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CHEMICAL COMPOSITION OF BUCKWHEAT PLANT PARTS AND SELECTED BUCKWHEAT PRODUCTS

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ABSTRACT

Chemical composition plant parts (roots, stalks, leaves, blossoms) of common buckwheat (*Fagopyrum esculentum* Moench) and selected products made from its seeds (peels, whole seed, wholemeal flour, broken seeds, crunchy products Natural and Cocoa, flour, and pasta) was determined. Samples were dried and ground to a fine powder. All analyses were performed according to the Commission Regulation no. 152/2009, while rutin concentration was determined by the modified HPLC method. The lowest content of moisture was found in roots (4.3%) and in peels (almost 8%) and the highest moisture (nearly 11%) was discovered in seeds. The lowest amount of crude protein (3.5%) was found in peels, the highest crude protein amount (>13%) in both flours and leaves (23%). The starch content (>50% in dry matter) differs from one sample to another. Only in peels the content of starch was about 3.5%. From all examined samples, the lowest content of fat was found in crunchy products Cocoa, 1.7%. The lowest amount of histidine was determined in all studied samples, except peels, the highest content of glutamic acid was determined in almost all samples, except peels. Whole-meal flour is very rich source of Ca and Fe. The content of these elements was 1172 $mg.kg^{-1}$ and 45.9 $mg.kg^{-1}$, respectively. On the other hand, the highest content of Pb (>1 $mg.kg^{-1}$) was found in broken seeds. The greatest concentration of rutin was determined in blossoms and leaves (83.6 and 69.9 $mg.g^{-1}$), respectively. On the other hand, the lowest concentrations of rutin were found in buckwheat products (generally less then 1 $mg.g^{-1}$, i.e. in wholemeal flour, 702 $\mu g.kg^{-1}$, the lowest (almost 10 $\mu g.kg^{-1}$) in pasta.

Keywords: chemical composition; buckwheat products; *Fagopyrum esculentum* Moench; moisture

INTRODUCTION

Buckwheat is one of the traditional crops cultivated in Asia, Central and Eastern Europe **(Wijngaard and Arendt, 2006)**. Common buckwheat (*Fagopyrum esculentum* Moench) is the most commonly grown species. Buckwheat is categorized as a pseudocereal, so it shows both differences and similarities with cereals. It is an annual, dicotyledonic plant from the family of *Polygonaceae* **(Skrabanja et al., 2004)**. Buckwheat does not have a large root system, but its physiological activity is significant. Buckwheat roots excrete formic, acetic, citric and oxalic acids which help the plant to take nutrients, mainly phosphorus, from hard available forms. The stalks are hollow and their colour is green to red. Leaves alternate on the both sides of the stalk. Buckwheat inflorescence is formed by 7 to 9 blossoms. They are tiny of white, pink or red colour **(Janovská et al., 2009)**. Its seeds are edible and have triangular shape. The pericarp has a hard fibrous structure and surrounds the seed coat, endosperm and embryo tightly. The endosperm consists mainly of starch. The buckwheat fruit contains proteins, saccharides, lipids, fibre, vitamins and minerals as basic components. It is a source of dietary minerals like zinc, copper and manganese **(Ikeda and Yamashita, 1994)**. It is also rich in dietary fibre, which has a positive physiological effect in the gastrointestinal tract and also significantly influences the metabolism of other nutrients. Buckwheat seeds do not contain any gluten proteins so they are safe for people with celiac disease.

Buckwheat can act in the prevention and treatment of hypertension and hypercholesterolemia and colon cancer. The preventive effect can be connected with the content of dietary fibre in buckwheat **(He et al., 1995)**. Similar effects are associated with the inclusion of resistant starch in the diet. Buckwheat seeds contain an important amount of resistant starch **(Skrabanja et al., 2001; Kreft and Skarabanja, 2002)**.

