

FLORISTIC COMPOSITION OF PERMANENT GRASSLAND IN THE NATURE PARK STARA PLANINA (SERBIA)

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ABSTRACT

The five most important meadow associations on the Stara Planina Mountain in National Park „Stara Planina” were analysed in order to define initial parameters for determination of grassland potential, as well as natural resources for production of biologically valuable and high quality food and revitalization of agricultural production in hilly-mountainous region. Floristic composition of five meadow associations is presented: *Medicago falcate* - *Festucetum rubrae* at three locations around the Pirot, *Trifolium* - *Agrostietum stoloniferae* Lj. Mark. 1973, *Agrostietum vulgaris* Z. Pavl. 1955, two ass. *Festucetum vallesiaceae* - *Agrostietum vulgaris* Danon et Blaž. 1978 and *Festuco-Agrostietum* Horv. (1951) 1982.em Trinajest.1972 one. All five associations are around Dimitrovgrad. First association of *Festucetum vallesiaceae* - *Agrostietum vulgaris* Danon et Blaž.1978 had the highest diversity with the total number of 75 species. The number of species in investigated associations was: grasses from 8 to 23, legumes from 8 to 17 and other species from 21 to 34. Participation of major meadow species based on their mass is presented in the paper. On the basis of their productivity the species belong to the associations of useful grasses, useful legumes and other useful species and weeds. The study of grasslands was done in order to establish production potentials and quality of grasslands used for grazing of small ruminants, i.e. sheep and goats.

Key words: floristic composition, permanent grassland, Stara Planina Mountain.

INTRODUCTION

Natural grasslands have the most important presence in the structure of agricultural land in Serbia. According to the latest statistical data (Statistical yearbook, 2007, Lazarević et al., 2009), they occupy 28.3% (1,448,000 ha) of land, and in Central Serbia 39.1% (1,302,000 ha). Grassland areas increase with the increase of altitude, so in mountainous regions they are dominant in agricultural production. Utilization of grasslands in livestock production in hilly-mountainous region is important in nutrition of large as well as small ruminants, i.e. sheep and goats. However, natural grasslands are mostly neglected with very low degree of utilization, due to the process of depopulation of this region. For the purpose of intensifying livestock production in mountainous region, organization of market production requires knowledge of production potential of plant associations and their dynamic changes during vegetation period. Different ecological conditions have caused the formation of large

number of meadow associations which differ in regard to productivity, not only between associations (Stošić et al., 1989; Kojić et al., 1992), but also between components of same association (Lazarević et al., 2003).

However, the highest presence and economical importance, at least in hilly-mountainous region, have the following associations: *Danthonietum calycinae*, *Festucetum rubrae*, *Agrostietum vulgaris* and *Nardetum strictae*. Utilization of grasslands by grazing of goats contributes to improvement and revitalization of grasslands since by grazing the regeneration of leguminous plants is favoured. After grazing by goats, on grasslands, higher share of leguminous plants remains (clover), than after grazing by sheep and cattle (Bown et al., 1989; Penning et al., 1996). In this way, pasture of improved quality can be used for grazing of more demanding animal species such as cattle and sheep (del Pozo et al., 1996). Mijović et al. (2006) reported that most studies on vegetation of the region of the Stara Planina Mountain, including grassland,

highlighted the high level of plant biodiversity, with about 1,190 species. Dajić-Stevanović et al. (2008) stated that in Serbia, most of semi-natural and natural grasslands are abandoned, or at least insufficiently managed, especially in underdeveloped regions, including the Nature Park Stara Planina. Floristic composition of grasslands is structured by current site conditions, mainly topography and soil (Janssens et al., 1998). In recent years changes in land use and other human activities have resulted in a decrease in species richness world-wide (Hooper et al., 2005).

The aim of this study was to characterize the floristic composition which presents very rich number of species and genetic diversity of grasslands on the Stara Planina Nature Park, to be used for grazing of small ruminants, i.e. sheep and goats.

MATERIAL AND METHODS

Study of the phytocenological composition and quality of natural meadows and pastures was done on eight locations of Stara Planina Mountain in the vicinity of towns of Dimitrovgrad (43°0'51" N, 22°46'32" E) and Pirot (43°09'07" N, 22°35'06" E) (Figure 1).

