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Quality of Grain of Different Proso Millet (*Panicum miliaceum* L.) Varieties

Éva B. Ábrahám[1*] • Nóra Őri[1] • Sándor Szabó[1] • László Romhány[2] • Lajos Blaskó[1] • György Zsigrai[1]

[1] Karcag Research Institute, RISF, CAAES, University of Debrecen, Hungary
[2] Research Institute of Nyíregyháza, RISF, CAAES, University of Debrecen, Hungary

Corresponding author: * **abrahameva@agr.unideb.hu**

ABSTRACT

The quality of the grain of 5 millet varieties was examined during our research work. There were 3 varieties with white coloured grain and 2 ones with red coloured grain among the tested 5 varieties. Millet grains were husked with a laboratory rice mill, than we milled them. We determined the total scavenger capacity, the total phenolic content and different mineral element (N, P, K, Mg, Ca, Cu, Mn, Fe, Zn) contents of whole and dehulled millet grains. The tannin content was detectable only in the bran therefore we cannot take this parameter into account during the data analyses. The quality differences of the tested millet varieties were characterized. The total phenolic content of red coloured whole millet grains was significantly higher compared to that of light coloured millet grains, but there was not significant difference between the dehulled millet grains of different cultivars. The dehulling process resulted in a significant decrease in the Fe- and Mn-contents of each variety.

Keywords: mineral element content, tannin, total scavenger capacity, total phenolic content
Abbreviations: DPPH, 1,1-diphenyl-2-pycrilhydrasil; **FAAS**, flame atomic absorption spectroscopy; **GAE**, gallic acid equivalent; **TE**, Trolox equivalent

INTRODUCTION

Millets and sorghum belong to the group of the most drought-tolerant cereal grain crops. Millets can be cultivated on a wide range of soils and under various climatic conditions because of their short growing season. Millet species are vital food crops for millions of people in parts of Africa and Asia but they are an underutilized resource in the developed countries (Schery 1963; Taylor *et al*. 2006).

Alternative plants are an integral part of the modern crop production, since they contribute to the increasing biodiversity and also to the designing of a varied crop rotation. The species of this plant group provide a basis for the production of the widely popularized "functional foods". Beyond mass feeding these plants can improve the quality of our meals (Romhány and Gondola 2011). Increase of human consumption of millet would be desirable also in Hungary because millet may be an alternative food for people who are allergic to gluten (Blaskó 2010). Millet cultivation would be important from the point of view of crop rotation as well. This crop can be cultivated as a main crop and as a secondary crop after winter cereals due to its short growing period.

Application of sorghum, proso millet or buckwheat at 30% (w/w) of the total diet of rats increased HDL cholesterol without changing total cholesterol level (Cho *et al.* 2000).

Whole millet grain contained only 8.8% protein, which was lower than the protein content of the other examined cereals in the experiment of Ragaee *et al*. (2006). They found 67% starch content and 199.8 mg/kg iron content, which was extraordinary compared to the other cereal grains. The manganese content of millet was 8.1 kg/100 g, the copper content was 3.4 mg/100 g, the zinc content was 65.9 mg/100 g. In the measurement of Ragaee *et al.* (2006), millet was intermediate in total phenolic content (1387 µg/g as gallic acid equivalent) compared to other cereals.

The mineral content of millet is relatively high compared to other cereals but its high phytic acid content must be taken into consideration which inhibit the Ca-adsorption in the human body and reduce the biological availability of Mg, Zn and Fe (Léder and Monda 1987).

All sorghum and millet species contain phenolic acids, which are located in the pericarp, testa, aleurone layer, and endosperm (Hahn *et al*. 1984; McDonough *et al*. 1986). Millet grains contain substantial level of a wide range of phenolic compounds which have antioxidant activity, for which millet can be used in functional foods (Dykes and Rooney 2006). Free radicals play an important role in oxidative stress (Kamath *et al*. 2004). Antioxidants reduce oxidative damage to biomolecules by modulating the effects of reactive oxidants (Duthie *et al*. 1996).

Phenols help in the natural defence of plants against pests and diseases. In case of white varieties the measured tannin value could not indicate actual tannin content but it most likely was only a background noise caused by phenolic compounds (Dykes and Rooney 2006).

Tannin has antinutrient effects (Léder and Monda 1987) because it binds to proteins reducing the nutritional contributions of the grain (Griffiths 1985; Léder and Monda 1987).

