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SUMMARY – Since mountain pasture is a complex ecosystem created by livestock grazing activity, the maintenance requires grazing. The study of the pasture utilisation by livestock has two different aspects: firstly as an animal production system and secondly as a framework for the management of these pastures. The knowledge of both aspects must be considered to make an adequate management of such territories, especially when these areas are within Natural Parks. The work was focused on the diet quality of the sheep and goats grazing in the Natural Park of Gorbeia (Basque Country), during their stay in mountain pastures (June-October). The present study was carried out on commercial flocks within a free-ranging production system. The estimation of diet quality was stated from the faecal nitrogen concentration [g N/100 g of dry matter (DM)], which is considered a good predictor of diet quality and has been used for both species. The average faecal N value during the grazing season was 2.27± 0.27 g N/100 g DM. The effect of both factors considered, species and season, were significant ($p < 0.001$). Sheep had significantly higher values of faecal N than goats (2.35 ± 0.03 vs 2.02 ± 0.04 g N/100 g DM). These differences could reflect differences in grazing strategies. The highest values of faecal N were found during the first part of the grazing season, decreasing as summer progresses, probably because of the herbaceous components withering. A recovery of faecal N concentration was observed at the end of the grazing season. However goats seem more able to maintain the faecal N concentration throughout the mountain grazing period.

Key words: Natural Park, diet quality, faecal nitrogen, free-ranging sheep and goats.

RESUME – *"Qualité du régime pour ovins et caprins pâturant dans le parc naturel de Gorbeia (Pays Basque)". Les estives sont un écosystème complexe produit par l'activité du bétail, qui a besoin du pâturage pour son entretien. L'étude de son utilisation par les animaux a deux perspectives, d'abord, son importance dans la production animale, et ensuite, son influence sur l'entretien des surfaces utilisées. La connaissance de ces aspects est très nécessaire pour la gestion correcte de ces territoires, surtout s'il s'agit de parcs naturels. Le travail porte sur l'analyse de la qualité de la nourriture des ovins et caprins qui pâturent dans le Parc Naturel du Gorbeia pendant la saison d'estive (juin-octobre), et il a été réalisé dans des troupeaux privés, amenés dans un système de production extensif sans gardiennage. La qualité des aliments sélectionnés par les deux espèces a été évaluée à partir de la concentration en azote fécal [g N/100 g de matière sèche (MS)], un bon estimateur de la qualité de l'ingesta. L'azote fécal moyen obtenu a été de 2,27 ± 0,27 g N/100 MS, et l'effet du bétail, ainsi que la saison de pâturage ont été significatifs ($p < 0,001$). Dans ce sens, les brebis ont eu des valeurs plus hautes que les chèvres (2,35 ± 0,03 vs 2,02 ± 0,04 g N/100 MS). Cette différence peut être expliquée par les caractéristiques de la végétation ainsi que par le mode de sélection des deux espèces. D'autre part la valeur plus haute a été trouvée dans la première partie de la période de pâturage, pour les deux types d'animaux, diminuant au fur et à mesure qu'avance l'été. Cette diminution est, probablement, conséquence du flétrissement de la composante herbacée, concordant avec la récupération de l'azote fécal à la fin de la période considérée, à l'automne. Les chèvres ont une plus grande capacité de maintenir la concentration de N fécal, et seraient capables d'obtenir un régime de qualité plus uniforme que les brebis.*

Mots-clés : *Parc Naturel, qualité du régime, azote fécal, pâturage en liberté.*

Introduction

Due to the extreme topographic variability of the territory of the Basque Country, traditional livestock system has used communal pastures with a mixed-grazing system with beef cattle, dairy sheep, goats and mares (Ruiz *et al.,* 1998; Marijuán *et al.*, this volume) during the grazing season.

