



Summer diet selection of dairy goats grazing in a Mediterranean shrubland and the quality of secreted fat



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ABSTRACT

This study aims to evaluate the preferences and nutritive value of dairy goats summer diet selection in a Mediterranean shrubland and its effect on milk yield and quality, with specific reference to fatty acid (FA) composition. A commercial flock of the indigenous Payoya goat was used in the present study, carried out from August to October of 2008. The goats were divided into two groups: a free-range grazing group (goats had free access to pasture, (G) $n = 100$) and an indoor group (goats were housed in a stable, and received 1.5–2 kg/goat/day of alfalfa hay and pea straw mixture, (I) $n = 60$). A supplementary concentrate was fed to both groups at 0.5 kg/goat/d, during milking. Diet composition of the grazing goats was estimated through *in situ* observations. Chemical composition and nutritive value of selected diets, hay and concentrate samples were analyzed. Milk samples were taken from pooled milk of all animals in each group the day after diet observations, and basic chemical composition and FA profile were performed. *Myrtus communis* and *Pistacia lentiscus* were the most frequently ingested species. Milk yield and basic chemical composition were greater in group I than in group G for most of the studied parameters. The percentages of the nutritionally desirable FA (α -linolenic acid, C20:5 n-3, total n-3 PUFA) were significantly higher in milk from the G group, while the C18:2 n-6 *cis*, total n-6 PUFA and n6:n3 ratio were significantly lower than in I group. Total conjugate linoleic acid and its isomers were not affected by feeding-type group. In conclusion, the pastures selected could be considered to be of low to intermediate nutritional quality (4 MJ/kg DM of net energy for lactation). In addition, small but significant differences were found on milk yield and milk FA composition according to feeding treatment (grazing vs. concentrate-forage diet). Particularly, grazing goats showed higher levels of FA recognized as having beneficial effects on human health.

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1. Introduction

Andalusia is the second goat milk-producing region in Europe, goat stocks comprising essentially autochthonous breeds, such as the Payoya goat (MARM, 2011). The importance of this breed has recently increased and there are actually around 15,000 Payoya goats, most of the flocks

under a grazing-based management, with scrubland occupying most of the grazing area (Nahed et al., 2006; Ruiz et al., 2008). Additionally, and according to Ruiz et al. (2008), the net energy obtained from grazing to cover the animals energy requirements varies greatly between 50 and 80% from system to system. The use of indoor feeding (concentrate and forage) as a complement to grazing varies as well, and is determined by several factors such as availability of grass, productivity level of the animals and seasonal variation of pastures. Furthermore, unlike sheep and cattle, which predominantly select leafy

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material during spring, browse constitutes 50–80% of the forage selected by goats all year round (Silanikove et al., 2010). It was suggested that this behavior is an adaptive mechanism that allows goats to maintain a high intake of browse to preserve their specific superior capacity in utilizing food rich in tannins and other source of secondary metabolites (Silanikove et al., 2010). Nevertheless, the diet selection, its nutritional value, and the food intake rate of goats grazing in the Andalusian shrublands are poorly understood (Ruiz et al., 2008). An understanding of diet selection and intake rates by ruminants on rangelands can strengthen efficient management practices and profitable animal production (Ruiz et al., 2008; Mancilla-Leytón et al., 2012).

Nowadays, current research is oriented towards reducing the milk's amount of saturated fatty acids (SFA) and increasing polyunsaturated fatty acids (PUFA) which benefits human health. In particular, great attention is given to n-3 fatty acids and conjugated linoleic acid (CLA) (MacRae et al., 2005). Several works on dairy goats have highlighted the potentiality of grazing on herbaceous pasture to enhance milk and dairy products proportion of PUFA, α -linolenic acid (the main n-3 FA in milk), and/or CLA (D'Urso et al., 2008; Silanikove et al., 2010), in comparison to conventional concentrate-forage diets or low grazing systems. According to Silanikove et al. (2010) milk from goats feeding on pasture may present an overlooked "treasure trove" with respect to its health promoting lipid profile. However, there is little information on how Mediterranean forage species (particularly shrub and woody species) affect the fat composition of milk and cheese, and contradictory results have been found (Tsiplakou et al., 2006; Vasta et al., 2008).

So, the present study aims to evaluate the foraging behavior of dairy goats in summer, with focus on the preferences and nutritive value of the diet selected between shrub and woody species in a Mediterranean shrubland, and their effect on milk yield and quality, with specific reference to fatty acids composition.

2. Materials and methods

2.1. Study area, experimental farm and goats

The study was conducted in a pine forest (100 ha) of a private estate located within the Doñana Natural Park limits, in the southwestern Iberian Peninsula (37° 14' N, 6° 20' W). The climate is Mediterranean, with wet (80% of precipitation occurring between October and March) and mild (average monthly temperature of 10 °C in December and January) winters, and very hot (average temperature of 25 °C in July and August) and dry (rarely rains in July and August) summers. Average annual rainfall in the study area is 540 mm.