In the experiment of Léder and Monda (1987) the tannin content of the whole proso millet grains varied between 0.055-0.178% while that of the dehulled grains between 0.023-0.034%. Lorenz (1983) compared the tannin content of different proso millet cultivars. The dark cultivars had the highest tannin content whereas the light-coloured cultivars were comparatively low in tannins. In the research of Kim *et al.* (2010) the total phenolic content ranged from 18.0 to 26.5 mg GAE/g in proso millet. The presence of polyphenols and phytate in cereal products has been shown to interfere with the bioavailability of minerals such as iron (Towo *et al*. 2004).

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Short Communication

Table 1 Total phenolic content of whole and dehulled millet grains as gallic acid equivalent (GaE) µg/g.

Cultivars	Total phenolic content (µg GaE/g)	
	Whole grain	Dehulled grain
Lovászpatonai pirosmagvú	718.6	174.8
Maxi	448.9	212.4
Gyöngyszem	549.5	215.2
Rumenka	889.7	228.5
Biserka	419.2	216.9

$LSD_{5\%}$: 1.35 GaE µg/g

Table 2 DPPH (1,1-diphenyl-2-pycril-hydrasil) radical scavenging activity in different millet cultivars (µg Trolox unit/g).

Cultivars	Total phenolic content (µg GaE/g)	
	Whole grain	Dehulled grain
Lovászpatonai pirosmagvú	102.0	11.7
Maxi	52.9	13.9
Gyöngyszem	23.7	BDL
Rumenka	53.5	BDL
Biserka	22.6	BDL

$LSD_{5\%}$: 10.57 TE µg /g

Table 3 Mineral element content of whole millet grains.

Elements		Cultivars					$LSD_{5\%}$
		Lovászpatonai pirosmagvú	Maxi	Gyöngyszem	Biserka	Rumenka	
N	(%)	2.1	1.8	2.0	1.6	2.2	0.20
P_2O_5	(%)	0.9	0.8	1.2	1.1	1.1	0.26
K_2O	(g/100 g)	0.3	0.4	0.4	0.4	0.5	0.09
Ca	(g/1000 g)	0.7	0.5	0.3	0.9	0.4	0.20
Mg	(g/1000 g)	1.6	1.4	2.0	2.1	2.0	0.56
Cu	(mg/kg)	9.0	10.5	16.3	16.3	17.9	2.73
Mn	(mg/kg)	16.3	11.7	21.5	23.0	19.4	3.91
Fe	(mg/kg)	77.8	53.0	61.5	53.0	64.3	17.63
Zn	(mg/kg)	28.0	25.6	36.6	29.4	36.0	5.96

Table 4 Mineral element content of dehulled millet grains.

Elements		Cultivars				
		Lovászpatonai pirosmagvú	Maxi	Gyöngyszem	Biserka	Rumenka
N	(%)	1.9	1.8	2.4	2.0	2.5
P_2O_5	(%)	0.8	0.6	1.2	0.8	1.2
K_2O	(g/100 g)	0.3	0.2	0.4	0.3	0.5
Ca	(g/1000 g)	0.3	0.3	0.2	1.0	0.4
Mg	(g/1000 g)	1.3	1.1	1.7	1.3	1.6
Cu	(mg/kg)	13.4	12.1	15.2	13.2	15.9
Mn	(mg/kg)	14.7	10.6	13.7	11.7	11.6
Fe	(mg/kg)	41.4	38.8	48.0	34.8	46.5
Zn	(mg/kg)	27.6	26.7	39.2	33.0	38.8

MATERIALS AND METHODS

Five Hungarian bred millet cultivars were tested during our research work. Among the tested cultivars the 'Maxi', 'Gyöngyszem' and 'Biserka' are yellow-coloured, while 'Lovászpatonai' and 'Rumenka' are red-coloured. Millet grains were dehulled with a Zaccaria No. 1. testing rice mill for 60 sec. We measured the tannin content, the total phenolic content, the 1,1-diphenyl-2-pycril-hydrasil (DPPH) radical scavenging activity, N, P_2O_5, K_2O, Ca, Mg, Cu, Mn, Fe and Zn contents of both whole and dehulled millet grains.

The tannin content was measured according to the MSZ ISO 9648: 1994 Hungarian standard.

