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Biomass production and quality value of pastoral species in the Rif Mountains

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Abstract. Rangelands represent the most important feed sources for goats in the Northern Morocco. The objective of the present study was to assess the biomass production and chemical composition of pastoral species in the Rif Mountains. This study was conducted in silvopastoral areas (Beni Arouss) exclusively used by goat herds. Five sample plots were selected using the method of stratification. To measure biomass of shrubs a reference module method was applied. For eight pastoral species, selected by the goats, dry matter (DM), crude protein (CP), mineral matter (MM), fat matter (FM), and crude fiber (CF) were performed according to the AOAC procedures. The pasture was characterized by an average diversity level of pastoral flora (60 species) dominated by shrubs. The biomass produced was 3,428 kg DM ha^{-1} composed for 75% *by Cistus crispus, Inula viscosa, Pistacia lentiscus* and *Quercus ilex*. For chemical composition, DM (20.2% to 50.4%), CP (1.3% to 3.5%), MM (3% to 16.8%), FM (3% to 12.5%), CF (11.1% to 24.8%) varies between *Calicotome villosa, C. crispus, Erica arborea, I. viscosa, Q. ilex, Lavandula stoechas, Olea europea,* and *P. lentiscus*. The continuous use of pastoral resources and lack of pasture management in Beni Arouss area has considerably reduced the palatable pasture species and has allowed the appearance of low pastoral value species such as *Arisarum vulgare,* and *Coriaria myrtifolia*. To ensure the sustainability of pastoral resources, breeders should lead appropriate rangeland management actions.

Keywords. Biomass – Chemical composition – Silvopastoral – Rif Mountain.

La production de biomasse et la qualité des espèces pastorales dans les montagnes du Rif

Les parcours représentent la source d'alimentation la plus importante pour les caprins dans le Nord du Maroc. L'objectif de cette étude est d'évaluer la production de biomasse et la composition chimique des espèces pastorales dans les montagnes du Rif. Cette étude a été menée dans des zones sylvo-pastorales (Beni Arouss) exclusivement utilisées par des troupeaux de caprins. Cinq placettes d'échantillonnage ont été choisies en utilisant la méthode de stratification. Pour mesurer la biomasse des arbustes, la méthode du module de référence a été appliquée. Pour huit espèces pastorales, les plus utilisées par les caprins, les teneurs en matière sèche (MS), matière azotée totale (MAT), matière minérale (MM), matière grasse (MG), et cellulose brute (CB) ont été déterminées selon les procédures de l'AOAC. Le pâturage est caractérisé par une diversité floristique moyenne (60 espèces) dominée par les arbustes. La biomasse produite est de 3428 kg MS ha^{-1} *composée à 75% par* Cistus crispus, Inula viscosa, Pistacia lentiscus *et* Quercus ilex. *Pour la composition chimique, la teneur en MS (20,2% à 50,4%), en MAT (1,3% à 3,5%), en MM (3% à 16,8%), en MG (3% à 12,5%), et en CB (11,1% à 24,8%) varient entre* Calicotome villosa, C. crispus, Erica arborea, I. viscosa, Q. ilex, Lavandula stoechas, Olea europea *et* P. lentiscus*. L'utilisation continue des ressources pastorales et l'absence d'une gestion des pâturages dans la région de Beni Arouss a considérablement réduit les espèces fourragères appétibles et a permis l'apparition d'espèces à faible valeur pastorale tels que* Arisarum vulgare *et* Coriaria myrtifolia*. Pour assurer la durabilité des ressources pastorales, les éleveurs doivent mener des actions appropriées de gestion des parcours.*

Mots-clés. *Biomasse – Composition chimique – Sylvopastoral – Montagne du Rif.*

I – Introduction

Mediterranean forests are rich in plant species and life forms (Le Houérou, 1981). They constitute an important year-round source of feed for livestock. In the Rif Mountains, forest pasture are traditionally an integral part of the feeding calendar of goats and consequently of the pastoral systems of the region. These forest pastures are used and overexploited throughout the year and most are characterized by shrub vegetation. The forest has undergone profound changes inducing major malfunctions between pastoral supply and demand in silvopastoral areas (FAO, 2011). This imbalance is mainly due to climate change, overgrazing, population and especially bad operating practices of silvopastoral resources such as limbing (Chebli *et al.*, 2012a).