The vegetation comprises an arboreal stratum of pine trees (*Pinus pinea* L.) with 38% mean coverage, and an understory of Mediterranean scrub. The characteristics of the prevalent species in the understory are detailed in Table 1. Seventy percent of the understory was covered with shrubs, with a total of twenty species, the most common being *Rosmarinus officinalis* (17.1%), *Cistus salvifolius* (16.2%), and *Halimium halimifolium* (11.5%).

A commercial flock of indigenous Payoya goats was used in the present study, carried out from August to October 2008. Goats kidded between October 2007 and January 2008, and during the experiment were in late stage lactation and milked once a day. Goats were divided into two groups, homogeneous in parity and milk production at the previous lactation: a free-range grazing group (G, n = 100) and a control or indoor group (I, n = 60). The grazing group goats (G) had free access to pasture. The indoor group goats (I) were housed in a stable, and received a mixture of alfalfa

Table 1

Cover (%) of shrub species found in the understory of a Mediterranean pine forest in Doñana Natural Park, SW Spain.

Species	Cover (%)
<i>Daphne gnidium</i>	0.9
<i>Cistus monspeliensis</i>	1.1
<i>Helichrysum italicum</i>	1.3
<i>Cistus crispus</i>	1.4
<i>Phillyrea angustifolia</i>	1.5
<i>Stauracanthus genistoides</i>	1.5
<i>Genista hirsuta</i>	2.9
<i>Genista triacanthos</i>	3.1
<i>Cistus ladanifer</i>	3.7
<i>Cistus libanotis</i>	3.9
<i>Lavandula stoechas</i>	4.3
<i>Thymus mastichina</i>	5.3
<i>Quercus coccifera</i>	5.9
<i>Erica scoparia</i>	6.6
<i>Pistacia lentiscus</i>	8.1
<i>Halimium calycinum</i>	9.4
<i>Myrtus communis</i>	11.1
<i>Halimium halimifolium</i>	11.5
<i>Cistus salvifolius</i>	16.2
<i>Rosmarinus officinalis</i>	17.1

hay and pea straw (in the proportion of 1 part of alfalfa to 3 parts of straw) at 1.5–2 kg/goat/day. A supplementary concentrate was fed to both groups at a rate of 0.5 kg/goat/d, during milking.

2.2. Diet selection and composition

From August to October, the grazing group entered the study area. The management may be considered to be semi-extensive, although in order to exploit the 100 ha in a uniform manner, the goats were closely controlled and moved around by a shepherd. In order to determine which shrub species are preferred by the goat herd, a method of direct observation was used. This observational surveying method is very efficient for determining the shrub species grazed, the relative preferences and variations throughout the year. Although modified, the procedure described by Meuret et al. (1985) was followed. In this experiment, surveys were performed thrice a month in the understory of the pine forest, with 10 min monitoring period per goat stretching from the beginning to the end of the grazing day. Every surveying day, 10–15 goats were monitored (30–45 goats/month). Goats were chosen at random, without repeating any individual in the same surveying. The recorded variables for each goat and monitoring period were: number of species consumed and organ of the consumed species (leave, stem, flower, or fruit), number of bites per species, consumption time per species and displacement time (from plant to plant) (Mancilla-Leytón and Martín Vicente, 2011). After every 10 min period, the monitored goat was changed.

In order to estimate the nutritional value of the shrubs ingested by goats, the amount of each species ingested in each bite (g of dry matter, DM) also needed to be estimated (Mancilla-Leytón et al., 2012). A manual simulation of grazing (handplucked) was performed (100 samples/species), from which the weight per bite was obtained. Weight per mouthful was estimated by imitating the biting behavior of goats (clipping material physically comparable to that selected by the animals) (Mancilla-Leytón et al., 2012). These samples were dried at 60 °C (48 h), their dry weight determined and their nutritive value analyzed. The Meuret et al. (1985) formula was used to calculate dry matter intake of each plant: $DMI_i = (GP/OP) \times (Bi \times WBi)$; where DMI_i is the dry matter intake of 'i' species; GP, the grazing period; OP, the observation period; Bi , the bites of 'i' species; and WBi , the weight of bite of 'i' species. For each monitored period, mean grazing percentage values of each species were used to calculate the relative presence of plant species in the diet selected by goats.

2.3. Chemical analysis of concentrate and shrubs

Samples of selected diets (only G group), hay (only I group) and concentrate (both groups) were dried and ground to pass the 1-mm screen of a Wiley mill before analysis. AOAC (2005) methods were used to determine

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