Buckwheat Grains and Buckwheat Products – Nutritional and Prophylactic Value of their Components – a Review

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Abstract


Buckwheat is introduced into the diet as an alternative crop of renewed interest due to its nutritive and health-promoting value. Experiments with animal models have demonstrated that buckwheat flour may alleviate diabetes, obesity, hypertension, and hypercholesterolemia. A number of nutraceutical compounds exist in buckwheat grains and other tissues. These are a rich source of starch, proteins, antioxidants, and dietary fibre as well as trace elements. The biological value (BV) of buckwheat proteins is comparable to BV of other protein sources. Besides high-quality proteins, buckwheat grains contain some components with prophylactic value: flavonoids, fagopyrins, or thiamin-binding proteins. For the food industry, buckwheat grains are a valuable raw material to be used for the production of functional foods. Buckwheat flour may be a valuable and important ingredient in diets or food products, taking into consideration its nutritive value and potential promotion of human health.

Keywords: buckwheat grains; nutritional components; resistant starch and dietary fibre; healing effect of components; dietary and prophylactic value; allergic reaction of buckwheat proteins

Buckwheat (Fagopyrum esculentum Möench) is an annual crop, it is a pseudocereal but its grains belong to cereals because of their similar use and chemical composition (Campbell 1997). Among a variety of buckwheat species, nine have agricultural and nutritional value. Two buckwheat species are commonly cultivated: common buckwheat (F. esculentum) and tartary buckwheat (F. tartaricum) (Krkošková & Mrázová 2005).

The main producers of buckwheat are China, Russian Federation, Ukraine, and Kazakhstan (Li & Zhang 2001; Bonafaccia et al. 2003). It is also produced in Slovenia, Poland, Hungary, and Brazil (Kreft et al. 1999a). There are some botanical and physiological similarities between buckwheat and weeds, one of them being the ability to correct growth without the use of artificial fertilisers or pesticides (Kreft et al. 1996). Moreover, buckwheat absorbs less water and lower amounts of nutrients from soil than other main crops (Li & Zhang 2001).

For many years, the cultivation of buckwheat was in decline, yet recently its has been observed to increase because of the health-promoting properties of its grains. Buckwheat grains and other tissues contain numerous nutraceutical compounds (Li & Zhang 2001) and they are rich in vitamins, especially those of B group (Fabjan et al. 2003).
The amino acid composition of buckwheat proteins is well balanced and of a high biological value (Kato et al. 2001), although the protein digestibility is relatively low (Luu et al. 2001). Buckwheat grains are an important source of microelements, such as: Zn, Cu, Mn, Se (Stibilj et al. 2004), and macromolecules: K, Na, Ca, Mg (Wei et al. 2003). With 80% unsaturated fatty acids more than 40% are constituted by polyunsaturated fatty acid (PUFA) (Krkošková & Mrázová 2005). The significant contents of rutin, catechins and other polyphenols as well as their potential antioxidiant activity are also of significance to the dietary value (Oomah & Mazza 1996; Wañate 1998). Moreover, buckwheat grains are a rich source of TDF (total dietary fibre), soluble dietary fibre (SDF), and are applied in the prevention of obesity and diabetes (Brennan 2005).

Chemical and nutritional components of buckwheat grains

Buckwheat grains contain a variety of nutrients, the main compounds being: proteins, polysaccharides, dietary fibre, lipids, rutin, polyphenols, micro- and macromolecules (Kim et al. 2004). The total content of components depends on the variety or environmental factors (Bárta et al. 2004).

Proteins. In literature, the protein content of buckwheat grains has been reported to range from 12% to 18.9% (Table 1). The high stability of buckwheat species should be emphasised taking into consideration the content of protein in grains, in comparison with that determined currently in three Polish varieties of buckwheat (Stempińska & Soral-Śmietana 2006). It has been confirmed by the comparison of the content of proteins determined earlier in commercial tests of Polish and Brazilian buckwheat grains (Soral-Śmietana 1984). Bran milling fractions of buckwheat have been shown to be characterised by a high concentration of proteins (Qian & Kuhn 1999; Krkošková & Mrázová 2005), whereas the protein concentration in the hull is low, about 4%, however, in the embryo it reaches 55.9% (Pomeranz & Sachs 1972). Buckwheat flour contains from 8.5% to near 19% of proteins depending on the variety, pesticides used, and fertilisation that are likely to affect the total concentration of buckwheat proteins (Fornal 1999).

