Bulgarian Journal of Agricultural Science, 29 (No 3) 2023, 430–439

Analysis and evaluation of the quality of fodder from perennial fodder crops in mountain conditions

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Abstract

Bozhanska, T. (2023). Analysis and evaluation of the quality of fodder from perennial fodder crops in mountain conditions. *Bulg. J. Agric. Sci., 29 (3)*, 430–439

The nutritional value of fodder from perennial grass crops was assessed on the basis of chemical composition and *in vitro* digestibility of the dry matter. The fodder mass of *Bromus inermis* Leyss. has the best quality parameters. The content of CP exceeds the average value of the indicator by 17.7%. Biomass has the lowest concentration of ADL (34.46 g kg^{-1}) and the highest IVDMD (695.85 g kg^{-1}). Fodder, obtained from *Lolium perenne* L., has the highest nutritional value and digestible dry matter. The excess in the average values of the indicators is from 7.2% to 20.8% and from 1.6% to 5.5%, respectively. The species registered the lowest content of NDF (569.46 g kg^{-1}), ADF (317.86 g kg^{-1}) and cellulose (251.70 g kg^{-1}). The grass stands of *Lolium perenne* L. and *Festuca arundinaceae* Scherb have the highest potential nutritional value (FUM – 0.76 in kg DM and FUG – 0.70 in kg DM). Changes in fodders quality characteristics are insignificant in terms of potential dry matter intake. The average values of the indicator vary from 1.84% (*Dactylis glomerata* L.) to 2.12% (*Lolium perenne* L.). The biomass of *Dactylis glomerata* L. has the lowest relative feeding value (87.34%) and the highest concentration of NDF (653.28 g kg^{-1}), cellulose (297.50 g kg^{-1}), hemicellulose (298.81 g kg^{-1}) and the amount of GE (18.92 MJ/kg DM). The vegetative mass of *Lolium multiflorum* L. has the lowest IVDMD (638.48-638.65 g kg^{-1}). The fodder of *Festuca pratensis* huds has minimum values of EE (8.07 MJ/kg DM), FUM (0.74 in kg DM) and FUG (0.67 in kg DM), and the content of CFr exceeds by 3.7% the average value of the trait (37.6%).

Keywords: grass fodder; NDF (Neutral Detergent Fibers); ADF (Acid detergent fiber); ADL (Acid detergent lignin); in vitro digestibility; nutritional value

Introduction

Sustainable production of high-quality fodder requires the selection of species and cultivars of fodder crops, adapted to local soil and climatic conditions (Naydenova & Katova, 2015; Katova, 2015; Churkova et al., 2016). Cultivars with high yield and quality of the vegetative mass can participate in the schemes for creating grass stands and meeting the needs of ruminants (Stoycheva et al., 2019).

In the conditions of the Central Balkan Mountains, the ecological plasticity, adaptability and productivity of forage grasses of Serbian origin were compared and established (Bozhanska, 2022). *Festuca arundinaceae* Scherb (cv. K-20) has the highest productivity of fresh mass in the first (1740.7 kg/da) and second (629.6 kg/da) regrowth, and with the highest yield of dry mass in the second regrowth (226.7 kg/da).

Different species and genotypes of local meadow grasses respond specifically to the agro-ecological characteristics of the area of distribution, show higher winter and cold resistance, disease resistance and increased productivity (Parsons, et al., 2011; Sampoux et al., 2011; McDonagh et al., 2016; Mitev et al., 2016; Vasileva & Enchev, 2018). A large number of perennial meadow grasses (*Dactylis glomerata; Festuca pratensis; Bromus inermis* Leyss; *Festuca arundi-*

naceae Scherb; *Festuca rubra*; *Lolium perenne*) are of good quality, favorable chemical composition and one of the most important fodder crops in Bulgaria. They are a major component in the composition of permanent and temporary grass stands in the mountain and foothill regions of Bulgaria (Iliev et al., 2017a, b).

The biochemical characteristics of perennial meadow grasses affect the nutritional value and digestibility of animal fodder (Fernandez-Nunez et al., 2012; Gardarin et al., 2014; Barbero et al., 2020; Deroche et al., 2020; Iliev et al., 2022). The amount of fiber fraction in the dry matter is directly related to air temperature, light intensity, soil water supply, latitude, grass stand harvesting phase and methods of storing mowed grass (Van Soest, 1994).

