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Rutin Content of the Grain of 22 Buckwheat (*Fagopyrum esculentum* Moench and *Fagopyrum tataricum* Gaertn.) Varieties Grown in Hungary

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ABSTRACT

Nineteen common buckwheat (*Fagopyrum esculentum* Moench) and three tartary buckwheat (*Fagopyrum tataricum* Gaertn.) varieties were grown in the summer 2007 at the Research and Experimental Farm of the Corvinus University in Soroksár, Hungary. The rutin content of the grain of *F. tataricum*, determined by high pressure liquid chromatography (HPLC), resulted several times higher than that of *F. esculentum.* Among the three varieties of *F. tataricum*, under investigation, 'Ishisoba' presented a significantly (P = 0.05) higher rutin content, although the actual differences of rutin levels remained rather modest. On the contrary, a large variation of the rutin content of the grain appeared among the 19 varieties of *F. esculentum* when comparing top and least rutin values observed ('Fukue' 51 mg/100 g dry weight (DW) and 'Mancan' 11 mg/100 g DW). However, the content of rutin of most of the varieties of *F. esculentum* was confined within a rather narrow range between 15 and 25 mg/100 g DW, values which are to be regarded as typical of this species. In this respect, 'Fukue' with 51 mg/100 g DW, for sure, represents a variety of *F. esculentum* capable of expressing an extremely high rutin content of the grain under the Hungarian environment. The rutin content of tartary buckwheat grain, though somewhat lower than the highest values reported in the pertinent literature, remained decidedly higher compared to that of common buckwheat.

Keywords: flavonoids, HPLC analysis
Abbreviations: DW, dry weight; **HPLC**, high pressure liquid chromatography

INTRODUCTION

Among minor crops buckwheat deserves special attention because some of the components of its grain are bioactive compounds capable to confer to food preparations the character of functional food or even that of FOSHU (Foods for Specified Health Use).

The proteins of buckwheat grain are appreciated for the high biological value, thanks to an extremely high content of the essential aminoacid lysine (Pomeranz and Robbins 1972), while the capacity to reduce the level of serum cholesterol has also been reported (Kayashita *et al.* 1995; Kayashita *et al.* 1997; Tomotake *et al.* 2000, 2001). Buckwheat starch, for its reduced digestibility (Skrabanja and Kreft 1998), avoids noxious picks of blood glucose (Skrabanja *et al.* 2001), an important condition in diabetics.

The presence of the flavonoid rutin in the buckwheat grain adds further interest in the use of this crop as food source. An increasing number of health beneficial effects are, in fact, being attributed to rutin: antihyperglycemic effect (Wang *et al.* 1992; Kamalakkannan *et al.* 2006); protective effect against the development of diabetes (Odetti *et al.* 1990; Srinivasan *et al.* 2005; Stanley Maizen Prince and Kamalakkaannan 2006), as well as a mitigation effect of diabetes consequences (Je *et al.* 2002; Nagasawa *et al.* 2003); antiglycation activity (Cervantes-Laurean *et al.* 2006); antioxidative property (Oomah and Mazza 1996; Afanas'eva *et al.* 2001); protective effects against haemoglobin oxidation (Grinberg *et al.* 1994); antilipoperoxidant activities (Negre-Salvayre *et al.* 1991); anti-inflammatory activity (Guardia *et al.* 2001); antiplatlet formation property (Sheu *et al.* 2004); a mitigation effect on cardiovascular diseases (He *et al.* 1995; Stanley Maizen Prince and Karthick 2007); antiangiogenic effect (Guruvayoorappan and Kuttan 2007); neuroprotective effect (Pu *et al.* 2007); antimutagenic activity (Aheme and O'Brien 1999, 2000; Undeger *et al.* 2004), anticancer activity (Deschner *et al.* 1991; Yang *et al.* 2000; Park and Park 2004).

Of the many species of buckwheat, two are of agronomic relevance: *Fagopyrum esculentum* or common buckwheat and *Fagopyrum tataricum* or tartary buckwheat. Common buckwheat is the most widespread, being the cultivation and consumption of tartary buckwheat limited to few provinces of the Himalayan districts of China and Bhutan. At present, the only place where tartary buckwheat is grown in Europe is the cross border region between Luxembourg, Germany and Belgium on a surface of approximately 50 ha (Bonafaccia and Fabjan 2003).

In general common buckwheat is a better grain yielder than tartary buckwheat (Fabjan *et al.* 2003). However, the rutin content of tartary buckwheat is up to two order of magnitude higher than that of common buckwheat (Kitabayashi *et al.* 1995a; Fabjan *et al.* 2003; Park *et al.* 2004; Brunori and Végvári 2007a, 2007b; Brunori *et al.* 2008).

