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Treatment of Human Diseases through Buck Wheat Nutrition

Muhammad Arshad Ullah[1]*, Ali Hassan[2] and Ameer Hamza[2]

[1]*Pakistan Agricultural Research Council, Pakistan*

[2]*PMAS- University of Arid Agriculture, Pakistan*

***Corresponding author:** Muhammad Arshad Ullah, Pakistan Agricultural Research Council, Islamabad, Pakistan

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ABSTRACT

Buck Wheat (BW) leaves containing a large amount of protein (24.20 %) that is suitable for growing and lactating animals, as well as for human food used as salad. In published studies protein, ether extract, and ash contents of the BW grain ranged between 10 -15%, 1.7-4.0%, and ash 22.7% DM, respectively. These differences are due to variation of geography, climate, environmental factors, soil type, the harvest time, cultivar, and growing site. BW's fat content is quite similar to other cereals. Fatty acid concentration of BW is lower than wheat, corn, or soybean. However, fatty acid composition of BW is similar with amaranth. Its medical properties have been confirmed by animal studies; it was shown that BW could reduce hypertension and plasma cholesterol decreasing hepatic lipogenic enzymes as well as hepatic lipid concentrations and gallstone formation. As a feed component BW has been used in ruminants, rabbits, pigs and chicken. However, high content of fibre and some anti-nutritive factors such as tannin, trypsin inhibitor that results in a low digestibility of protein and other nutrients limits the proportion of BW in mixed feeds. Furthermore, unlike other cereals, BW can grow in hard condition such as low or poor fertilizer, sandy soils, high temperature, dry wind, etc. and the presence of insects. Buckwheat has been used as an important raw material for functional food development because of its functionalities and compounds content, such as proteins, flavonoids, phytosterols, and other. Rutin, a secondary metabolite present in buckwheat, has shown anti-inflammatory, anticancer, antiatherogenic, and antioxidant activity. Buckwheat seeds contain very rare D-chiro-inositol, which is mainly found in the form of fagopyritols. This compound has acquired a lot of interest due to its glucose-lowering capacity in animal models. Buckwheat seeds, both groat and hull, and sprouts are an important source of rutin (quercetin-3-rutinoside) the con-tent of which depends on the variety of seeds and growth conditions. Along with rutin, a high content of epicatechin in flowers and leaves make these parts of buckwheat good antioxidant sources in human diet. The C-glucoflavones present mainly in buck-wheat seeds are vitexin, isovitexin, orientin and homoorientin, which exert antioxidant activity in vitro. Quercetin, the aglycone of rutin, is a flavonoid with a potent antioxidant activity that is present in buckwheat groats in a lower concentration. After fermentation of buckwheat grains by fungi Rhizopus oligosporusthe amount of amino acids, minerals was higher and allergenic proteins were reduced as compared to non-fermented material. Buckwheat honey is a reddish brown product with a strong animal aroma and low viscosity. Buckwheat tea is a popular health product in Asian and European countries. Buckwheat tea can be made of common or tartary buckwheat. Furthermore, buckwheat hulls, a by--product derived from the production of buckwheat products, has been also used for elaborating infusions. The content of rutin and the inhibitory activity against formation of Advanced Glycation End Products (AGEs) was higher in tartary buckwheat tea than in common buckwheat tea. Grains in the genus Fagopyrum are an excellent gluten-free raw material and contain a range of nutrients including bioactive carbohydrates, essential amino-acid, proteins, phytosterols, vitamins, carotenoids, and minerals. Buckwheat, compared to other cereals, has both the highest content and distribution of essential amino-acid for humans, resulting in balanced nutrition without excesses or deficiencies. Buckwheat has a higher content of albumin protein and starches resistantto digestion, resulting in the sustained release of nutrients, which is very important for people with diabetes and other diseases. Most importantly, buckwheat has the highest content of rutin with multiple phenolic hydroxyl groups in cereals, which can provide protection from diseases such as cardiovascular disease and cancer.

Keywords: Phenolic Hydroxyl; Fagopyrum; Plasma Cholesterol and Advanced Glycation end Products

Abbreviations: AGEs: Advanced Glycation End Products; BW: Buck Wheat; TG: Triglycerides

