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PROTEIN CHARACTERIZATION AND NUTRIENT COMPOSITION OF HUNGARIAN PROSO MILLET VARIETIES AND THE EFFECT OF DECORTICATION

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Six varieties of proso millet (*Panicum miliaceum* L.) and two commercially available millets were investigated in the present study. In order to explore the nutritional potential, major nutrient composition, mineral composition, antioxidant capacity, total phenols content (related to the antioxidant capacity) and dietary fibre content were determined. The effects of decortication on these components were examined. In addition, protein profile of the varieties and amylose/amylopectin ratio of the starch were examined. The range of the values measured for major nutrient composition corresponds with data of other millet species published in earlier studies. Remarkable differences were found among the protein contents of the varieties (11.58–14.80%). Although the concentration of minerals was low in the varieties examined, in comparison with other cereals wholegrain millet seems to be nutritionally valuable because of their high dietary fibre content. Decortication had no effect on the protein and fat content of millets, however, it significantly decreased the content of crude fibre, dietary fibre, minerals, total phenols content and antioxidant capacity. Consequently the applicability of millets as functional food decreases. Decortication had no effect on the amylose/amylopectin ratio of millet. No varietal differences were found in terms of protein characteristics.

Keywords: millet, protein characterization, nutrient composition, antioxidant capacity, dietary fibre, decortication

Millets are a group of cereal species belonging mostly to the genus Panicum and Pennisetum, family Poaceae, subfamily Panicoideae. All of them are small seeded grasses having high capability of resistance to extreme environmental circumstances such as drought or low soil fertility (McDONOUGH et al., 2000; BLACK et al., 2006). Cultivated species are mostly pearl millet *(Pennisetum glaucum)* and finger millet *(Eleusine coracana)* in Africa, pearl millet, foxtail millet *(Setaria italica)*, finger millet and proso millet *(Panicum miliaceum)* in Asia, proso millet and foxtail millet in Europe, while in the American continent proso millet is the only-cultivated species. Besides these often grown species, there are other types of millets having regional importance like fonio *(Digitaria exilis)* or tef *(Eragrostis tef)*. Since they belong to different species there are significant differences among their agronomical features and their chemical composition (ICRISAT/FAO, 1996; BLACK et al., 2006).

Millets are one of the most ancient crops, which were domesticated about 10000 years ago (HOUYUAN et al., 2009). According to some stone-age fossils they were important grains in that period in the area of Hungary. With the development of milling technologies, other

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cereals replaced millets and today this cereal has become negligible in this region (BEREI et al., 1962). Nowadays, in Europe and in North America millets are used mainly as birdseed and livestock fodder. On the contrary, in the semi-arid zones of Africa and in the lower socio-economic strata of the Indian subcontinent, where common grains, wheat, corn, or rice cannot be cultivated because of the poor environmental and agricultural circumstances, millets are one of the most used staple foods and are one of the major sources of energy and protein for millions of people in these areas. About 80% of the world's millet production is used in human nutrition (ICRISAT/FAO, 1996; OBILANA & MANYASA, 2002; OBILANA, 2003). Food products from millets are unleavened bread, dumpling, porridge, extruded products, snacks, baked products, malted and fermented drinks, and non-alcoholic beverages. Many of them are made by lactic acid fermentation improving their nutritional and functional properties (BELTON & TAYLOR, 2004).

Several studies can be found in the literature dealing with nutritional, functional and technological properties of millets. In view of nutritional quality it was reported that millets are inexpensive and nutritionally valuable compared to other cereals. The major nutrient composition of millets is similar to that of other cereals, but millets contain higher levels of fat. There are considerable differences depending on species and growing conditions. Generally, they possess high antioxidant and dietary fibre content and contain high amount of some important vitamins, essential amino acids and minerals (LÉDER & MONDA, 1987; OBILANA, 2003; LÉDER, 2004; RAGAEE et al., 2006). Regular intake of millet based foods has health benefits making millets promising as functional food. As they contain no gluten they can be adapted to diet of people suffering from coeliac disease (HEGDE et al., 2005; PARK et al., 2008).