Rutin is a secondary plant metabolite that antagonizes the increase of capillary fragility associated with hemorrhagic disease or hypertension in humans. It also decreases the permeability of the blood vessels and has an anti-oedema effect, reduces the risk of arteriosclerosis and has antioxidant activity. Rutin is a flavonol glycoside synthesized in higher plants as a protection against ultraviolet radiation and diseases **(Rozema et al., 2002)**. It was firstly detected in *Ruta graveolens*, which gave the common name to this pharmaceutically important substance. Among fruits, vegetables and grain crops, grapes and buckwheat are the most important rutin containing food **(Hagels, 1999)**. Most rutin is accumulated in the inflorescence, stalks and upper leaves **(Kreft et al., 2006)**.

This study has been carried out to determine the basic chemical composition of plant parts (roots, stalks, leaves, blossoms) of common buckwheat (*Fagopyrum esculentum* Moench) cultivated in the Czech Republic and selected products made from its seeds (peels, whole seed, wholemeal flour, broken seeds, crunchy products Natural and Cocoa, flour, and pasta).

MATERIAL AND METHODOLOGY

Sample preparation

Harvested plants of common buckwheat (*Fagopyrum esculentum* Moench), cultivated in the region of Slezské Rudoltice, Czech Republic, were washed several times in tap water to remove all soil and finally in distilled water. Plants were divided into four parts (roots, stalks, leaves, blossoms) and dried at the ambient temperature. Buckwheat products (peels, whole seed, wholemeal flour, broken seeds, crunchy products Natural and Cocoa, flour, and pasta) were from Pohankový mlýn Šmajstrla s.r.o., Frenštát p. R., Czech Republic. All samples were ground to a fine powder and sieved through 1 mm mesh. All analyses were realized according to the Official Journal of the European Union **(EC, 2009)** at the laboratory temperature 21 ±2 °C in triplicate. All used reagents were of the analytical grade.

Basic chemical analyses

First of all, the moisture content was determined using drying at 103 ±2 °C to the constant loss of the weight. Ash content was determined by burning of sample in the muffle-furnace at 550 °C for 5 hours. The energy was determined in an automatic bomb calorimeter PARR 1281 (Parr Instrument Company, Moline, IL, USA). The fat content was determined gravimetrically by a Soxhlet method using n-hexan as an extractant. Crude protein content was determined according to the Kjeldahl method using the Pro-Nitro 1430 apparatus (BIO PRO, Prague, Czech Republic). Tashiro indicator (Fluka, Germany) was used for the final titration with hydrochloric acid solution. Results were recalculated to the sample weight and by multiplying it with the factor 5.7, thus, the percentage of crude protein was obtained. Samples for starch determination were treated with dilute hydrochloric acid (Penta, Chrudim, Czech Republic). After clarification and filtration the optical rotation of the solution was measured by polarimetry (OPTIKA Microscopes, Ponteranica, Italy). Total fibre in legumes and buckwheat products was determined using the apparatus Ancom220 Fibre Analyzer (ANCOM Technology, New York, NY, USA). For the analysis, filter bags F57 with pore size 50 µm were used.

Amino acids

An amino acid analyzer AAA 400 (INGOS, Prague, Czech Republic) with spectrophotometric post column derivatization with ninhydrine was used for total amino acids determination after their release from proteins and peptides by acid and oxidative hydrolysis **(Buňka et al., 2004; Lazárková et al., 2011)**.

Minerals

Samples (0.3 to 0.5 g) were decomposed in a microwave device Ethos SEL (Milestrone, Sorisole, Italy) using concentrated HNO_3 (5 ml conc. HNO_3 + 5 ml of deionised H_2O) at a temperature of 210 °C for 30 min. The final mineralizate was transferred into 25 ml volumetric flasks after cooling to 80 °C. The flasks were refilled to the mark after cooling to a room temperature. Mineralizates were analyzed on an atomic absorption spectrometer AA 30 (Varian A.G., Australia, see Table 1 for wavelengths).

