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# Forage quality of dominant plant species of mountainous grasslands in northern Greece

Z.M. Parissi<sup>1\*</sup>, M. Karatassiou<sup>2</sup>, E.M. Abraham<sup>1</sup>, Ch. Gioufoglou<sup>1</sup>,  
S. Andreopoulos<sup>2</sup>, A. Th. Drakopoulou<sup>1</sup>

<sup>1</sup>Laboratory of Range Science (236), Faculty of Forestry and the Natural Environment,  
AUTH, 54124 Thessaloniki (Greece)

<sup>2</sup>Laboratory of Range Ecology (286), Faculty of Forestry and the Natural Environment,  
AUTH, 54124 Thessaloniki (Greece)

\*Corresponding author: pz@for.auth.gr

**Abstract.** The objective of this study was to detect differences in floristic composition and diversity indexes between four grasslands grazed by small ruminants in mountainous areas of Northern Greece. Moreover, the study was focused on the chemical composition of the dominant plant species. Vegetation cover was measured in each grassland, while floristic composition, and plant species diversity indexes were estimated. Moreover, plant material of dominant species was analyzed for crude protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Acid Detergent Lignin (ADL). The results revealed no significant differences between the vegetation cover of the grasslands, which is relatively high (83% to 98%). According to the results, forbs were the dominant functional group in most grasslands, followed by legumes. There was a high differentiation among species richness, Shannon index, and Morisita similarity index among the studied grasslands. Concerning the chemical composition, the forb and legume species had significantly lower NDF and ADF compared to grasses, while there was no significant difference in CP content of the tested species, except *Anthoxanthum odoratum* and *Thymus sibthorpii*. High species diversity and high forage quality were recorded in the studied grasslands.

**Keywords.** Floristic composition - nutritive value - diversity index – grazing - mountainous grasslands - northern Greece.

**Qualité fourragère des espèces végétales dominantes des prairies montagneuses du nord de la Grèce Résumé.** L'objectif de cette étude était de détecter des différences dans la composition floristique et les indices de diversité entre quatre prairies pâturées par de petits ruminants dans les zones montagneuses du nord de la Grèce. De plus, l'étude s'est concentrée sur la composition chimique des espèces végétales dominantes. Le couvert végétal a été mesuré dans chaque prairie, tandis que la composition floristique et les indices de diversité des espèces végétales ont été estimés. En supplément, le matériel végétal des espèces dominantes a été analysé pour la protéine brute (CP), la fibre détergente neutre (NDF), la fibre détergente acide (ADF) et la lignine détergente acide (ADL). Les résultats n'ont révélé aucune différence significative entre le couvert végétal des prairies, qui est relativement élevé (83 % à 93 %). Selon les résultats, les plantes herbacées étaient le groupe fonctionnel dominant dans la plupart des prairies, suivi des légumineuses. Il y avait une forte différenciation entre la richesse en espèces, l'indice de Shannon et l'indice de similarité Morisita parmi les prairies étudiées. Concernant la composition chimique, les espèces forb et légumineuses avaient des NDF et ADF significativement plus faibles que les graminées, alors qu'il n'y avait pas de différence significative dans la teneur en CP des espèces testées, à l'exception d'*Anthoxanthum odoratum* et *Thymus sibthorpii*. Une grande diversité d'espèces et une haute qualité de fourrage ont été enregistrées dans les prairies étudiées.

**Mots-clés.** Composition floristique- valeur nutritive- indice de diversité- pâturage- prairies montagneuses- nord de la Grèce.

## I – Introduction

The vegetation in Mediterranean grasslands ecosystems is characterized by a great species

diversity and richness, mainly due to seasonality and high climate variability (Blondel 2006). This high floristic composition in grasslands has been exploited by transhumance, as it is an ancient livelihood strategy of adaptation to spatial and temporal environmental variability (Oteros-Rozas *et al.*, 2013; Perez Leon *et al.* 2020). Floristic composition of grasslands affected by the interaction of environmental factors (Holechek *et al.* 2010), with management practices (Cop *et al.* 2009), and grazing intensity (Sasaki *et al.* 2008; Hilker *et al.* 2014).

Usually, grazing reduces the abundance of palatable species, which are replaced by less palatable ones (Briske, 2017). The result is low vegetation cover and an increase in non-economically desirable species (Alishtayeh and Salahat 2010) due to the removal of vegetation and consequently soil degradation from animal trampling. Moreover, the dominance of unpalatable species decreases the grazing capacity and affects the quality of animal products as milk or cheese. The objective of this research was the comparable study of the floristic composition and nutritive value of dominant plant species in mountainous grasslands of Northern West Greece grazed by different animal species. The grasslands in the area are mainly used by transhumance during the summer.

