

The Chemical Composition of Some Grass Species (*Poaceae* Sp.) from Ungrazed Forest Range in Northern Bulgaria

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Abstract—This research was carried out to determine the some macro minerals, crude protein, neutral and acid detergent fiber contents of six dominant forage grasses grown as naturally in the ungrazed forest range of Belovets village (43.0 °N, 26.0 °E) of northern Bulgaria, located at about 614-641 m altitude above sea level and with a total precipitation of 525 mm on average and an annual overall temperature of 10.8 °C. The range soil where the study was conducted was good in organic matter (4.8 %), moderate in phosphorus (P) content (average of 67.7 kg ha⁻¹), but rich in potassium (K) content (340.4 ha⁻¹) and with pH 6.2. Six grass species [sheep fescue (*Festuca ovina* L.), red fescue (*F. rubra* L.), perennial ryegrass (*Lolium perenne* L.), Kentucky bluegrass (*Poa pratensis* L.), orchardgrass (*Dactylis glomerata* L.) and smooth brome (*Bromus inermis* Leyss.)] were collected (approximately 450 g biomass) at full bloom stage, which were chosen not damaged by biotic and abiotic factors. Whole plant samples were sterilized with 2% sodium hypochlorite for 15 min and washed distilled water three times. Potassium (%), phosphorus (%), calcium (%), magnesium (%), crude protein (%), acid detergent fiber (ADF, %) and neutral detergent fiber (NDF, %) were determined in these dried (at 55 °C for 48 h) samples. The crude protein (CP) content (in dry matter, %) was determined by the micro-Kjeldahl method. P content (in dry matter, %) was determined spectrophotometrically. K, calcium (Ca) and magnesium (Mg) contents (in dry matter, %) were found using an atomic adsorption spectrophotometer. All samples were analyzed in triplicate. The highest crude protein (14.23 %), calcium (3.88 %), potassium (3.22 %) ratios were determined in smooth brome, whereas the lowest phosphorus ratio (0.22 %) was found in same plant. Sheep fescue produced more ADF (33.78 %) and NDF (62.10 %) ratios than other species. The magnesium ratio ranged from 0.23 to 0.29 %. The protein and minerals are the very important for life organisms. Eighteen mineral elements are known to be required by at least some animal species. Ca, P, Mg and K required in amounts ranging from a few tenth of a gram, to one or more grams per day. These grass species provided a balanced feed for animals throughout the growing season, pre-bud to full bloom stage. Therefore, sheep fescue, red fescue, perennial ryegrass, Kentucky bluegrass, orchardgrass and smooth brome can be sown and grazing to obtain mineral, fiber and crude protein contents in similar ecological conditions.

Keywords— Forage, forest range, grasses, mineral content.

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I. INTRODUCTION

Grassland is estimated at 3.27 billion hectares [1], or about 25 % of the world's landmass. Their area is cover 75.7 million hectares in the European Union (EU28) and Turkey [1], [2]. Grasslands are an important part of the world vegetation and these are feed sources as well as wild and domesticated animals. Besides, these areas, act as carbon sinks, erosion preventives, birds directive areas, habitat for small animals, nitrogen source [3], biodiversity, water source, desertification preventives, tourism and recreation [4]. Pastures and meadows have includes many plant species in the families: *Poaceae*, *Fabaceae*, etc. Many species of *Poaceae* family are the most important forage crops of agricultural areas. Forage grasses are herbaceous plants that are divided into annuals, biennials and perennials and each of these categories is further divided into cool and warm season forage grasses.

Kentucky bluegrass (*Poa pratensis* L.), smooth brome (*Bromus inermis* Leyss.), orchardgrass (*Dactylis glomerata* L.), red fescue (*F. rubra* L.), perennial ryegrass (*Lolium perenne* L.) and sheep fescue (*Festuca ovina* L.) of cool-season perennial forage grasses are the most well know species furnish essential energy, minerals and fibers. These species shows considerable variations in yield, morphological characteristics and feeding value (protein, fiber, minerals, vitamins, seconder metabolites as flavonoids contents and etc.) at different ecological conditions (altitude, slope aspect and amount of rainfall depending on them, soil type and etc.). For this reason, these characters of the same species should be known under different ecological condition. Ref. [5] stated that the crude protein content and fractionation varied depending on the forage crop species or varieties. High-producing dairy cows need hay with at least 20% crude protein (CP), less than 30% acid detergent fiber (ADF), and less than 40% neutral detergent fiber (NDF). Forages with better CP, ADF, and NDF values are not necessarily better for milk production. When CP is less than 35%, much of the forage passes through the rumen without being absorbed, so it is essentially wasted [6].