Na, K, Ca, Mg, Fe, Zn and Cu were determined by flame AAS (acetylene-air). Strontium nitrate at a concentration of 1000 $mg.L^{-1}$ was used as a spectral buffer to suppress the flame emission in the case of Ca, Mg. Cu, Fe, Zn, Ca and Mg were measured in absorption mode while Na and K in emission mode. Pb, Cd and Cr were measured in absorption mode with electrothermial atomization in the graphite tube. For protection, the N_2 gas in a purity of 5.0 was chosen. A matrix modifier (10 $g.L^{-1}$ solution $NH_4H_2PO_4$ + 10 $g.L^{-1}$ solution of $Mg(NO_3)_2$ (Sigma Aldrich, USA) and a deuterium lamp background correction was used in the case of Pb and Cd. A 10 $g.L^{-1}$ solution of ascorbic acid (reduced formation of CrO_2Cl_2) was selected as a matrix modifier for Cr determination. Concentrations of all elements were determined by the calibration curve method and the integration of peak area.

Rutin concentration

Rutin was determined using a modified HPLC method according to **Deineka et al. (2004)** and **Gokarn et al. (2010)** using an HPLC 10 AVP system equipped with a SCL-10 AVP control unit with a control software Class-VP 5.02, two LC-10AVP pumps, a GT-154 degasser, a CTO-10ASVP column thermostat, a Rheodyne 7120 injector valve, and a SPD-M10AVP diode array detector (all from Shimadzu, Tokyo, Japan). Two grams of the sample (rutin hydrate was from Dr. Ehrenstorfer GmbH, Augsburk, Germany) were extracted with methanol:acetic acid:water (100:2:100). After sonication and shaking, test-tubes were centrifuged at 4000 rpm for 5 minutes and filtrated through 0.45 µm filter (Millipore, Bedford, MA, USA). The subsequent HPLC analysis was provided using Waters C18 column (75 mm x 4.6 mm, 5 µm pore size; all from Waters Corp., Milford, MA, USA). Used mobile phase consisted of 2 % acetic acid:acetonitrile:methanol (75:15:10), the flow rate was 1 ml per minute, and the detection was performed at 355 nm.

Statistical evaluation

All results were statistically evaluated using the variation statistics (ANOVA, StatSoft, Prague, Czech Republic) according to **Snedecor and Cochran (1967)** using the statistical package Unistat, v. 5.5 (Unistat Ltd, England).

Table 1 Wavelengths for particular elements [nm].

Element	Na	K	Ca	Mg	Zn	Cu	Fe	Pb	Cd	Cr
Wavelength	589.0	766.5	422.7	285.2	213.9	324.7	248.3	217.0	228.8	357.9

RESULTS AND DISCUSSION

Chemical composition of buckwheat plant parts (Table 2) and buckwheat products (Table 3) was studied. Firstly, moisture content of all samples was determined. It was subsequently recalculated to the dry matter content.

Basic chemical composition

The lowest content of moisture was found in roots (4.3%). As can be seen from Table 2, the highest crude protein amount was determined in leaves (22.7%) and in blosssoms (19.1%). Very low contents of starch were found in all parts, especially in blossoms they were undetectable. Contrarily, the highest content of fat was found in roots (4.3%). The greatest concentration of rutin was determined in blossoms and leaves (83.6 and 69.9 $mg.g^{-1}$, respectively).

Results for buckwheat products are presented in Table 3. The lowest content of moisture is in peels, almost 8%. On the other hand, the highest moisture was discovered in seeds, nearly 11%. The ash content ranges from 1 to 3%. The lowest content of fat was found in crunchy products Cocoa, 1.68%. The highest content of fat was determined in wholemeal flour, 7.49% in average. **Edwardson (1996)** reported the amount of fat in buckwheat seeds, dark and light flour as 3.2, 3.5 and 2.5%, respectively. These values are lower than those obtained in our experiment. The greatest crude protein content was determined in both flours, almost 14%, the decreased content of crude protein is in peels, about 3.5%. **Edwardson (1996)** presents the protein content in seeds as 16.8% and in light flour 11.7%. His value for seeds is higher than the one determined in our laboratory experiment, the second one, for the light flour, is lower than the value presented in Table 3.

The starch content (Table 3). In studied products its content is in the range of 50-70% in dry matter, except peels. In them, the starch amount was only about 3.62 %. Table 3 also shows the amount of fibre in particular samples. This component was detected only in peels and products which contain peels as whole seeds and wholemeal flour. Peels contain more than 65% of fibre. The energy values of examined samples range from 16 to 18%.

