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Effects of pelleted total mixed rations with different rumen degradable protein on milk yield and composition of Jonica dairy goat

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ABSTRACT

The present study was conducted in order to examine the effects of diets with different ruminal degradable protein sources on the performance of lactating goats fed pelleted total mixed rations (PTMR). Forty multiparous Jonica goats in early-lactation were divided into two equal groups and fed for 135 days the experimental diets. Two types of PTMR were formulated to be isonitrogenous and isocaloric while providing different rumen degradable levels of crude protein: (1) high-degradable protein diet (HD) containing soybean meal, sunflower meal and urea (46% N), and (2) low-degradable protein diet (LD) including only corn gluten meal. Apparent digestibility of the two PTMR was tested using Jonica bucks placed in individual pens and results indicated significant differences ($P < 0.05$) for crude protein, crude fibre, neutral detergent fibre and acid detergent fibre nutrients' utilization. In milk performance trial, no significant differences ($P > 0.05$) were registered in dry matter intake and milk yield. Goats fed LD diet containing corn gluten meal showed the highest milk fat, protein and casein concentration, but not significant differences ($P > 0.05$) were observed on other milk components and renneting properties. It was concluded that a decrease of rumen degradable protein (RDP) level in PTMR does not negatively influence nutrient utilization and milk production and composition of Jonica dairy goat.

1. Introduction

In order to increase the milk production and composition through dietary manipulation of protein and energy many attempts have been made in the diets of ruminants (Sahoo and Walli, 2008). Protein is typically the most important and expensive nutrient in dairy ration which needs to be efficiently utilized. More recently, the use of rumen degradable protein (RDP) and rumen undegradable protein (RUP) has gained acceptance and ARC (1984) and NRC (2007) have replaced the traditional crude protein (CP) system with RDP and RUP system for ruminants. Many studies have been conducted to investigate the effects of feeding different RUP levels on performance of ruminants (Kumar et al., 2005). A source of RUP in diet is important to supply post-ruminal protein and amino acids to complement the microbial protein and to support the increased requirements of a yielding ruminant specially in early lactation (Hongerholt and Muller, 1998).

The limited amount of research to date carried out in goats has only analyzed the effect of using less degradable protein sources instead of soybean protein. Very few and even contradictory results have been obtained (Sanz Sampelayo et al., 1999). What rather Morand-Fehr et al. (1991) reported, is that in the majority of cases in which isonitrogenous and isocaloric diets are used, the total protein and casein content in the goat milk did not appear to be very sensitive to changes in dietary protein content.

Contrary to growing animals that exhibited clear response of improved growth to diets differing in synchrony for the hourly supply of energy and nitrogen in

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Table 1
Ingredient composition of experimental diets fed to lactating Jonica goats.

	Dietary treatment[a]	
	HD	LD
Ingredients (g/kg DM)		
Corn	255	210
Durum wheat straw	200	200
Durum wheat bran	193	238
Corn gluten meal, 60% CP	–	140
Soybean meal, 44% CP	132	–
Dehydrated alfalfa	75	75
Sunflower meal, 28% CP	50	–
Dehydrated beet pulp	30	76
Calcium carbonate	20	22
Molasses cane	20	20
Dicalcium phosphate	12	11
Urea, 46% N	5	–
Mineral–Vitamin Mix[b]	4	4
Sodium chloride	4	4

[a] HD: diet with high rumen degradable protein; LD: diet with low rumen degradable protein.
[b] Supplied per kg of diet: vitamin A 20,000 IU; vitamin D3 2000 IU; vitamin E 30 mg; vitamin B1 3 mg; vitamin PP 250 mg; vitamin B12 0.01 mg; Co 0.5 mg; Fe 50 mg; I 2.5 mg; Mn 50 mg; Cu 10 mg; Se 0.1 mg; Zn 105 mg.

the rumen (Tufarelli et al., 2009b), comparisons between performance of lactating ruminants fed synchronous or asynchronous diets have yielded responses from nil to modest (Mabjeesh et al., 1999, in cow; Morales et al., 2008, in goat; and Tufarelli et al., 2009c, in ewe) relative to daily milk yield and composition. This can result from asynchrony being buffered by a relatively steady flow of nutrients in animals fed totally mixed rations, promoting synchrony (Landau et al., 2005).

Because of the scarce information available and because practically all of the goat milk produced in Italy is destined for cheese production (Tufarelli et al., 2009a), and the casein and fat contents have logistic, ecological and economical implications of utmost importance for the industry, we analyzed the effect of total mixed rations containing nitrogen sources with different ruminal degradation characteristics on the production and composition of the milk of Jonica goats.