The major protein fractions of the grains are water-soluble and salt-soluble albumins and globulins representing almost one-half of all buckwheat proteins. Globulins consist of 12–13 subunits with molecular weights from 16 kDa to 66 kDa (Krkošková & Mrázová 2005).

The main storage protein of buckwheat grains is 13S globulin (Aubrecht & Biacs 1999; Li & Zhang 2001). It has a hexametric structure with disulfide-bonded subunits composed of bonded acidic and basic polypeptides. This structure is common for all legumin-like storage proteins (Aubrecht & Biacs 1999). Buckwheat globulins are also composed of 8S vicilin-like proteins (Radović et al. 1999). The average albumin content is 21%, whereas the highest one reaches 30–33% (Bharali & Chrungoo 2003). Buckwheat prolamin have a different characteristic in comparison to wheat, barley, and rye prolamins, which enables buckwheat grains application in the prophylactic of gastrointestinal tract diseases, mainly celiac disease (Kreft et al. 1996). Buckwheat grains may constitute a valuable source of dietary proteins with a high content of essential amino acids, which is important for people who do not tolerate gluten proteins (Aubrecht & Biacs 2001) or with proteins deficiency in the diet.

Buckwheat proteins are rich in arginine and lysine, the primary amino acids limiting the content of proteins in cereals, whereas the contents of methionine and threonine in buckwheat proteins are low (Table 2).

Thiamin-binding proteins (TBP) serve as B1 vitamin transporters in the plant and stabilise it during technological processing. They can also improve thiamin stability during storage as well as its bioavailability. Mistunaga et al. (1986) were the first to isolate the thiamin-binding proteins (TBP) from buckwheat grains. TBP in buckwheat represent an oligomer, during SDS-PAGE they migrate as a single band corresponding to the molecular weight of 42 kDa to 45 kDa. They have a 1:1 binding stoichiometry with thiamin (Li &

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**Table 1. Content of proteins in buckwheat grains**

<table>
<thead>
<tr>
<th>N (% d.m.) × 6.5</th>
<th>Authors</th>
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<tbody>
<tr>
<td>12.0 – 13.0</td>
<td>Steadman et al. (2001)</td>
</tr>
<tr>
<td>12.11</td>
<td>Li and Zhang (2001)</td>
</tr>
<tr>
<td>8.5 – 18.87</td>
<td>Krkošková and Mrázová (2005)</td>
</tr>
<tr>
<td>12.02</td>
<td>Stempińska and Soral-Śmietana (2006)</td>
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TBP may be used in the cases of thiamin deficiency and difficulties in its storage (Wanatabe et al. 1999). An increasing incidence of allergy manifestations or symptoms is observed in people who consume buckwheat-containing food products often and in high quantities. The main reason for such immunological disorders are low molecular weight proteins, particularly those with molecular weights of 15, 22, or 26 kDa (Yoshioka et al. 2004; Handoyo et al. 2006; Morita et al. 2006).

Polysaccharides and dietary fibre. Starch is the major storage component of buckwheat grains. It is accumulated in the endosperm as an energetic material necessary for the plant growth. In the whole grain of buckwheat, starch content varies from 59% to 70% of the dry mass, demonstrating fluctuations under variable climatic and cultivation conditions (Qian & Kuhn 1999). However, current results of starch analysis in buckwheat grains of three Polish varieties have shown that the starch content lies in a narrow range, i.e. from 63% to 66% d.m. (Stempińska & Soral-Śmietana 2006).

The composition of starch isolated from buckwheat grains differs from that of cereal starches. It may contain higher amounts of proteins, ash, and phosphorus (Soral-Śmietana et al. 1984b). The content of bound lipids is two times higher than that of free lipids. Upon hydrothermal processing of buckwheat grains, the content of free lipids fraction was observed to increase, however, buckwheat starch was shown to be predominated by both lipid fractions (Soral-Śmietana et al. 1984a).

Amylose content of buckwheat starch granules fluctuates between 15% and 52% and its degree of polymerisation varies from 12 to 45 glucose units (Campbell 1997). Buckwheat starch granules are spherical, oval and polygonal in shape with noticeable flat areas due to compact packing in the endosperm, the granule size distribution ranges from 2 to 6 µm (Soral-Śmietana et al. 1984b; Acquistucci & Fornal 1997).