Introduction

Some studies have indicated high nutritive and biological value of Buckwheat (BW) (i.e.moderate protein content with favourable amino acid composition, good source of minerals and B vitamins) (Bonafaccia, et al. [1-4]), especially, its green part is rich in natural phenolic - antioxidants (Leiber, et al. [5]). Therefore, BW is used as food and medicine for humans. Its medical properties have been confirmed by animal studies; it was shown that BW could reduce hypertension and plasma cholesterol (Leiber, et al. [5,6]) decreasing hepatic lipogenic enzymes as well as hepatic lipid concentrations and gallstone formation (Leiber, et al. [5]) was also reported. As a feed component BW has been used in ruminants, rabbits, pigs and chicken (Benvenuti, et al. [3,7-9]). However, high content of fibre and some anti-nutritive factors such as tannin, trypsin inhibitor that results in a low digestibility of protein and other nutrients (Bonafaccia et al., 2013a; (Jacob, et al. [3,4]) limits the proportion of BW in mixed feeds. Furthermore, unlike other cereals, BW can grow in hard condition such as low or poor fertilizer, sandy soils, high temperature, dry wind, etc. and the presence of insects (Kulikov, et al. [10]). BW originates from the Southwestern mountainous area of China (Ohnishi, et al. [11]). BW is a dicotyledonous plant, belonging to the Polygonaceae family (Ohnishi, et al. [11]). Two kinds of main BW are Fagopyrum esculentum (common BW) and Fagopyrum tataricum (tartary BW). Both of them are mainly cultivated in the temperate zones of the Northern hemisphere (Ohnishi, et al. [11]). BW leaves containing a large amount of protein (24.20 %) that is suitable for growing and lactating animals, as well as for human food used as salad (Kim, et al. [12]).

In published studies protein, ether extract, and ash contents of the BW grain ranged between 10 -15%, 1.7-4.0%, and ash 22.7% DM, respectively (Jacob, et al. [3,13]) (Leiberet al., 2012). These differences are due to variation of geography, climate, environmental factors, soil t ype, the harvest time, cultivar, and growing site. BW's fat content is quite similar to other cereals. Fatty acid concentration of BW is lower than wheat, corn, or soybean. However, fatty acid composition of BW is similar with amaranth (Jahaniaval, et al. [14]). The significance of high vitamin content is that B vitamins act as co-factors, a prosthetic group of enzymes, which play a key role in energy and protein metabolism of the body cells. Moreover, B6 vitamin (pyridoxine) reduces blood plasma homocysteine level andthus prevent cardiovascular diseases (Schnyder, et al. [15]). It is believed that BW has positive effects on healthbecause it helps relax, activate and well-work of the intestine as well as cure swelling, cloudy urine, diarrhoea and high blood pressure (Suzuki, et al. [16]). Not only in Asia but also in Europe, some early studies reported the use of BW flours and bran in different bakery products, pasta-noodle, cookie, cake, crepe, bread, breakfast cereal and soap formulations. In addition, whole BW flour may be added into flat bread to improve its nutritional value such as crude fibre and mineral (Fe, K, Mg and P) content, as well as provide protein with high biological value (Yıldız, et al. [17]).

Examples of functional foods include fortified beverages, juices, milk, yoghurts, margarines, cereals, etc. (González, et al. [18]). These products are of interest for an increasingly health-concerned society and may be especially relevant for preventing or delaying a number of age-related diseases (González, et al. [18]). Recently, buckwheat as a pseudocereal has received increas-ing attention as a potential functional food (Krkośková, et al. [19,20]). Buckwheat has been used as an important raw material for functional food development because of its functionalities and compounds content, such as proteins, flavonoids, phytosterols, and other (Ötles, et al. [21]). Rutin, a secondary metabolite present in buckwheat, has shown anti-inflammatory, anticancer, antiatherogenic, and antioxidant activity (Kreft, et al, [20,22]).

Buckwheat protein extracts have been related to cholesterol--lowering and anticancer effects in animals (Liu, et al. [6,23]). Incorporation of buckwheat into bread has proved to significantly lower postprandial blood glucose and insulin responses compared to white wheat bread (Skra-banja, et al. [24]). D-chiro-inositol has been associated with reduction of symptoms of non-insulin-dependent diabetes mellitus (Kawa, et al. [25]). Therefore, obtaining different buckwheat-based bakery and non-bakery products with health--promoting components (fiber, antioxidants and/or minerals), the optimization of recipes and technological process pa-rameters, and the characterization of final products in terms of sensory acceptance and potential functional properties, have acquired a considerable interest in the past few years (Burluc, et al. [26]). For this purpose, the sensory and technological quality of buckwheat-based bakery and non-bakery products have been improved substantially. Hence, buckwheat products such as bread, biscuits, snacks, noodles and cookies as well as tea, sprouts and honey, are currently commercialized and consumed (Hatcher, et al. [27]). They are mainly consumed in a dehulled form. Buckwheat seeds show a percentage of carbohydrates of 73.3%, with starch being the main component (Bonafaccia, et al. [1]). Buckwheat flour is suit- able for the use in celiac diet, because of its low non-toxic pro-lamine content (Alvarez-Jubete et al., 2009). Both common and tartary buckwheat grains are a good source of unsaturated fatty acids, mainly oleic and linoleic acids (Bonafaccia, et al. [1,28]) re-ported a dietary fiber content of 27.38% in buckwheat seeds.