2. Materials and methods

2.1. Animals, diets and milk trial

The experiment was carried out in the winter and spring (January–May of 2008) in Bari province of the Apulia region in Southern Italy (latitude: 41°7′ and longitude: 16°52′) for 135 days and involved 40 multiparous lactating Jonica goats that had kidded in autumn. The trail included 15 days of adaptation to the diet followed by 120 days of feeding the two experimental diets. At kid weaning, goat were divided into two groups of 20 each, balanced for age, parity, time of kidding, number of kids suckled, body weight (48.4 ± 4.41 kg) and milk yield and composition. The animals were dewormed before start of the experiment and maintained under strict hygiene and uniform management. Goat health was checked throughout the study period and no cases of clinical mastitis were recorded. The experimental design was a completely randomized, with 20 replicates per treatment. Goats were housed in four 100 m^2 pens inside a building. Each pen was provided with a 300 m^2 outdoor paddock. Fresh water was provided to all the animals twice a day at 10:30 and 16:00 h.

Two pelleted total mixed rations (PTMR) were formulated to be isocaloric and isonitrogenous while providing different rumen degradable levels of protein (Table 1). The high-degradable (HD) diet contained soybean meal, sunflower meal and urea (46% of N), and the low-degradable diet (LD) included only corn gluten meal as main protein source. Both diets contained 17.5% of crude protein (CP, on dry matter). Diets contained a different protein fractions according to CNCPS (Sniffen et al., 1992; Licitra et al., 1996) (Table 2). Forages were previously chopped by grinding at 25 mm in length, then forage was mixed to concentrate and pelleted (8 mm of diameter) to reduce differences in physical form and to prevent feed selection by animals. The diets were balanced according to goats' requirements of energy, protein and minerals in accordance with INRA (1989), taking into consideration a goat body weight of 50 and 2.0 kg of daily milk production (Table 2).

Table 2
Chemical composition (% DM) and N fractions (% total N) of experimental diets fed to lactating Jonica goats.

	Dietary treatment[a]		
	HD	LD	SEM
Chemical composition			
Dry matter	89.67	89.41	0.71
Crude protein	17.49	17.59	0.45
Crude fibre	16.31	16.04	0.41
Ether extract	3.02	2.97	0.31
Ash	9.21	8.92	0.49
Starch	22.33	22.21	1.07
Neutral detergent fibre	37.27	37.51	0.98
Acid detergent fibre	21.54	21.17	1.01
Acid detergent lignin	2.83	2.49	0.19
Cellulose	18.15	18.14	0.69
Hemicellulose	15.63	16.34	0.81
Nitrogen fractions[b]			
A	23	11	0.02
B_1	5	7	0.01
B_2	54	60	0.03
B_3	11	12	0.02
C	7	10	0.01
Calculated analysis[c]			
Milk FU (*n*/kg DM)	0.75	0.74	
PDIN (g/kg DM)	78.21	134.24	
PDIE (g/kg DM)	73.42	139.41	
PDIA (g/kg DM)	32.71	94.63	
NE_L (Mcal/kg DM)	1.46	1.46	

[a] HD: diet with high rumen degradable protein; LD: diet with low rumen degradable protein.
[b] A, non-protein-N; B1, true soluble protein-N; B2, neutral detergent soluble protein-N; B3, neutral detergent insoluble protein-N; C, acid detergent insoluble protein-N.
[c] Calculated according to INRA (1989).

Each goat was offered 2 kg/day (as fed basis) of pelleted total mixed ration split in three equal meals a day (6:00, 12:00 and 18:00 h). Goat were milked twice daily (7:00 and 19:00 h) using pipeline milking machines. Body weight of goats was recorded at the beginning and at the end of the experimental period.

2.2. Digestion trial

Apparent digestibility of experimental diets was measured in individual pens equipped with feeders and automatic watering trough. Four castrated Jonica bucks of 67 ± 2.7 kg live weight were used. Each animal received the two PTMRs in different periods, following a 2 × 2 Latin square design in duplicate. Each period consisted of 14 days of adaptation to diet in individual stalls with a concrete floor, 2 days of adaptation to feacal collection bags applied on bucks, and 5 days of faeces collection (Givens et al., 2000). After 7 days of adaptation period, the digestibility of the PTMR, were offered simultaneously to the four animals.

Seven days of adaptation period was used after each change, which lasted 7 days too. The bucks were fed twice daily, at 7:00 and 19:00 h. Offered diets were recorded daily and composite samples, pooled on an individual animal basis at the end of each collection period, were dried at 105 °C for 24 h. Another sample of the diet was ground in a hammer mill with a 1 mm size screen and stored until analysis. Faeces were col-