For a sustainable and integrated development of pastoral and forest resources, it is essential to establish a resource assessment system.

We conducted this study in a pastoral area of the Moroccan Rif Mountains (Beni Arouss) exclusively used by goat's herds to assess pastoral production by botanical composition and biomass production of major pastoral species and their chemical composition.

II – Materials and methods

The study was carried out in Bouzahri, located in the Northern Morocco. Bouzahri is a part of the Beni Arouss region; it is characterized by private croplands and domanial forest. The pasture, concerned in our study, is located at 35°28' N 5° 60' W and between 260 to 430m above sea level. The climate is Mediterranean, with rainfall exceeding 500 mm/year.

The area of study is a forest rangelands exploited by goat breeders. The study was conducted over a period of eight months to assess the species composition and the productivity of pastoral plants by evaluating the vegetation qualitatively and quantitatively.

The qualitative evaluation of vegetation concerned floristic diversity and chemical composition. For floristic diversity, in each sampling period, a herbarium was collected to determine the floristic composition. For chemical composition, mainly for eight pastoral species, the most selected by the goats, dry matter (DM), crude protein (CP), mineral matter (MM), fat matter (FM), and crude fiber (CF) were performed according to the AOAC procedures (AOAC, 1997). This qualitative evaluation was performed during the month of May and June 2013.

For quantitative evaluation and in order to control spatial heterogeneity, the stratification method as proposed by Qarro (1996), Kouraimi (1997) and Chebli *et al.* (2012b) was used. Shrubs biomass was measured using a non-destructive method known as the reference module. We identified five quadrats in order to analyze the heterogeneity of silvopastoral area. The size of the quadrats adopted to measure the phytomasse is 2m x 5m. This quantitative evaluation was performed during the month of May 2012 and 2013, corresponding to the vegetative peak which is considered the ideal time for the measurement of the vegetation (Qarro 1996, Kouraimi 1997). Several interviews with breeders were carried out during the study period to gather information on grazing processes and to complete the database on the species characterization.

III – Results and discussion

The study area is characterized by a relatively rugged topography with moderately elevated slopes. The vegetation mainly consists in shrubs. The soil is poor and strongly susceptible to erosion.

1. Botanical composition

Floristic composition has revealed the existence of sixty plant species mainly dominated by shrubs. With our field observation and interviews conducted with breeders, different plant species dominating the site and who constitute more than 70% of the species selected by goats were identified: *Ajuga iva* L. (Schreber), *Calamintha nepeta* L. (Kuntze*), Cistus crispus* L.*, Cistus monspeliensis* L.*, Erica arborea* L.*, Lavandula stoechas* L.*, Lythrum junceum* L.*, Mentha pulegium* L.*, Mentha rotundifolia* L. (Hudson) and *Pistacia lentiscus* L. Compared to previous years breeders have noticed, appearance of other unpalatable species invading grazing areas. This situation is explained mainly by the lack of adequate management of rangeland, causing overexploitation of pastoral resources and contributes to appearance of low palatability species. According to observations and interviews conducted with breeders, we observed the appearance of degraded areas dominated by annual unpalatable plant species such as *Arisarum vulgare* (Targioni-Tozzetti) and *Coriaria myrtifolia* L.

2. Chemical composition

The chemical composition was performed for the most consumed species by goats in the pastoral area (table 1). Pastoral species in Bouzahri pasture have a DM content exceeding 29%, except *I. viscosa*. The content of MM is important in *I.viscosa* (16.82%) and *L. stoechas* (9.60%). It does not exceed 7% for the other species. The most palatable species are characterized by low levels of CP (1.30 to 2.90% DM), a moderate composition of CF (11.10 to 29.55% DM) and high levels of FM for 50% of the species analyzed (7.17 to 12.51% DM). The values of other parameters differ depending on pastoral species studied (Table 1).