Amino acid composition

Amino acid composition of all analyzed buckwheat products is presented in Table 4. All products contain all amino acids. The lowest amount of histidine was determined in all studied samples, except peels, where the lowest content of methionin was found; the highest content of glutamic acid was determined in almost all samples, only in peels, the greatest content of glycine was ascertained. Also the arginine content is quite high.

Table 2 Average concentration of moisture, crude protein, starch, fat in % (mean ±S.D.) and rutin contents (mean ±S.D.) in mg.g-1.

Sample	Moisture	Crude protein	Starch	Fat	Rutin
Roots	4.3 ±0.02	5.6 ±0.16	0.0 ±0.01	4.3 ±0.01	3.6 ±0.12
Stalks	7.7 ±0.01	6.5 ±0.03	1.1 ±0.01	2.6 ±0.01	0.5 ±0.09
Leaves	7.5 ±0.02	22.7 ±0.26	6.0 ±0.01	3.1 ±0.01	69.9 ±2.7
Blossoms	6.5 ±0.02	19.1 ±0.10	n.a.	5.7 ±0.01	83.6 ±3.1

Table 3 Content of moisture, ash, fat, crude protein, starch, fibre in % (mean ±S.E.) and energy values (mean ±S.E.) in $MJ.kg^{-1}$.

Sample	Moisture	Ash	Fat	Crude protein	Starch	Fibre	Energy
Peels	7.98 ±0.03	1.57 ±0.05	4.61 ±0.00	3.48 ±0.23	3.62 ±0.18	65.9 ±1.17	18.2 ±0.18
Whole seed	10.4 ±0.03	2.00 ±0.01	7.34 ±0.01	10.2 ±0.23	53.3 ±0.36	14.8 ±1.04	16.9 ±0.03
Seeds	10.7 ±0.06	2.36 ±0.03	3.97 ±0.00	12.8 ±0.26	53.5 ±0.36	6.65 ±0.19	16.7 ±0.10
Broken seeds	9.11 ±0.04	1.59 ±0.01	5.95 ±0.02	9.16 ±0.02	69.0 ±0.35	ND	16.4 ±0.10
Crunchy Natural	7.53 ±0.02	0.82 ±0.00	2.44 ±0.00	6.77 ±0.33	77.8 ±0.18	ND	16.6 ±0.12
Crunchy Cocoa	6.53 ±0.03	0.98 ±0.01	1.68 ±0.01	6.50 ±0.17	72.9 ±0.18	ND	16.7 ±0.12
Flour	10.1 ±0.01	2.18 ±0.01	3.06 ±0.01	13.8 ±0.53	66.8 ±0.18	ND	16.8 ±0.08
Wholemeal flour	9.46 ±0.07	2.81 ±0.05	7.49 ±0.01	13.9 ±0.00	61.7 ±0.00	ND	17.3 ±0.05
Pasta	9.35 ±0.03	0.94 ±0.00	3.51 ±0.01	8.06 ±0.37	75.5 ±0.36	ND	16.4 ±0.11

S.E. - standard error; ND - fibre was not detected

Table 4 Amino acid content in buckwheat products (mean ±S.D.) in mg.g^{-1}DW.