Given the climate change, of particular interest are the species and genotypes that have stable productivity and quality in drought conditions. Placed in water-deficient conditions, the species *Dactylis glomerata* (cv. Amera and cv. Minora) and *Festuca pratensis* (cv. Skra and cv. Fantazja), registered a significant decrease in dry matter yield (by about 31%) and an increase in the values of the protein nutritional value of the fodder mass (Staniak, 2016).

Evaluation of fodder quality based on the composition of the fiber components of cell walls (as an energy source, limiting fodder intake and digestibility) and the relative nutritional value of fodder (RFV), is a determining factor in modern animal feeding systems (Reynolds, 2000; Bélanger et al., 2013; Stejskalova et al., 2013). According to Katova & Naydenova (2017), the significance of the fibrous structural components of cell walls for dry matter digestibility, crude protein, energy and mineral content, is crucial for a balanced animal diet and high productivity. The concentration of neutral and acid-detergent fibers, polyosides – hemicellulose and cellulose, acid-detergent lignin and complexes between them are key indicators of fodder quality and digestibility (Burns et al., 2012; Bélanger et al., 2013; Stoycheva & Vasileva, 2021).

The previous studies on the fiber composition and its effect on the quality of the fodder concern fodder produced from Bulgarian grass cultivars in plain conditions. According to the results, the dry matter in the grass stands of *Bromus inermis* Leyss (cv. Nika), has a proven higher content of detergent acids and hemicellulose than *Festuca arundinaceae* Scherb. (cv. Albena) and *Dactylis glomerata* (cv. Dabrava). The excess in the values of the indicators is respectively by 9.53% (NDF), 3.30% (ADF), 5.71% (hemicellulose) in tall fescue and by 7.9% (NDF), 2.43% (ADF), 5.47% (hemicellulose) in cock's foot (Naydenova, 2009).

The aim of the present study is to evaluate the quality and nutritional value of fodder biomass from perennial fodder grasses in the foot-hills of Bulgaria.

Material and Methods

The field experiment was conducted at the Research Institute of Mountain Stockbreeding and Agriculture – Troyan (in the Central Balkan Mountain), and includes seven cultivars of fodder grasses originating in Serbia:

1. Perennial ryegrass – K-11 (*Lolium perenne* L.);
2. Italian ryegrass – K-13 (*Lolium multiflorum* L.);
3. Italian ryegrass – K-29t (*Lolium multiflorum* L.);
4. Tall fescue – K-20 (*Festuca arundinaceae* Scherb.);
5. Meadow fescue – K-21 (*Festuca pratensis* Huds.);
6. Cocksfoot – K-24 (*Dactylis glomerata* L.);
7. Smooth brome grass – BV-1 exp. (*Bromus inermis* Leyss).

The variants were set by the block method, in four replications with a plot size of 5 m^2. The sowing of meadow grasses was carried out in the period 15-20 March. The seeds were scattered by hand, and a single fertilizing was applied by 6 kg N da^{-1} active substance in the form of ammonium nitrate (NH_4NO_3). Sowing rate of the species is in accordance with that at 100% germination of the seeds in pure condition. The soils in the experimental area are light gray, pseudo-podzolic. The content of the main nutrients in the soil layer of 0-20 cm is: total N – 20.2 mg/1000 g; P_20_5 – 2.4 mg/100 g; K_2O – 9.9 mg/100 g; humus – 1.44% and at 20-40 cm is: total N – 8.6 mg/1000 g; P_20_5 – 1.2 mg/100 g; K_2O – 5.9 mg/100 g; humus – 0.96%.

The grass stands were mowed in the tasseling/ear formation phase for grasses. During the experimental period, nine cuttings were carried out, of which three in the year of sowing (2016) – in the form of sanitary mowing and six (two each year), distributed in the second 2017), third (2018) and fourth (2019) vegetation.