However, it is reported that in food products the presence of the seed-coat of millets leads to darker colour, chewy texture and musty odour, which hinders the applicability of millets in food industry (SHOBANA & MALLESHI, 2007). Furthermore, certain parts of seed-coat contain anti-nutritive compounds (phytates, tannins, polyphenols, tripsin inhibitor, hydrochloric acid) reducing the bioavailability of minerals and proteins (LÉDER & MONDA, 1987; GARCÍA-ESTEPA et al., 1999; JINGJUN et al., 2007; SHOBANA & MALLESHI, 2007). By dehulling of seeds these problems can be avoided, but losing the seed-coat also results in a decrease of functional components. Significant reduction was reported in the amount of some minerals, certain vitamins and in dietary fibre content (LÉDER, 2004; LESTIENNE et al., 2005; 2007; SHOBANA & MALLESHI, 2007). According to some sources, malting and fermentation reduce the level of anti-nutritive agents and improve the functional properties as well (SRIPRIYA et al., 1997; AKUBOR & OBIEGBUNA, 1999; EL HAG et al., 2002; BADAU et al., 2005).

A few literary studies can also be found dealing with protein characterization of different millet species. As millets do not form a taxonomic group their protein characteristics can be varying considerably pending their species. In general, it can be stated that millets do not possess high molecular weight subunits. Studies published so far reveal millet polypeptides with weight of not higher than 100 kDa. Some of the studies reported significant qualitative varietal differences in protein composition of millets, while others found no such dissimilarities (PARAMESWARAN & THAYUMANAVAN, 1995; KUMAR & PARAMESWARAN, 1998; MOHAMED et al., 2009).

Studies until now have been originated mostly from India and Africa. Comprehensive studies investigating Hungarian millets have not been published so far, although there are eight registered varieties of proso millet (Panicum miliaceum L.) in Hungary (CENTRAL

AGRICULTURAL OFFICE, 2008). The present study aimed to investigate the major nutrient composition, protein composition, mineral profile, functional components and the amylose/amylopectin ratio of starch in six Hungarian varieties and two commercially available millets. The second goal was to examine the effect of decortication on the nutritional properties of the studied millet varieties.

1. Materials and methods

Three pure-bred varieties of Hungarian millets (GK Alba, GK Piroska, Fertődi-2) were kindly provided by the Cereal Research Non-Profit Limited Company, Szeged and three pure-bred varieties (Biserka, Gyöngyszem, Rumenka) by the Centre for Agricultural Sciences of the University of Debrecen – Research Centre of Nyíregyháza. Two commercially available decorticated millets (Biopont, Natura) were obtained from local shops in Budapest. According to their labelling, Biopont originated from China, and Natura originated from the European Union.

Decortication of the pure-bred varieties was carried out by a laboratory procedure in the Central Food Research Institute in Budapest. The separated and cleared fractions were used for the analyses. For production of wholemeal flour millets were ground using a Cemotech 1090 Sample Mill (Tecator AB, Höganas, Sweden) equipped with 1.0 mm screen for analyses of basic chemical composition and using a KMF 100 Basic mill (IKA Werke, Staufen, Germany) with 0.5 mm screen for analyses of functional components and amylose/amylopectin ratio of total starch. The ground samples were stored in plastic pots at room temperature.

Millets were analysed for moisture and ash according to the standard (HUNGARIAN STANDARD, 2007). Crude protein content was determined by combustion method using a nitrogen analyser (A.O.A.C., 1984; Leco Instrument UK Ltd., Stockport, UK). Measurements were calibrated by dried soy flour standard. Nitrogen to protein conversation factor of 6.25 was used. Crude fibre was determined by Weende method (AN 01/78, FIBERTEC SYSTEM M, Tecator AB, Höganäs, Sweden) and crude fat by hexane extraction in a Soxhlet apparatus (AN 23/80, Soxtec System HT-6, Tecator, Höganäs, Sweden).

Mineral composition was determined by ICP-OES method using Labtest Plasmalab instrument. The digestion of the samples was carried out in concentrated nitric acid, using microwave oven.

Protein characteristic was determined by SDS-PAGE (sodium dodecyl sulphate polyacrylamide gel electrophoresis) and LOC (lab-on-a-chip) techniques. SDS-PAGE measurement and sample preparation were carried out according to SINGH and co-workers (1991) on BIO-RAD mini PROTEAN 3 cell instrument, with SDS-PAGE MW Standards (No.: 161-0303, Biorad Laboratories). Lab-on-a-chip measurements and sample preparations was accomplished according to manufacturer's protocol (Agilent Protein 80 Kit Quick Start Guide, Publication number: G2938-90063) on 80 protein kit with 2100 Bioanalyzer (Agilent Technologies, Inc., Waldbronn, Germany).

