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Effects of concentrate and *Acacia cyanophylla* foliage supplementation on nitrogen balance and milk production of grazing ewes

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ABSTRACT

This study was conducted to evaluate the effects of natural protection of protein from microbial degradation in the rumen by acacia tannins on digestibility, nitrogen (N) retention and milk production in dairy ewes. An experimental sheep flock grazing rye grass pasture was divided into four groups. Indoor, animals were supplemented with 300 g of concentrate, 300 g of concentrate + 100 g *Acacia cyanophylla* foliage (acacia), 300 g of concentrate + 200 g acacia for C, C1A, C2A groups, respectively, and only 100 g of acacia for group A. Digestibility and N balance were measured for animals in metabolic cages fed with cut fresh grass.
Acacia tannins interact with concentrate supply and significantly affected digestibility. Higher OM and CP digestibility was observed for C1A and C2A groups in comparison with the A group. Digestibility of OM, NDF and CP was higher for animals supplemented with concentrate than for those not supplemented. N retention increased with ration CP content. Acacia tannins led to a high increase of N retention for C1A and C2A groups compared to C group (10.3 vs. 5.8 g/day for animals fed acacia and those not fed acacia, respectively). So, urinary nitrogen excretion decreased from 6.5 g/day for C group to 4.5 g/day for C1A. Milk yield was the highest for C1A group (555 ml/day) and the lowest for A group (500 ml/day) whereas it was intermediate for other groups. Milk fat content decreased with groups fed acacia in comparison to groups not fed acacia (7.3 vs. 7.6%). Milk protein content decreased when ewes received acacia and concentrate.

1. Introduction

Tunisian dairy sheep is localized in sub humid area characterized by a high forage production and pasture growing. Grass nitrogen (N) is highly degradable in the rumen and can lead to the absorption of large amounts of NH_3 nitrogen across the rumen wall (Meissner et al., 1993). The NH_3 is converted to urea in the liver, and excess amounts are excreted as urea in the milk and urine.

For lactating animals, it is considered that about 25 to 35% of protein intake will be converted to proteins in milk (Lapierre et al., 2002) while the rest will be excreted in urine (35–45%) or feces (30–40%), therefore it is reasonable to search ways to reduce these losses. Indeed, proper use of N from feeds reduced N discharges into the environment. In addition, environmental pressures are increasing on livestock production systems. Nitrogen excreted by ruminants, in particular, contributes to groundwater pollution. Protein supplementation for sheep fed protein deficient ration leads to an increase of protein quantity secreted in milk (Bocquier and Caja, 2001; Atti and Rouissi, 2003). However, pasture grass is characterized by its lushness of soluble N fermentable in the rumen resulting in a decrease in N retention. As a solution, the protection of proteins from microbial degradation in the rumen by chemical treatment was often used; however the use of formaldehyde is increasingly rejected because of the possible toxicity, indeed a positive

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correlation between oral administration of formaldehyde and its presence in the milk has been found on dairy cows and goats (Buckley et al., 1988; Barry and Tome, 1991). The protection of proteins by natural products like tannins present in local feed resources could increase the retention of N without negative repercussion (Terril et al., 1992). The objective of this study was to evaluate the use of acacia tannins to protect proteins and its interaction with concentrate supply and their effects on diet digestibility, N balance and milk production by sheep.

