Journal of Microbiology, Biotechnology and Food Sciences

Margitanová et al. 2012 : 1 (February Special issue) 949-956

REGULAR ARTICLE

VARIETAL DEPENDENCE OF ANTIOXIDANT ACTIVITY IN DIFFERENT ANATOMICAL PARTS OF COMMON BUCKWHEAT *(FAGOPYRUM ESCULENTUM MOENCH)* IN DIFFERENT GROWTH PHASES

Eva Margitanová [1], Alena Vollmannová [1], Lívia Krížová [1], Iveta Čičová [2]*

Address: [1]Slovak University of Agriculture in Nitra, Faculty of Biotechnology and Food Sciences, Department of Chemistry, Tr. A. Hlinku 2, 949 76 Nitra, Slovak Republic

[2]Plant Production Research Centre, Bratislavská 122, 921 68 Piešťany, Slovak Republic

*Corresponding author: e.margitanova@gmail.com

ABSTRACT

The pseudocereals such as buckwheat, quinoa, amaranth have attracted interest in recent years. One of the reasons for this renewed interest is their excellent nutrient profile. In addition to being one of the important energy sources due to their starch content, these pseudocereals provide good quality protein, dietary fibre and lipids rich in unsaturated fats. The aim of our work was to study antioxidant activity in 4 chosen cultivars of common buckwheat during vegetation period. Four cultivars were analysed: Špačinska, Bambi, Jana C1, Aiva. Samples of plant material were obtained from Plant Producion Research Centre in Piešťany. Antioxidant activity (AOA) of stem, leaves, flowers and seeds of buckwheat was assessed with using of DPPH radical (2.2 – diphenyl-1-picrylhydrazyl) at wavelength 515.6 nm. The antioxidant activity of buckwheat was evaluated in growth phases I. (formations of buds), in phase II. (at the beginning of flowering), in phase III. (full flowering), in phase IV. (full ripeness). The antioxidant activity in stems of all tested cultivars of common buckwheat was in range from 49.109 % (Špačinska, phase I.) to 73.705 % (Špačinska, phase IV.). The antioxidant activity in leaves of all tested varieties of common buckwheat was in range from 77.937 % (Bambi, phase IV.) to 99.655 % (Bambi, phase II.). The antioxidant activity in flowers of all tested varieties of common buckwheat was in range from 88.75 % (Bambi, phase III.) to 92.665 % (Špačinska, phase I.). The antioxidant activity in seeds of all tested

cultivars of common buckwheat was in range from 39.787 % (Špačinska, phase III.) to 88.241 % (Bambi, phase III.). From the standpoint of antioxidant activity in individual plant parts the cultivars Špačinska, Bambi were the most suitable ones for food productions.

Key words: common buckwheat, antioxidant activity, seeds

INTRODUCTION

Buckwheat *(Fagopyrum esculentum Moench)* is highly nutritious pseudocereal known as a dietary source of protein with favourable amino acid composition and vitamins **(Bonafaccia, Marocchini and Kreft, 2003),** starch and dietary fiber essential minerals and trace elements **(Bonafaccia, Gambelli, Fabjan and Kreft, 2003).**

Many of the health benefits of buckwheat have been attributed to its high levels of phenolic compounds and antioxidant activity **(Wijngaard and Arendt, 2006).** Phenolic compounds are found in abundance in buckwheat, including rutin, hyperin, orientin, vitexin, quercetin, isovitexin, kaempferol-3-rutinoside, isoorientin, and catechins **(Dietrych Szostak and Oleszek, 1999; Morishita, Yamaguchi and Degi, 2007).** Antioxidants are usually classified as hydrophilic compounds, such as, vitamin C along with many phenolic or lipophilic compounds, including vitamin E, tocotrienols, and carotenoids **(Gökmen, Serpen and Fogliano, 2009).** Phenolic compounds in buckwheat had antioxidant activity **(Holasova *et al.*, 2002)** and higher concentrations of these compounds are found in the outer layers of the grain bran.Buckwheat was found to have various bioactivities which include increasing lactic acid bacteria in rat intestine, treatment of allergic inflammation, reducing the serum glucose level, suppressing gallstone formation and cholesterol level, inhibiting the protease and scavenging radicals **(Kawa, Taylor and Przybylski, 2003; Kim *et al.*, 2003).** Buckwheat (*Fagopyrum esculentum Moench)* is suitable for people who are celiac sensitive to wheat gluten **(Alvarez-Jubete, Arendt and Gallagher, 2010)** and is a good source of manganese, magnesium and dietary fibre.

