscript are significantly ($P \leq 0.05$) different.

* $P \leq 0.05$, NS = non significant.

Table 3. Effect of R/C ratio and type of lucerne on milk composition in dairy goats

	Experimental diets				Significance of diet effect
	AH Hay	AL Hay	DH Deshydrate d	DL Deshydrate d	
Type of lucerne					
Ratio R/C	60/40	30/70	60/40	30/70	
Fat percentage (FP) (%)	3.21 ^a	3.10 ^{ab}	3.20 ^a	2.95 ^b	*
Protein percentage (PP) (%)	31.2	3.17	3.20	3.20	NS
Difference FP – PP (%)	+0.9 ^a	-0.8 ^{ab}	+0.2 ^{ab}	-2.4 ^b	*
Frequency of percentage reversions (% in number goat-week)	33.3	78.8	45.5	75.8	

^{a,b}In the same line the values which have not a same subscript were significantly ($P \leq 0.05$) different.

NS = non significant, * $P \leq 0.05$.

Consequently it was probable that the production of acetate in rumen that is the main precursor of C4-C16 milk fatty acids was more limited (Morand-Fehr *et al.*, 1991). The type of lucerne did not influence fat percentages when goats were received diets rich in roughages (AH and DH diets) but deshydrated lucerne decreased significantly fat percentages of goat milk when the R/C ratio was low in diets. Probably the level of fibrosity in AH and DH diets was sufficiently high to get an effect of deshydrated lucerne containing 66% long particles only; so its fibrosity was lower than in lucerne hay. The fibrosity of AL and DL diets low in roughages was limited, an extra decrease of fibrosity due to deshydrated lucerne was probably sufficient to decrease rumen pH and acetate production. In fact, these results showed an significant interaction between the level and the type of roughages.

The effects of experimental diets on protein percentages were not significant but diets containing deshydrated lucerne tended to increase protein percentages. Consequently the difference fat percentage-protein percentage were higher with H diets than D diets. The frequency of percentage reversions were upper when goats were received diets with low R/C ratios. The frequency about 75% is very high and risks to have bad consequences on cheese quality. This high frequency is due to the physiological period (3-7 months of lactation) favorable to percentage inversions (Nourtier, 1997) and the experimental goat flock which have a high aptitude to present percentage reversions.

Conclusion

Nutritional factors can increase the frequency of fat and protein percentage reversions, particularly the R/C ratio but when this ratio is low, the type of roughage, particularly roughage with a limited fibrosity can increase the frequency of percentage reversion.

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