The aim of the present investigation was to determine the chemical composition (some macro minerals, crude protein, acid detergent fiber and neutral detergent fiber contents) of six dominant cool-season forage grasses (Kentucky bluegrass, smooth brome, orchardgrass, red fescue, perennial ryegrass

and sheep fescue) grown as naturally in the ungrazed forest range at northern Bulgaria ecological conditions.

II. MATERIAL AND METHODS

This study was conducted in the ungrazed forest pasture of Belovets village in Bulgaria. Kentucky bluegrass, smooth brome, orchardgrass, red fescue, perennial ryegrass and sheep fescue species (dominant grass species in the range) were collected from south aspect of pasture had an altitude of 614-641 m, with a total precipitation of 525 mm on average and an annual overall temperature of 10.8 °C. The pasture was formed under the oak (*Quercus* sp.) forests and has been maintained since ten years by the ungrazed of wild and domesticated animals. Soil properties of pasture are presented in Table I.

TABLE I
SOIL TRAITS OF PASTURE

Indices	Values
pH	6.3±0.02
Organic Matter,%	4.8±0.05
P ₂ O ₅ , kg ha ⁻¹	67.7±0.11
K ₂ O, kg ha ⁻¹	340.4±0.20

Approximately 450 g biomass for each species were collected at full bloom stage, which were chosen not damaged by biotic and abiotic factors [7]. Whole plant samples were sterilized with 2% sodium hypochlorite solution for 15 min and washed distilled water three times [8] and immediately dried at 55 °C for 48 h and stored room temperature [9]. All dried samples were ground through a 1 mm screen [10].

After plant samples were wet-fired with nitric-perchloric acid, phosphorus (P) content (in DM, %) was determined spectrophotometrically. The potassium (K), calcium (Ca) and magnesium (Mg) contents (in DM, %) were found using an atomic adsorption spectrophotometer. Samples were analyzed for NDF (in DM, %), ADF (in DM, %) [11] and N using the Kjeldahl procedure [12]. The CP was then calculated by multiplying the N content by 6.25. All samples were analyzed in triplicate for CP, ADF, NDF and mineral contents. The data were analyzed according to one-way analysis of variance (ANOVA) by SPSS 13.0 (SPSS Inc., Chicago, IL, USA) statistical software and the significant differences among means were identified by Duncan's multiple range tests at a significance level of $P < 0.01$.

III. RESULTS AND DISCUSSION

The results are given in tables II and III. A significant forage grass species were found for CP, NDF, ADF, Ca, K and P ratios measurements. The highest CP (14.23 %), Ca (3.88 %), K (3.22 %) ratios were determined in smooth brome, whereas the lowest P ratio (0.22 %) was found in same plant. A forage quality property of grasslands varies with different botanical composition (grasses and legumes ratios, etc.), management and improvement applications, soil characteristics, ecological conditions, biotic stress factors and growth stages of plants. Generally, grass species

characteristically contain lower protein contents (8-22%) compared with legume species (12-26%) [13].

TABLE II
THE NDF, ADF AND CP CONTENTS IN SOME GRASS SPECIES (IN DM)

Species	CP (%) ^Y	NDF (%)	ADF (%)
Kentucky bluegrass	12.88e	54.67c	30.27b
Smooth brome	14.23a	55.11c	30.19b
Orchardgrass	14.00b	54.23d	30.38b
Red fescue	13.56c	55.44c	29.78bc
Sheep fescue	13.20d	62.10a	33.78a
Perennial ryegrass	13.54c	56.77b	30.74b
LSD	0.207	0.997	0.984
Sign.	**	**	**

**_Y: $P < 0.01$, ^Y: Forage grass species with different letter for the same column are significantly different ($P < 0.01$)

