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Influence of different concentrates on milk yield and quality from Italian indigenous goat

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Abstract

This paper contains a study of the effects of in-pasture dietary supplementation by different concentrates on the milk yield and quality of Bianca Monticellana, an indigenous goat breed reared in Italy. Two groups of lactating goats put out to pasture were fed poliphita hay; each group received one of two dietary concentrates during the first lactation stage. The administered concentrates contained similar energy (0.53-0.55 Milk FU) and protein (101.5-102.8 g). The average milk yield from morning-only milking in groups, 0.78-0.95 kg/head, was higher than the yield recorded during previous years in the same breed and lactation stage. The fat and protein content of the milk from the two groups were similar to those observed in animals of the same breed that produced lower milk yield. Comparison with values from cosmopolitan goat breeds indicates that this milk has an optimal ability to clot. In conclusion, the milk yield and quality of Bianca Monticellana can improve following administration of rations that appropriately address the dietary requirements. Moreover, the milk from these goats is suitable for cheese-making, a basic condition that brings a gratifying income to the farmer and consequently assures a greater population of indigenous breeds.

Keywords: Indigenous Goat, Concentrate Supplement, Milk Yield, Quality

Introduction

In Italy, many breeds of various species, including goats, are maintained in populations of limited size. Several indigenous goat breeds are reared in the Latium region near Rome, with most widespread breeds being the Bianca Monticellana and Grigia Ciociara breeds.

A previous investigation of these indigenous goat breeds reported that rearing occurred on a semi-extensive farming system based mainly on grazing, maternal suckling of the kid during the first month of lactation, and manual milking (Tripaldi et al., 2009). Approximately one-third of the farms did not supplement in-pasture nutrition, while the remaining farms supplemented with hay only, concentrate only or both hay and concentrate. Supplementation was provided over a period varying from the suckling of kids up to the entire duration of lactation. This milk was utilised to make cheese by a traditional process and was destined for local markets. Indeed, the resulting cheese serves as a rare example of Italian pure goat cheese, since goat milk is usually mixed with ewe milk to produce mixed sheep-goat cheese (Pirisi et al., 1995).

Unfortunately, the milk yield, fat content, and protein content in the indigenous goat milk were lower than those of other goat breeds in Italy (Tripaldi et al., 2009), and it was hypothesized that this sub-optimal performance was like due to a dietary deficiency. Although agro-pastoral systems have largely escaped recent agricultural policies and consumption, they have demonstrated their economic validity and benefit from other advantages such as environmental conservation. Nonetheless, the preservation of indigenous breeds and their development depend in great measure on the ability to obtain products of good quality. In cheese, these attributes are affected by milk characteristics in addition to the applied process; supplementation of in-pasture nutrition may contribute to an improvement in milk yield and quality. Correct supplementation may also enable better estimation of the productive ability of these goat breeds.

In this study we investigated the effects of two commercial concentrate supplementation on milk yield and quality from Bianca Monticellana goats.

Materials and Methods

This investigation was conducted on a commercial farm rearing the Bianca Monticellana goat breed. After calving (February-March), 20 animals were divided in two groups homogeneous for parity and milk yield. Only goats that gave birth to twins were included in the experimental groups. The two groups were maintained in separated locations. Every day the animals were put out to a pasture characterised by an elevated presence of Mediterranean brush plants. Poliphita hay was available *ad libitum*, and two concentrates were administered to the animals in the barn. The C concentrate included broad bean, field beans, wheat middlings, maize meal, distillery by-products, barley meal, pea meal, sugar cane molasses, vegetable fat, and minerals (Table 1). The G concentrate included flakes of maize, barley, broad bean, and soybean, as well as minerals (Table 1). The analysis of foodstuffs was carried out in accordance with methods from the Association of Official Agricultural Chemists (AOAC, 2002). Milk FUs were calculated according to equations from the Institut National de la Recherche Agronomique (INRA, 1988), and the amounts of protein digestible in the intestine allowed by nitrogen (PDIN) and of protein digestible in the intestine allowed by energy (PDIE) were calculated from the equations of Vérité and Peyraud (1989). The amount of concentrates C and G daily administered to lactating goats, 500 and 450 g/head, respectively, contained similar energy (0.53-0.55 Milk FU) and protein content (101.5-102.8 g) in dry matter and differed in NDF content, 137.5 and 74.4 g, respectively.