Free-grazing herbivorous do not use all the available resources homogeneously. They make two different levels of selection: *horizontal* (Malechek, 1990) and *vertical* (El Aich and Rittenhouse, 1988). The first one involves *habitat selection* and the second one *vegetation selection* and they can be more or less

overlapped depending on the animal species, geographic location and available vegetation (Bullock, 1985; Marijuán, 1997; Mysterud, 2000; Osoro *et al.*, 2000).

The traditional pastoral system in the mountain areas of the Basque Country has changed. There has been an increase in the number of cows and mares grazing the mountain areas probably related to the European Agricultural Policy norms (PAC), and to a better compatibility with other economical activities. Besides, this change in livestock coincides with modifications in the vegetation with an increase of shrubby plants. This could affect the selection of free-ranging animals, which are considered as tools to manage these environments (Grant *et al.*, 1985; Milne and Grant, 1986; Reseau SPACE, 1999; Osoro, 2000).

The period which coincides with the valley stay and stall-fed is quite studied. However, in the last years the extensive system is gaining importance firstly as a production system and secondly, but not less important, as a management system of protected areas. This period is less monitored and it is necessary to analyse it in order to optimise animal production systems as well as to preserve the territory.

Taking all those facts into account, the objectives of the current work were to: (i) determine the diet quality of the traditional users (sheep and goats) during that extensive period; (ii) analyse its monthly evolution; and (iii) compare their grazing strategies.

Materials and methods

The study was carried out in the massif of Gorbeia, in the Basque Country. It is a mountainous area next to the Gulf of Biscay and it is oriented NW-SE (Fig. 1). It was declared Natural Park in 1994 with a surface of 20,016 ha, which makes it the largest Natural Park in the Basque Country.

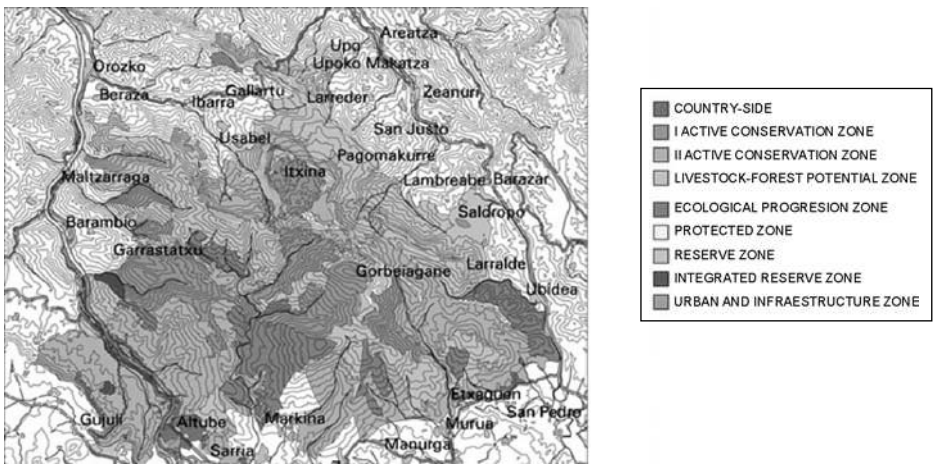

Fig. 1. The Natural Park of Gorbeia with the different zones defined from a conservation point of view.

The altitude of the territory results in a typical mountainous climate. The massif works as a barrier which stops the humid winds coming from the Gulf of Biscay, generating differences between the northern basin, more humid, and the southern one, sunnier and drier. The rainfalls of the studied area are abundant during all the year (2000-2100 mm) (Albizu *et al.*, 1999), being autumn and winter the rainiest months. Average temperature is 10.5ºC with July-August the hottest months and January-February the coldest ones.

Average stocking intensity of the Park is 0.45 standard livestock units (SLU)/ha, ranging 0.08 SLU/ha and 0.92 SLU/ha depending on the orientation, slope and altitude of the studied area (Marijuán, 1997).

