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SUMMARY – Forty-five Cilentana goats were equally divided into three groups that received, as pasture supplementation, three concentrates with a different NSC:degradable protein ratio: 0.84, 0.73 and 0.60, respectively for groups A, B and C. The concentrates were fed at 200, 300 and 400 g/head/d, and at 45, 30 and 15 days before lambing, respectively. Then, the quantities increased until 800 g/head/d. After two months from lambing, the lambs were sold; the milk yield was monitored monthly for 5 controls. Each time, individual milk samples were collected and analysed for protein, fat, lactose, non-protein nitrogen and casein. Group A showed significantly higher milk yields, averaged over the whole trial period (1.463 *vs* 1.343 *vs* 1.182 kg/d, respectively for groups A, B and C; P<0.01) and a lower non-protein nitrogen percentage (0.21 *vs* 0.24 and 0.23, respectively for groups A, B and C; P<0.01).

Keywords: Non-structural carbohydrates; degradable protein; Cilentana goat, grazing.

RESUME – *"Effet du rapport entre hydrates de carbone non structurels et protéines dégradables du concentré, sur la production et la qualité du lait de chèvres Cilentana au pâturage". Quarante-cinq chèvres Cilentana ont été également divisées en trois groupes recevant, comme supplémentation du pâturage, trois concentrés ayant différents rapports NSC/protéines dégradables : 0,84, 0,73 et 0,60, respectivement pour les groupes A, B et C. Les concentrés étaient distribués à raison de 200, 300 et 400 g/tête/j, et à 45, 30 et 15 jours avant l'agnelage, respectivement. Ensuite, les quantités augmentaient jusqu'à 800 g/tête/j. Deux mois après l'agnelage, les agneaux étaient vendus ; la production de lait était suivie mensuellement pendant 5 contrôles. Chaque fois, des échantillons individuels de lait étaient prélevés et analysés pour connaître les protéines, matière grasse, lactose, azote non protéique et caséine. Le groupe A montrait des productions de lait significativement supérieures, d'après la moyenne calculée sur toute la période de l'essai (1,463* vs *1,343* vs *1,182 kg/j, respectivement pour les groupes A, B et C ; P<0,01) et un pourcentage plus faible en azote non protéique (0,21* vs *0,24 et 0,23, respectivement pour les groupes A, B et C ; P<0,01).*

Mots-clés : *hydrates de carbone non structurels, protéines dégradables, chèvre Cilentana, pâturage.*

Introduction

In the mountainous areas of Cilento (Salerno province) an autochthonous goat population called "Cilentana" is extensively bred, whose milk production potential has been studied by our research group since 1995 in order to identify the most suitable characteristics of concentrate for goats as a pasture supplement. The latter, particularly luxuriant in spring, is mainly constituted by Leguminosae. In a previous study (Sarubbi *et al.,* 2000), as pasture protein is mainly represented by the degradable fraction, the effect of isoproteic (18% CP on DM) concentrates differing in rumen degradability (65% *vs* 47%) on the productive traits of goats was evaluated. Even if the milk yield was not influenced by treatment, the percentage of milk protein was significantly higher in the group fed the concentrate with the lowest protein degradability (3.64 ± 0.5% vs 3.49% ± 0.4; P<0.01). On the other hand, in order to balance the protein intake of small ruminants at grazing, an increase in the dietary non-structural carbohydrates (NSC) is suggested even if the results on milk yield were contrasting: increase (Brown and Hogue, 1985), decrease (Cavani *et al.*, 1990; Cannas *et al.,* 1998) or varying as function of stage of lactation (Bovera *et al.,* 2004). Thus, it seemed interesting in the present study to evaluate the effect of the ratio NSC:degradable protein in the concentrate on milk yield and quality of grazing Cilentana goats.

Material and methods

The trial was carried out in a farm where goats are hand-milked twice daily, births are concentrated at the beginning of February and kids are weaned at about two months of age. Forty-five Cilentana goats were equally divided into three groups fed the following concentrates as pasture supplementation: C, control (CP: 18.0% DM; NSC: 39.3% DM); A and B differing from C in effective protein degradability (47 *vs* 65%) or NSC content (47.3 vs 39.3%), respectively (see Table 1). Thus, the NSC to degradable protein ratio was 0.84, 0.73 and 0.60, respectively for groups A, B and C. The concentrates were fed at 200, 300 and 400 g/head/d, at 45, 30 and 15 days before lambing, respectively. Then, the quantities increased until 800 g/head/d. All the groups grazed on 20 ha from 08:00 to 16:00 hours and spent the nights at the stall. After kid weaning, individual milk yield was recorded monthly, for a total of 5 controls. Each time individual milk samples (obtained by mixing the production of the two daily milkings) were analysed for protein, fat and lactose (near infra-red method); non-protein nitrogen (NPN) and casein as suggested by ASPA (1995). The chemical-nutritional characteristics of concentrates were estimated according to ASPA (1980), Van Soest *et al.* (1991) and INRA (1978) indications; the nitrogen bound to NDF (NDIP) according to Sniffen *et al.* (1992).

