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Nutritional comparison of tartary buckwheat with common buckwheat and minor cereals

Giovanni BONAFACCIA[1], Nina FABJAN[2]

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ABSTRACT

Since the epidemiological studies show that consumption of whole grains and grain-based products is associated with reduced risk of chronic diseases, a great interest for different cereals and similar plants have appeared. Several minor cereals, pseudocereals and other alternative crops, that have been left off production in the beginning of previous century, are now being reintroduced in European functional food production.

Key words: buckwheat, rutin, fibre, cereals, health effects

IZVLEČEK

PRIMERJAVA HRANILNE VREDNOSTI TATARSKE AJDE Z NAVADNO AJDO IN DRUGIMI ŽITI

Mnoge epidemiološke študije so pokazale, da je prehrana bogata z žiti in žitnimi izdelki povezana z manjšim tveganjem razvoja različnih kroničnih bolezni. Tako je povečana skrb za zdravje in kakovostno prehrano sprožila ponovno zanimanje za pridelavo nekaterih že opuščenih žit in drugih poljščin.

Ključne besede: ajda, rutin, vlaknine, žita, zdravstveni učinki

1 INTRODUCTION

In Europe there are several minor cereals, which were grown until the beginning of previous century. After that, common and tartary buckwheat and minor cereals were no more widely used, as they have been replaced by more productive species (mainly by common wheat, corn and potatoes). Now, with greater concern for human health and for functional food, for sustainable agriculture and for ecological growing a great interest for these plants has appeared. Reborn interest for the forgotten crops have

[1] National Institute of Nutrition, Via Ardeatina, 546, I-00178 Roma, Italy

[2] Univ. dipl. inž. agr., Nove trate 37, 3330 Mozirje

found growers, breeders and food technologists unprepared, as there have been until recent years no collecting of genetic material, nor breeding or studies on nutritional and technological value of minor cereals.

2 ALTERNATIVE CEREALS AND CEREAL FOODS IN EUROPE

In Europe, the following alternative cereals, minor cereals and pseudocereals, which could be used for human consumption, are now being grown again more widely:

Barley (*Hordeum vulgare* L.) is used for human food mainly as dehusked barley in different groats and other traditional foods. It is popular in Slovenia, Austria and some other countries of Central Europe. The use of naked barley is not traditional in Europe but there are some possibilities for the future use, as there is no need for the use of energy for dehusking. However, cultivars with naked seeds could be more susceptible to diseases and less vigorous in less suitable soil conditions. Thus we do not know if naked barley could be used in the European ecological agriculture. Barley is important food material because of relative high content of minerals, proteins, fibers and beta-glucans. Beta-glucans and other soluble dietary fibers may have important potential to lower the levels of total cholesterol and low-density lipoprotein cholesterol in the serum (Lee et al., 1997).

Oats (*Avena sativa* L.) is used for food products rich in dietary fiber. It is mainly consumed as oat flakes, which are traditional food especially in the countries of Northern Europe. Newly strigosa oats (*Avena strigosa*) reappeared as well in genetic and nutritional research.

Rye (*Secale cereale* L.) is widely used for traditional bread, in combination with wheat flour. Rye-wheat bread has special taste and is rich in protein, fiber and minerals. It is used mainly in the Central and Northern Europe.

Spelt wheat (*Triticum aestivum* L. subsp. *spelta*) is a form of wheat with husked grain, which should be dehusked prior to utilisation. Spelt wheat is a traditional crop in Northern Italy (Alto Adige), Austria and Germany. Traditionally it used to be grown in Belgium, Switzerland, Czech Republic, Slovakia and Slovenia, and it is reappearing again, being mainly grown without the use of chemicals. Spelt wheat is very suitable for ecological growing, as it is, because of husked grains, genetic polymorphism of populations and genetically based resistance, better resistant to pests and diseases; and suitable for growing in Alps and in harsh climatic conditions. Spelt wheat is traditionally used for different types of baked bread products, according to our research results it could be used as well for pasta and extruded products, very rich in dietary fiber.