## II - Materials and methods

In early July 2019, the study was conducted in three grasslands in Aetia (grassland 1,2,3) and one in Polyneri (grassland 4) villages located in the Regional Unit of Grevena. The elevation of the research areas is around 1100 m, and the climate is characterized as Dfb in the Köppen-Geiger system ([www.en.climate-data.org](http://www.en.climate-data.org)). The mean air temperature was at 9.9°C, and the mean annual rainfall at 779 mm. Transhumant flocks of ruminants (small ruminants about 600 heads in Aetia; small ruminants about 900 head and 80 cattle in Polyneri) grazed in those grasslands from April to October in a continuous grazing system.

In each grassland, vegetation cover was measured with the line and point method (Cook and Stubbendieck, 1986), and floristic composition was calculated and classified into five functional plant groups: (1) grasses, (2) legumes, (3) forbs, (4) woody and (5) graminoids. Moreover, plant diversity indices Species Richness (N), Shannon-Wiener diversity index ( $H'$ ), Evenness (J), Berger-Parker's index of Dominance (d) and Morisita's Index of Similarity (CA) were calculated with Past software (Paleontological Statistics Ver 2.17) (Hammer *et al.* 2001) for each grassland (Shannon and Weaver, 1949; Morisita, 1959; Pielou, 1966; Henderson, 2003):

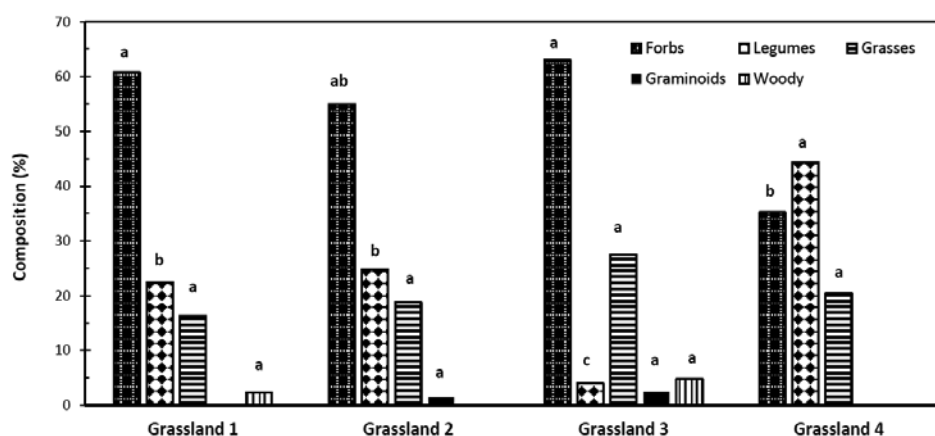
At the same time, the above-ground biomass was harvested by three 0.5 m x 0.5 m quadrats, oven-dried at 60°C for 48 hours, ground through a 1 mm screen, and analysed for N using a Kjeldahl procedure (AOAC, 2002). Crude protein (CP) was then calculated by multiplying the N content by 6.25. Additionally, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Acid Detergent Lignin (ADL) were determined with the ANKOM fiber analyzer with the addition of sulphite, but not  $\alpha$ -amylase to the solution for the NDF determination. All analyzes were carried out on duplicate samples, and results reported on a DM basis.

Statistical analysis of the data was performed using ANOVA with the use of the SPSS® statistical software v. 25.0 (SPSS Inc., Chicago, IL, USA). The Tukey criterion (Steel and Torrie, 1980) at the 0.05 probability level was used to detect the differences among means.

## III – Results and discussion

Vegetation cover in the studied grasslands ranged between 83 -98%, and there were no significant differences among them. It seems that the vegetation cover is high, regardless of the continuous grazing in the area from May to October. Similar results have been found for another

mountainous area in Greece with similar edaphoclimatic conditions (Abraham et al., 2009). Forbs were the dominant functional group in the first three grasslands (Aetia village), and there was no significant difference among them (Figure 1). On the contrary, legumes were the dominant functional group in the grassland of Polyneri, and their percentage was significantly higher compared to the other tested grasslands. Regarding the grasses, their participation did not significantly differ among the studied grasslands. Additionally, woody species were recorded in Aetia (grassland 1&3). Species composition results from environmental factors, climate, and management (Cop et al. 2009; Holechek et al. 2010) and enhances the establishment of different species in different habitats (Jafari et al. 2004).