AA	Peels		Whole seed		Seeds		Broken seeds		Crunchy Natural	
	AA content	CV	AA content	CV	AA content	CV	AA content	CV	AA content	CV
	mg.g^{-1}	%	mg.g^{-1}	%	mg.g^{-1}	%	mg.g^{-1}	%	mg.g^{-1}	%
Lys	0.99 ±0.04	4.0	6.01 ±0.64	11.0	4.10 ±0.37	9.0	2.63 ±0.11	4.0	2.19 ±0.05	8.0
His	0.70 ±0.04	6.0	2.71 ±0.35	13.0	2.37 ±0.14	6.0	1.21 ±0.12	10.0	1.16 ±0.03	3.0
Arg	0.97 ±0.08	9.0	11.5 ±0.81	7.0	8.82 ±0.61	7.0	4.57 ±0.16	4.0	4.21 ±0.59	14.0
Glu	1.71 ±0.06	4.0	14.1 ±1.60	11.0	14.1 ±0.12	1.0	7.04 ±0.34	5.0	6.70 ±0.67	10.0
Asp	1.82 ±0.12	7.0	9.83 ±0.26	3.0	7.61 ±0.18	2.0	4.43 ±0.21	5.0.	4.21 ±0.43	10.0
Thr	0.92 ±0.08	9.0	3.27 ±0.17	5.0	3.39 ±0.18	5.0	1.85 ±0.06	3.0	1.75 ±0.14	8.0
Ser	0.95 ±0.08	9.0	3.89 ±0.43	11.0	3.90 ±0.03	1.0	2.12 ±0.04	2.0	2.02 ±0.18	9.0
Pro	0.99 ±0.07	7.0	4.02 ±0.42	10.0	3.07 ±0.25	8.0	2.05 ±0.11	6.0	1.97 ±0.10	5.0
Gly	1.90 ±0.13	7.0	6.35 ±0.15	2.0	4.58 ±0.24	5.0	2.94 ±0.13	4.0	2.83 ±0.32	11.0
Ala	1.02 ±0.08	8.0	4.36 ±0.48	11.0	3.62 ±0.27	7.0	2.31 ±0.07	3.0	2.18 ±0.18	8.0
Val	1.06 ±0.07	6.0	5.36 ±0.63	12.0	4.44 ±0.40	9.0	2.65 ±0.07	3.0	2.52 ±0.16	6.0
Ile	0.68 ±0.04	6.0	3.43 ±0.14	4.0	2.75 ±0.02	1.0	2.03 ±0.07	4.0	1.92 ±0.02	1.0
Leu	1.15 ±0.10	8.0	5.77 ±0.25	6.0	4.70 ±0.26	6.0	3.35 ±0.05	1.0	3.18 ±0.11	3.0
Met	0.57 ±0.01	3.0	2.93 ±0.16	6.0	1.90 ±0.17	9.0	1.90 ±0.08	3.0	1.44 ±0.17	12.0
Tyr	0.71 ±0.06	9.0	3.09 ±0.35	11.0	2.29 ±0.07	3.0	1.44 ±0.11	8.0	1.35 ±0.09	6.0
Phe	0.90 ±0.08	9.0	6.09 ±0.30	7.0	3.59 ±0.27	8.0	2.39 ±0.11	4.0	2.35 ±0.24	10.0
Cys	0.44 ±0.03	7.0	4.45 ±0.07	5.0	3.07 ±0.05	2.0	1.51 ±0.05	4.0	1.84 ±0.13	7.0

Table 4 (Continue) Amino acid content in buckwheat products (mean ±S.D.) in mg.g^{-1} DW.

AA	Crunchy Cocoa		Wholemeal flour		Pasta	
	AA content	CV	AA content	CV	AA content	CV
	mg.g^{-1}	%	mg.g^{-1}	%	mg.g^{-1}	%
Lys	6.18 ±0.32	5.0	7.57 ±0.07	9.0	3.05 ±0.06	2.0
His	2.78 ±0.23	8.0	3.20 ±0.37	12.0	1.66 ±0.06	4.0
Arg	11.9 ±0.50	4.0	14.0 ±1.47	11.0	5.00 ±0.35	7.0
Glu	16.4 ±1.07	6.0	19.0 ±1.99	10.0	8.23 ±0.80	10.0
Asp	9.06 ±0.88	10.0	11.0 ±0.89	8.0	5.44 ±0.60	11.0
Thr	3.80 ±0.32	8.0	4.77 ±0.61	13.0	2.25 ±0.22	10.0
Ser	4.62 ±0.34	7.0	5.73 ±0.71	12.0	2.52 ±0.27	11.0
Pro	4.03 ±0.25	6.0	4.96 ±0.38	8.0	2.20 ±0.17	8.0
Gly	6.24 ±0.27	4.0	8.18 ±0.77	9.0	3.96 ±0.38	10.0
Ala	4.51 ±0.26	6.0	5.45 ±0.56	10.0	2.66 ±0.27	10.0
Val	5.45 ±0.38	7.0	6.48 ±0.65	10.0	3.08 ±0.32	10.0
Ile	4.11 ±0.50	12.0	4.52 ±0.30	7.0	1.95 ±0.18	9.0
Leu	6.71 ±0.59	9.0	7.33 ±0.71	10.0	3.43 ±0.31	9.0
Met	2.91 ±0.08	3.0	5.58 ±0.12	2.0	2.31 ±0.15	7.0
Tyr	3.01 ±0.03	1.0	4.06 ±0.37	9.0	1.81 ±0.20	11.0
Phe	4.94 ±0.35	7.0	6.09 ±030	5.0	2.70 ±0.22	8.0
Cys	4.32 ±0.03	1.0	4.45 ±0.07	2.0	2.42 ±0.19	8.0