The chemical composition of dry feed was analyzed, according to *Weende* analysis: Crude protein (CP, % DM), according to *Kjeldahl* (according to BDS/ISO-5983); Crude fiber (CFr, % DM). Feed nutritional value was assessed by the Bulgarian system as feed unit for milk (FUM), and feed units for growth (FUG) and calculated on the basis of equations, according to the experimental values of CP, CFr, CF (Crude fat, according to BDS/ISO-6492) – by extraction into a *Soxhlet* extractor) and NFE (Nitrogen-free extractable substances) = 100 – (CP, % + CFr, % + CF, % + Ash, % + Moisture, %), recalculated by the coefficients for digestibility by Todorov (2010) are found Gross energy (GE, MJ/kg DM) = 0.0242*CP + 0.0366*CF + 0.0209*CFr + 0.017*NFE – 0.0007*Zx, and Exchangeable energy (EE, MJ/kg DM) = 0.0152*DP (Digestible protein) + 0.0342*Dft (Digestible fat) + 0.0128*DF (Digestible fibers) + 0.0159*DNFE (Digestible Nitrogen-free extractable) – 0.0007*Zx.

The fiber structural elements in plant cell were analyzed in a laboratory: Neutral Detergent Fibers (NDF, g kg^{-1} DM); Acid detergent fiber (ADF, g kg^{-1} DM) and Acid detergent lignin (ADL, g kg^{-1} DM), according to detergent analysis of Van Soest and Robertson (1979), and enzyme *in vitro* digestability of dry matter (IVDMD, g kg^{-1} DM), according to two-step pepsin-cellulose method of Aufrere (1982). The polyoses were empirically calculated: Hemicellulose (g kg^{-1} DM) = NDF – ADF and Cellulose (g kg^{-1} DM) = ADF – ADL.

Evaluation of feeding value on the basis of fiber components (Linn & Martin, 1991):

- Digestible Dry Matter (DDM, % = 88.9 – (0.779 x ADF in %);
- Dry Matter Intake (DMI, % = 120/NDF in %);
- Relative Feeding Value (RFV, % = DDM x DMI/1.29).

Statistical data processing includes correlation and regression analysis with calculated theoretical regression lines (ANOVA). To evaluate the data on changes in the composition, digestibility and nutritional value of fodder, the following were calculated: arithmetic mean (X, cm); standard deviation (SD, cm) and variation coefficient (CV, %).

Results and Discussion

Fiber structural components of cell walls and in vitro dry matter digestibility in perennial meadow grasses

Neutral Detergent Fibers are a laboratory indicator with a significant rank for fodder quality and predicting its free intake by animals (Naydenova & Todorova, 2009). On average for the study period, the fodder biomass of *Lolium perenne* L. (cv. K-11) has the lowest content of neutral detergent fibers (569.46 g kg^{-1}), acid-detergent fibers (317.86 g kg^{-1}) and cellulose (251.70 g kg^{-1}) (Table 1).

The biological sufficiency and potential fodder, intake by animals, depends to a large extent on the content of fully digestible polyoside, hemicellulose and incompletely digestible cellulose.

According to our results, the dry matter in the stands of *Dactylis glomerata* L. (cv. K-24) has the highest concentration of NDF (653.28 g kg^{-1}), cellulose (297.50 g kg^{-1}) and hemicellulose (298.81 g kg^{-1}). Hemicellulose is a polysaccharide that affects the assimilation and digestibility of fodder by ruminants.

The fodder biomass of *Festuca pratensis* Huds. (cv. K-21), has a higher content of fibrous structural components of the cell walls than *Festuca arundinaceae* Scherb. (color K-20). The excess in the average values of the indicators was respectively 7.3% (for NDF), 5.7% (for ADF), 13.8% (for ADL), 9.2% (for hemicel) and 3.5% (for celul). The vegetative mass of *Festuca arundinaceae* Scherb. recorded approximately 2.0% higher *in vitro* digestibility of dry matter compared to *Festuca pratensis* Huds.

Similar comparative results for both species are presented by Smoliak & Bezeau (1967), Imani et al. (2009) and Lou et al. (2018). The age of grass stand, the amount of lignin and the evaluation of the degree of lignification are traits that affect the fodder quality (Naydenova & Katova, 2013). The amount of lignin acts inversely on grass biomass digestibility (Jung, 1997). In the present experiment, according to the analysis of the lignin fraction (ADL), a significant difference in the values of the indicator was found in the cultivars of *Lolium multiflorum*. The concentration of the quality indicator in the grass stands of cv. K-29t exceeds by 76.7% those of cv. K-13 (61.22 g kg^{-1}). The dry matter in cv. K-29t also has the highest average values of acid-detergent fibers (361.11 g kg^{-1}), acid-detergent lignin (108.15 g kg^{-1} and 18.6% lower content of easily degradable polysaccharide, such as hemicellulose relative to the maximum mean value. *In vitro* digestibility of the dry matter for cv. K-29t (638.48 g kg^{-1}) and cv. K-13 (638.65 g kg^{-1}) is almost identical.