Table 1. Chemical composition of the main pastoral species in Bouzahri pasture

Pastoral species	DM† (%)	MM (%)	SD	CP (%)	SD	FM (%)	SD	CF (%)	SD
Calicotome villosa	29.42	4.40	0.19	3.45	0.06	2.93	0.46	29.55	0.19
Cistus crispus	39.85	6.23	0.45	1.36	0.03	12.51	0.28	16.55	1.44
Erica arborea	45.13	2.97	0.10	1.30	0.03	8.68	0.21	22.59	0.25
Inula viscosa	20.16	16.82	0.28	2.83	0.06	10.20	0.10	16.22	1.18
Lavandula stoechas	36.09	9.60	0.38	1.78	0.02	4.90	0.13	22.95	1.35
Pistacia lentiscus	32.01	5.51	0.46	2.90	0.02	3.40	0.14	11.10	0.25
Olea europea	50.35	5.14	0.09	1.40	0.09	7.17	0.06	22.00	0.57
Quercus ilex	42.04	3.34	0.41	1.78	0.02	2.48	0.08	24.75	1.54

† DM: dry matter; MM: mineral matter; SD: standard deviation; CP: crude protein; FM; fat matter; CF: crude Fiber.

3. Biomass production

This pasture was characterized by an average diversity level of pastoral flora dominated by shrubs. Grazing is practiced throughout the year except during rainy days where breeders use limbing. The grazing time does not exceed 6 hours per day. Biomass production of palatable species is estimated to 3428 kg DM per hectare, composed for 75% by *C. crispus, I. viscosa, P. lentiscus* and *Q. ilex* (fig.1). The biomass production of pastoral species is decreased of 34.1% between 2012 and 2013 (5,205 kg ha^{-1} *vs* 3,428 kg ha^{-1} DM; Chebli, 2012c). This difference can be explained in part by continuous use of pastoral resources and lack of appropriate pasture management.

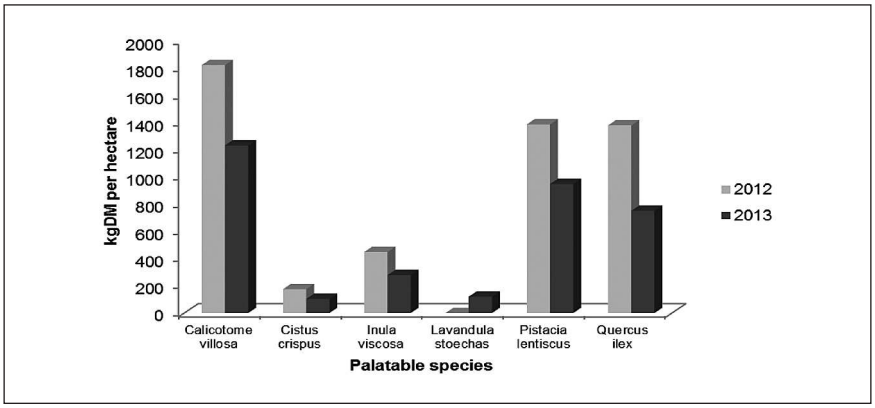

Fig. 1. Bimoass production of palatable species in Bouzahri pasture in 2012 and 2013.

IV – Conclusions

On the basis of our results related to the chemical composition we state that the most palatable species are characterized by a low levels of protein, a moderate amount of crude fiber and high levels of fat for 50% of the species analyzed. This pastoral area is under degradation and characterized by the presence of unpalatable species and the decrease of palatable biomass. To ensure the sustainability of pastoral resources in this area, breeders should adopt an appropriate rangeland management actions and reduce overgrazing by using rotational grazing systems to allow regeneration of palatable species. For further study, we suggest investigating the relationship between palatability and plant chemical composition or digestibility in order to complete the results obtained in this work.

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