From the nutritional point of view, there exist three fractions of starch: rapidly digestible starch (RDS), slowly digestible starch (SDS), and resistant starch (RS). Resistant starch is not absorbed in the small intestine and is partly or completely available for fermentation by microflora in the large intestine. It could show similarity to dietary fibre. In uncooked buckwheat grains, RS consti-

### Table 2. Aminoacids of buckwheat grains (% w/w)

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<tr>
<td>Lysine</td>
<td>6.17</td>
<td>4.9</td>
<td>5.68</td>
</tr>
<tr>
<td>Histidine</td>
<td>2.44</td>
<td>1.4</td>
<td>2.52</td>
</tr>
<tr>
<td>Arginine</td>
<td>8.85</td>
<td>5.4</td>
<td>11.16</td>
</tr>
<tr>
<td>Glutamic acid</td>
<td>15.37</td>
<td>9.7</td>
<td>19.38</td>
</tr>
<tr>
<td>Aspartic acid</td>
<td>9.10</td>
<td>5.2</td>
<td>9.54</td>
</tr>
<tr>
<td>Threonine</td>
<td>4.04</td>
<td>1.9</td>
<td>3.5</td>
</tr>
<tr>
<td>Serine</td>
<td>4.89</td>
<td>2.4</td>
<td>4.61</td>
</tr>
<tr>
<td>Proline</td>
<td>4.57</td>
<td>2.6</td>
<td>7.93</td>
</tr>
<tr>
<td>Glycine</td>
<td>6.23</td>
<td>4.2</td>
<td>5.66</td>
</tr>
<tr>
<td>Alanine</td>
<td>4.82</td>
<td>3.0</td>
<td>3.89</td>
</tr>
<tr>
<td>Valine</td>
<td>4.97</td>
<td>3.4</td>
<td>4.26</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>3.41</td>
<td>2.6</td>
<td>3.12</td>
</tr>
<tr>
<td>Leucine</td>
<td>6.12</td>
<td>2.8</td>
<td>5.94</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.99</td>
<td>1.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Tyrosine</td>
<td>1.94</td>
<td>1.5</td>
<td>3.03</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>4.42</td>
<td>2.0</td>
<td>4.3</td>
</tr>
<tr>
<td>Tryptophane</td>
<td>2.14</td>
<td>1.5</td>
<td>2.0</td>
</tr>
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Zhang 2001).
Starch is not only a substrate 33–38% of total starch, but after cooking – only 7–10% (Figure 1). Resistant starch in buckwheat grains of three Polish varieties constituted from 16% to over 18% d.m., while the Kora variety stood out from the other varieties (Śmietanka & Soral-Śmietana 2006). The factors influencing starch availability include its botanical origin and physical properties, the ratio of amylose to amylpectin, and starch interactions with other constituents (Kreft et al. 1996). It was proved that, in the presence of milk proteins and cereal flour (corn), the complexing factor is buckwheat starch and its lipids induced by the extrusion process (Soral-Śmietana 1992). Starch is not only a significant source of energy for humans, it is also reported to interact with the gut microflora (Bird et al. 2000; Wronkowska et al. 2006).

Soluble carbohydrates, including fagopyritols, are concentrated mainly in the embryo, their concentration is low in endosperm whereas their total contents ranges from 1% to 6% (Steinman et al. 2000).

Fagopyritol A1 and Fagopyritol B1 are the most remarkable of all the fagopyritols accumulated. Fagopyritol A1 (Obendorf et al. 2000) is an active substance that may be used in the treatment of e.g. diabetes and polycystic ovarian syndrome (PCOS) (Horbowicz et al. 1998; Janet et al. 2005).

According to the current definition, dietary fibre is the edible part of a plant or analogous carbohydrates that is resistant to digestion and absorption in the human small intestine but is partly or completely fermented by microflora in the large intestine (AACC Report 2001). Dietary fibre consists also of oligosaccharides, polysaccharides, and other hydrophilic derivatives (Gibson et al. 2000). Non-starch polysaccharides such as cellulose, hemicelluloses, pectins, gums, and non-celloulosic polysaccharides are the main components of dietary fibre. They are concentrated in tissues with thicker cell walls, aleurone, seed coat and hulls. Total dietary fibre (TDF) is classified in view of its affinity to water as either insoluble dietary fibre (IDF) or soluble dietary fibre (SDF). In general, IDF includes cellulose, lignins, and certain non-cellulosic polysaccharides, while SDF includes pectins and some associated non-cellulosic polysaccharides (Asp et al. 1993; Brennan 2005; Young et al. 2005). The whole grains contain 7% TDF, while bran with hull fragments has 40% TDF (Steinman et al. 2001).