Milk samples were collected weekly from each animal throughout the trial. The first collection occurred in the middle of April (after kid weaning), and the fourth sample was collected in the middle of May, before the goats were transferred for mountain grazing. Milk yield from morning milking was recorded at each sampling and the milk characteristics were ascertained as follows (ASPA, 1995): pH, fat, protein, and lactose content by infrared spectroscopy (Milkoscan FT 120, Foss, Denmark), urea by the differential pH method (differential pH analyzer, Eurochem, Italy), somatic cell count by the fluoro-opto-electronic method (Somacount 300, Bentley, USA), and clotting properties with a lactodynamograph (Maspres, Italy). The following lactodynamographic parameters were taken into account: clotting time, curd firming time, curd firmness measured 30 minutes after rennet addition, and firmness after a time period equal to double the clotting time. Statistical analysis was performed using a factorial model by the general linear model procedure (SAS, 1993).

Table 1: Chemical composition and net energy content of concentrate amount administered during the trial (on dry matter).

Concentrate	Amount (g)	NE (Milk FU)	CP (g)	CF (g)	EE (g)	Ash (g)	NDF (g)	Starch (g)	PDIN (g)	PDIE (g)
C	500	0.53	101.5	36.8	20.2	41.8	137.5	187.5	67.5	52.5
G	450	0.55	102.8	28.3	29.0	23.6	74.4	173.1	48.9	47.1

Table 2: Mean yield, chemical and healthy characteristics of goat milk produced by two feeding groups

group	sampling	yield (kg/morning milking)	fat (%)	protein (%)	lactose (%)	urea (mg/dl)	somatic cell ($*10^3$/ml)
C	1	0.72 ± 0.10	4.61 ± 0.17	3.84 ± 0.17	4.73 ± 0.05	37.12 ± 1.73	513 ± 84
	2	0.78 ± 0.98	4.20 ± 0.17	3.44 ± 0.17	4.60 ± 0.05	37.63 ± 1.67	466 ± 81
	3	0.83 ± 0.96	3.99 ± 0.17	3.46 ± 0.16	4.59 ± 0.05	39.89 ± 1.63	427 ± 80
	4	0.78 ± 0.10	4.02 ± 0.17	3.49 ± 0.17	4.64 ± 0.05	45.64 ± 1.70	384 ± 83
	mean	0.78 ± 0.51[b]	4.2 ± 0.09	3.56 ± 0.08	4.64 ± 0.03	40.07 ± 0.87[a]	448 ± 42
G	1	0.95 ± 0.96	4.65 ± 0.16	3.65 ± 0.16	4.63 ± 0.05	32.89 ± 1.63	484 ± 80
	2	0.96 ± 0.10	4.60 ± 0.17	3.57 ± 0.16	4.68 ± 0.05	36.29 ± 1.63	385 ± 80
	3	0.94 ± 0.96	4.39 ± 0.16	3.72 ± 0.16	4.53 ± 0.05	36.71 ± 1.63	502 ± 80
	4	0.94 ± 0.10	4.08 ± 0.18	3.64 ± 0.17	4.66 ± 0.05	41.96 ± 1.74	423 ± 85
	mean	0.95 ± 0.51[a]	4.23 ± 0.09	3.65 ± 0.08	4.62 ± 0.03	36.96 ± 0.86[b]	449 ± 42

[a,b] Values bearing differnt supersccripts differ significantly ($P \leq 0.05$)