Emmer wheat (*Triticum dicoccum* Schubler) is another wheat with husked grain, and is used after dehusking, for traditional popular soups in some regions of the central Italy (Toscana). It is grown as well in some places in Czech Republic and in Slovakia for ecological food products (Dostalek, 1997).

Einkorn wheat (*Triticum monococcum*) was among first cereals used for food, but in Bronze Age it was replaced by other more productive cereals. After dehulling, flour suitable for production of baked foods rich in carotenoids and proteins, could be obtained (Borghi et al., 1996; Dostalek, 1997).

There are two **buckwheat (*Fagopyrum*)** species used for food around the world. Common buckwheat (*Fagopyrum esculentum* Moench) originates from Southwest China and has gradually been spread to all continents, while tartary buckwheat (*Fagopyrum tataricum* Gaertn.) is grown and used in the mountainous regions of Southwest China (Sichuan), in northern India, Bhutan and Nepal. In Europe, tartary buckwheat is currently grown as a crop only in small part of Northwest Europe (Bonafaccia et al., 2003a).

Common buckwheat (*Fagopyrum esculentum* Moench) has been grown for centuries here in Europe and is now, alongside spelt wheat (Bonafaccia et al., 2000), one of the most important alternative crops, suitable for ecological growing, without the use of artificial fertilizers or pesticides. Common buckwheat is grown in all parts of Slovenia. The »green« social attitude here is widespread (Vadnal, 2002), so it is important to develop and to extend environmentally conscious technologies and to increase the growing of alternative crops like buckwheat. In Italy, buckwheat is grown in the Alpine region (Valtellina and Val Venosta) and used for preparing typical, regional food products.

Common buckwheat is used for flour and groats products in central and Eastern Europe (Kreft, 1994). It is traditionally used for pasta products (in south-eastern France, in northern Italy and in Slovenia), for blended bread (in combination with wheat, corn and other cereals) mainly in Slovenia, Austria and Czech Republic, and for different types of other flour foods. In some countries of Central and Eastern Europe (Slovenia, Croatia, Poland, Belarus, Ukraine and Russia) buckwheat groats are widely used, they may have important content of retrograded starch (Škrabanja and Kreft, 1998) and could thus be very suitable for diabetic patients and in prevention of colon cancer. It's suitable textural properties for pasta and other products, could be achieved by the balance of other proteins and starch (Ikeda et al., 1997). There are, however, only a few reports on the technological quality of buckwheat (Bonafaccia and Kreft, 1994; Ikeda, 1997; Ikeda et al., 1997).

Buckwheat products are known for the resistant starch (Škrabanja et al, 1998; Škrabanja et al., 2001) and as an important source of antioxidative substances (Kreft et al., 1994; He et al., 1995; Watanabe, 1998; Kreft et al., 1999; Park et al., 2000; Nagai et al., 2001), trace elements (Ikeda and Yamashita, 1994) and dietary fibre (Steadman et al., 2001). Buckwheat proteins have a high biological value, but relatively low true digestibility (Škrabanja et al., 2000). Buckwheat protein products have been associated with preventive nutrition (Kayashita et al., 1999; Tomotake et al., 2000; Liu et al., 2001). Buckwheat has no gluten, so it is safe for patients with coeliac disease (Skerrit, 1986).

Tartary buckwheat (*Fagopyrum tataricum* Gaertn.) was traditionally grown in small quantities in some countries of the Central Europe especially in Alpine region but, since about 1980, this ceased. As far as we know, the cross border region Islek –

which covers northern Luxemburg, the Westeifel (Germany) and the border area of the German-speaking part of Belgium - is at present the only place in Europe where the tartary buckwheat is still grown for human food on approximately 50 ha. The Luxemburgish ministry of agriculture has charged the University of Ljubljana to perform a pluriannual research project in order to develop the cultivation and utilization of tartary buckwheat. About 30 years ago tartary buckwheat could also be found as a crop in some parts of Slovenia, namely in Gorenjska, Dolenjska and Zgornjesavinjska dolina, but nowadays it is replaced by common buckwheat and may be found only as a weed in common buckwheat crop (Kreft, 1995). Tartary buckwheat could be grown like common buckwheat or even in more harsh climatic conditions.