Badrzadeh et al. (2008), found a difference in the fiber composition of the plant mass, which is due to seasonal fluctuations in the area of cultivation, genotype, botanical characteristics of plants and the ratio between leaf and stem mass.

In the period 2017-2019, only in the dry matter from grass stands of *Bromus inermis* Leyss. (cv. BV-1exp.), we observe a decreasing trend in the values of acid-detergent lignin (by 13.1 to 40.1%) and in the coefficient determining the degree of lignification (by 13.9 to 29.5%) (Figure 1). *Bromus inermis* Leyss. (cv. BV-1exp.), has the lowest concentration of acid-detergent lignin (34.46 g kg^{-1}), which positively affected the *in vitro* digestibility of the dry matter. The vegetative mass has maximum values of the trait (695.85 g kg^{-1}), compared to those of the other included in the experiment species (cultivars) of perennial meadow grasses.

The biological process of lignification is assessed as a major factor, limiting the nutritional value of fodder and inhibiting dry matter digestibility (Naydenova, 2009). Our evaluation, given the changes (from the second to the fourth vegetation) in the degree of lignification for cultivars of *Lolium multiflorum* L., is the result of the coefficients indicated by years: 12.01 (2017), 8.57 (2018), 8.57 (2019) – for grade cv. K-13 and 8.54 (2017), 8.54 (2018), 36.20 (2019) – for grade cv. K-29t.

In *Dactylis glomerata* L. (cv. K-24), *Lolium perenne* L. (cv. K-11), *Festuca arundinaceae* Scherb. (cv. K-20) and *Festuca pratensis* Huds. (cv. K-21), there was a significant increase in the average values of the lignification process in

Table 1. Fiber structural components of cell walls and *in vitro* digestibility of dry matter (g kg^{-1}) of perennial meadow grasses (cultivars)

Indicator	NDF	ADF	ADL	Hemicel	Celul	IVDMD
Lolium perenne L. (cv. K-11)						
2017	517.69	291.78	44.18	225.91	247.60	751.73
2018	622.60	332.20	44.00	290.40	288.20	675.02
2019	568.10	329.60	110.30	238.50	219.30	652.12
Mean	569.46	317.86	66.16	251.60	251.70	692.96
SD	52.47	22.62	38.23	34.18	34.63	52.17
Lolium multiflorum L. (cv. K-13)						
2017	632.48	347.89	75.96	284.59	271.93	669.31
2018	621.70	347.80	53.30	273.90	294.50	617.21
2019	635.20	340.90	54.40	294.30	286.50	629.43
Mean	629.79	345.53	61.22	284.26	284.31	638.65
SD	7.14	4.01	12.78	10.20	11.44	27.25
Lolium multiflorum L. (cv. K-29t)						
2017	578.02	340.04	49.34	237.98	290.70	636.13
2018	621.70	358.20	53.10	263.50	305.10	679.12
2019	613.40	385.10	222.00	228.30	163.10	600.19
Mean	604.37	361.11	108.15	243.26	252.97	638.48
SD	23.20	22.67	98.62	18.18	78.16	39.52
Festuca arundinaceae Scherb. (cv. K-20)						
2017	591.29	329.64	43.46	261.65	286.18	702.25
2018	568.00	309.80	47.60	258.20	262.20	688.73
2019	636.80	353.40	124.40	283.40	229.00	635.73
Mean	598.70	330.95	71.82	267.75	259.13	675.57
SD	34.99	21.83	45.58	13.66	28.71	35.16
Festuca pratensis Huds. (cv. K-21)						
2017	600.71	322.24	32.38	278.47	289.86	689.00
2018	630.70	325.00	37.20	305.70	287.80	689.85
2019	695.40	402.60	175.70	292.80	226.90	608.45
Mean	642.27	349.95	81.76	292.32	268.19	662.43
SD	48.39	45.62	81.39	13.62	35.77	46.75
Dactylis glomerata L. (cv. K-24)						
2017	633.44	351.81	33.70	281.63	318.11	683.93
2018	627.40	344.40	48.70	283.00	295.70	673.03
2019	699.00	367.20	88.50	331.80	278.70	654.21
Mean	653.28	354.47	56.97	298.81	297.50	670.39
SD	39.71	11.63	28.32	28.58	19.77	15.03
Bromus inermis Leyss. (cv. BV-1exp.)						
2017	631.49	347.26	41.89	284.23	305.37	690.5
2018	591.60	310.70	36.40	280.90	274.30	716.92
2019	630.50	336.30	25.10	294.20	311.20	680.13
Mean	617.86	331.42	34.46	286.44	296.96	695.85
SD	22.75	18.76	8.56	6.92	19.84	18.97