For the analysis of ferric reducing/antioxidant power (FRAP) and for the analysis of total phenols content (TPC) extracts were prepared as follows: 5.0 g flours were weighed into a flask and were mixed with 50 ml of 80% methanol for 20 min. The mixtures were kept in the refrigerator (4 °C) for 15 min and then centrifuged at 4000 r.p.m. for 5 min. Afterwards the supernatants were transferred into 50 ml volumetric flasks and the residues were subjected

to another cycle of extraction again. The extracts in the volumetric flasks were diluted to volume (50 ml) with methanol and stored dark at 4 °C until analysis.

The ferric reducing power – related to the antioxidant capacity – of the samples was measured using Ferric Reducing/Antioxidant Power Assay according to BENZIE and STRAIN (1999). Distilled water was used as blank and solution of known ferric concentration was prepared for standard.

Total phenols – related to the antioxidant capacity as well – were measured colorimetrically using Folin–Ciocalteu reagent, according to SINGLETON and SLINKARD (1977). The TPC was calculated as mg ferulic acid equivalent per 100 g flour.

Analytical determinations of total dietary fibre were performed using an enzymatic–gravimetric procedure (ICC Standard N° 156, BIOQUANT Total Dietary Fibre Kit, Merck Co., Darmstadt, Germany).

The amylose/amylopectin ratio of starch was determined by an enzymatic method (K-AMYL 04/06, Amylose/Amylopectin Assay Procedure, Megazyme Ltd., Ireland).

All of the measurements were made in triplicates. For appraising the results repeatability standard deviations of the measurements were taken into consideration.

2. Results and discussion

2.1. Major nutrient composition

The major nutrient composition (protein, crude fat, ash and crude fibre) of the decorticated and the wholegrain millet flours and some comparative data of wheat flour, wholegrain barley and sorghum are summarized in Table 1. All the measured values are similar to data of other millet species published in earlier studies and correspond to literary values of proso and pearl millet (MCDONOUGH et al., 2000; OBILANA & MANYASA, 2002; LÉDER, 2004). There were no remarkable differences between Hungarian varieties and commercially available millets. It can be stated that wholegrain millets and wheat contained similar amounts of protein. In comparison with nutrient compositions of nutritionally valuable cereals (sorghum and barley), wholegrain millets seems to be equivalent, although there were differences among their compositions. As a result of the decortication, dehulled millets contained remarkably lower amounts of ash and crude fibre than sorghum and barley and their nutrient composition was comparable to that of wheat flour.

There were significant differences in terms of protein content among the varieties (11.58–14.80%), which is noteworthy for breeders to achieve higher values. Decortication had no considerable effect on protein content. This result is in conformity with the observations of LÉDER and MONDA (1987) and LESTIENNE and co-workers (2005), however, it is not corresponding to the report made by SHOBANA and MALLESHI (2007). According to their study, the protein content of the decorticated millets was lowered by 22% compared to the wholegrain ones. This contradiction might be explained by the different decortication procedures applied in the experiments. It also has to be noted that different millet species were investigated in the studies mentioned (SHOBANA & MALLESHI (2007) worked with finger millet, LÉDER and MONDA (1987) worked with proso millet, LESTIENNE and co-workers (2005) worked with pearl millet).

Table 1. Nutrient composition of wholegrain and decorticated samples (% dry basis) ± standard deviation of triplicates

Sample		Protein	Crude fat	Ash	Crude fibre
Natura	Dehulled	13.65±0.07	2.98±0.02	1.29±0.04	2.01±0.28
Biopont	Dehulled	12.44±0.01	3.51±0.07	1.15±0.02	3.12±0.56
Biserka	Wholegrain	11.58±0.08	3.96±0.03	3.12±0.19	9.59±0.18
	Dehulled	11.23±0.04	3.32±0.04	1.00±0.06	1.20±0.1
GK Piroska	Wholegrain	13.23±0.13	3.65±0.01	2.68±0.06	14.67±0.50
	Dehulled	13.84±0.06	3.96±0.15	1.36±0.04	2.49±0.10
Gyöngyszem	Wholegrain	12.69±0.16	3.53±0.03	3.03±0.17	14.78±0.38
	Dehulled	13.17±0.02	3.00±0.06	1.02±0.05	1.81±0.04
Fertődi-2	Wholegrain	14.80±0.58	3.51±0.10	3.08±0.04	13.84±0.24
	Dehulled	15.20±0.30	3.78±0.01	1.36±0.02	1.58±0.06
Rumenka	Wholegrain	13.56±0.09	4.51±0.03	3.34±0.17	14,60±0.18
	Dehulled	14.66±0.14	4.49±0.05	1.21±0.07	1.67±0.27
GK Alba	Wholegrain	14.50±0.28	3.82±0.05	3.61±0.14	10.95±0.34
	Dehulled	14.17±0.09	4.24±0.08	1.11±0.05	1.85±0.19
Range	Wholegrain	11.58–14.80	3.5–4.5	2.7–3.6	9.6–14.8
	Dehulled	11.23–15.20	2.9–4.5	1.0–1.4	1.2–3.1
Wheat flour		8.3–19.3[a]	1.8[a]	1.25–2[a]	2.3[b]
Barley[c]	Wholegrain	9.3	2.8	1.7	16.4
Sorghum[c]	Wholegrain	8.3	3.9	2.6	13.8