2. Material and methods

2.1. Experimental design and treatments

The experiment was carried out in the dairy experimental farm of the National Institute of Agricultural Research of Tunis (INRAT) on 68 Sicilo–Sarde breed ewes. The average date of parturition was December 19th; lambs were weaned at 45 days of age. At this time, ewes were divided into four homogeneous groups, 17 ewes each, according to age (5.1 years), body weight (36.4 ± 4.6 kg) and initial milk production (555 ml/day). Ewes were conducted together during the day (from 10:00 to 15:00) on rye grass pasture with rotational grazing system with a stocking rate of 57 ewes/ha. Indoors, ewes were separated and housed per group which were supplemented with 300 g of concentrate, 300 g of concentrate + 100 g *Acacia cyanophylla* foliage (acacia), 300 g of concentrate + 200 g acacia, and only 100 g of acacia for the control (C), C1A, C2A and A groups, respectively. For C1A and C2A groups, concentrate was distributed to ewes after complete consumption of acacia (Nsahlai et al., 1999). The experiment lasted 71 days. Concentrate is a mixture of barley (80%), soybean meal (18%) and mineral vitamin supplement (2%). Acacia was air dried for 2 weeks and then stored until needed. The condensed tannin content of acacia is 31.5 g/kg dry matter (DM); which is equivalent to 2.9 and 5.8 g of condensed tannin for 100 and 200 g of acacia supplement, respectively. These values were in accord with Min et al. (2003) recommendations. Chemical composition of concentrate and acacia is reported in Table 1. At the forth experimental week, about the middle of the experiment, (April 4th to April19th) five animals from each group were installed in individual metabolic cages for a digestion trial for a 10-day adaptation period followed by a 5-day total faecal collection period. Concentrate and acacia were offered once daily at 09:00. Fresh cut grass from the pasture was provided in two equal meals at 09:00 and 16:00 in separate troughs.

Table 1
Chemical composition of rye grass, concentrate and *Acacia cyanophylla*.

	Rye grass		Concentrate	*Acacia cyanophylla*
	1st month	2nd month		
Dry matter (DM) (%)	20.5	23.45	92.3	91.5
Organic matter (% DM)	89	87.5	94.1	87.9
Crude protein (% DM)	12.5	8.8	16.3	12.2
Neutral-detergent fiber (% DM)	54.6	69.8	29	42.1
Acid-detergent fiber (% DM)	31.9	58.8	18.7	36.1
Acid-detergent lignin (% DM)	5	37.7	10.4	21.5
Ash (% DM)	11	12.5	5.9	12.1
Total phenols (g/kg DM)	–	–	–	26.5
Condensed tannins (g/kg DM)	–	–	–	31.5

2.2. Measurements

Ewes were milked daily at 06:30 and 16:30. Individual milk yield was recorded twice a month during the whole experimental period and individual milk samples (20 ml) were taken and kept (4 °C) for analysis. Grass weight was determined before entering each paddock by cutting 5 quadrates (1 m^2) of pasture at 6 cm above the ground; total grass production was calculated according to sample weights and the paddock area. This operation occurred 7 times during the experimental period, 3 times for each month and one time for the last 11 days. After desiccation, the samples for each month were pooled and two sub-samples were taken for chemical analyses. The mean daily grass availability was calculated as the ratio of paddock grass production by ewes' number and by number of days spent in the paddock. During the faecal collection period, distributed and refused feeds were weighed daily at 08.00, and one sample from each feed was taken and stored. Total daily faecal output for each animal was collected, weighed and homogenised, then samples were kept at −15 °C. Pooled samples of faeces obtained from each animal were used for chemical analyses. Urine was collected in buckets and preserved with 50 ml of 10% sulphuric acid solution. Daily urine samples for each sheep were thawed, bulked then stored at −15 °C until analyzed.

2.3. Laboratory analysis

Milk fat, protein and urea N were analyzed using MilkoScan 4000 (Foss Electric, integrated Milk Testing). The chemical composition of grass, concentrate, acacia and the samples related to digestibility trial (distributed feed, refusals, and feces) was determined. Samples of these components were dried in a forced-air oven at 105 °C for 24 h to determine DM. Dried samples were then ground through a 1-mm screen. Ground samples were used to determine ash content (450 °C for 8 h), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) by the method of Goering and Van Soest (1970). Crude protein was determined for these samples and urine ones by Kjeldahl method (AOAC, 1984).

Acacia cyanophylla leaf samples were analyzed to determine total phenols (TP) by Folin–Ciocalteu reagent using tannic acid as a standard (Makkar et al., 1993). Total phenols were expressed as tannic acid equivalents. Condensed tannins (CT) were also analyzed using the butanol–HCl method and the concentration was expressed as leucocyanidin equivalents according to Porter et al. (1986) and Makkar et al. (1993). The use of butanol–HCl assay gives an estimate of the specific content of proanthocyanidins, repeating units of CT (Schofield et al., 2001). CT amounts were estimated (A550 nm × 78,26/% MS) after Makkar and Goodchild (1996).