http://dx.doi.org/10.15414/agrobiodiversity.2017.2585-8246.482-487

AGROBIODIVERSITY 2017
FOR IMPROVING NUTRITION, HEALTH AND LIFE QUALITY

OPEN ACCESS

THE BIOCHEMICAL COMPOSITION OF PLANT RAW MATERIAL OF *PANICUM VIRGATUM* L. VARIETIES

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Received 25. 6. 2017 Revised 29. 6. 2017 Published 30. 11. 2017

In article represented the results of a biochemical study of nine varieties and one cultivar of *Panicum virgatum* L. The investigations were carried out in the stage of seed ripening that is the most productive phase for these plants. Plant raw material collected and analyzed in the department of the Cultural flora of M.M. Gryshko National Botanical Garden of NAS of Ukraine. The determination of dry matter was conducted by drying to constant mass; total content of saccharides and monosaccharides – by Bertrand method in water extracts; ascorbic acid – by 2.6-dichlorophenol-indophenol titration of acid extracts; carotene – by spectrophotometric method in petrol extracts; ash – by combustion at 300–800 °C; calcium and phosphorus – by titrimetric method in acid solutions. It's found that level of dry matter was in a range from 41.96% (*Panicum virgatum* f. SL-1) to 65.28% (*Panicum virgatum* f. RB), total content of saccharides – from 3.11% (*Panicum virgatum* f. RB) to 8.69% (*Panicum virgatum* cv. Zoriane), monosaccharides – from 1.50% (*Panicum virgatum* f. RR) to 6.94% (*Panicum virgatum* f. DB), content of ash – from 3.04% (*Panicum virgatum* f. RR) to 5.27% (*Panicum virgatum* f. SL-1), calcium – from 0.353% (*Panicum virgatum* f. SL-2) to 0.987% (*Panicum virgatum* f. PP), phosphorus – from 0.065% (*Panicum virgatum* f. RB) to 0.110% (*Panicum virgatum* f. VP), ascorbic acid – from 11.80 mg% (*Panicum virgatum* f. RB) to 61.94 mg% (*Panicum virgatum* cv. Zoriane), carotene – from 0.05 mg% (*Panicum virgatum* f. RB) to 1.06 mg% (*Panicum virgatum* f. DB). Energetic value of plant raw material was in a range from 4,102.00 Kcal/ kg (*Panicum virgatum* f. DB) to 4,325.41 Kcal/kg (*Panicum virgatum* f. RB).

Keywords: *Panicum virgatum* L.; varieties; plant raw material; biochemical properties; energetic value

Introduction

Panicum virgatum L. (switchgrass) is a perennial grass native to the USA and Canada with an array of ploidy levels and ecotypes. It is used as a pasture and range grass for forage production (Huang et al., 2003). Last time these plants have characterized by using in a branch of biofuel production (Tigunova et al., 2016). Switchgrass doesn't require annual establishment, requires fewer chemical inputs (pesticide and fertilizer) than traditional row crops, produces large quantities of biomass and provides important ecosystem service. Some research has included work on breeding and genetics, ethanol potential, establishment, field-scale production economics, weed control, harvest and fertility management, documentation of the value of ecosystem services, energy balance, and entomology. The research to date fully supports that switchgrass for bioenergy is productive, protective of the environment and profitable for the farmer (Mitchell et al., 2012). *Panicum virgatum* is a C4 species

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using the photosynthetic pathways that have higher photosynthetic, water, and nitrogen use efficiencies and greater tolerance to heat, nitrogen, and water stresses. These physiological attributes lead to high biomass productivity in switchgrass, especially under water- and nutrient-limited conditions (Parrish and Fike, 2005; Woli et al., 2012; Zegada-Lizarazu et al., 2012).

According to Kulyk (2015) and Kulyk (2016) the yield of a crude biomass of these plants was up to 24 T/ga and dried biomass – up to 20 T/ga depends on the group of ripeness. The main components of the switchgrass biomass are cellulose (35%), hemicellulose (29%), and lignin (26%) (Jefferson and McCaughey, 2012; Tigunova and Shulga, 2015). The maximal chlorophyll values were observed during anthesis (Liatukas, 2015).