Tartary buckwheat is known to have a high content of rutin and other polyphenols, and thus also higher than common buckwheat. The content of rutin in tartary buckwheat is determined as up to 3% dry weight (DW) in the herb, while quercitrin values were in the range of 0.01% to 0.05% DW. Only traces of quercetin were detected, in just some of the samples. Tartary buckwheat seeds contained more rutin (about 0.8 to 1.7% DW) than common buckwheat seeds (0.01% DW) (Fabjan et al., 2003). Rutin and quercetin content in seeds depends on variety and growing conditions. Tartary buckwheat seeds contained traces of quercitrin and quercetin, which were not found in common buckwheat seeds (Kitabayashi et al., 1995).

In common and in tartary buckwheat there is a prevalence of unsaturated fatty acids – C18:1, C18:2, C18:3 and C20:1 (Bonafaccia et al., 2003a). In both species most lipid substances are concentrated in the bran.

In common buckwheat bran, protein content was 21.6%, and in tartary buckwheat, 25.3% (Bonafaccia et al., 2003a).

There are relatively small differences in the contents of vitamins B1 and B2 between the two main utilisable milling fractions, but more substantial differences in the content of vitamins B6 (up to 0.61 mg/100 g in the tartary buckwheat bran fraction). Total B vitamin content is higher in tartary buckwheat than in common buckwheat (Bonafaccia et al., 2003a).

In common and in tartary buckwheat most trace elements (analysed were Se, Cr, Rb, Zn, Fe, Co, Sb, Ba, Ni, Ag, Hg and Sn) are concentrated mainly in the bran. However there are relatively small differences in the contents of iron, antimony, and chromium between flour (extraction rate 55%) and bran fractions. In tartary buckwheat fine flour (extraction rate 42%) there is a lower trace element content than in normal flour. The potential use of buckwheat bran as a dietary source of Zn, and Se, is indicated (Bonafaccia et al., 2003b).

On the basis of these analyses, it can be concluded that tartary buckwheat bran is an excellent food material with a potential for preventive nutrition.

Grain amaranth (*Amaranthus sp.*) is grown in small quantities in some countries of the Central Europe, like in Czech Republic and Slovakia, it is interesting as it could be grown without the use of chemicals. It is consumed as groats, or used for extruded products.

Proso millet (*Panicum mileaceum* L.) was a traditional crop in the Central and Eastern Europe, and is now reappearing, mainly to be used in traditional groat foods (Moudry, 1995).

Foxtail millet (*Setaria italica* Beauv.) was in history grown in some parts of Europe for human consumption. It is possible that interest for this crop will reappear. It could be used in similar ways as grain amaranth or proso millet.

One of the most important constituents of traditional minor cereals are fibers. It was found (Bonafaccia, 1996) that other cereals have much more dietary fibres in comparison to common wheat (Table 1). Dietary fiber in cereal foods is important for prevention of colon cancer and obesity, which are both more and more serious problems in the modern European societies. With special milling and technological procedures it is possible to retain much of fibres in the products. Further it is possible by hydrothermal treatment to obtain some retrograded starch, which may have similar functionality as fibers. In buckwheat and spelt wheat a considerable content (about 1 % or more) of phytic acid (myoinositol phosphate) can be found. Phytic acid may have protective role against colon cancer and some other forms of cancer (Shamsuddin et al., 1992).

Table 1.: Chemical composition of some cereal flours (% dry matter basis).

				Dietary fibres		
Crop	Protein	Ash	Lipids	Soluble	Insoluble	Total
Wheat	11.5	1.7	1.0	1.0	1.5	2.4
Common buckwheat	11.0	2.6	3.4	1.2	5.3	6.5
Tartary buckwheat	10.3	1.8	2.5	0.5	5.8	6.3
Oats	12.6	1.8	7.1	3.3	4.9	10.2
Rye	11.7	1.5	1.8	3.6	10.0	13.6
Spelt wheat	13.5	1.9	2.5	0.6	5.4	6.0

Further group of substances of interest are secondary plant metabolites and other non-nutritional constituents (for example rutin, quercetin, beta-glucans and several trace elements like Zn and Se). Non-nutritional substances, with other food constituents, may help to maintain the health of the human organism.

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