DPPH radical scavenging activity of the millet samples was measured according to Yamaguchi *et al.* (1998). DPPH reagent solution (0.1 mmol/l) was added to the 80% (v/v) methanol extract. Distilled water was used as the blank sample. The reaction mixture was incubated for 30 min at 37°C. The absorbance was read at 517 nm against a blank sample. The calibration was done by Trolox solution. The radical scavenging activity was measured as a decrease in the absorbance of DPPH and given in Trolox unit.

The total phenolic content was measured with the method of Folin - Ciocalteu according to Singleton *et al*. (1969). Folin-Ciocalteu reagent and saturated Na_2CO_3 solution was added to the 80% (v/v) methanol extract. The absorption of the samples was measured at 750 nm. The total phenolic content was calculated from the calibration curve made with gallic acid.

The mineral element content of the samples was measured according to the MSZ-08-1783:1983 Hungarian standard. The N-content was measured with Kjeldahl-method, K_2O-content with FES, while Mg- and Ca-content with flame atomic absorption spectroscopy (FAAS) after acidic (H_2SO_4-$HClO_4$) digestion. Samples were prepared with microwave digestion for microelemental analysis (Cu, Mn, Fe and Zn content) and measured with FAAS.

RESULTS AND DISCUSSION

Total phenolic content of different millet grain extracts

Total phenolic content of the whole millet grains ranged from 419.2 to 889.7 µg GaE/g (**Table 1**). Lower total phenolic contents were found in case of the light coloured millet grains (419.2-549.5 µg GaE/g) than in case of the red coloured millet grains (718.6 and 889.7 µg GaE/g).

The process of husking reduced the total phenolic content significantly. The phenolic compounds concentrated mainly in the bran, and the phenolic content of the red coloured grains was higher than the phenolic content of the light coloured grains. The total phenolic content of the dehulled millet grains ranged from 174.8 to 228.5 µg GaE/g. There was not considerable difference between the total phenolic content of the light and the red coloured millet grains.

The DPPH radical scavenging activity of different millet grain extracts

The DPPH radical scavenging activity of the whole millet grains ranged between 22.6 to 102.0 µg TE/g (**Table 2**). The DPPH radical scavenging activity of 'Lovászpatonai pirosmagvú' was salient (102.0 µg TE/g). This parameter of 'Rumenka' (another red coloured millet cultivar) was only 53.5 µg TE/g. The DPPH radical scavenging activity of 'Maxi' was the highest (52.9 µg TE/g) among the light coloured cultivars. 'Gyöngyszem' and 'Biserka' reached only around 23 µg TE/g value. We found significant differences between the dehulled and the whole millet grains in this respect. The DPPH radical scavenging activity of the dehulled grains of 'Gyöngyszem', 'Rumenka' and 'Biserka' was below the detected limit. These parameters of the 'Lovászpatonai pirosmagvú' and 'Maxi' were 11.7 and 13.9 μg TE/g.

Element contents of different millet grain extracts

Comparing the mineral element content of the different cultivars we found no significant differences between the N-, P-, K-contents. The Ca- Mg- and microelement contents of the 'Maxi' proved to be relatively low while the Fe-content of 'Lovászpatonai pirosmagvú' was higher than that of the other varieties (**Tables 3, 4**).

Mineral element analysis of dehulled grains showed no mentionable differences between the cultivars except the relatively low P_2O_5 - and microelement contents of 'Maxi'.

The dehulling process resulted in a significant decrease of the Fe- and Mn-contents in case of each cultivar. The Fe content of the whole millet grains ranged from 53.0 to 77.8 mg/kg, and the Fe content of dehulled grains ranged from 34.8 to 46.5 mg/kg. The Mn content of whole grains varied between 11.7 to 23.0 mg/kg but that was reduced by husking to 10.6-14.7 mg/kg.

From the results it can be concluded, that the tannin content of the millet grains was below the detected limit in our measurements. The total phenolic content of red coloured whole millet grains was significantly higher than the total phenolic content of light coloured millet grains, but there was not significant difference between the dehulled millet grains of different cultivars. The DPPH radical scavenging activity of 'Lovászpatonai pirosmagvú' was higher than that of the other cultivars. The dehulling process resulted in a significant decrease of the Fe- and Mn-contents in each variety while the quantity of the other examined mineral elements did not change.

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