Rutin content of common buckwheat is deeply influenced by variety (Kitabayashi *et al.* 1995b; Ohsawa and Tsutsumi 1995; Oomah and Mazza 1996; Brunori and Végvári 2007a, 2007b; Brunori *et al.* 2007, 2008), location (Oomah and Mazza 1996; Brunori and Végvári 2007a; Brunori *et al.* 2008) and to minor extent by sowing time (Dietrych-Szostak *et al.* 2007; Gao *et al.* 2007; Brunori *et al.* 2008) and related day length (Ohsawa and Tsutsumi 1995).

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Table 1 Buckwheat varieties utilized: origin and seed source.

Variety	Origin	Source
'La Harpe'	France	Semfor, Casaleone, Verona, Italy
'Darja'	Slovenia	Parco Scientifico e Tecnologico del Molise, Campobasso, Italy
'Golden'*	Bosnia-Hercegovina	
'AC Manisoba', 'Koban', 'Mancan', 'Springfield'	Canada	Kade Research Ltd., Morden, Manitoba, Canada
'Jana', 'Pyra', 'Špačinska'	Czech Republic	University of South Bohemia, Faculty of Agriculture, Ceské Budejovice, Czech Republic
'Kora', 'Luba', 'Panda'	Poland	Hodowli Róslin Palikije, Wojciechów, Poland
'Emka'	Poland	Department of Gene Bank, Division of Genetics and Plant Breeding,
'Aelita'	Russia	Research Institute of Crop Production, Prague-Ruzyne, Czech Republic
'Arakawa Village', 'Fukue', 'Kamiagata'	Japan	Plant Germ-Plasm Institute, Graduate School of Agriculture, Kyoto University, Japan
'Kitawasesoba', 'Donan'*, 'Kitayuki', 'Ishisoba'*	Japan	Plant Genetic Resources Laboratory, Dept. of Upland Agriculture, National Agricultural Research Center for Hokkaido Region, Shinsei, Memuro-cho, Kasai-gun, Hokkaido, Japan

* *F. tataricum* varieties.

Tartary buckwheat, apparently, presents a rather narrow range of grain rutin content which, however, reaches always very high levels (Brunori and Végvári 2007a, 2007b; Brunori *et al.* 2008).

Recent evidences have shown that both buckwheat species can be satisfactorily grown under the Hungarian pedoclimatic conditions (pers. obs.).

In view of introducing the cultivation of buckwheat in Hungary to sustain a novel class of food preparation with the character of functional food or even that of FOSHU, common and tartary buckwheat varieties were grown in the summer of 2007 and the content of rutin in the grain determined. The results are reported in the present paper.

MATERIALS AND METHODS

Nineteen common buckwheat (*Fagopyrum esculentum* Moench) and three tartary buckwheat (*F. tataricum* Gaertn.) varieties were utilized for the present investigation. The seed was either purchased or kindly provided as shown on **Table 1**.

Replicated small plots of 9 m^2 were grown in the summer 2007 at the Research and Experimental Farm of the Corvinus University in Soroksár. At the time of seed bed preparation a supplement of 100 Kg/ha of N as NH_4NO_3 and 90 Kg/ha of P as P_2O_5 was provided. Sowing took place on the 19th of April.

Hand weeds control was secured during the first month from seedlings emergence. Approaching seed ripening a rather severe and sudden bird damage occurred so to negate any evaluation of the grain yield. At ripening, however, enough seed could be harvested and utilized for the assessment of the rutin content of the grain.

Wholemeal was obtained from clean grains by the use of a FOSS TECATOR CYCLOTEC 1093 sample mill. Three replicated samples of 200 mg wholemeal were extracted with either 2 ml (*F. esculentum*) or 4 ml (*F. tataricum*) of methanol (HPLC grade) depending on the expected content of rutin, supposedly higher in the latter species. Extraction was performed in the dark, for 24 hours, at room temperature.

Rutin content was determined by the HPLC method according to the procedure previously described (Brunori and Végvári 2007b).

The rutin content of the grain was subjected to statistical analysis through the *t*-test (P = 0.05).

RESULTS

The rutin content of the grain of common and tartary buckwheat varieties is reported in **Tables 2** and **3**. With the exception of varieties 'Fukue' (51 mg/100 g DW) and 'Kamiagata' (30 mg/100 g DW), the large majority of the 19 common buckwheat varieties presented rutin contents comprised between a rather narrow range from 25 mg/100 g DW to 15 mg/100 g DW. The variety 'Mancan' with 11 mg/100 g DW presented the least rutin content.