[a]KHAN & SHEWRY (2009); [b]POMERANZ (1988); [c]JULIANO (1999)

No remarkable differences were found among the crude fat contents of the different varieties (3.5–4.5%). The decortication had no significant effect on fat content, which corresponds to the observation of LESTIENNE and co-workers (2005). However, in the studies made by LÉDER and MONDA (1987) and SHOBANA and MALLESHI (2007) significant decrease in fat content during decortication was reported. This contradiction might again be due to the dissimilar decortication processes used in the studies. During decortication the germ in which oil is concentrated can be separated from the seed reducing the amount of fat. Significant differences can occur depending on the nature of the decortication procedure in terms of presence or absence of the germ fraction after the process. Since millets are relatively rich in fat, qualitative analyses of their lipids would be reasonable. It is also worth mentioning that the high fat content can result in shelf-life problem as the millet flour become rancid rapidly.

As expected, wholegrain millets had remarkable higher ash and fibre content compared to the decorticated ones (Figs 1, 2). Since it is well known that the seed-coat contains high level of both, this result proves that the decortication process was successful. The decorticated varieties of millets contained relatively similar amount of ash and fibre (ranging from 1.00% to 1.36% and from 1.20% to 3.12%, respectively) independently of the ash and fibre content of the wholegrain millets (ranged from 2.68% to 3.61% and from 9.59% to 14.78%, respectively). Based on these results it can be stated that considerable differences in these components exist mainly among the seed-coat of the varieties.

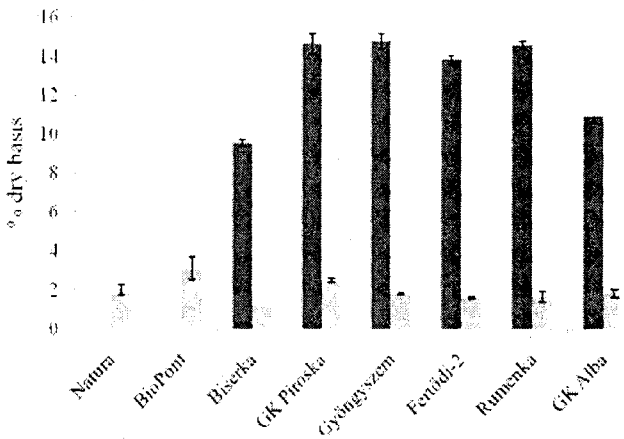

Fig. 1. Crude fibre content of decorticated and wholegrain samples with ± standard deviation of triplicates.
■: Wholemeal; □: dehulled

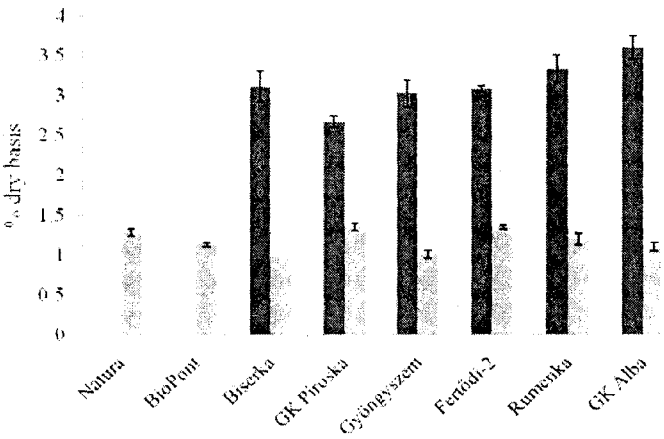

Fig. 2. Ash content of decorticated and wholegrain samples with ± standard deviation of triplicates.
■: Wholemeal; □: dehulled