TABLE III
THE CALCIUM, PHOSPHORUS, MAGNESIUM AND POTASSIUM CONTENTS IN SOME GRASS SPECIES (IN DM)

Species	Ca (%) ^Y	K (%)	P (%)	Mg (%)
Kentucky bluegrass	2.98b	2.80c	0.29b	0.26
Smooth brome	3.88a	3.22a	0.22c	0.26
Orchardgrass	3.00b	2.85c	0.31a	0.27
Red fescue	2.89b	2.90bc	0.30ab	0.28
Sheep fescue	3.11b	2.94b	0.29b	0.28
Perennial ryegrass	2.87bc	3.00b	0.28b	0.27
LSD	0.457	0.113	0.054	
Sign.	**	**	**	NS

**_Y: $P < 0.01$, ^Y: Forage grass species with different letter for the same column are significantly different ($P < 0.01$); NS: $P > 0.01$

Sheep fescue produced more ADF (33.78 %) and NDF (62.10 %) ratios than other species (Table 2). Grass cell walls may contain cellulose, hemicellulose, protein, lignin, cutin, waxes and minerals as well as pectin. The digestibility of its negatively correlated with both the cell wall content and lignin content within the cell wall. The NDF approximates the total cell wall constituents including hemicelluloses; however, ADF primarily represents cellulose, lignin and ash. In general, forages that contain less than 70% NDF and more than 8% CP will contain enough digestible protein and energy, vitamins, and minerals to maintain older animals. Thus, even many low quality forages and crop residues can meet the maintenance needs of some classes of animals, if protein and minerals are adequate [14], [15]. Ref. [16] found that the highest NDF (59.5-72.7%) and ADF (35.6-45.9%) ratios for Kentucky blue grass and smooth brome. Seasonal forage quality variation of twelve cool season grass species were investigated by [17]. They reported that the ADF ratios of perennial ryegrass varied from 20.2 to 27.7%.

The Mg ratio ranged from 0.23 to 0.29 % in grass species ($P > 0.01$) (Table 3). Mineral values in forage crops depends on

soil traits and available amounts of elements in it, fertilization and other cultivation applies, climatic conditions as well as plant growth stages and different morphological parts of crops. On the other hand, fiber content of forage crop species are affected above-mentioned many factors. Ref. [18] reported that the requirement for major mineral nutrients for gestating beef cows or lactating beef cows is 0.6-0.8 % (w/w) for K, 0.18-0.44 % for Ca, 0.18-0.39 % for P and 0.04-0.10 % for Mg. The K, Ca and Mg levels in plants are usually in the range 1.39-2.50 %, 0.77-3.00 % and 0.20-1.20 %, respectively, which is adequate for plant growth [19]-[21]. Ref. [22] studied content of mineral elements in some grasses and legumes and obtained similar values for K ratio (14.4±1.9 g kg⁻¹, red fescue and 14.3±1.7 g kg⁻¹, smooth brome), Ca ratio (4.82±0.4 g kg⁻¹, perennial rye grass; 4.49±1.1 g kg⁻¹, smooth brome and 3.80±0.91 g kg⁻¹, orchardgrass), P ratio (1.7±0.39 g kg⁻¹, smooth brome) and Mg ratio (1.02±0.81 to 1.76±0.27 g kg⁻¹, all grasses). Ref. [23] reported the CP, Ca, Mg, K, P ratios ranged from 5.45%, 0.46%, 0.08%, 0.77% and 0.14%, respectively in red fescue. They obtained that the same values ranging from 6.90%, 0.51%, 0.12%, 2.66% and 0.22%, respectively in perennial ryegrass. Ref. [24] determined that the mineral contents of some cereal forages grown as naturally pastures, their obtained that K, Ca, P and Mg ratios ranging from 1.99-3.25 %, 0.09-1.15 %, 1.10-1.19 % and 0.07-0.26%, respectively.

According to the results, mineral, crude protein, ADF and NDF contents in this range grasses are generally similar among the species. The mineral contents of those are generally adequate to meet the needs of livestock. Therefore, sheep fescue, red fescue, perennial ryegrass, Kentucky bluegrass, orchardgrass and smooth brome can be sown and grazing to obtain mineral, fiber and crude protein contents in similar ecological conditions.

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