Table 3: Mean clotting properties of goat milk produced by two feeding groups

group	sampling	clotting time (min)	curd firming time (min)	curd firmness 30 minutes (mm)	curd firmness two clotting time (mm)	pH
C	1	18.39 ± 1.82	2.64 ± 0.53	40.97 ± 3.66	46.88 ± 2.66	6.75 ± 0.02
	2	15.74 ± 1.75	3.55 ± 0.51	37.53 ± 3.51	39.87 ± 2.72	6.71 ± 0.02
	3	17.51 ± 1.73	3.54 ± 0.50	38.31 ± 3.47	42.37 ± 2.52	6.66 ± 0.02
	4	18.78 ± 1.80	3.55 ± 0.52	37.74 ± 3.63	34.47 ± 2.64	6.69 ± 0.02
	mean	17.61 ± 0.91[b]	3.32 ± 0.26	37.64 ± 1.82	40.90 ± 1.35[b]	6.70 ± 0.01[b]
G	1	20.88 ± 1.92	3.24 ± 0.56	34.69 ± 3.87	47.96 ± 2.82	6.78 ± 0.02
	2	22.41 ± 1.74	2.8 ± 0.53	35.53 ± 3.70	47.04 ± 2.69	6.75 ± 0.02
	3	27.72 ± 1.73	3.22 ± 0.56	30.53 ± 3.88	47.76 ± 3.00	6.70 ± 0.02
	4	22.74 ± 2.06	3.52 ± 0.60	29.16 ± 4.17	41.72 ± 3.03	6.72 ± 0.02
	mean	23.44 ± 0.96[a]	3.20 ± 0.29	32.47 ± 2.00	46.12 ± 1.49[a]	6.74 ± 0.01[a]

[a,b] Values bearing differnt supersccripts differ significantly ($P \leq 0.05$)

Results and Discussion

We compared the yield and chemical characteristics of milk obtained from the two experimental groups of goats, one group fed with concentrate C and the other fed with concentrate G (Table 2). The average milk yield from morning milking during the period following kid weaning was significantly higher in the G group (0.95 kg vs 0.78 kg; $P \leq 0.05$). A higher neutral detergent fibre (NDF) content of the C concentrate (13.75 g vs 7.44 g) may have negatively affected the milk yield of this group, as previously observed in early-lactating cows (Adin et al., 2009).

In a previous study of indigenous goat breeds on 33 farms, including the site of our feeding study, the average milk yield from both the morning and evening milkings in the first month after kid weaning was 1.02 kg (Tripaldi et al., 2009). The average milk yield produced by this farm from morning milking and in the same lactating stage was 0.42 kg. The official milk recording for the following year (AIA, 2009) at the same farm and during the same lactation stage was approximately 0.65 kg for the morning milking. Our observation of an increase in milk yield from animals in the feeding trial shows that each of the concentrates was probably more appropriate to the animals' nutritional requirements than the rations habitually administered by the farm. However, it should be stressed that the official milk recording may have stimulated an improvement in farm management following its application to the Bianca Monticellana breed.

Milk obtained from the C and G group goats (Table 2) did not significantly differ in terms of mean fat content (4.20% vs 4.23%, respectively) or protein content (3.56% vs 3.65%, respectively). It is noteworthy that although the G group produced more milk than the C group, the milk composition was not negatively affected (Table 2). Previously, a morning milk yield of 0.54 kg for indigenous goat breeds was accompanied by similar protein content (3.60%) but a higher average fat content (4.70%; Tripaldi et al., 2009). The mean fat content observed in milk from a Mediterranean goat breed reared in Sardinia (ARAS, 2009) was 4.63% vs. 4.46% (April vs May), while the mean protein content was 3.95% vs 3.85% (April vs May).