Table 1. Chemical composition (%DM), nutritive value (UFL/kg DM) and effective protein degradability (%) of concentrates A, B and C

Concentrate	A	B	C
Crude Protein	18.0	18.0	18.0
Ether extract	3.2	3.0	3.0
NDF	32.3	27.0	32.3
ADF	14.9	11.5	14.9
ADL	4.0	3.0	4.0
NDIP	1.6	1.9	1.6
Ash	8.0	8.0	8.0
NSC	39.3	47.3	39.3
UFL/kg DM	0.97	1.12	0.97
Effective protein degradability	47	65	65

Non-structural carbohydrates (NSC) content was calculated according to Sniffen *et al.* (1992):

$$NSC = 100 - [(NDF - NDIP) + CP + EE + ash]$$

The lower protein degradability of the concentrate fed to group A was obtained using ingredients previously tested by the nylon bags technique in our department (ASPA, 1994; Infascelli *et al.,* 1995). The effect of different concentrates was tested by the GLM PROC of SAS (2000); the control effect was also tested.

Results and discussion

The nutritive value of concentrate B was higher (1.12 *vs* 0.97 UFL/kg DM) compared to concentrates A and C, due to its higher NSC and lower NDF content (Table 1). However, assuming that the energy intake from grazing in the study areas was 0.65 UFL/day (Rubino, 1996) and as all the concentrates were fed at 800 g/head/day during lactation, equal to 0.78 UFL in the case of concentrate B and 0.69 UFL in the case of A and C, the energy requirements for goats yielding 1.3 kg of milk with 5% fat were meet (INRA, 1978).

The average milk yield (Table 2) was significantly different (1.463 ± 0.539 *vs* 1.343 ± 0.443 *vs* 1.181 ± 0.345 kg for groups A, B and C, respectively; $P<0.01$), indicating that 0.84 is the best NSC: degradable protein ratio for the concentrate. The difference between groups A and C differs from our previous results obtained with the same goat population (Sarubbi *et al*., 2000), in which the protein degradability of the concentrate did not affect milk yield. In contrast, the present results agree with those of Romero *et al.* (1994) for Nubian goats. Comparing group B and C, the difference in milk yield could be attributed to the higher level of NSC in the concentrate fed by B group, even if Cannas *et al.* (1998) found higher milk yield in Sarda ewes fed a diet with lower NSC concentration.

Table 2. Milk yield and quality of goats fed A, B and C concentrates

	Milk (g/d)	Protein (%)	Fat (%)	Lactose (%)	NPN (%)	Casein (%)
Concentrate effect						
A	1463.2^{A} (539.4)	3.48 (0.38)	5.11 (0.81)	4.61 (0.25)	0.21^{B} (0.05)	2.76 (0.34)
B	1343.0^{B} (443.3)	3.50 (0.36)	5.03 (0.80)	4.60 (0.25)	0.24^{A} (0.05)	2.78 (0.31)
C	1181.9^{C} (345.6)	3.54 (0.39)	5.14 (0.84)	4.63 (0.20)	0.23^{A} (0.05)	2.79 (0.37)
Control effect						
1	1556.3^{A} (474.6)	3.34^{C} (0.34)	4.69^{B} (0.64)	4.80^{A} (0.18)	0.23^{B} (0.03)	2.76^{B} (0.28)
2	1653.6^{A} (357.8)	3.35^{C} (0.33)	5.01^{AB} (0.73)	4.72^{A} (0.14)	0.24^{AB} (0.04)	2.70^{B} (0.27)
3	1407.1^{B} (358.4)	3.46^{BC} (0.27)	5.16^{A} (0.78)	4.56^{B} (0.14)	0.21^{BC} (0.07)	2.71^{B} (0.26)
4	1209.3^{C} (308.0)	3.54^{B} (0.28)	5.27^{A} (0.76)	4.53^{B} (0.18)	0.17^{C} (0.03)	2.73^{B} (0.37)
5	819.3^{D} (264.9)	3.84^{A} (0.42)	5.38^{A} (0.99)	4.46^{C} (0.22)	0.26^{A} (0.03)	3.00^{A} (0.41)
Significance						
C	**	NS	NS	NS	*	NS
S	**	**	**	**	**	**
CxS	*	NS	NS	NS	**	NS

( ): standard deviation; NS: not significant; *: P<0.05; **: P<0.01; A,B,C: P<0.01.
C: concentrates; S: control; CxS: concentrate x control interaction.

Milk fat was unaffected by treatment, even if the B group showed the lowest values. These results disagree with those of Sahlu *et al.* (1995) who, in Alpine goats, found a linear increase of fat as a function of dietary energy. It is noteworthy that milk fat of group B was significantly lower compared to that of groups A and C at the 3rd control (Fig. 1), when the pasture was more luxuriant. Probably, concentrate B (>NSC) led to a decrease in pasture intake and, thus, in structural carbohydrates with consequent lower production of acetate in the rumen.