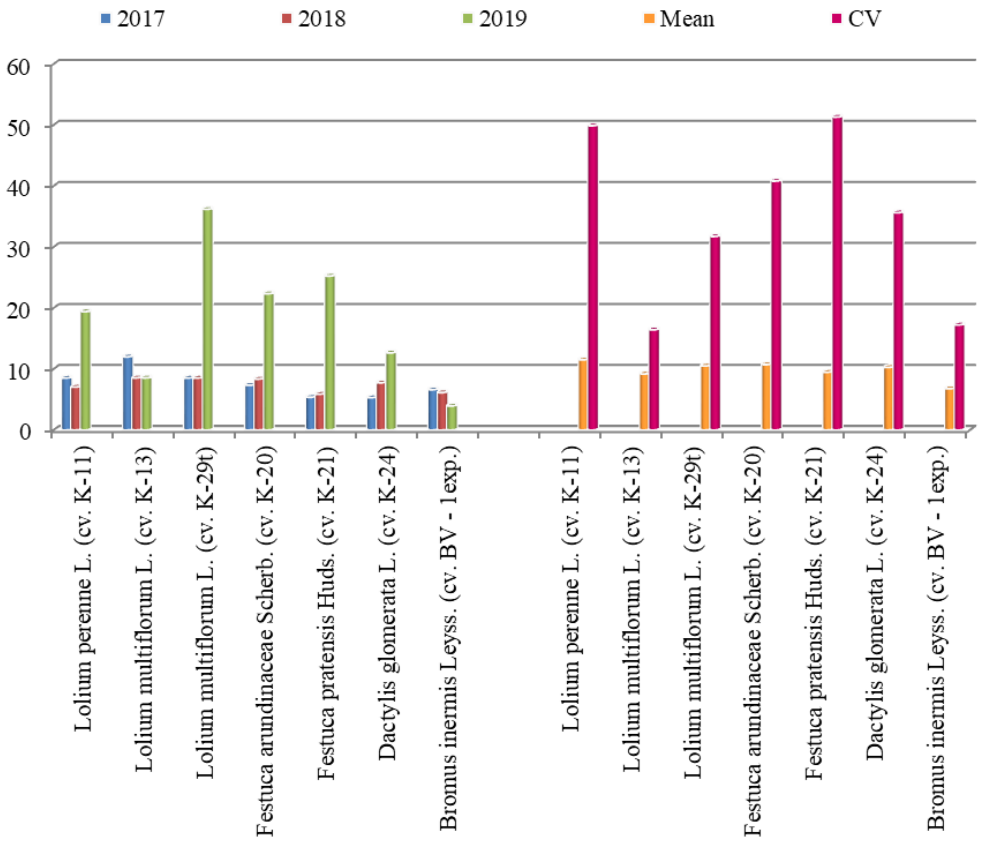

Fig. 1. Degree of lignification of perennial meadow grasses (coefficient)

the dry matter by 137.9%, 174.7%, 204.4% and 368.6%, respectively, with a high coefficient of variation (CV = 35.64-51.32%).

For the experimental period, with the highest degree of lignification (coefficient 11.54) are the grass stands with *Lolium perenne* L. (cv. K-11), while the lowest (coefficient 6.8) one was registered in the grass stands with *Bromus inermis* Leyss. (cv. BV – 1exp.).

Energy nutritional value of perennial meadow grasses

For the experimental period, the fodder mass of *Dactylis glomerata* L. (cv. K-24) had the highest average gross energy value (18.92 MJ/kg DM), followed by *Bromus inermis* Leyss. (cv. BV-1exp.) – 18.84 MJ/kg DM and *Festuca pratensis* Huds. (cv. K-21) – 18.73 MJ/kg DM (Table 2). The lowest value of the indicator (18.48 MJ/kg DM) is the fodder of *Festuca arundinaceae* Scherb. (cv. K-20).