The objective of our work was to determine antioxidant activity in different anatomical parts of common buckwheat *(Fagopyrum esculentum Moench)* in different growth phases.

MATERIAL AND METHODS

The cultivars of common buckwheat *(Fagopyrum esculentum Moench)* Špačinská, Bambi, Jana C1, Aiva were obtained from Centre of Plant research and production in Piešťany. The antioxidant activity of buckwheat was evaluated in growth phases I. (formations of bubs), in phase II. (at the beginning of flowering), in phase III. (full flowering), in phase IV. (full ripeness). For the analysis of free radical scavenging activity, 2,2 – diphenyl – 1 – picrylhydrazyl (DPPH) was used according to the protocol of **Brand – Williams *et. al* (1995)**. To obtain a stock solution, 0.025g of DPPH was diluted to 100 mL with methanol and kept in a cool and dark place. Immediately before the analysis, a 1:10 dilution of stock was prepared with methanol. For the analysis, 3.9 mL of DPPH working solution was added to a cuvette and the absorbance at 515 nm was measured (A_0) with a Shimadzu spectrophotometer (Shimandzu, Kyoto, Japan). Subsequently, 0.1 mL of extract was added the cuvette with DPPH, and the absorbance was measured after 10 min (A_{10}). An increasing amount of antioxidants present in the methanol extract of the samples reduced DPPH and faded the colour of the solution in a correlation, proportionaly to the antioxidant concentration. The percentage of DPPH inhibition was measured according to the following equation:

$$Inhibition(\%) = \frac{(A_0 - A_{10})}{A_0} x100$$

RESULTS AND DISCUSSION

The antioxidant activity (AOA) in different anatomical parts of common buckwheat plants (*Fagopyrum esculentum* Moench.) of four cultivars (Špačinska, Bambi, Jana C1, Aiva) were analyzed in our work during the vegetation. In the phase I. (formation of bubs) the antioxidant activity was measured in stems and leaves. The lowest AOA (phase I.) was found in stems in cultivar Špačinská 49.105 % and the highest antioxidant activity was in cultivar Jana C1 69.787 %. Antioxidant activity in leaves was recorded from 83.549% (Jana C1) to 89.654% (Špačinská). In the phase II. (at the beginning of flowering) stems, leaves and also flowers were analysed. The highest antioxidant activity in stems from all tested cultivars of common buckwheat had cultivar Bambi 83.232 %. The highest antioxidant activity in leaves from all tested cultivars of common buckwheat had cultivar Bambi 99.665 %. In the flowers there was antioxidant activity higher than in stems and the highest AOA in flower had cultivar Špačinská (92.665 %). In the phase III. (full flowering), the stems, leaves, flowers and seeds were analysed. The

leaves and flowers had higher value of antioxidant activity than stems of all measured cultivar of common buckwheat. The antioxidant activity in stems during the III. growth phase was in interval from 44.792 (Aiva) to 80.065% (JanaC1), in leaves was from 85.877% (Aiva) to 88.321% (Špačinska). The antioxidant activity in seeds during the III. growth phase was in interval from 39.787 (Špačinska) to 88.241% (Bambi). On the basis of obtained result we could state that antioxidant activity in individual anatomic parts (phase III.) of common buckwheat was in followed order: stems < seeds < leaves < flowers. In phase IV. (full ripeness) stems, leaves and seeds were analyzed. The determined antioxidant activity AOA in observed cultivars was in interval 42.179% - 73.705% (stems), 77.937% - 93.315% (leaves) and 49.374% - 76.351% (seeds). The highest AOA in stems and leaves represented cultivar Špačinska. The highest antioxidant activity in seeds represented cultivar Bambi 76.351%. Based on obtained results of antioxidant activity determination we can create followed order: seeds< stems < leaves.