The milk protein was unaffected by treatment and gradually increased as a function of lactation time (Fig. 2). This parameter was significantly (P<0.01) different between groups A and C (3.46% *vs* 3.62%, respectively) at the 4th sampling, the only period in which the pasture in the study areas is scarce. At that time, the group A of goats, fed the concentrate with lower degradable protein, probably had scarce available nitrogen for the synthesis of ruminal protein and, as a consequence, a lower amino acid availability for the mammary gland.

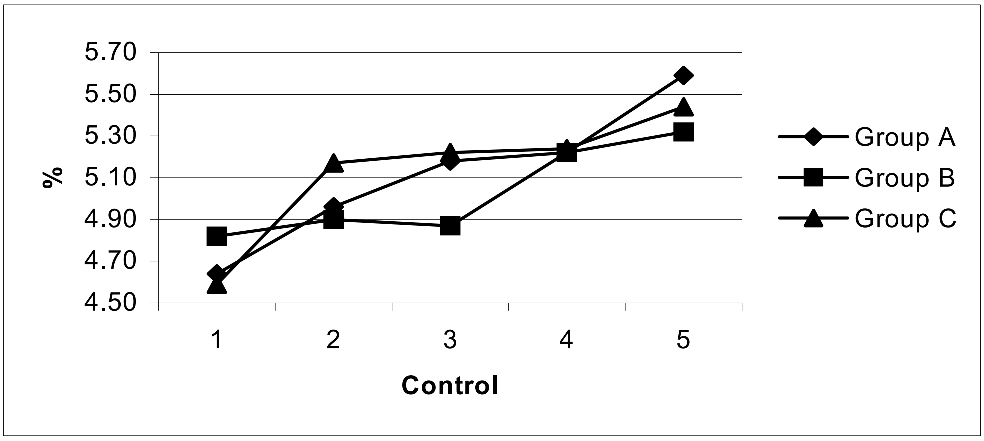

Fig. 1. Milk fat (%) in milk produced by goats fed A, B and C concentrate.

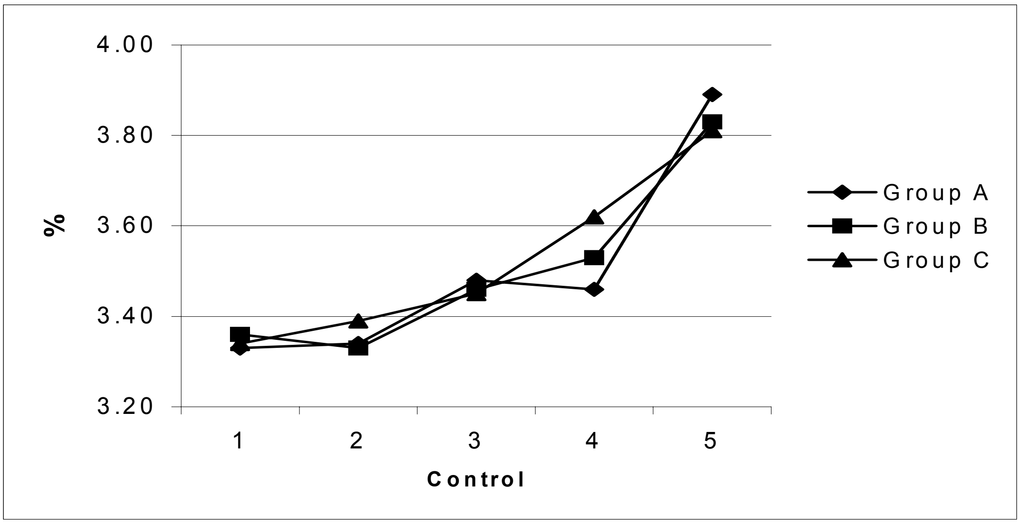

Fig. 2. Milk proteins (%) in milk produced by goats fed A, B and C concentrate.

In contrast, Sanz Sampelayo *et al.* (1999) found an increase in milk protein in Granadina goats as dietary protein degradability decreased. However, Romero *et al.* (1994) found no effect of dietary protein degradability on milk protein content in Nubian goats while Morand-Fehr *et al.* (1981) reported increases in milk protein as the dietary energy increased.

Casein represented about 80% of milk protein, showing the good cheese-making aptitude of Cilentana goats milk. Indeed, curd firmness increases as the casein percentage does (Piccolo *et al.,* 1998). The NPN (non protein nitrogen) was significantly (P<0.01) lower in group A than in B and C groups, probably due to the lower degradable nitrogen intake. This is confirmed by the significantly (P<0.01) lower values found at the 4th control for all groups. Also the low NPN values indicate aptitude for cheese-making; indeed, according to Piccolo *et al.* (1998), high NPN levels negatively affect both curd formation and firmness.

Conclusions

The decrease in the NSC:degradable protein ratio negatively affected milk yield without influencing milk quality. Therefore, in order to improve the performance of grazing Cilentana goats, it seems more suitable to feed animals concentrates with low degradable protein.

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