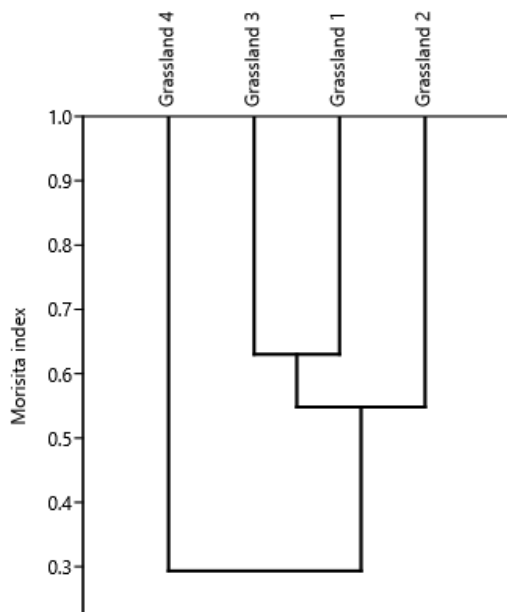


**Figure 1.** Vegetation composition at the study grasslands. Means for the same parameter followed by the same letter are not significantly different ( $P \leq 0.05$ )

The highest number of species and Shannon's index were recorded at grasslands 2 and 4 (Table 1). These grasslands are characterized by higher elevation slopes compared to the others. This differentiation in slope inclination is likely to affect floristic diversity, as was also reported by Margioulas et al. (2016). The opposite trend was noticed for the Berger Parker index of dominance which reached the higher value in grassland 1 and the lower one in grassland 4. According to the results, evenness was more or less the same between the study grasslands, and the differentiation among grasslands was confirmed with the Morisita index.

**Table 1.** Species diversity indices (N, H', J, d) of the four grasslands (R1-R4)

	R1	R2	R3	R4
Species richness (N)	27	28	19	45
Shannon's index (H')	2,802	3,079	2,586	3,439
Evenness (J)	0,6101	0,7759	0,6987	0,6923
Berger-Parker's index (d)	0,2674	0,1099	0,1647	0,09091



**Figure 2.** Morisita index for the four study grasslands

There was no significant difference in the CP content of the tested species, which was high, except *Thymus sibthorpii* Benth. and *Anthoxantum odoratum* (Table 2). Similar results have been found for *Hordeum bulbosum* L. f (Shadnough 2013), *Poa bulbosa* L. (Shahri et al. 2019), for *A.millefolium* (Vondraskova et al. 2012). According to the results of CP, the tested species could exceed the demands of small ruminants for maintenance and lactation except for *A.odoratum* and *Th. sibthorpii* that cover only maintenance demands (NRC, 1981, 1985). Nevertheless, these species are less consumable from the animals.

Concerning the NDF content, *A. odoratum* had the significantly higher one, following from the other grass species (Table 2), while forbs and legumes had significantly lower content compared to the other functional groups. Similar results for CP and NDF content have been found for *H. bulbosum* from Shadnough (2013), for *Poa bulbosa* (Shahri et al. 2019), for *A. millefolium* (Vondraskova et al. 2012). The same trend was recorded for ADF content, with grasses having the higher content followed by forbs and significantly lower legumes. On the contrary, forbs had significantly higher ADL followed by grasses and legumes. As there were structural differences between the tested plant species, the variation among the chemical composition was expected (Shadnough 2013). Moreover, the establishment of relationships between floristic composition, the nutritive value of plant species, and the quality of animal products as dairy products and meat has an important economic prospect and ought to be investigated (Ioannidou et al. 2019). Additionally, integrated management plans for mountainous rangelands will help the equilibrium between floristic diversity, grazing, and animal products.

**Table 2.** Chemical composition of the dominant species of the study grasslands

Species	CP	NDF	ADF	ADL
<b>Forbs</b>				
<i>Achillea millefolium</i>	170ab	320e	248e	50b
<i>Thymus sibthorpii</i>	101b	355d	251e	78a
<b>Grasses</b>				
<i>Anthoxanthum odoratum</i>	103b	640a	285c	31d
<i>Poa bulbosa</i>	180a	600b	303b	22e
<i>Poa pratensis</i>	245a	540c	270d	43c
<i>Hordeum bulbosum</i>	168ab	600b	317a	37cd
<b>Legumes</b>				
<i>Medicago</i> sp.	235a	300f	225f	41c
<i>Lotus corniculatus</i>	210a	295g	200g	55b

Means in the same column and for the same parameter followed by the same letter are not significantly different ( $P \leq 0.05$ )

## IV - Conclusions

High differentiation in floristic diversity was detected among the studied grasslands grazed by different animal species. Grazing by cattle and sheep enhanced the floristic diversity. Nevertheless, the forage quality of mountainous plant species was high in all cases.

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