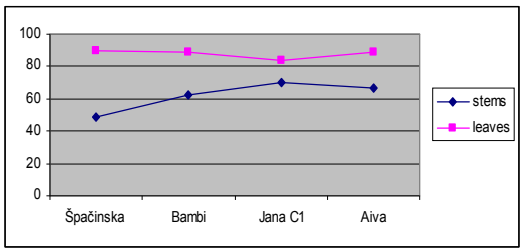

Fig 1 Antioxidant activity in I. growth phase

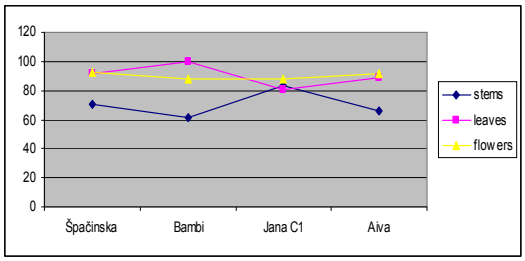

Fig 2 Antioxidant activity in II.. growth phase

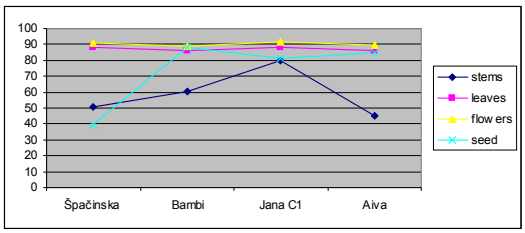

Fig 3 Antioxidant activity in III. growth phase

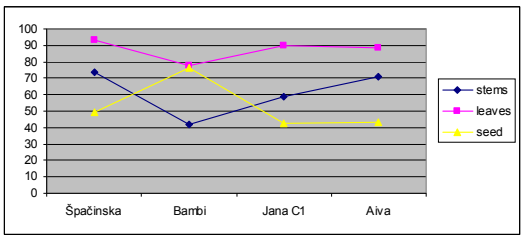

Fig 4 Antioxidant activity in IV. growth phase

Several authors deal with monitoring of antioxidant activity of various plant sources **(Lee *et al.*, 2010; Serpen *et al.*, 2008; Kim *et al.*, 2008).**

Our results correspond with **Velioglu *et al.* (1998)** referred high antioxidant activity of common buckwheat and measured in range from 63.7% to 94.9%. **Zdunczyk *et al.* (2006)** reported that antioxidant activity of buckwheat is 2-7 times higher than that of barley, triticale and oats.

Table 1 AOA of stems of various buckwheat cultivars

Cultivar	n	I.		II.		III.		IV.	
		Mean	st. dv.	Mean	st. dv.	Mean	st. dv.	Mean	st. dv.
Špačinska	4	49.11^{bcd}	0.95	70.55^{bc}	0.95	50.85^{cd}	1.36	73.71^{bcd}	1.51
Bambi	4	62.53^{ac}	3.17	61.16^{ac}	2.8	60.10^{cd}	5.15	42.18^{acd}	0.13
Jana C1	4	69.79^{ab}	2.83	83.29^{abd}	2.74	80.07^{abd}	0.96	59.07^{abd}	3.01
Aiva	4	66.93^{a}	1.03	65.90^{c}	3.2	44.79^{abc}	2.27	70.53^{abc}	1.21

The same letter means that there was no significant inter - varietal differences of AOA in buckwheat stems (α = 0.05)

Statistical evaluation of obtained result (table1) shows that, statistically significant differences of determined AOA in stems were confirmed only between cultivars Špačinska and Aiva (I.phase), Jana C1 and Aiva (II.phase).It means that cultivar is not important factor influencing AOA of buckwheat stems.