S.D. - Standard deviation; CV - coefficient of variability; DW – dry weight

Table 5 Content of mineral elements (mean ±S.D.) in 1000 g DW.

Element	Concentrations of elements in 1000 g DW								
	Peels	Whole seed	Seeds	Broken seed	Crunchy natural	Crunchy cocoa	Flour	Wholemeal flour	Pasta
Pb[a]	428 ±4.27	510 ± 5.10	222 ±2.15	1049 ±10.5	194 ±1.94	422 ±4.22	412 ±4.12	831 ±8.31	384 ±3.84
Cd[a]	44.0 ±0.40	78.0 ±0.77	73.0 ±0.72	53.0 ±0.52	67.0 ±0.66	44.0 ±0.40	108 ±1.06	130 ±1.30	54.0 ±0.05
Cr[a]	64.0 ±0.64	49.0 ±0.49	69.0 ±0.69	477 ±4.77	109 ±1.09	111 ±1.10	144 ±1.42	149 ±1.49	113 ±1.13
Zn[b]	5.56 ±0.05	17.6 ±0.18	27.9 ±0.28	16.7 ±0.17	11.9 ±0.12	17.6 ±0.17	32.6 ±0.32	35.4 ±0.17	10.1 ±0.12
Cu[b]	4.71 ±0.05	7.32 ±0.07	6.73 ±0.07	5.03 ±0.05	4.78 ±0.05	5.01 ±0.05	7.82 ±0.08	11.6 ±0.11	5.71 ±0.01
Na[b]	8.56 ±0.09	6.80 ±0.07	5.56 ±0.06	1.62 ±0.02	10.9 ±0.11	15.9 ±0.05	2.11 ±0.02	5.29 ±0.05	5.87 ±0.06
Fe[b]	16.5 ±1.65	24.3 ±0.24	28.7 ±0.29	16.9 ±0.17	11.7 ±0.12	20.0 ±0.20	30.1 ±0.30	45.9 ±0.45	15.3 ±0.15
Ca[b]	999 ±4.99	533 ±2.66	148 ±0.74	113 ±0.56	246 ±1.23	87.9 ±0.87	266 ±1.33	1171 ±5.85	123 ±1.22
Mg[c]	1.08 ±0.05	1.71 ±0.01	2.20 ±0.01	1.44 ±0.01	0.87 ±0.00	0.94 ±0.01	2.16 ±0.01	2.38 ±0.01	0.99 ±0.05
K[c]	5.76 ±0.03	4.79 ±0.02	4.76 ±0.02	3.16 ±0.01	2.02 ±0.01	2.65 ±0.13	4.61 ±0.02	6.08 ±0.03	2.47 ±0.01