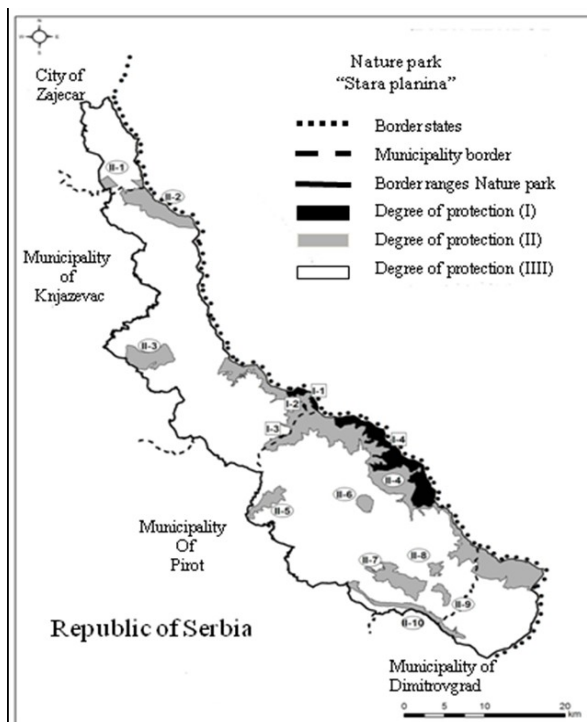


Figure 1. Nature Park "Stara Planina" – locations Pirot and Dimitrovgrad

Stara Planina Mountain is the highest mountain in south-eastern Serbia, declared in 1997 as the Nature Park. The total protected area of the mountain accounted for 142.220 ha. The study sites are characterized by mean annual temperature amplitude of about 18.8°C. January is the coldest month, with mean air temperatures of about +1.3°C. July is the warmest month, with mean air temperature of about +21°C. Mean daily temperatures, above +5°C, lasts from early March to late November. Mean daily temperatures, above +20°C, lasts from middle June to early October. The average annual temperatures for the seasons are: for spring of about +9.5°C, for summer of about +18.8°C, for fall of about +11.0°C and for winter of about +1.1°C. The study sites are characterized by a mean temperature of about 16°C in vegetation period (Marinkov, 2008). The study sites are characterized by a mean annual precipitation of about 640.7 mm and mean relative humidity of air 72.5% (long-term averages from 1961 to 1990).

The tests were carried out on litogen types of soil. The main characteristics of the soil (depth: 0-50 cm) were: pH 5.52 (moderately acid); humus – 5.14% (medium to good provided with humus), total N – 0.26% (suitable content). The soil contained 9.3 mg phosphorus/100g soil.

Meadow and pasture associations are described according to principles and methodology of Swiss-French Phytocenological School (Braun-Blanquet, 1964), in the way that in phytocenological screenings scale for numerical presence and cover, the following symbols were used: + for rare species and 1, 2, 3, 4, and 5 for the higher dominant species (Braun-Blanquet, 1928). Presence of quality plant species was determined according to data presented by Kojić et al. (2001), by their separation from the sample taken from area of 1 m² in spring of 2008, their weight was measured and their presence calculated in percentage.

Quality plant species were grouped in following categories: quality grasses, quality leguminous plants and useful and conditionally useful plant species. Weeds were categorized as very poisonous and

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slightly poisonous (Caputa, 1966; Šoštarić-Pisačić and Kovačević, 1974; Klapp, 1986; Kojić et al., 2001). Additionally, meadow associations were determined based on results obtained in previous phytocenological researches on the territory of Serbia (Kojić et al., 2004).

RESULTS

In analyses of floristic composition of plant associations of meadows Nature Park „Stara Planina” used for grazing of small ruminants, i.e. sheep and goats, results were obtained and presented as average value of two screenings in the next 5 tables. Five associations and species were determined and presented in groups of plants in two main families: *Poaceae* (Table 1) and *Fabaceae* (Table 2), as well as species of other families

(Tables 3, 4 and 5). Within families, plants were distributed according to the species and quality if used for ruminant nutrition. From aspect of food value for livestock all species can be fundamentally divided into useful or harmful plants.

The group of useful plants was segmented into two subcategories: useful species and conditionally useful species (Table 3). The group of harmful plants was segmented into three subcategories: worthless species (Table 4), harmful and slightly poisonous species and very poisonous species (Table 5). In all tables analyzing associations was denoted by figures 1 to 8 and meaning: *Medicago falcate - Festucetum rubrae* (1, 2, 3), *Trifolio campestre-Agrostietum* (4), *Agrostietum vulgaris* (5), *Festucetum vallesiaceae* (6, 7), *Festuco-vallesiaceae-Agrostietum vulgaris* (8).