2.2. Protein characterization

Results of protein characterization measurements are presented in Fig. 3. Comparing the results of conventional gel electrophoresis and those of LOC the pattern of protein profile were the same and capable to characterize the varieties although minor differences were spotted in the sizing of polypeptides. It can be explained by the deviation of the two measurements according the different migration behaviours of proteins in conventional gel electrophoresis and in microchip-chip based capillaries (BALÁZS et al., 2011). The protein characteristics of the examined Hungarian millet varieties showed negligible qualitative differences, while considerable quantitative dissimilarities were found among them. These differences presumably are not of varietal origin, but rather caused by different environmental effects and breeding conditions, which have significant impact on the protein characteristics. From all samples eight protein subunits were detected, according to their electrophoretic

mobility during LOC analysis. The following molecular masses were determined in every case: 58 kDa, 50 kDa, 40 kDa, 18 kDa, 17 kDa, 12 kDa, 7 kDa, 5 kDa. However numerous other protein peaks were detected in lower concentration – at maximum 18 different polypeptides were distinguished our analysis. The 18 kDa subunit was present in the highest concentration. In addition two further subunits can be seen in the gel image of the SDS-PAGE, out of the calibrated range of the measurements. In comparison with literary data it can be said that no contradiction were revealed in terms of protein characteristics, although there are considerable differences among the millet species examined in the present and earlier studies. It also has to be noted that no literary data can be found about protein characterization of proso millet.

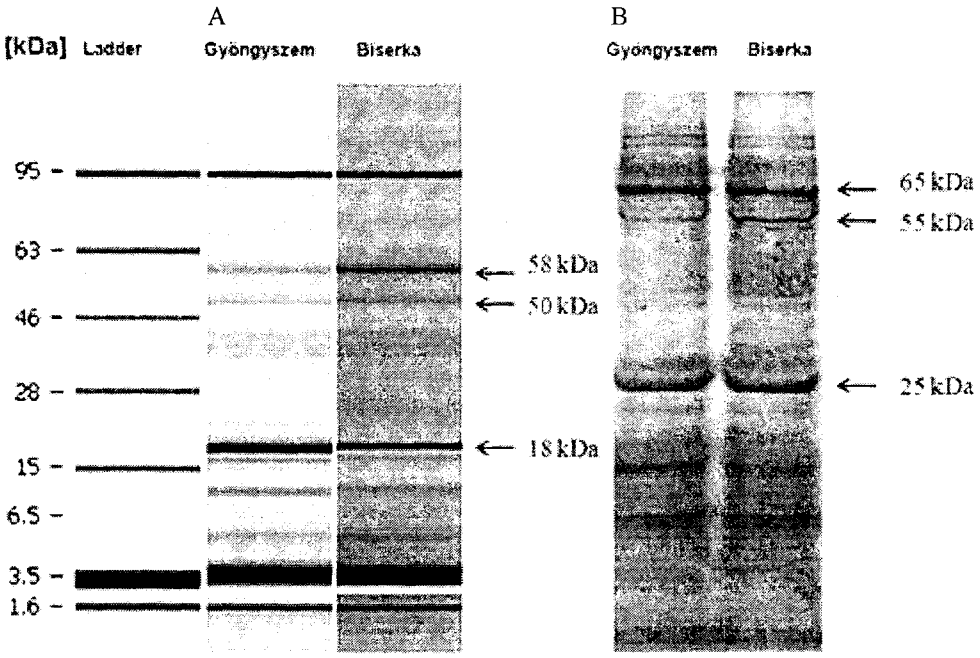

Fig. 3. Lab-on-a-chip gel image (A) and SDS-PAGE image (B) of Gyöngyszem and Biserka, the same protein subunits, with highest amount are marked with arrows for visualisation of the difference between sizings

2.3. Characterization of carbohydrate – amylose/amylopectin ratio of starch

The amylose/amylopectin ratio of starch of millet samples examined (28–38% amylose of total starch) corresponds with data of other millet species published before (ICRISAT/FAO, 1996). No considerable differences were found between values of Hungarian varieties and commercially available millets. Results are presented in Table 2. Decortication had no effect on this ratio, since the seed-coat contains only little amounts of starch. According to literature sources the composition of millet starch is similar to that of maize (OBILANA & MANYASA, 2002), which may have importance from a functional point of view.