Materials and methodology

Plant raw material collected from the experimental collections of Cultural Flora department of M.M. Gryshko National Botanical Garden of the NAS of Ukraine. All biochemical analyses were conducted using the above-ground part of plants of *Panicum virgatum* varieties. The determination of absolutely dry matter conducted with drying to constant weight at 100–105 °C according to Yermakov (1972). The total content of saccharides and monosaccharides were investigated by Bertrand method in water extracts. The concentration of ascorbic acid (AA) of the acid extracts determined by a 2.6-dichlorophenol-indophenol method that based on the reduction properties of AA. Both analyses carried out according to V.P. Krishchenko (1983). The concentration of total carotene determined according to Pleshkov (1985). The procedure carried out in petrol extracts by spectrophotometric method using 2800 UV/VIS Spectrophotometer, Unico. Mixtures were left in a shaker for 2 hours and their absorbance was measured at the wavelength of 440 nm (Плешков, 1985). The level of total ash was determined using the method of combustion in muffle-oven (SNOL 7.2-1100, Termolab) at 300–800 °C until the samples turned into white ash to constant weight according to Z.M. Hrycajenko et al. (2003). The concentration of calcium was determined by titration method of acid extracts with Trilon B. Phosphorus content in plants was identified in acid extracts using molybdenum solution. Calcium and phosphorus determination carried out according to H.N. Pochinok (1976). To measure of the caloric value of seeds was equipped with a calorimeter IKA C-200 (Germany). Dry plant raw material in a range from 0.1 to 0.2 g was put in the decomposition vessel (IKA C 5010/5012) that fills with medical oxygen. Experimental data were evaluated by using Excel 2010. Mean values of three replicates and standard deviations are given in Table 1, 2 and Figure 1.

Results and discussion

In the M.M. Gryshko National Botanical Garden have been investigated varieties and cultivars of *Panicum virgatum* (Рахметов та ін., 2015; Щербакова і Рахметов, 2017). Biochemical investigation of the plant has very important for evaluation raw material of a cultivated grasses. Maximizing dry matter yield is the primary objective when harvesting switchgrass for bioenergy (Mitchell et al., 2012). We identified among ten investigated samples that content of dry mass was in a range from 41.46 to 65.28%.

Because of high productivity and quality of plant raw material, the leading position among energetic plants have a sugar-containing plants that is value source for biofuel production (Рахметов та ін., 2014). The total content of saccharides was from 3.11 to 8.69% and monosaccharides – from 1.50 to 6.94% depending on varieties.

Table 1 The content of dry matter, total content of saccharides and monosaccharides in plant raw material of *Panicum virgatum* L. varieties in seed ripening phase, %

Sample	Dry matter	Total content of saccharides	Monosaccharides
***P. virgatum* f. DB**	42.10 ±0.21	7.91 ±0.48	6.94 ±0.23
***P. virgatum* f. DN**	43.86 ±0.26	7.78 ±0.13	3.76 ±0.27
***P. virgatum* f. RB**	65.28 ±0.35	3.11 ±0.37	2.05 ±0.16
***P. virgatum* f. PL**	43.42 ±0.19	4.35 ±0.02	3.75 ±0.30
***P. virgatum* f. PP**	46.82 ±0.22	8.23 ±0.15	4.72 ±0.32
***P. virgatum* f. RR**	58.34 ±0.04	4.59 ±0.15	1.50 ±0.11
***P. virgatum* f. SL-1**	41.96 ±0.88	6.04 ±0.13	4.44 ±0.03
***P. virgatum* f. SL-2**	44.31 ±0.30	4.65 ±0.24	3.08 ±0.18
***P. virgatum* f. VP**	51.33 ±0.45	6.19 ±0.10	2.38 ±0.13
***P. virgatum* cv. Zoriane**	50.45 ±0.36	8.69 ±0.27	5.95 ±0.12