[a] $\mu g.kg^{-1}$; [b] $mg.kg^{-1}$; [c] $g.kg^{-1}$; ; DW – dry weight

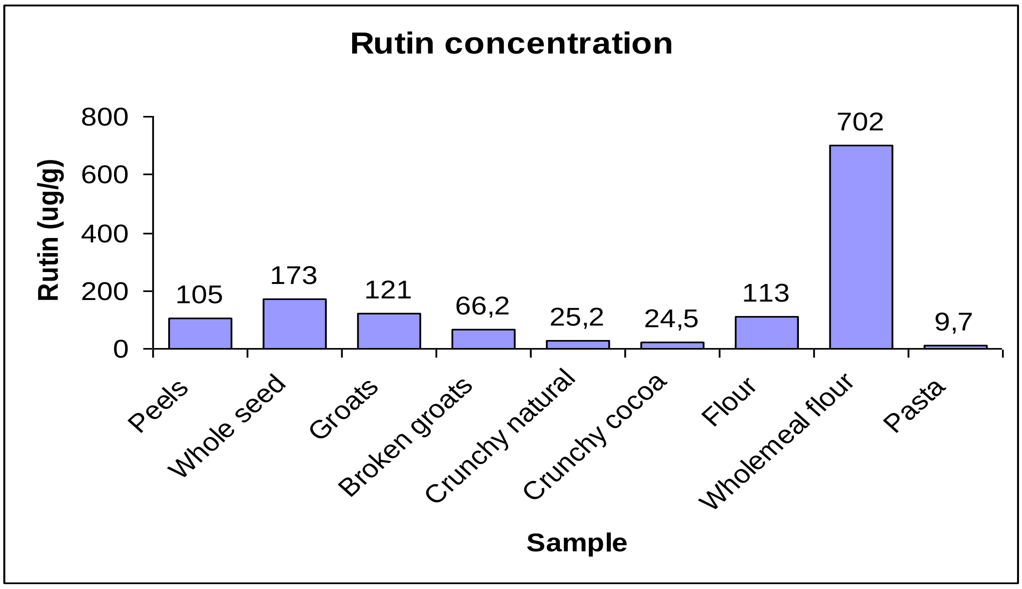

Figure 1 Concentration of rutin in $\mu g.g^{-1}$ DW.

Minerals

The mineral composition of examined buckwheat products is presented in Table 5. Wholemeal flour is very rich source of Ca and Fe. The content of these elements is 1172 $mg.kg^{-1}$and 45.9 $mg.kg^{-1}$of dry matter, respectively. Peels are also good source of Ca. The lowest content of Ca was determined in crunchy Cocoa, 87.90 $mg.kg^{-1}$, maybe because of the processing. On the other hand, the highest content of Pb was found in broken seeds, more than 1 $mg.kg^{-1}$.

Rutin concentration

From Figure 1, it can be concluded, that the greatest concentration of rutin in buckwheat products was determined in wholemeal flour, 702 $\mu g.g^{-1}$. On the other hand, the lowest concentration of rutin (nearly 10 $\mu g.g^{-1}$) was found in pasta. **Kreft et al. (2006)** in their study presented the value of rutin concentration in buckwheat seeds as 0.2 $mg.g^{-1}$ in dark flour. The value of rutin concentration in light flour is close to the value obtained in our experiment. Other values, when compared to our experiment, are a little bit different. In wholemeal flour, the concentration of rutin is more than three times higher than the value reported by **Kreft et al. (2006)**, probably due to the traditional mechanical milling.

CONCLUSION

Buckwheat is a plant from the family of Polygonaceae. It contains potassium, phosphorous, calcium, iron, zinc, vitamins B, E and rutin. Rutin is a bioflavonoid which is used for blood vessels treatment. Obtained results confirm that the highest concentration of rutin is accumulated in leaves and blossoms of the buckwheat plant. Usually, they are the main part of tea mixtures used for vessel diseases treatment.

On the other hand, lower concentration is in buckwheat products. Used buckwheat seeds, were mechanically peeled. These seeds then have light colour and the preparation does not require any long-time cooking.

Buckwheat flour is processed by milling of seeds or by broken seeds and the value of dry matter/moisture is depending on the quality of storage. Total crude protein content is influenced genetically, by the area of growing, by weather and soil. Dry weather during buckwheat seeds´ creating causes premature ripening; a part of sugars stays in stalks and the amount of crude protein in seeds is increasing. Buckwheat for human nutrition is used in many forms. People use mainly seeds for making a meal.

Nowadays, people can buy a broad range of buckwheat products, such as pasta, crunchy products, flour etc.

It is difficult to compare obtained results with literature sources because not all products have been studied. All experiments could be influenced by many factors, e.g. the variety of the plant, different climatic conditions, processing of the seed, laboratory conditions, reagents, modification of the method, etc. Also the processing of seeds to buckwheat products can influence their chemical properties.

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