Table 2. Amylose content of starch (%) of wholegrain and decorticated samples with ± standard deviation of triplicates

Samples	Wholegrain	Dehulled
Natura	37.28±1.72	–
Biopont	34.88±0.70	–
Biserka	34.90±1.13	35.34±1.09
GK Piroska	36.31±1.30	31.99±1.73
Gyöngyszem	37.65±0.36	37.23±0.86
Fertődi-2	32.92±1.62	33.50±0.95
Rumenka	28.96±0.42	28.14±0.74
GK Alba	34.87±0.57	34.41±1.98
Range	28.96–37.65	28.14–37.23

2.4. Mineral composition

In contrast to literary data, the measured Hungarian millet samples exhibited poor mineral profiles compared to values of other cereals (winter wheat, purple tef, sorghum) published in earlier studies (MENGESHA, 1966; RAGAEE et al., 2006). As the mineral content of grains depends to a large extent upon the growing conditions (principally the mineral content of the soil) general inferences cannot be drawn from these results. Results and comparisons are shown in Table 3.

Although the millet samples investigated possessed similar ash content, considerable differences were found in terms of their mineral profiles. GK Piroska had generally higher content of minerals – except P, Sr, Fe, Mn – than Gyöngyszem. During decortication the concentration of minerals changed in different ways. In case of GK Piroska the portion of Zn, S, P, Mg content became larger, the concentration of other minerals lowered. In case of Gyöngyszem Ti, Si, Ni, Na, Cr were the minerals of which concentration increased, that of the others decreased. According to these results it can be stated that there are not only dissimilarities between the concentration of minerals, but also among the arrangements of them. To sum up the changes it can be stated that decortication had reducing effect on the mineral content of millets.

2.5. Other, nutritionally important functional components

The measured values of functional components of the millet varieties are presented in Table 4. In the literature several data can be found concerning FRAP and TPC of different cereals including millets. However, they cannot be compared to our results, as in those studies many different procedures were applied to determine them. Even if the same method was used the milling and/or preparation of extracts of the grain samples is either unknown or different, but the outcome of the measurements depends considerably on it. Hence, comparison of FRAP and TPC can only be made within the samples here studied.

Regarding TPC the decortication had a reducing effect in all samples (53.31–106.23 mg/100 g in wholegrain varieties, 37.76–50.54 mg/100 g in dehulled samples, see Fig. 4). Biopont had outstanding TPC among the decorticated millets (99.38 mg/100 g), it possessed twice as much than the other varieties. This may have occurred because Biopont originated

Table 3. Mineral composition of two millet samples. Values not reaching the limit of quantification are marked with less-than signs

	GK Piroska (wholegrain)	GK Piroska (dehulled)	Gyöngyszem (wholegrain)	Gyöngyszem (dehulled)	Whole wheat flour[a]	Purple teff[b] (wholegrain)	Sorghum[b] (wholegrain)
	mg/kg						
Ag	5.9	0.9	< 0.8	< 0.8	–	–	–
Al	18	4	2.6	2.4	8	124.0	–
As	< 2	< 2	< 2	< 2	–	–	–
B	7	6.6	5.5	4.6	0.9	13.3	–
Ba	0.97	0.18	0.17	< 0.15	6.0	23.0	–
Be	0.03	< 0.03	< 0.03	< 0.03	–	–	–
Bi	< 3	< 3	< 3	< 3	–	–	–
Ca	118	72	109	88.4	260	2070	27.3
Cd	0.8	< 0.2	< 0.2	< 0.3	0.05	–	–
Co	3.4	0.5	< 0.5	< 0.5	0.02	0.6	–
Cr	2.6	1.6	0.8	1.7	0.02	–	0.8
Cu	9.7	5.7	4.8	3.7	5.1	58.6	0.2
Fe	32.2	30.3	34.8	23.6	52	236.3	10.6
Hg	< 0.1	< 0.1	< 0.1	< 0.1	–	–	–
K	2190	1760	2010	1530	2800	2230	239.9
Li	3.9	< 1.3	< 1.3	< 1.3	–	–	–
Mg	1170	1200	1160	851	1300	1900	187.7
Mn	10.2	9.31	12.3	8.81	36	25.0	1.2
Na	93	88	86	93	–	200.7	4.6
Ni	3.2	1.6	2.6	2.7	0.4	–	–
P	3000	3120	3250	2810	3500	4530	349.9
Pb	< 3	< 3	< 3	< 3	–	–	–
S	1210	1340	1110	1210	–	–	–
Sb	< 100	< 100	< 100	< 100	–	–	–
Se	< 7	< 7	< 7	< 7	–	–	–
Sn	< 2	< 2	< 2	< 2	–	–	–
Sr	0.34	0.25	0.59	0.54	–	< 1	–
Ti	35.7	12.7	2.4	3.1	–	–	–
V	1.8	< 0.7	< 0.7	< 0.7	–	–	–
W	13	< 3	< 3	< 3	–	–	–
Zn	21.2	24.1	18.4	18.5	36	75.7	3.1
Zr	4.1	< 0.7	< 0.7	< 0.7	–	–	–