**Lipids.** Buckwheat grains contain from 1.5% to 4% of total lipids (Steinman et al. 2001), but the content of raw fat in buckwheat flour exceeds 3% (Soral-Śmietana 1987). Free lipids isolated from buckwheat grains constitute 2.5% of d.m., whereas bound lipids – about 1.3% d.m. (Soral-Śmietana et al. 1984a). It was demonstrated that in buckwheat flour the content of free lipids is higher than that of bound lipids, but reverse situation was observed after the extrusion process (Soral-Śmietana 1987). The highest concentration of lipids was found in the embryo (7–14%), whereas the lowest in the hull (0.4–0.9%) (Bonaffacia et al. 2003).

Triacylglycerides are the main components of the neutral fraction of lipids containing fatty acids from C12 to C22, with a predominating contribution of: oleic (42%), linolic (32%), and palmitic acids (16%) (Soral-Śmietana et al. 1984a). By analysing the composition of fatty acids, these authors found that bound lipids in the whole buckwheat grains and those in buckwheat starch differ in terms of the concentrations of dominant acids: palmitic (16 and 26%, respectively), oleic (32 and 40%, respectively), and linolic (46 and 22%, respectively). The application of two hydrothermal processes with different intensities evoked changes in the proportions of saturated fatty acids and unsaturated fatty acids in buckwheat grains. An in-depth research of the free to bound lipids ratio was showed its value to reach 1:2. Predominance of linolic acid is marked in the polar fraction of free lipids of buckwheat starch both before and after hydrothermal processes. The observed changes in the concentration of stearic acid in glyco- and phospholipids of free lipids was also evoked by hydrothermal processes (Soral-Śmietana et al. 1984a). Fatty acids may play a role in modifying the risk of breast, colon, and prostate cancer incidence. Polyunsaturated fatty acids (PUFA), such as...
Minerals and vitamins. Generally, the content of minerals in buckwheat grains and their morphological fractions (dry base) reaches: 2–2.5% in whole grains, 1.8–2.0% in kernel, 2.2–3.5% in dehulled grains, about 0.9% in flour, and 3.4–4.2% in hulls (Li & Zhang 2001). Buckwheat is rich in potassium (K), magnesium (Mg), calcium (Ca), and sodium (Na). P, K, and Mg are most concentrated in bran, particularly in the bran from which the hulls were removed before milling the grains. Buckwheat may be an important nutritional source of such microelements as iron (Fe), manganese (Mn), and zinc (Zn) (Wei et al. 1995). Trace elements, e.g. chromium (Cr) or selenium (Se), are occasionally detected at very low levels. Stibilj et al. (2004) reported after cultivation experiments reported that foliar fertilisation makes buckwheat grains a rich source of dietary Se and a useful raw material for enriched food products (Steadman et al. 2001; Wei et al. 2003; Stibilj et al. 2004).

Buckwheat grains were also demonstrated to contain vitamins: B₁, B₂, B₆ (Fabjan et al. 2003). These are concentrated in the peripheral parts of endosperm and embryo, hence the highest quantity of B vitamins is found in the bran. Tartary buckwheat bran contains about 6% of daily therapeutic doses of pyridoxine (Schynder et al. 2001), effective in the reduction of blood plasma homocysteine levels.

Buckwheat components with healing effects

Buckwheat grains and hull consist of some components with healing properties and biological activity, i.e.: flavonoids and flavons, phenolic acids, condensed tannins, phytosterols, and fagopyrins. Their contents and compositions differ depending on the buckwheat species and growing conditions. Generally, flavonoids content of F. tartaricum (about 40 mg/g) is higher than that of F. esculentum (10 mg/g) (Oomah & Mazza 1996; Li & Zhang 2001; Chao et al., 2002). Xuan and Tsuzuki (2004) rank buckwheat (Fagopyrum sp.) among allelopathic plants.