In Table 2 represented the content of ash, calcium, and phosphorus in above-ground part of different varieties of *Panicum virgatum* L. in the period of seed ripening. Investigated plants characterised by the content of ash in a range from 3.19 to 5.27%. In our previous data, we analysed four varieties and one cultivar: *Panicum virgatum* f. VP, *Panicum virgatum* f. RB, *Panicum virgatum* f. VP and *Panicum virgatum* cv. Zoriane. According to obtained results, the content of dry matter was 40.70, 42.52, 36.06 and 37.14% respectively. Above-ground part of these plants accumulated 4.36% (*Panicum virgatum* f. VP), 4.70% (*Panicum virgatum* f. RB), 6.90% (*Panicum virgatum* f. VP) and 7.32% (*Panicum virgatum* cv. Zoriane) of the total content of saccharides (Рахметов та ін., 2014). As shown in Table 1 the content of monosaccharides was from 1.50% (*Panicum virgatum* f. RR) to 6.94% (*Panicum virgatum* f. DB).

Table 2 The content of ash in plant raw material of *Panicum virgatum* L. varieties in seed ripening phase, %

Sample	Ash	Calcium	Phosphorus
***P. virgatum* f. DB**	3.47 ±0.16	0.360 ±0.060	0.074 ±0.001
***P. virgatum* f. DN**	4.70 ±0.13	0.610 ±0.010	0.088 ±0.002
***P. virgatum* f. RB**	4.02 ±0.16	0.823 ±0.095	0.065 ±0.000
***P. virgatum* f. PL**	4.33 ±0.18	0.427 ±0.055	0.097 ±0.004
***P. virgatum* f. PP**	4.83 ±0.52	0.987 ±0.015	0.085 ±0.001
***P. virgatum* f. RR**	3.04 ±0.48	0.397 ±0.045	0.074 ±0.000
***P. virgatum* f. SL-1**	5.27 ±0.09	0.443 ±0.025	0.066 ±0.000
***P. virgatum* f. SL-2**	3.97 ±0.08	0.353 ±0.075	0.082 ±0.004
***P. virgatum* f. VP**	3.19 ±0.19	0.597 ±0.055	0.110 ±0.005
***P. virgatum* cv. Zoriane**	3.50 ±0.03	0.983 ±0.015	0.076 ±0.005

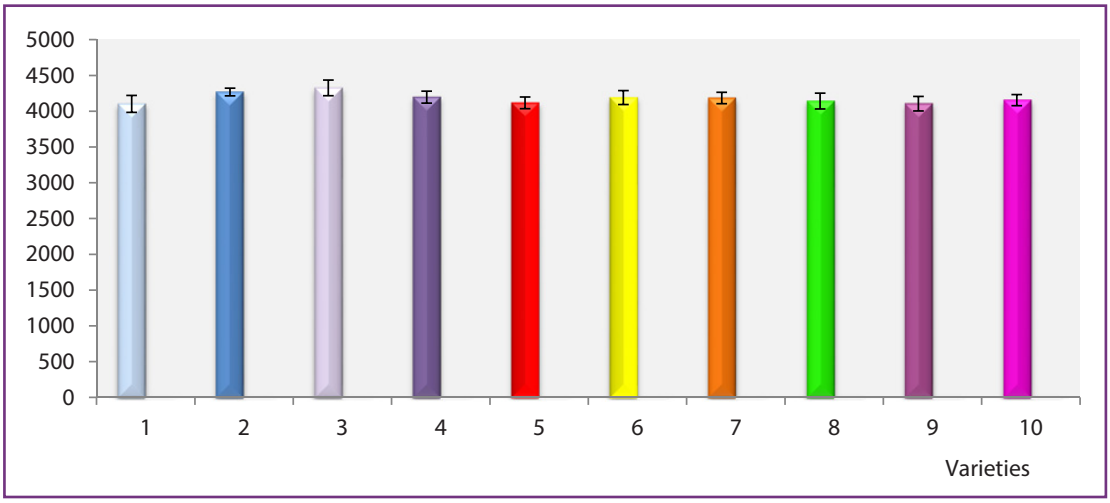

Figure 1 The energetic value of the plant raw material of *Panicum virgatum* L. varieties in a seed ripening phase, Kcal/kg
1– *Panicum virgatum* f. DB, 2 – *Panicum virgatum* f. DN, 3 – *Panicum virgatum* f. RB, 4 – *Panicum virgatum* f. PL, 5 – *Panicum virgatum* f. PP, 6 – *Panicum virgatum* f. RR, 7 – *Panicum virgatum* f. SL-1, 8 – *Panicum virgatum* f. SL-2, 9 – *Panicum virgatum* f. VP, 10 – *Panicum virgatum* cv. Zoriane