The amount of energy associated with satisfying the basic physiological processes in animals varies from 8.07 MJ/kg DM (*Festuca pratensis* Huds.) to 8.26 MJ/kg DM (*Lolium perenne* L.). In the case of cultivars of *Lolium multiflorum* L., the values of the indicator are completely identical (8.13 MJ/kg DM). The amount of metabolic energy in the biomass of *Festuca arundinaceae* Scherb. (cv. K-20) is 2.1% higher than *Festuca pratensis* Huds. (cv. K-21).

Exchangeable energy in grass stands of *Dactylis glomerata* L. (cv. K-24) and *Bromus inermis* Leyss. (cv. BV-1exp.) is 8.12 MJ/kg DM and 8.21 MJ/kg DM, respectively.

The vegetative mass of *Lolium perenne* L. (cv. K-11) and *Festuca arundinaceae* Scherb. (cv. K-20) has the highest content of feed units for milk (0.76 in kg DM) and growth (0.70 in kg DM). Regardless of the amount of FUM (0.75 in kg DM) and FUG (0.68 in kg DM) is the biomass of the cultivars *Lolium multiflorum* L., *Dactylis glomerata* L. and *Bromus inermis* Leyss. Compared to other perennial grasses, grass stands with *Festuca pratensis* Huds (cv. K-21) record the lowest values of feed units (FUM – 0.74 in kg DM and FUG – 0.67 in kg DM) in the dry matter.

The energy nutritional value of fodder includes the biological metabolism and the quantitative ratio of nutrients in the dry matter. Changes in the nutritional value of the studied perennial meadow grasses did not show a significant

Table 2. Energy nutritional value of perennial meadow grasses (cultivars)

Indicator	GE_MJ	EE_MJ	FUM	FUG	DDM	DMI	RFV
Lolium perenne L. (cv. K-11)							
2017	18.92	8.36	0.77	0.70	66.15	2.32	118.80
2018	18.91	8.21	0.75	0.68	63.04	1.93	94.12
2019	18.49	8.22	0.76	0.69	63.19	2.11	103.49
Mean	18.77	8.26	0.76	0.70	64.13	2.12	105.47
SD	0.25	0.08	0.01	0.01	1.76	0.20	12.46
CV	1.31	0.99	1.08	1.34	2.74	9.22	11.81
Lolium multiflorum L. (cv. K-13)							
2017	18.99	8.01	0.73	0.66	61.79	1.90	90.95
2018	18.26	8.24	0.76	0.70	61.79	1.93	92.41
2019	18.34	8.13	0.75	0.69	62.34	1.89	91.32
Mean	18.53	8.13	0.75	0.68	61.97	1.91	91.56
SD	0.40	0.12	0.02	0.02	0.31	0.02	0.76
CV	2.15	1.46	2.10	3.26	0.51	1.09	0.83
Lolium multiflorum L. (cv. K-29t)							
2017	18.48	8.09	0.75	0.68	62.41	2.08	100.45
2018	18.75	8.12	0.75	0.68	61.01	1.93	91.25
2019	18.42	8.17	0.75	0.69	58.91	1.96	89.39
Mean	18.55	8.13	0.75	0.68	60.78	1.99	93.70
SD	0.18	0.04	0.00	0.01	1.76	0.08	5.92
CV	0.95	0.48	0.65	1.00	2.90	3.92	6.32
Festuca arundinaceae Scherb. (cv. K-20)							
2017	18.59	8.13	0.75	0.68	63.19	2.03	99.47
2018	18.30	8.42	0.78	0.72	64.75	2.11	106.04
2019	18.55	8.16	0.75	0.69	61.40	1.88	89.67
Mean	18.48	8.24	0.76	0.70	63.12	2.01	98.39
SD	0.16	0.16	0.02	0.02	1.68	0.12	8.24
CV	0.85	1.94	2.47	3.43	2.66	5.77	8.38
Festuca pratensis Huds. (cv. K-21)							
2017	18.51	8.11	0.75	0.68	63.82	2.00	98.78
2018	18.66	8.13	0.75	0.68	63.58	1.90	93.73
2019	19.02	7.96	0.73	0.65	57.51	1.73	76.97
Mean	18.73	8.07	0.74	0.67	61.64	1.88	89.83
SD	0.26	0.09	0.01	0.02	3.58	0.14	11.42
CV	1.41	1.16	1.60	2.43	5.80	7.31	12.71
Dactylis glomerata L. (cv. K-24)							
2017	19.40	8.09	0.74	0.66	61.48	1.90	90.35
2018	18.77	8.24	0.76	0.69	62.10	1.91	92.14
2019	18.57	8.03	0.74	0.67	60.31	1.71	80.15
Mean	18.92	8.12	0.75	0.68	61.31	1.84	87.34
SD	0.43	0.11	0.01	0.02	0.91	0.11	6.47
CV	2.29	1.36	1.67	2.41	1.48	5.99	7.39
Bromus inermis Leyss. (cv. BV-1exp.)							
2017	19.20	8.07	0.74	0.66	61.87	1.90	91.21