Antioxidant activity is the fundamental prophylactic property important for the human organism. A variety of biological functions, e.g. antimutagenic, anticarcinogenic, antiaging, originate from that property (Holasová et al. 2002).

About six flavonoids have been isolated from buckwheat grains. Of the total pool of buckwheat grains flavonoids, rutin was observed to predominate (Kreft et al. 1999b). Rutin, quercetin, orientin, vitexin, isovitexin, and isoorientin were identified in buckwheat hulls (Diétrych-Szóstak & Oleszek 1999, 2001). Some types of buckwheat flour could be considered as food with a high content of flavonoids, expressed as rutin (Figure 2), since their contents are higher than in cereal grains, cabbage, apple, red wine or tea (Zieliński & Kozłowska 2000).

Rutin, a flavonol glycoside, is a plant metabolite that was discovered in 1842. Rutin content depends on the variety and growth conditions (Ohsawa & Tsutsuji 1995). Kitabayashi et al. (1995) reported that its content in buckwheat grains ranges from 12 to near 36 mg/100g dry basis.

C-Glycosylflavons present in buckwheat seedling cotyledons are vitexin, isovitexin, orientin and isoorientin. Condensed catechins, phenolic acids, including hydrobenzoic acids, synigric, p-hydroxy-benzoic, vanillic, and p-coumaric acids, are present in the bran-aleurone layer of buckwheat grains (Przybylski et al. 1998). Soluble oligomeric condensed catechins occur in common buckwheat grains which, along with phenolic acids, provide astringency and affect the colour and biological activity of buckwheat products.

Plant sterols (so-called phytosterols), although identified in buckwheat grains at low levels, also exert a positive effect on the blood cholesterol level. β-Sitosterol, which represents at least 70% of total sterols, occurs in the endosperm and embryo tissues of buckwheat grains. It cannot be absorbed in human body and displays a considerable competitive inhibitory effect on cholesterol absorption.
in vivo (Bryngelsson et al. 1999; Normén 2001; Krkošková & Mrázová 2005).

The level of fagopyrins in buckwheat grains is very low and their isolation is difficult. It was reported that fagopyrins found in buckwheat can be utilised in the treatment of type II diabetes (Li & Zhang 2001; Bonaffaccia et al. 2003; Horbowicz & Obendorf 2005).

Dietary and prophylactic value of buckwheat grains or products

Buckwheat is nutritionally interesting due to, e.g., a very low content of prolams in its grains. Buckwheat flour can be a valuable ingredient in diets or food products for coliac patients. Coliac disease (also known as gluten-sensitive enteropathy) is a genetically-determined disease of the small intestine linked with gluten intolerance. However, an increase is also observed in the incidence of the so-called potential celiac disease, particularly in adult patients. Prolamins of the gluten proteins complex found in wheat, barley, rye, and probably also oat react with the mucosa of small intestine, causing damage by activating the immune system to attack the delicate lining of the gut, which is responsible for absorbing nutrients and vitamins (Kunachowicz 2001; Rujner 2002).

Buckwheat proteins may show a strong supplemental effect with other vegetable proteins due to the well balanced aminoacid composition (Li & Zhang 2001). The Lys/Arg and Met/Arg ratios in buckwheat proteins are lower than those in most plant proteins. This indicates that buckwheat should be characterised by the properties capable of lowering blood cholesterol level. According to Huff and Carroll (1980) and Sugiyama et al. (1985), buckwheat proteins can exert a strong cholesterol-lowering effect and have a high biological value (BV).

The addition of protein products of buckwheat to diets significantly lowers the levels of cholesterol in serum, liver, and gallbladder of hamsters and suppresses the formation of gallstones by altering cholesterol metabolism (Tomotake et al. 2002), whereas protein extracts are more efficient in lowering the blood cholesterol level, particularly that of LDL and VLDL (Kayashita et al. 1995; Misawo & Iwao 1996; Tomotake et al. 2006). The hypocholesterolemic effect in humans is linked with a lower digestibility of buckwheat proteins and the presence of fibre-like substances, which is indicated by an increase in the contents of neutral and acid sterols in rat faeces observed upon the administration of a diet rich in buckwheat protein products (Kayashita et al. 1997; Tomotake et al. 2001).