Biomass properties such as ash composition can affect energy conversion processes such as direct combustion (Zhuo et al., 2015). Investigations of ash content showed that this sign was in a range from 3.04% (*Panicum virgatum* f. RR) to 5.27 (*Panicum virgatum* f. SL-1) %. As reported Hu et al. (2010), the ash content of *Panicum virgatum* L. was from 0.4 to 4.6% depends on switchgrass population.

We identified that maximal content of calcium in ash was 0.987% (*Panicum virgatum* f. PP) and minimal – 0.353% (*Panicum virgatum* f. SL-2). The concentration of phosphorus was in a range from 0.065% (*Panicum virgatum* f. RB) to 0.110 (*Panicum virgatum* f. VP).

We investigated the accumulation of ascorbic acid in phase ripening phase. The content of ascorbic acid wasn't significant for all investigated plants. *Panicum virgatum* f. DB accumulates 19.27 mg%, *Panicum virgatum* f. DN – 30.09 mg%, *Panicum virgatum* f. RB – 11.80, *Panicum virgatum* f. PL – 13.94 mg%, *Panicum virgatum* f. PP – 28.20 mg%, *Panicum virgatum* f. RR – 13.44 mg%, *Panicum virgatum* f. SL-1 – 13.70 mg%, *Panicum virgatum* f. SL-2 – 18.62 mg%, *Panicum virgatum* f. VP – 27.86 mg%, *Panicum virgatum* cv. Zoriane – 61.94 mg%. According to Rakhmetov et al. (2014) the accumulation of ascorbic acid in above-ground part was 59.84 mg% (*Panicum virgatum* f. VP), 42.07 mg% (*Panicum virgatum* cv. Zoriane), and 23.28 mg% (*Panicum virgatum* f. RB).

It was investigated the content of carotene in above-ground part of plants of *Panicum virgatum*. Research showed that *Panicum virgatum* f. DB in the seed ripening period accumulates 1.06 mg%, *Panicum virgatum* f. DN – 0.16 mg%, *Panicum virgatum* f. RB – 0.05 mg%, *Panicum virgatum* f. PL – 0.62 mg%, *Panicum virgatum* f. PP – 0.71 mg%, *Panicum virgatum* f. RR – 0.61 mg%, *Panicum virgatum* f. SL-1 – 0.32 mg%, *Panicum virgatum* f. SL-2 – 0.74 mg%, *Panicum virgatum* f. VP – 0.55 mg%, *Panicum virgatum* cv. Zoriane – 0.81 mg%. As identified Rakhmetov et al. (2014) the content of carotene was 0.21 mg% (*Panicum virgatum* f. VP), 0.42 mg% (*Panicum virgatum* cv. Zoriane), and 0.43 mg% (*Panicum virgatum* f. RB).

It's should be noted that among investigated plants ws in a range from 4,102.00 Kcal/kg (*Panicum virgatum* f. DB) to 4,325.41 (*Panicum virgatum* f. RB). As showed previous data, obtained by Rakhmetov et al. (2014) the energetic value of plant arwmaterial was from 4,011.67 to 4,349.67 Kcal/kg.

Conclusions

Results showed that in conditions of M.M. Gryshko National Botanical Garden among the investigated plants the leader of accumulation of dry matter and calories was *Panicum virgatum* f. RB. Maximal sign of total content of saccharides and concentration of ascorbic acid was characterized for *Panicum virgatum* cv. Zoriane. The most content of monosaccharides and carotene found in plant raw material of *Panicum virgatum* f. DB. The higher level of ash observed in sample *Panicum virgatum* f. SL-1, calcium – in *Panicum virgatum* f. PP and phosphorus – in *Panicum virgatum* f. VP. To conclude, investigated plants of *Panicum virgatum* L. can be used not only as energetic plants but as fodder crops.

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