Table 1. Presence of *Poaceae* plant species in analyzed associations

Species	1	2	3	4	5	6	7	8
<i>Lolium perenne</i>						1.1	+1	
<i>Poa pratensis</i>	+1	+1	1.1			1.1	1.1	
<i>Festuca pratensis</i>		+2	+1		1.1	1.1	2.2	1.1
<i>Alopecurus pratensis</i>	+1	+1	+1			1.1		
<i>Phleum pratense</i>	1.1		1.1	1.1			1.1	
<i>Arrhenatherum elatius</i>				2.2	2.2	3.3	3.3	2.2
<i>Dactylis glomerata</i>					3.3	2.2		2.3
Total species of high quality	3	3	4	2	3	6	5	3
<i>Festuca rubra</i>	+1	+1	3.3	4.3	2.2	1.1	4.4	4.4
<i>Festuca vallesiaceae</i>						4.4	4.4	3.3
<i>Festuca arundinaceae</i>					1.1	1.2	1.1	
<i>Agropyron repens</i>					1.1	+1	1.1	
<i>Anthoxantum odoratum</i>	+1	+1	+1			+1		
<i>Agrostis capillaries</i>		+2	3.3	2.2	4.4	1.1	2.2	3.3
<i>Cynosurus cristatus</i>	+1	+1	+1		1.1	1.1		
<i>Bromus erectus</i>		+1						
<i>Poa violaceae</i>						1.1	+1	1.1
<i>Danthonia calycina</i>	+1	+1		1.1	1.1	+1		
Total species of medium quality	4	6	4	3	6	9	6	3
<i>Briza media</i>		+1	+1	1.2	2.2	+1	1.1	2.2
<i>Deschamsia caespitosa</i>				1.1				1.1
<i>Danthonia decumbens</i>						+1		
<i>Festuca ovina</i>	3.3	3.3	2.2	4.3	1.1	+1	3.3	3.3
<i>Poa nemoralis</i>					+1	+1		
<i>Trisetum flavescens</i>					+1	+1		
<i>Avena fatua</i>					+1		1.1	
<i>Bromus racemosus</i>					+1			
<i>Bromus comutatus</i>					+1	+1		
<i>Koeleria cristata</i>						+1		
<i>Aira capillaries</i>						+1	+1	
<i>Holcus molis</i>						+1		
Total low quality and worthless species	1	2	2	3	7	9	4	3
Total grasses	8	11	10	8	16	24	15	9

Table 2. Presence of *Fabaceae* plant species in analyzed associations

Species	1	2	3	4	5	6	7	8
<i>Medicago falcate</i>	3.2	3.3	3.3			2.3	1.2	
<i>Medicago lupulina</i>		+1	1.1			1.1	1.1	
<i>Trifolium resupinatum</i>							1.1	
<i>Lotus corniculatus</i>		+2	1.1	3.3	1.1	1.1	3.3	2.2
<i>Trifolium repens</i>	+1	+1	1.1	1.1	1.1	1.1	1.1	1.1
<i>Vicia grandiflora</i>					+1	+1		
<i>Vicia sativa</i>						1.1		
<i>Lathyrus pratensis</i>	+1	+1	+1		+1	1.1		1.2
<i>Trifolium pratense</i>				1.1	+1			1.1
Total species of high quality	3	5	5	3	5	7	5	4
<i>Trifolium medium</i>	+1	+1		1.1	+1	2.3	3.3	
<i>Vicia tetrasperma</i>	+1							
<i>Trifolium aplestre</i>	+1			1.1		+1	+1	
<i>Vicia craca</i>	+1	+1			+1	1.1	+1	1.1
<i>Trifolium campestre</i>				3.3	2.2	1.2	1.1	
<i>Lathyrus tuberosus</i>				1.1				
<i>Vicia angustifolia</i>						+1		
<i>Vicia hirsuta</i>						+1	+1	+1
<i>Vicia villosa</i>								+1
<i>Trifolium montanum</i>						+1	+1	
<i>Trifolium pannonicum</i>							+1	
<i>Anthyllis vulneraria</i>						+1		
<i>Onobrychis viciaefolia</i>	1.1	+1			1.1	1.1		1.1
Total species of medium quality	5	3	-	4	4	9	7	4
<i>Lathyrus nissolia</i>			+1		+1	+1		
<i>Ononis arvensis</i>	+1	+1	+1					
<i>Genista pubescens</i>						+1	+1	
<i>Coronilla varia (slightly poisonous legumes)</i>	+1	+1	+1	1.1				
Total low quality and worthless species	2	2	3	1	1	2	1	-
Total leguminous plants	10	10	8	8	10	17	12	8