Table 2 AOA of leaves of various buckwheat cultivars

Cultivar	n	I.		II.		III.		IV.	
		Mean	st. dv.	Mean	st. dv.	Mean	st. dv.	Mean	st. dv.
Špačinska	4	89.65^{bc}	89.65	91.31^{bcd}	89.65	88.32^{d}	88.32	73.70^{bcd}	0.36
Bambi	4	88.74^{ac}	88.74	99.66^{acd}	99.66	86.44^{d}	86.44	60.1^{acd}	0.19
Jana C1	4	83.55^{abd}	83.55	80.81^{abd}	80.82	80.06^{d}	87.95	59.07^{ab}	0.73
Aiva	4	88.80^{c}	88.80	88.73^{abc}	88.73	44.79^{ac}	85.88	70.53^{ab}	1.04

The same letter means that there was no significant inter - varietal differences of AOA in buckwheat leaves (α = 0.05)

Statistical evaluation of obtained result (table 2) shows that, statistically significant differences of determined AOA in stems were confirmed only between cultivars Jana CI and Aiva (phase I.) and Špačinska - Aiva, Bambi - Aiva, Jana C1 - Aiva (phase III.). It means that cultivar is not important factor influencing AOA of buckwheat leaves.

Table 3 AOA of flowers of various buckwheat cultivars

Cultivar	n	II.		III.	
		Mean	st. dv.	Mean	st. dv.
Špačinska	4	92.67^{c}	0.64	90.63^{c}	0.45
Bambi	4	87.68^{a}	3.69	88.75^{cd}	1.22
Jana C1	4	88.17^{ad}	0.78	91.48^{ab}	0.79
Aiva	4	91.63^{c}	0.67	89.83^{b}	0.61

The same letter means that there was no significant inter - varietal differences of AOA in buckwheat flowers (α = 0.05)

Statistical evaluation of obtained result (table 3) shows that, statistically significant differences of determined AOA in flowers were confirmed between cultivars Špačinska – Bambi, Špačinska – Jana C1, Bambi – Aiva, Jana C1 – Aiva (phase II.) and Špačinska - Aiva, Špačinska – Jana C1, Bambi – Jana C1, Bambi – Aiva (phase III.).The determined AOA in flowers is significantly influenced by variety of buckwheat.

Table 4 AOA of seeds of various buckwheat cultivars

Cultivar	n	III.			
		Mean	st. dv.	Mean	st. dv.
Špačinska	4	39.8^{bcd}	2.68	49.57^{bcd}	0.42
Bambi	4	88.24^{acd}	1.34	76.35^{acd}	1.01
Jana C1	4	81.01^{ab}	2.65	42.29^{ab}	2.1
Aiva	4	84.78^{ab}	2.05	43.45^{ab}	1.86

The same letter means that there was no significant inter - varietal differences of AOA in buckwheat seeds (α = 0.05)

The statistical evaluation of determined values of AOA in buckwheat seeds (table 4) shows, that cultivar can not be considered as the factor influencing this parameter.

CONCLUSION

Common buckwheat *(Fagopyrum esculentum Moench)* has recently attracted much interest due to their health benefits. Buckwheat has been reported to possess higher antioxidant activity than other cereals, mainly due to high rutin content. Determination of total antioxidant activity is important in terms of selection of suitable cultivars with potentially positive contribution to the health of consumers.

The aim of our work was determine antioxidant activity in stems, leaves, flowers and seed during growth. The primary antioxidants in buckwheat are rutin, quercetin, hyperin, and catechins. The antioxidant activity in stems of common buckwheat in all observed phases were in range from 42.179% (Bambi) to 83.292% (Jana C1), in leaves from 77.937% to 99.655% (Bambi), in flowers from 87.677% (Bambi) to 92.665% (Špačinska) in seed from 39.787 % (Špačinska) to 88.241% (Bambi). The greatest attention of common buckwheat was attributed of seeds in term of their use in food industry. The role of variety as the factor influencing determined AOA was confirmed only in flowers of common buckwheat. Seeds of common buckwheat could be found also in food industries which are milled on flour used for production of many products. From the standpoint of antioxidant activity in individual anatomical parts the cultivar Špačinska, Bambi were the most suitable ones for food productions.

Acknowledgments: This contribution is the result of the project implementation: Centre of excellence for white green biotechnology, ITMS 26220120054, supported by the Research & Development & Operational Programme funded by the ERDF.