In order to limit habitat selection and analyse the vertical one, the study was carried out in a 180 ha *management unit* (Steward and Eno, 1998). Altitude of the study area ranged between 820-1090 m.a.s.l. and it was representative of these Atlantic mountain pastures. One third of this pilot territory was tree-

covered with broad-leafs (*Fagus sylvatica*) and conifer plantations (*Pinus radiata*). As a result of the shepherd utilisation, different plant communities have established in the pastures. A mixture of herbaceous species (*Agrostic capillaris*, *Festuca gr. rubra* and *Trifolium repens*) with different cover of shrubby ones (*Erica* spp., *Ulex europeus* and *Pteridium aquilinum*) was found in those areas with less slope and subject to a traditional grazing system. The average herbaceous production of those pastures is 2824 kg of dry matter (DM)/ha/year, with the maximum in August (Albizu *et al.*, 1999).

This area of communal character is used from May to November-December with a mixed-animal population in a free-ranging system. The calendar depends on the breeding schedule of each species (Table 1) and on farmers interests.

Table 1. Calendar of mountain pasture utilisation by each ruminant specie

Month	Sheep			Goats	Cows	Mares
	Breeding	Mountain milking	Valley milking			
Pasture entrance	May	May	July	May	May	April
Physiological status	Lactating	Milking	Dry	Lactating	Lactating	Gestation
Breeding put away	August	–	†	Nov.-Dec.	Sept.-Oct.	Sept.-Oct.
Adults put away	Nov.-Dec.	Nov.-Dec.	Oct.	Nov.-Dec.	Nov.-Dec.	Dec.
Males introduction	Sept.-Oct.	Sept.-Oct.	††	Sept.	May	May

†Ewe-lambs do not range mountain pastures with ewes.
††Males are introduced after the artificial insemination of a variable percentage of ewes.

Studied flocks were made of local sheep and goat breeds. In the case of sheep, a milk selection program has been running for the *Latxa* dairy ewe for the last 15 years (Ugarte *et al.*, 1995). This program and the implied management improvement have influenced the production system resulting in different production subsystems. The more traditional ones went to mountain pastures in the middle of spring, lasting the milking period in pasture until July. However, this system is disappearing because nowadays only those ewes with the sucking lambs are sent to the mountain, where ewes are not milked. As far as the more intensive systems are concerned, ewes are milked in the valley and they are only sent to the mountain after drying.

The local goat breed is the Azpi Gorri and is currently under a recuperation program because it is in risk of disappearance. These animals go to the mountain pastures in flocks formed with animals of different farms and composed by females with or without suckling kid.

The study was carried out during the summer 2001 using commercial folks. Taking into account its management limitations (Thompson, 1987; Robbins *et al.*, 1995), faecal nitrogen (N) was chosen as estimator of diet quality (Hollowey *et al.*, 1981; Holecheck *et al.*, 1982; Núñez-Hernández *et al.*, 1992). Samples from sheep and goat faeces were collected monthly from 4 adult animals between June and September. Samples were immediately frozen and were maintained as such until processing. Faecal N was measured chemically using the Kjeldhal technique (AOAC, 1999).

Data was analysed using the general lineal model (SAS, 1988):

$$Y_{ijk} = \mu + S_i + T_j + S_i*T_j + e_{ijk}$$

where, S_i is the animal specie (sheep or goat); T_j is the sampling month (from June to September); being S_i*T_j the interaction between both effects.

Results and discussion

The average faecal N value during the grazing season was 2.27 ± 0.27 g N/100 g DM. These values were higher than those found in the Pyrenean mountains for the same animal species (Aldezabal *et al.*,

1993) and could be a reflect of the different vegetation composition on both zones (Aldezabal *et al.*, 1993; Albizu *et al.*, 1999).

Moreover, these faecal N values were higher than those found in bigger mixed-grazing species, as beef-cattle and mares (1.96 ± 0.026 g N/100 g DM and 1.72 ± 0.026 g N/100 g DM, respectively), in the same mountain area and period (Mandaluniz and Oregui, 2002). These differences in diet quality depending on animal size has been shown in some studies (Aldezabal *et al.*, 1993) and it could be related to a more intensive selection capacity by the small ones (Gordon and Illius, 1994).