[a]KHAN & SHEWRY (2009); [b]MENGESHA (1966); [c]RAGAEE et al. (2006)

Table 4. Functional components of wholegrain and decorticated samples with ± standard deviation of triplicates

Sample		Dietary fibre content (% dry basis)	FRAP (Fe^{2+} equivalent mg/100g dry basis)	TPC (ferulic acid equivalent mg/100g dry basis)
Natura	Dehulled	3.26±0.03	67.49±4.49	44.33±1.75
Biopont	Dehulled	3.37±0.46	63.40±3.59	99.38±2.62
Biserka	Wholegrain	11.79±0.24	117.01±7.74	67.04±5.52
	Dehulled	2.71±0.59	48.19±1.92	41.26±1.84
GK Piroska	Wholegrain	14.54±0.43	184.77±2.45	99.57±4.80
	Dehulled	3.53±1.13	62.43±2.88	42.86±1.07
Gyöngyszem	Wholegrain	18.20±0.52	108.33±3.86	71.10±2.63
	Dehulled	4.25±0.13	46.93±1.10	37.76±0.85
Fertődi-2	Wholegrain	20.41±0.91	115.89±5.23	75.49±1.57
	Dehulled	4.48±0.16	59.15±1.62	50.54±0.85
Rumenka	Wholegrain	18.65±0.48	184.03±5.71	106.23±2.09
	Dehulled	4.58±0.66	47.23±1.19	40.90±1.50
GK Alba	Wholegrain	16.30±1.53	88.04±2.05	53.31±0.31
	Dehulled	4.17±0.93	63.25±2.10	38.06±1.36
Range	Wholegrain	11.8–20.4	88.1–184.8	53.31–106.23
	Dehulled	2.7–4.6	46.9–63.4	37.76–50.54
Whole wheat[a]		11–12.7	–	–
Wheat flour[a]		2–2.5	–	–
Barley[b]	Wholegrain	24.63	–	–
Sorghum[b]		21.01		

[a]KHAN & SHEWRY (2009); [b]RAGAEE et al. (2006)

from China, and presumably belongs to another species than the other millets derived from Europe.

The decortication had reducing effect on FRAP values as well (46.93–63.40 mg/100 g in case of dehulled millets, 88.1–184.77 mg/100 g for wholegrain samples, see Fig. 5). As expected, they correlated with TPC values (HODZIC et al., 2009). One sample having higher FRAP value had higher TPC as well compared to another variety (except Biopont having superior TPC mentioned above).

Dietary fibre content of millet varieties studied was in agreement with the results published earlier (RAGAEE et al., 2006). Millets contained similar or slightly lower amounts of dietary fibre compared to dietary fibre-rich sorghum or barley. Therefore, wholegrain millets seemed to be promising as dietary fibre source. During dehulling, the values decreased considerably (11.79–20.41% in whole grain varieties and 2.71–4.58% in decorticated samples, see Fig. 6).

Concluding the results of the nutritional components measured (dietary fibre, FRAP and TPC) it can be stated that within all varieties dehulled millets contained similar amounts, while in case of wholegrain varieties bigger differences were found. This corresponds to the findings above that differences in certain components are mainly found in the seed-coat of millets. In agreement with literature sources discussed in the introduction (LESTIENNE et al., 2007; SHOBANA & MALLESHI, 2007) it can also be stated that the seed-coat contains the highest quantity of nutritional components and decortication has extreme lowering effect on their amount reducing the nutritive value of millet. Nevertheless, decortication seems to be unavoidable for reducing the nutritionally disadvantageous antinutritive factors presented in the seed coat. In the future the composition of dietary fibre and other functional components (e.g. vitamins) should be investigated in consideration of changes in their bioavailability occurring during decortication.