Table 2. Continued

2018	18.70	8.31	0.77	0.70	64.67	2.03	101.62
2019	18.84	8.24	0.76	0.69	62.73	1.90	92.47
Mean	18.91	8.21	0.75	0.68	63.09	1.94	95.10
SD	0.25	0.13	0.02	0.02	1.44	0.07	5.68
CV	1.34	1.56	2.09	3.05	2.28	3.72	5.98

GE (MJ/kg DM); EE (MJ/kg DM); DDM (%); DMI (%); RFV-relative (%); FUM (n in kg DM) and FUG (n in kg DM)

difference in potential dry matter intake (DMI). The average values of the indicator vary from 1.84% (*Dactylis glomerata* L.) to 2.12% (*Lolium perenne* L.). The fodder mass of *Lolium perenne* L. registered the highest relative nutritional value (RFV – 105.47%) and digestible dry matter (DDM – 64.13%). Compared to other perennial species, the excess in the values of the indicators is from 7.2% to 20.8% (for RFV) and from 1.6% to 5.5% (for DDM). The biomass of *Dactylis glomerata* L. (cv. K-24) has the lowest relative nutritional value (87.34%) and the highest degree of potential dry matter intake.

Using the range of values for RFV, provided by Linn and Martin (1989), we can determine that, the feed mass obtained from *Lolium multiflorum* L. (cv. K-13), *Lolium multiflorum* L. (cv. K-29t), *Festuca arundinaceae* Scherb. (cv. K-20), *Festuca pratensis* Huds. (cv. K-21), *Dactylis glomerata* L. (cv. K-24) and *Bromus inermis* Leyss. (cv. BV-1exp.), is quality class – IV (87 – 102), i. e. suitable for beef cattle and dry cows. The RFV values for *Lolium perenne* L. feed (cv. K-11) place it in quality class – III (103 – 124), i. e. suitable for good quality beef cattle, older heifers, less productive dairy cows.

Based on laboratory-determined quality indicators, such as crude protein, crude fiber, neutral detergent fiber, acid detergent fiber, acid detergent lignin and *in vitro* digestibility of the dry matter is given a rank, according to its impact on the nutritional value of fodder (Table 3). The presented ranks and their arithmetic sums determine the individual evaluation of the studied species (cultivars) of perennial meadow grasses.

For the conditions of the Central Balkan Mountain, the changes in the composition of *Bromus inermis* Leyss. (cv. BV-1 exp), allowed the formation of fodder with the best quality parameters. Biomass of this species, has the high-

Table 3. Mean values (%) and rank (R) in relation to the composition and *in vitro* enzymatic digestibility of perennial meadow grasses (cultivars)

Indicator Species (Cultivar)	CP	R	CFr	R	NDF	R	ADF	R	ADL	R	IVDMD	R	Sum R	R
Lolium perenne L. (cv. K-11)	13.2	3	36.2	2	56.9	1	31.8	1	6.6	4	69.3	2	13	2
Lolium multiflorum L. (cv. K-13)	9.6	6	38.3	5	63.0	5	34.6	3	6.1	3	63.9	6	28	5
Lolium multiflorum L. (cv. K-29t)	11.0	5	38.0	4	60.4	3	36.1	6	10.8	7	63.8	7	32	6
Festuca arundinaceae Scherb. (cv. K-20)	12.3	4	35.2	1	59.9	2	33.1	2	7.2	5	67.6	3	17	3
Festuca pratensis Huds. (cv. K-21)	12.3	4	39.0	7	64.2	6	35.0	4	8.2	6	66.3	5	32	6
Dactylis glomerata L. (cv. K-24)	13.9	2	38.8	6	65.3	7	35.4	5	5.7	2	67.0	4	26	4
Bromus inermis Leyss. (cv. BV-1 exp)	14.6	1	37.6	3	61.8	4	33.1	2	3.4	1	69.6	1	12	1
Mean	12.4		37.6		61.8		34.2		6.9		66.8			
SD	1.7		1.4		2.8		1.5		2.3		2.3			
CV	13.8		3.7		4.5		4.5		33.3		3.4			
Min	9.6		35.2		57.0		31.8		3.4		63.8			
Max	14.6		39.0		65.3		36.1		10.8		69.5			