Nevertheless, those results are in some contradiction with the animal mountain-period profit. In spite of a higher diet quality during the mountain period, sheep lost weight whereas cows gained or maintained it (Marijuán, 1997; Oregui *et al.*, 2001; Mandaluniz and Oregui, 2001). This could indicate some kind of opposition between quality selection and ingestion.

The used model explained an important part of the variance (63%). Animal species and sampling time had a significant effect ($p < 0.001$) (Table 2) but not the interaction between them ($p > 0.05$). As far as the animal species is concerned, sheep had a significant ($p < 0.001$) higher faecal N value than goats (2.35 ± 0.03 vs 2.02 ± 0.04 g N/100 g DM, respectively). These differences could be related to a different diet selection of these species (Bullock, 1985; Pfister *et al.*, 1988; Hofmann, 1989; Garmo *et al.*, 1990; Bartolome *et al.*, 1998; Osoro *et al.*, 2000; Degano *et al.*, 2001). While sheep are grazers, goats are browsers and brushes are poorer in N content (Tolera *et al.*, 1997). Due to the capacity of goats to metabolise secondary compounds of these shrubby species (Skene and Brooker, 1995) faecal N value could not be affected.

Table 2. Faecal N content (g N/100 g DM) evolution in sheep and goats during mountain period

Sampling time	Sheep	Goats
1. June	2.72 ± 0.09^{aA}	2.29 ± 0.09^{aB}
2. July	2.37 ± 0.09^{bA}	1.97 ± 0.09^{bB}
3. August	2.19 ± 0.09^{b}	–
4. September	2.40 ± 0.09^{bA}	2.13 ± 0.09^{abA}

^{ab}LS means in the same column with different superscript letters are different ($p < 0.05$).
^{AB}LS means in the same row with different superscript letters are different ($p < 0.05$).

As far as the sampling moment is concerned, the highest faecal N values were found during the first part of the grazing season coinciding with the highest quality of the grass (Albizu *et al.*, 1999), and probably with a higher diversity of the diet (Bullock, 1985). As the summer evolved the faecal N decreased, probably as a result of the withering process of herbaceous components of the pasture (Mattson, 1980), or to a reduction of the grass disponibility. There was a recuperation of faecal N value in September in both species (Table 2), probably as a consequence of the autumn grass re-growth.

According to the faecal N content, although the interaction between the species and the moment was no significant, goats could be able to maintain a more constant diet quality than ewes, probably because they are more opportunistic in dietary shifts related to seasonal changes in forage availability (Pfister *et al.*, 1988; Barroso *et al.*, 1991; Fedele *et al.*, 1993). This could be related to a higher capacity to forage over a broader range of heights (Wilson *et al.*, 1975) attributed to the foraging behaviour with the heads raised and in bipedal stance. This facts could give them a nutritional advantage over sheep, although each species has the opportunity to express their potential for feeding in different vegetation strata or availability (Pfister *et al.*, 1988; Papachristou and Nastis, 1993; Edwards *et al.*, 1994). Moreover, dietary overlap of this to species has been studied and it goes between 20-70% depending on the studied area and sampling time (Bullock, 1985).

Conclusions and future research lines

Results obtained from faecal N data show differences in diet selection and quality between sheep and goats in free-grazing conditions. The lower quality of goat intake, according to the lower N faecal content,

could be attributed to its browser capacity. This fact could be also the reason for maintaining the diet in a same quality along the grazing period. The differences between species in selection and the evolution during the grazing season help us to better understand these results.

In order to improve N faecal value as diet quality estimator, and specially in those browsers species, it should be interesting to study the effect of secondary compounds on digestion (Thompson, 1987; Garin *et al.*, 1996).

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