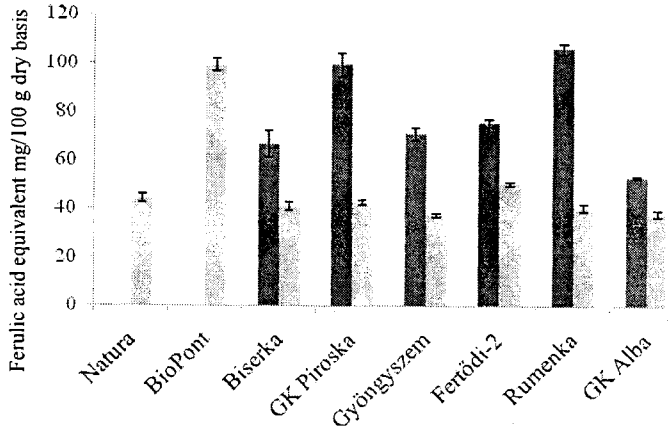

Fig. 4. TPC of decorticated and wholegrain samples with ± standard deviation of triplicates. ■: Wholegrain; □: dehulled

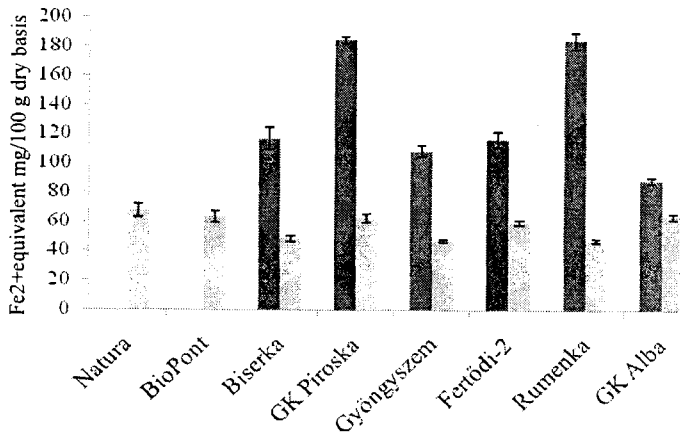

Fig. 5. FRAP of decorticated and wholegrain samples with ± standard deviation of triplicates. ■: Wholegrain; □: dehulled

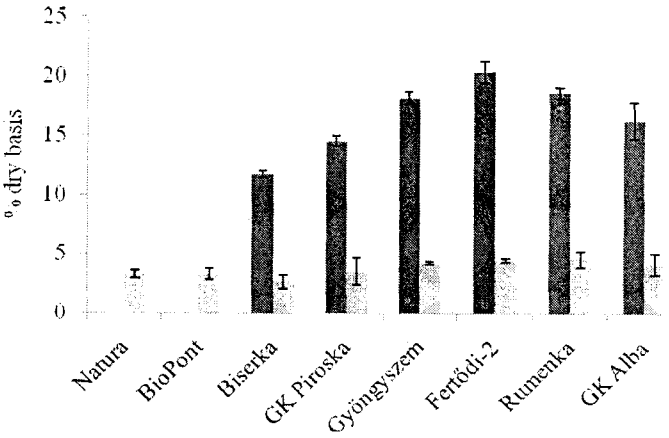

Fig. 6. Dietary fibre content of decorticated and wholegrain samples with ± standard deviation of triplicates. ■: Wholegrain; □: dehulled

3. Conclusions

In general, the nutrient composition of Hungarian millet varieties was similar to those of commercially available millets and to values of other millets investigated in studies before. Except for protein content, there were no considerable differences in the composition of decorticated millet varieties, while among wholegrain samples significant differences were found. Although the concentration of minerals was relatively low in the varieties examined, in comparison with other cereals wholegrain millet seems to be nutritionally valuable being a rich source of dietary fibre. Nevertheless, it was shown that decortication had lowering effects on these components, reducing the applicability of millet in value added food production. Beside the SDS-PAGE, the LOC as a novel method, proved to be an appropriate tool for fast protein profile screening for the millet samples. No remarkable differences were found among Hungarian varieties in terms of quality parameters, but differences were found between the concentrations of distinguished proteins. To get more detailed information of the nutritional potential of millet in future studies further nutritional properties (e.g. bioavailability of components, anti-nutritive factors, amino acid composition and amount of vitamins) should be examined considering the effect of decortication. It would also be expedient to study technological possibilities of eliminating the disadvantageous effects of decortication. Moreover, functional characteristics of millet flour should be taken into consideration as well.

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