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Research Article
Chemical Composition of Six Grass Species (*Poaceae* sp.) from Protected Forest Range in Northern Bulgaria

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Abstract

Background and Objective: The forage grasses shows considerable variations in yield, morphological characteristics and feeding value at grazed, ungrazed and different ecological conditions. For this reason, these characters of the same species should be known under different ecological conditions. The aim of the present investigation was to determine the some forage quality traits six dominant cool-season forage grasses grown as naturally in the protected forest range at northern Bulgaria ecological conditions. **Materials and Methods:** Samples were collected (approximately 450 g biomass) for two years 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 (%) and neutral detergent fiber (%) were determined in these dried (at 55°C for 48 h) samples. The crude protein content dry matter (%) was determined by the micro-Kjeldahl method. All samples were analyzed in triplicate. **Results:** 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 0.26-0.28%. The mineral contents of those are generally adequate to meet the needs of livestock. **Conclusion:** Therefore, sheep fescue, red fescue, perennial ryegrass, Kentucky bluegrass, orchardgrass and smooth brome can be grazed to obtain mineral, fiber and crude protein contents in similar ecological conditions of the world.

Key words: Acid detergent fiber, crude protein, forage grass, mineral content, neutral detergent fiber

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The permanent grassland is estimated[1] at 3.27 billion ha, or about 25% of the world's landmass. Their area is cover 75.7 million ha 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 and 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 (*Poapratensis* 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 conditions. Ates[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 some forage quality characteristics (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 protected forest range under northern Bulgaria ecological conditions.

Table 1: Soil traits of pasture

Indices	Values
pH	6.3±0.02
Organic matter (%)	4.8±0.05
P_2O_5 (kg ha^{-1})	67.7±0.11
K_2O (kg ha^{-1})	340.4±0.20

MATERIALS AND METHODS

This study was conducted during two years (April-June) in the protected forest range of Belovets village in northern 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 725 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 10 years by the ungrazed of wild and domesticated animals. Soil properties of pasture were presented in Table 1.

Approximately 450 g biomass for each species was collected at full bloom stage, which was 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 (DM, %) was determined spectrophotometrically. The potassium (K), calcium (Ca) and magnesium (Mg) contents (DM, %) were found using an atomic adsorption spectrophotometer. Samples were analyzed for NDF (DM, %), ADF (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.

Statistical analysis: 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 $p>0.01$.

RESULTS AND DISCUSSION

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. 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. Sheep fescue produced more ADF (33.78%) and NDF (62.10%) ratios than other species (Table 2). The Mg ratio ranged from 0.26-0.28% in grass species ($p>0.01$) (Table 3).

Generally, grass species characteristically contain lower protein contents (8-22%) compared with legume species (12-26%)[13]. 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]. Cymbaluk[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 Martinson *et al.*[17]. They reported that the ADF ratios of perennial ryegrass varied from 20.2 to 27.7%. Yavuz and Karadag[18] emphasized that NDF and ADF ratios ranged from 61.64-64.81 and 38.44-41.37%, respectively, in orchardgrass.

Mineral and protein 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. NRC[19] 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[20-22]. Juknevicius and Sabiene[23] 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 ± 0.81-1.76 ± 0.27 g kg^{-1}, all grasses). Acar *et al.*[24] 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. Gursoy and Macit[25] 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. Todorova *et al.*[26] and Tuna *et al.*[27] found that crude protein content of *Chrysopogon gryllus* varied from 3.85-15.18% under central Balkan mountain and Tekirdag ecological conditions. Beyene and Mlambo[28] researched botanical and chemical composition of 7 warm season grass species (*Bothriochloa radicans, Cynodon dactylon, Digitaria argyrograpta, Digitaria longiflora, Eleusine coracana, Panicum maximum* and *Urochloa mosambicensis*) in semi-arid communal rangelands of Swaziland and obtained lower values for CP (5.0-9.5%).

Table 2: The ndf, adf and cp contents in some grass species (DM)

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

*: Forage grass species with different letter for the same column are significantly different; **p<0.01

Table 3: Calcium, phosphorus, magnesium and potassium contents in some grass species (DM)

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

*Forage grass species with different letter for the same column are significantly different, **: p<0.01, NS: p>0.01

CONCLUSION

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 grazed to obtain mineral, fiber and crude protein contents in similar ecological conditions of the world.

SIGNIFICANCE STATEMENT

This study discovers the some forage quality traits of 6 dominant cool-season forage grasses (Kentucky bluegrass, smooth brome, orchard grass, red fescue, perennial ryegrass and sheep fescue) grown as naturally the protected forest range under northern Bulgaria ecological conditions that can be beneficial for animal feeding. The forage quality properties of this grass species found in protected forest pastures of northern Bulgaria has not been investigated. This study will help the researcher to uncover the critical areas of forage quality traits in 6 dominant cool-season forage grasses under northern Bulgaria ecological conditions that many researchers were not able to explore. Thus, a new theory on animal feeding may be arrived at.

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