Table 3. Presence of useful and conditionally useful species in analyzed associations

Species	1	2	3	4	5	6	7	8
<i>Saguisorba minor</i>	1.1	+1	+1	+1	+1	+1	+1	
<i>Achillea millefolium</i>	1.1	+1		+1	+1	+1	+1	+1
<i>Taraxacum officinale</i>	+1	+1	+1		+1	+1	+1	+1
<i>Plantago lanceolata</i>	+1		+1	+1	+1	+1	+1	+1
<i>Galium verum</i>			+1	+1	+1	+1	+1	+1
<i>Leontodon hispidus</i>				+1				
Total useful species	4	3	4	5	5	5	5	4
<i>Filipendula hexapetala</i> L.	+1				+1			
<i>Fragaria vesca</i>	1.1	+1	+1	+1	+1	+1		
<i>Daucus carota</i>			+1		+1	+1	+1	+1
<i>Daucus carota</i>			+1		+1	+1	+1	+1
<i>Scabiosa columbaria</i>	+1	+1	+1	+1				
<i>Convolvulus arvensis</i>	+1	+1	+1		+1	+1	+1	+1
<i>Silena alba</i>						+1	+1	
<i>Crepis biennis</i>								
Total conditionally useful species	4	3	5	2	5	5	4	3

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Table 4. Presence of worthless species in analyzed associations

Species	1	2	3	4	5	6	7	8
<i>Potentilla argentea</i>	1.1	+1	+1	+1	+1	+1	+1	
<i>Potentilla reptans</i>	1.1					+1		
<i>Potentilla verna</i>					+1			
<i>Prunella vulgaris</i>	1.1		+1		+1		+1	
<i>Primula veris</i>	+1							
<i>Asperula cynanchica</i>	+1		+1					
<i>Polygala comosa</i>	+1					+1		+1
<i>Rumex crispus</i>	+1	+1	+1		+1			
<i>Rumex acetosella</i>							+1	
<i>Erigeron canadensis</i> L.	+1							
<i>Crataegus monogyna</i>	+1	+1	+1	+1		+1		+1
<i>Senecio tenuifolius</i>	+1	+1	+1			+1		
<i>Verbena officinalis</i>	1.1	+1	+1					
<i>Teucrium chamaedrys</i>	+1			+1		+1		
<i>Matricaria chamomila</i>								+1
<i>Carex acutiformis</i>								+1
<i>Carduus acanthoides</i>	+1		+1					
<i>Salvia pratensis</i>	+1	+1	+1		+1			
<i>Stachys maritima</i>	+1	+1						
<i>Chenopodium album</i>	1.1	+1						
<i>Symphytum officinale</i>						+1	+1	
<i>Cichorium intybus</i>						+1	+1	+1
<i>Dianthus barbatus</i>								+1
<i>Andropogon gerardii</i>	+1		+1					
<i>Plantago media</i>		+1		+1			+1	
<i>Thymus serpyllum</i>		+1	+1		+1	+1		
<i>Rosa canina</i>		+1	+1	+1		+1	+1	
<i>Galium molugo</i>		+1	+1			+1	+1	+1
<i>Origanum officinale</i>	+1	+1	+1					
<i>Veronica polita</i>		+1						
<i>Anagallis arvensis</i>		+1						
<i>Rubus idaeus</i>				+1		+1	+1	
<i>Rubus cespitosus</i>						+1		
<i>Salvia pratensis</i>				+1				
<i>Potentilla aurea</i>				+1				
<i>Centaurea jacea</i>				+1	+1	+1	+1	+1
<i>Carthamus lanatus</i>				+1				
<i>Salvia nemorosa</i>				+1	+1	+1		
<i>Agrimonia eupatoria</i>				+1		+1		+1
<i>Gentiana asclepiadea</i>					+1			
<i>Plantago major</i>					+1			
<i>Cerastium pumilum</i>					+1			
<i>Myosotis versicolor</i>					+1			
<i>Ajuga reptans</i> L.					+1			
<i>Artemisia absinthium</i>						+1	+1	
<i>Knautia arvensis</i>						+1	+1	
<i>Agrimonia odorata</i>						+1		
<i>Inula hirta</i>						+1		
<i>Stachys alpina</i>						+1	+1	
Total worthless species	18	15	14	12	13	21	13	9