However, the relatively low standard deviation (SD) of the average rutin contents disclosed significant differences (P = 0.05) for this trait among common buckwheat varieties (**Table 2**).

Table 2 Grain rutin content of 19 common buckwheat (*Fagopyrum esculentum* Moench) varieties grown, in the summer 2007, at the Research and Experimental Farm of the Corvinus University in Soroksár, Hungary. Rutin contents identified with the same letter are not statistically different according to the *t*-test with the level of significance P = 0.05.

Variety	Rutin (mg/100 g DW)	SD
Fagopyrum esculentum		
'Fukue'	51 a	1.55
'Kamiagata'	30 b	0.35
'Kitawasesoba'	25 c	0.48
'Špačinska'	23 cd	0.97
'Darja'	23 d	0.83
'Springfield'	20 de	0.74
'Panda'	20 def	1.00
'Pyra'	19 e	0.31
'Kora'	19 ef	0.90
'La Harpe'	19 ef	1.10
'Luba'	18 ef	0.54
'Kitayuki'	17 f	0.62
'Arakawa Village'	17 fg	0.84
'Koban'	16 f	0.15
'AC Manisoba'	16 fg	1.05
'Aelita'	15 g	0.09
'Emka'	15 g	0.39
'Jana'	15 g	0.24
'Mancan'	11 h	0.81

Table 3 Grain rutin content of three tartary buckwheat (*Fagopyrum tataricum* Gaertn.) varieties grown, in the summer 2007, at the Research and Experimental Farm of the Corvinus University in Soroksár, Hungary. Rutin contents identified with the same letter are not statistically different according to the *t*-test with the level of significance P = 0.05.

Variety	Rutin (mg/100 g DW)	SD
Fagopyrum tataricum		
'Ishisoba'	1193 a	24.92
'Golden'	1041 b	37.17
'Donan'	979 b	9.48

The rutin content of tartary buckwheat, ranging from 1193 mg/100 g DW of 'Ishisoba' to 979 mg/100 g DW of 'Donan' (**Table 3**), was decidedly higher than that of common buckwheat. The rutin content of the grain of the variety 'Ishisoba' was significantly higher (P = 0.05) than that of 'Golden' and 'Donan' (**Table 3**).

DISCUSSION

Due to the relevance of the rutin in confering health beneficial properties to buckwheat based food preparations, the content of this flavonoid in the grain needs not to be overlooked when considering the possibility to adopt the cultivation of buckwheat as innovative and alternative crop, as would be the case of Hungary. Recent preliminary agronomic trials (pers. obs.) have indicated that common buckwheat (*F. esculentum*) and tartary buckwheat (*F. tataricum*) can satisfactorily be grown under the Hungarian environmental conditions.

Compared to tartary buckwheat, common buckwheat is considered a better yielder (Fabjan *et al.* 2003) although the grain rutin content of the former is definitely higher (Kitabayashi *et al.* 1995a; Fabjan *et al.* 2003; Park *et al.* 2004; Brunori and Végvári 2007a, 2007b; Brunori *et al.* 2008).

As to the rutin content of common buckwheat grain, it is known the influence of variety (Kitabayashi *et al.* 1995b; Ohsawa and Tsutsumi 1995; Oomah and Mazza 1996; Brunori and Végvári 2007a, 2007b; Brunori *et al.* 2007, 2008) and environment (Oomah and Mazza 1996; Brunori and Végvári 2007a; Brunori *et al.* 2008). Therefore, it is not surprising that at least one variety, namely 'Fukue', presented quite interesting levels of rutin, suggesting that among the commercial varieties of this species, few may be identified that can set appreciable levels of rutin in the grain while at the same time expressing acceptable grain yield potentials.

The present results do confirm previous data on the high rutin content of the grain in tartary buckwheat (Kitabayashi *et al.* 1995a; Fabjan *et al.* 2003; Park *et al.* 2004; Brunori and Végvári 2007a, 2007b; Brunori *et al.* 2008) although the actual figures were not as high as the top values so far reported (Fabjan *et al.* 2003; Brunori and Végvári 2007a).

Tartary buckwheat grown under the Hungarian environment, however, has the capability to fortify common buckwheat flour as far as rutin content is concerned. This would make available mixes of buckwheat flour that possess rutin levels that can provide the consumers with an effective supply of rutin (40 mg/day) through the assumption of a single meal (breakfast, lunch, dinner).

If buckwheat has to play a role as innovative crop in Hungary and contribute as novel ingredient of recipes to enhance the health beneficial properties of local and traditional food preparations it would appear advisable that as many as possible varieties of both buckwheat species are evaluated in order to identify those best adapted to the local pedo-climatic conditions either for grain yield potential and grain rutin content.

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