est content of crude protein (17.7% higher than the average value of the indicator), the lowest concentration of acid detergent lignins (102.9% lower than the average value of the indicator) and 4.0% higher *in vitro* digestibility of the dry matter, compared to the average value of the indicator.

Food energy value is determined and predicted with the highest degree of reliability by the concentration of fiber components.

The low values of neutral (by 8.6%, compared to the average value of the indicator) and acidic (by 7.5%, compared to the average value of the indicator) detergent fibers determine the high quality characteristic of the vegetative mass in *Lolium perenne* L. (cv. K-11).

Festuca pratensis Huds. (cv. K-21) and *Festuca arundinaceae* Scherb. (cv. K-20) have the highest (39.0%) and the lowest (35.2%) content of crude fiber in the dry matter, respectively. The amount of fiber fraction in the composition of *Festuca arundinaceae* Scherb. is 6.8% lower than the average value of the trait.

Conclusions

Based on laboratory-tested indicators of composition, digestibility and nutritional value of perennial grass species, it was found that the grass stands of *Bromus inermis* Leyss. (cv. BV-1 exp) have the best quality characteristics. In the conditions of the Central Balkan Mountain, the species forms biomass with the highest content of crude protein (14.6%). The excess over the average value of the trait (12.4%) is by 17.7%. The fodder mass has the lowest concentration of ADL (34.46 g kg^{-1}) and the highest *in vitro* digestibility of dry matter (695.85 g kg^{-1}).

The nutritional value and quality evaluation of fodder from *Lolium perenne* L. (cv. K-11) is most influenced by the low content of NDF (569.46 g kg^{-1}), ADF (317.86 g kg^{-1}) and cellulose (251.70 g kg^{-1}). This is the species with the highest relative nutritional value (RFV) and digestible dry matter (DDM). The excess in the values of the indicators, compared to those of the other species (cultivars) is from 7.2% to 20.8% (for RFV) and from 1.6% to 5.5% (for DDM).

The highest nutritional value (FUM – 0.76 in kg DM and FUG – 0.70 in kg DM) are the grass stands of *Lolium perenne* L. (cv. K-11) and *Festuca arundinaceae* Scherb. (cv. K-20). Biomass of *Festuca arundinaceae* Scherb. is 6.8% lower crude fiber content, compared to the average value of the trait (37.6%).

The fodder weight of *Dactylis glomerata* L. (cv. K-24) has the highest concentration of NDF (653.28 g kg^{-1}), cellulose (297.50 g kg^{-1}), hemicellulose (298.81 g kg^{-1}) and gross energy (18.92 MJ/kg DM). The species has the lowest relative nutritional value (87.34%) and the lowest degree of potential dry matter uptake.

Changes in the nutritional value of the studied fodder crops did not show a significant difference in the potential dry matter intake (DMI). The average values of the indicator vary from 1.84% (*Dactylis glomerata* L.) to 2.12% (*Lolium perenne* L.).

The vegetative mass of the species *Lolium multiflorum* L. has the lowest *in vitro* digestibility of dry matter (638.48-638.65 g kg^{-1}). The average values of ADF (361.11 g kg^{-1}) and ADL (108.15 g kg^{-1}) in the dry matter of K-29t grass stands were the highest and the amount of hemicellulose the lowest (243.26 g kg^{-1}).

The fodder of *Festuca pratensis* Huds. (cv. K-21) has minimum values of metabolic energy (8.07 MJ/kg DM) and feed units for milk (0.74 in kg DM) and growth (0.67 in kg DM).

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Received: **May, 13, 2022**; *Approved*: **September, 07, 2022;** *Published:* **June, 2023**