Buckwheat proteins products (BWP) are acknowledged as preventive nutrients (Liu et al. 2001). They are also associated with the suppression of colon carcinogenesis by reducing cell proliferation, and with the suppression of mammary carcinogenesis by lowering serum estradiol.

They can suppress gallstone formation better than can soy protein isolates (Tomotake et al. 2000, 2001). Numerous experiments have proved that buckwheat proteins extract may be used as a potential functional food additive to treat hypertension, obesity, alcoholism, as well as constipation (Kato et al. 2001; Tomotake et al. 2002).

In buckwheat grains dietary fibre contains about 7% of the soluble fraction whereas resistant starch (comparable with it in terms of the physiological functions) constitutes about 28% of total starch in the whole grain (Stempnińska & Soral-Śmietana 2006). Préstamo et al. (2003) investigated the effect of buckwheat products ingestion on the microbial composition of the colon of rats, the detection having been carried out on Enterobacteria and Bifidobacteria. The researchers reported an increase in the numbers of aerobic, mesophilic and lactic acid bacteria with the buckwheat products as compared to control. They observed a slight decrease of Enterobacteria and less pathogenic bacteria. These results confirm that buckwheat products may be considered as potential prebiotic components in human gastrointestinal tract.

In the technological cycles of experimental buckwheat products for fast consumption, the so-called convenient food, buckwheat flour was used as a component mixed with milk proteins and cereals (Śmietana et al. 1985, 1988). During the extrusion process (Fornal et al. 1987a), biopolymers like proteins and starch coming from several sources underwent physicochemical and structural transformations (Fornal et al. 1985, 1987b), as a result of factors such as heat, friction, pressure, and limited amounts of free water. Hence, as a consequence of hydrothermal transformations, this process resulted in the improvement of the true digestibility examined in the intestinal tract of rats, yet with a rise in the temperature of the extrusion process the biological value (BV) and NPU index of extruded products indicated a slight decrease in comparison with the proteins
of non processed buckwheat flour (Kozikowski et al. 1989).

The changes in the structure of cereal starches and buckwheat starch prove the possibility of small and weak crystallites formation at various levels of aggregation and random distribution upon extrusion (Soral-Smietana 1992). This indicates that thermally-induced amylose-lipid complexes in this products can cooperate with B type crystallites and behave as an amorphous material.

Honey obtained from buckwheat flowers increases the antioxidative potential of human blood serum and in vitro studies indicated that it protects lipoproteins of blood serum against oxidative processes more effectively than saccharic analogues (Gheldof et al. 2003).

The most interesting fact for the food industry is the improvement of functional properties of food as well as the health-promoting benefits resulting from food consumption. Buckwheat flour is used to produce multicomponent mixtures to obtain food of a complex nutritive value, but buckwheat flour can be also obtained characterised by decreased activities of proteases and α-amylase (Fornal 1999).

**Buckwheat proteins in the aspect of allergic reactions**

Although buckwheat grains contain a significant amount of proteins of well-balanced aminoacid composition and display a high biological value, the newest results signalise that some buckwheat proteins may provoke allergies. Allergic reactions after the consumption of buckwheat food are noticed and, in their worst form, they may cause hemorrhagic disease, connected with a rapid decrease of blood pressure known as the anaphylactic shock. The main symptom of allergy to buckwheat products is eczema or urticaria, appearing in a short time after their consumption. The detection of allergic protein of buckwheat with IgE immunoblotting shows that allergic reactions are triggered by numerous low molecular weight legumin-like proteins (15–29 kDa). According to Yoshioka et al. (2004), the protein of 22 kDa is the major protein binding IgE antibodies. Morita et al. (2006) confirmed this information and showed another allergic protein of 15 kDa. Moreover, the proteins of 24, 19, 16, 9 kDa are known as strong allergens (Ličen & Kreft 2005).

Bearing in mind the nutritive and health-promoting value of buckwheat products, researchers try to eliminate allergic proteins of buckwheat grains. They use advisable modifications, e.g. enzymatic modifications that consist in enzymatic separation of allergenic constituents or controlled fermentations performed by yeast or mould strains (Handoyo et al. 2006).

The conditions of our health depend on the quality of food in diet. To sum up, because of the valuable chemical composition of buckwheat grains, these are an important component in the diet and, taking into consideration the biological activity of other components presented in this review, they can play prophylactic or therapeutic roles.

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