Table 5. Presence of harmful slightly poisonous and very poisonous species from different families

Species	1	2	3	4	5	6	7	8
<i>Rhinanthus minor</i>	1.1		+1	+1	+1			
<i>Mentha arvensis</i>						+1		
<i>Mentha longifolia</i>	+1	+1						+1
<i>Chlematis vitalba</i>	+1					+1		
<i>Mentha longifolia</i>	+1	+1						+1
<i>Hypericum perforatum</i>			+1		+1	+1		+1
<i>Carlina acaulis</i>	+1	+1	+1					
<i>Carduus acanthoides</i>					+1		+1	+1
<i>Cirsium arvense</i>								+1
<i>Convallaria majalis</i>				+1				
<i>Euphorbia cyparissias</i>				+1	+1		+1	
Total harmful and slightly poisonous species	5	3	3	3	4	3	2	5
<i>Heleborus odoris</i>	+1	+1						+1
<i>Euphorbia amigdaloides</i>							+1	
<i>Colchicum autumnale</i>					+1			
Total of very poisonous species from different families	1	1	-	-	1	-	1	1

Table 6. Total species of other families and total species

Species	1	2	3	4	5	6	7	8
Total species of other families	32	25	26	22	28	34	25	21
Total species	50	47	44	38	54	76	53	38

Table 7. Yield of dry matter and parameters of quality (content of crude proteins and fibre)

Species	1	2	3	4	5	6	7	8
Yield of dry matter t ha ⁻¹	3.08	3.23	3.70	3.25	3.76	2.98	2.60	3.79
Chemical composition of dry matter								
Crude proteins, %	12.5	12.2	13.0	10.4	6.53	10.10	10.6	8.24
Crude fibre, %	21.5	22.3	21.60	28.5	34.41	30.60	27.1	32.46

DISCUSSION

On location Stara Planina Mountain in the vicinity of Pirot, Basara, where species were determined from three meadows of similar floristic composition, dominant species were *Medicago falcate* and *Festuca rubra*, so all three associations were determined as *Medicago falcate* - *Festucetum rubre*. In this association, *Medicago falcate* was scored 3 for numerical presence and cover, *Lotus corniculatus* 2 and 1, and *Trifolium repens* 1. Number of species in all three samples was 50, 47 and 44 (Table 6), of which from the family *Poaceae* 8, 11 and 10

species (Table 1), family *Fabaceae* 10, 10 and 8 species (Table 2), and remaining were weed species, useful or harmful for goat grazing. Main parameters of quality in samples of these associations, based on carried out chemical analyses, showed that the content of crude proteins was 12.55, 12.29 and 13.00% and the content of crude fibre was 21.56, 22.30 and 21.60% (Table 7). These grasslands belong to groups of quality grasslands, according to yield of dry matter, which was of 3.08, 3.23 and 3.70 t ha⁻¹ (Table 7). This quantity of hay can be prepared for nutrition of goats in winter period and in this way quality feed can be provided for animals,

especially at the end of winter and at the beginning of spring, when kidding of goats is expected. Subcategory useful species includes 4, 3 and 4 species and conditionally useful species 4, 3 and 5 species (Table 3). To the Subcategory worthless species belong 18, 15 and 14 species (Table 4), to harmful and slightly poisonous species 5, 3 and 3 species and to very poisonous species 1, 1 and 0 species (Table 5).

In the vicinity of Dimitrovgrad, on four locations, 4 associations were determined: on location Mojinci – association *Trifolium campestre* - *Agrostietum*, on location Kamenica association *Agrostietum vulgare*, in Sukovo, two meadows of type *Festucetum vallesiacae* and on location Senokos association *Festuca vallesiacae* - *Agrostietum vulgare*. The association with the highest number of species was *Festucetum vallesiacae* from the first meadow with 76 recorded species. Also, the highest number of grass species was recorded in this meadow 23.6 from the group of high quality grasses, 8 of medium quality and 9 from the group of poor quality or worthless grasses. The highest numerical presence and cover was established for species *Festuca vallesiacae* 4.4. Of the high quality grass species the following are present *Arrhenatherum elatius* 3.3, *Dactylis glomerata* 2.2, *Festuca pratensis* 2.2 and *Lolium perenne* 1.1 (Table 1). On this meadow yield of dry matter was 2.98 t ha⁻¹, whereas on the other meadow of the same association yield was the lowest of all investigated associations 2.60 t ha⁻¹ (Table 7). Content of crude proteins was 10.67%, of crude fibre 27.17%, which means that they belong to association of medium quality (Table 7). Subcategory useful species included 5 species and conditionally useful species 4 species (Table 3). Subcategory worthless species included 13 species (Table 4), harmful and slightly poisonous species 2 species and very poisonous species 1 (Table 5).