REFERENCES

ALVAREZ-JUBETE - L., ARENDT, E. K. - GALLAGHER, E. 2010. Nutritive value ofpseudocereals and their increasing use as functional gluten-free ingredients. In *Trends in Food Science and Technology*, 2010, no.21, p.106–113.

BONAFACCIA, G. - GAMBELLI, L. - FABIAN, N. - KREFT, I. 2003. Trace element in flour and bran from common and tartary buckwheat. In *Food Chemistry*, vol. 83, 2003, p. 1-5.

BRAND-WILLIAMS, W. - CUVELIER, M.E. - BERSET, C. 1995. Use of a free radical method to evaluate antioxidant activity. In *Lebensmittel-Wissenschaft und Technologie,* vol. 28, 1995, no.1, p. 25-30.

DIETRYCH-SZOSTAK, D. - OLESZEK, W. 1999. Effect of processing on the flavonoid content in buckwheat (Fagopyrum esculentum Möench) grain. In *Journal of Agricultural and Food Chemistry*, 1999, no. 47, p.4383 - 4387.

GÖKMEN, V. - SERPEN, A. - FOGLIANO, V. 2009. Direct measurement of the total antioxidant activity of foods: the 'QUENCHER' approach. In *Trends in Food Science and Technology*, vol. 20, 2009, no.6–7, p.278–288.

HOLASOVA, M. - FIEDLEROVA, V. - SMRCINOVA, H. - ORSAK, M. - LACHMAN, J. - VAVREINOVA, S. 2002. Buckwheat – The source of antioxidant activity in functional foods. In Foo*d Research International*, 2002, no.35, p.207–211.

KAWA, J. M. - TAYLOR, C. G. - PRZYBYLSKI, R. 2003. Buckwheat concentrate reduces serum glucose in streptozotocin-diabetic rats. In. *Journal of Agricultural and Food Chemistry*, 2003, no.51, p. 7287–7291.

KIM, C. D. - LEE, W. K. - NO, K. O. - PARK, S. K.- LEE, M. H. - LIM, S. R. 2003. Anti-allergic action of buckwheat (Fagopyrum esculentum Moench) grain extract. In *International Immunopharmacology*, 2003, no. 3, p.129–136.

LEE, J.S. - BOK, S.H. - JEON, S.M. - KIM, H.J. - DO, K.M. 2010 Antihyperlipidemic effects of buckwheat leaf and flower in rats fed a high-fat diet. In *Food Chemistry*, vol. 119, 2010, p. 235-240.

MORISHITA, T. - YAMAGUCHI, H. - DEGI, K. 2007. The contribution of polyphenols to antioxidative activity in common buckwheat and tartary buckwheat grain. In. *Plant Production Science,* 2007, no.10, p.99–104.

SERPEN, A. - GÖKMEN, V. - PELLEGRINI, N. - FOGLIANO, V. 2008. Direct measurement of the total antioxidant capacity of cereal products. In *Journal of Cereal Science*, vol. 48, 2008, p. 816-820.

StatSoft,Inc.2001.STATISTICA(data analysis software), version 6.0 Dostupné na internete : (www.statsoft.com) .

VELIOGLU, Y.S. - MAZZA, G. - GAO, L. - OOMAH, B.D. 1998. Antioxidant activity and total phenolics in selected fruits, vegetables and grain products. In *Journal of Agricultural and Food Chemistry*, 1998, vol.468, p. 4113-4117.

WIJNGAARD, H. H. - ARENDT, E. K. 2006. Buckwheat. In *Cereal Chemistry*, 2006, vol. 83, p. 391–401.

ZDUNCZYK, Z. - FLIS, M. - ZIELINSKI, H. - WROBLEWSKA, M. - ANTOSZKIEWICZ, Z. - JUSKIEWICZ, J. 2006. In vitro antioxidant activities of barley, husked oat, naked oat, triticale and buckwheat wastes and their influence on the growth and biomarkers of antioxidant status in rats. In *Journal of Agriculture and Food Chemistry,* vol. 54, 2006, p. 4168 - 4175.