The average urea content was significantly higher in C-group milk than in G-group milk (40.07 mg/dl vs 36.96 mg/dl, $P \leq 0.05$; Table 2). However, the PDIN and PDIE values were more balanced in the G-group milk (48.9 g and 47.1 g, respectively) than in the C-group milk (67.5 g and 52.5 g, respectively. Data regarding goat-milk urea are scarce and contradictory. The urea concentration in the milk from both of our experimental groups was higher than the optimal values (28-32 mg/dl) reported by Brun-Bellut et al. (1984), but within the range (30-40 mg/dl) accepted by Daccord (2002). Urea content analysis is intended to evaluate the nutritional balance supplied to the milk-producing animals; protein and energy are the most important factors in the feed ration. If the level of nitrogenous substances is high and the energy content is low, the urea concentration in blood plasma and in milk will increase considerably (Oltner, 1983). Balancing energy and protein increases the efficiency of dietary protein utilisation and is motivated by the need to reduce feeding costs (protein feed is more expensive than energetic feed) and to respect the environment (decrease in nitrogen excretion).

The somatic cell counts of the milk from the two experimental groups were equal ($448*10^3$/ml in Group C vs $449*10^3$/ml in Group G; Table 2). These values are much lower than the values reported by Tripaldi et al. (2009) for the same indigenous goat breed during the first stage of lactation (>1,000*10^3/ml). The only existing limit for somatic cell count in goat milk was fixed in the United States at 1,000*10^3/ml (Paape et al., 2001).

The mean pH of the milk from the G group was significantly higher than that from the C group (6.74 vs 6.70, $P \leq 0.01$; Table 3). Both of these observed values were higher than the previously reported value of 6.68 in goat milk (Superchi et al., 2004; Tripaldi et al., 2009). The observed clotting time was significantly higher in G-group milk than in C-group milk (17.61 min vs 23.44 min, $P \leq 0.01$; Table 3); this parameter is positively related to pH (Storry and Ford, 1982; Delacroix, 1985; Okigbo et al., 1985; Remeuf et al., 1991; Delacroix et al., 1994). Although the mean curd firming times of the two groups did not significantly differ (3.32 min for Group C vs 3.20 min for Group G; Table 3), the mean curd firmness measured 30 min after rennet addition was lower in G-group milk (37.64 mm for Group C vs 32.47 mm for Group G; Table 3) and was negatively affected by the higher coagulation times of these samples. When curd firmness was measured after double the clotting time, the curd firmness of G-group milk was significantly higher than C-group milk (46.12 mm vs 40.90 mm, $P \leq 0.01$; Table 3). Curd firmness has been directly related to protein content, particularly to casein content (Marziali and Ng-Kwai-Hang, 1986; Remeuf et al., 1991; Storry and Ford, 1982), suggesting that the higher protein content of the G-group milk may have positively affected the curd firmness after twice the clotting time had passed.

Previously reported (Tripaldi et al., 2009) mean clotting times (14.12 min) and curd firming (2.80 min) times for Bianca Monticellana milk were lower than the times observed in this trial (Table 3). The mean doubled clotting time observed by Tripaldi et al. (2009) was 42.53 mm, a value similar to that observed in a more recent trial. Milk with optimal clotting properties has good reactivity to rennet - short clotting time and short curd firming time - and exhibits high curd firmness. Thus, the milk from Bianca Monticellana is superior to milk from cosmopolitan breeds such as the Saanen and Alpine breeds (Mariani et al., 1987; Remeuf et al., 1989; Fantuz et al., 2001; Superchi et al., 2004). The mean curd firmness attained by milk of the cosmopolitan breeds ranged from 21.36 mm to 28.00 mm (Mariani et al., 1987; Fantuz et al., 2001), and during the first stage of lactation the mean value was 24.91 mm (Palocci, unpublished data). Curd firmness is the principal factor affecting cheese-making yield (Bynum and Olson, 1982), and our observations on curd firmness from Bianca Monticellana milk are promising for the future of cheese made from this milk.

Conclusions

In conclusion, this investigation has demonstrated that the milk yield and quality from Bianca Monticellana improved when the goats' dietary needs were addressed through correct supplementation. The productive capacity of the animals included in this trial was higher than previously reported values. Moreover, the milk from these goats exhibited characteristics required for good cheese-making, a basic condition that will lead to a gratifying income for the farmer and a wider dissemination of this indigenous breed.

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