On location Veliki Jastrebac, a joint association *Agrostio* - *Festucetum vallesiacae* was determined with a total of 34 species, of which 20.59% were grasses of high and good quality, among which are *Agrostis capillaris*

L., *Festuca rubra* L., *Festuca vallesiacae* L., *Poa pratensis* L., *Festuca pratensis* Huds. and *Cynodon dactylon* L. Of leguminous plants of high quality the following were present: *Medicago lupulina* L., *Trifolium repens* L. and *Trifolium pratense* L. (Tomić et al., 2009). Association *Agrostietum vulgare* gave high production of dry matter 3.6 t ha⁻¹, and *Trifolium campestre* dominated with score 2 of leguminous species, and of grass species *Agrostis capillaris* 4.4., *Dactylis glomerata* 3.3., *Arrhenatherum elatius* 2.2. and *Festuca rubra* 2.2.

Association *Agrostietum vulgare* on location of the hunting ground Karakuša has a total of 35 species, of which 8 were grasses, only 3 leguminous plants and 24 species of other families, with the highest numerical presence and cover of *Agrostis capillaris* L. (34.3%) of grasses and *Trifolium repens* L. of legumes. Although the dry matter production was high, quality was rather low since the protein content was low 6.53%. The same association realized a production of green mass of 3.15 t ha⁻¹ and dry matter production of 1.1 t ha⁻¹ (Tomić et al., 2009).

On the territory of Stara Planina Mountain, on four locations of the association *Agrostietum vulgare*, Tomić et al. (2005 a) found the following presence of useful grasses, leguminous species and other useful species - from 70.1 to 85.8%. Share of useful grasses was 47.8-62.8% and useful legumes 12.4-30.8%. In researches of Kojić et al. (1992), in the same association on location of Rudnjan plateau, the highest numerical presence and cover of the species *Agrostis vulgare* L. (5.5), *Agropyron repens* L. (3.3), *Poa nemoralis* L. (2.2), and *Festuca rubra* L. (1.1) was determined. Of leguminous species with some-what higher presence and cover were following *Trifolium repens* L. and *Trifolium campestre* Schreb. (1.1). According to some authors (Đorđević and Mijatović, 1963), total number of species in association *Agrostietum vulgare* on different locations - Ljig, Suvobor, Gorski Kotar, Kopaonik and Golija varied from 56 to 116 species. The greatest number of grass and leguminous species was on the location Golija (13 and 10

species, respectively). In a review of meadow association Radočela (Mrfat-Vukelić et al., 1988), most surface was occupied by association *Agrostietum vulgaris* with 62 species.

CONCLUSIONS

In the study of grasslands on Stara planina mountain in the vicinity of Pirot and Dimitrovgrad, the following associations was determined by floristic analyses: *Medicago falcate* - *Festucetum rubrae*, *Trifolium* - *Agrostietum stoloniferae* Lj. Mark.1973, *Agrostietum vulgaris* Z. Pavl.1955, *Festucetum vallesiaceae* - *Agrostietum vulgaris* Danon et Blaž. 1978 and *Festuco* - *Agrostietum* Horv. (1951) 1982 am Trinajest. 1972. The number of species in associations varied from 38 to 76, with different share in percentage in regard to quality in families *Poaceae* and *Fabaceae*, as well as other families. Numerical presence and cover of species caused different production of dry matter, in the interval from 2.60-3.76 t ha⁻¹. Such diversity is reflected also in the quality of dry matter, as the content of crude proteins varied from 6.53-13.0%. Considering both production and quality, these grasslands provide good grazing for small ruminants, such as sheep and goats.

Acknowledgement

Research was financed by the Ministry of Education and Science, Republic of Serbia, project TR-31053.

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