Buckwheat seeds contain very rare D-chiro-inositol, which is mainly found in the form of fagopyritols (Wijngaard, et al. [28]). This compound has acquired a lot of interest due to its glucose-lowering capacity in animal models (Yao, et al. [29]). Buckwheat seeds, both groat and hull, and sprouts are an important source of rutin (quercetin-3-rutinoside) the con-tent of which depends on the variety of seeds and growth con-ditions (Zielińska, et al. [30]). Along with rutin, a high content of epicatechin in flowers and leaves make these parts of buckwheat good antioxidant sources in human diet (Kalin-ova et al., 2006). The C-glucoflavones present mainly in buck-wheat seeds are vitexin, isovitexin, orientin and homoorientin, which exert antioxidant activity in vitro (Zielińska, et al. [31]). Quercetin, the aglycone of rutin, is a flavonoid with a potent antioxidant activity that is present in buckwheat groats in a lower concentration (Zielińska, et al. [32]). Tannins isolated from buckwheat showed a relatively high lev-el of activity against Listeria monocytogenes (Amarowicz, et al. [33]). Seeds and sprouts contain GABA, while 2HN has been re-cently identified in buckwheat flour (Aoyagi, et al. [34]). In vitro and in vivo studies have shown that the consumption of buck-wheat and buckwheat enriched foods is related to a wide range of biological and pharmacological activities: hypocho-lesterolemic, hypoglycemic, anticancer and anti-inflammatory (Zhang, et al. [20]). These beneficial effects have been as-sociated with a high antioxidant capacity of buckwheat, which is attributed mainly to their phytochemicals (Zielińska, et al. [35]).

The bioactive components present in the buck-wheat flour show multiple beneficial effects on health (Zielińska, et al. [32,36]). showed that wheat flour enriched with 15% of husked or unhusked buckwheat flour exhibited higher content of sugar, more free amino acids, higher flavor 5'-nucleotides, and 2 – to 3-fold higher total volatile content in comparison to wheat bread. (Bojňanská, et al. [37]) reported that a substitution of 30% wheat flour with buckwheat flour yielded a buckwheat-en-hanced wheat bread acceptable from the technological, senso-ry and health point of view. (Vogrinćić, et al. [38]) described an increase in the antioxidant activity and rutin content in dough and breads with a growing percentage of tartary buckwheat flour.

Tartary buckwheat flavones have been used to enrich wheat bread (Gawli, et al. [39,40]). reported that buckwheat-enriched wheat bread had the highest phenolic content and antioxidant activity in com- parison with amaranth and quinoa enriched wheat bread. It has been reported that buckwheat-enriched wheat bread can inhibit in vitro the formation of advanced glycation end--products (AGEs) (Szawara, et al. [41]). Moreover, (Bojňanská, et al. [37]) showed an increase in the plasma anti-oxidant capacity after four weeks of 30% buckwheat-enriched wheat bread consumption. The research also showed that the addition of buckwheat increased the content of proteins, minerals, fibers as well as rutin in bread. In addition, buck-wheat, along with other pseudocereals, has been proposed as an alternative source to increase the folate content in staple foods, such as bread, pasta and cookies (Schoenlechner, et al. [42]). In the recent studies it has been reported that the use of whole buckwheat flour in the elaboration of Turkish flat bread, lavaş, increased the content of fiber, phytic acid, Fe, K, Mg and P contents (Yildiz, et al. [17]) According to (Bojňanská, et al. [37]), the rheological properties of dough change when the amount of buckwheat in the blend is increased. It was shown that e.g.prolongation of the dough development time required more energy input and longer kneading period. It has also been described that addition of buck-wheat hull hemicelluloses (0.3–0.5%) obtained from seeds to the wheat flour had positive effects on the bread quality, contributing to higher scores for product overall acceptabil-ity (Hromádková, et al. [43]).

The incorporation of buckwheat sour-dough in wheat bread also improved the crumb structure and volume of the bread, alongside with prolonged shelf life and increased content of polyphenols (Moroni, et al. [44]). However, it has been documented that buckwheat sourdough showed a decrease in the network connectivity, and exhibited reduced elasticity. Furthermore, the sourdough bread had a lower volume and a harder crumb (Moroni, et al. [45]). Recently, Lactobacillus delbrueckiisubsp. lactis has been de-scribed to increase the total phenolic content and the anti-oxidant capacity in buckwheat sourdough (Gandhi, et al. [46,47]) showed a good acceptability of buckwheat enriched snacks, at a level no higher than 30%, proposing corn-buckwheat snacks as an attrac tive type of appetizer with increased nutritional properties. The biscuits enriched with buckwheat had increased spread, hard-ness and fracturability (Filipčev, et al. [48,49]) successfully incorporated buckwheat flour into refined wheat flour biscuits up to a level of 20% to yield biscuits of en-hanced nutritional quality with acceptable sensory attributes. In a study carried out by (Filipčev, et al. [48], the sensory analysis of ginger nut biscuits, popular traditional biscuits containing honey, indicated that addition of 40% buckwheat flour was the best scored, but 50% provided a sensory accept-able product with enhanced bio-functional properties.

The Japanese Food Agency stipulates that a minimum of 35% buckwheat must be present for noodles to be called soba noodles (Hatcher, et al. [50]). Most of the soba noodles contain at least 60% of buckwheat, although some handmade soba noodles are made with 100% buckwheat flour (Hatcher, et al. [27]). The noodles are consumed both hot and cold, with the most common type, – mori soba – being boiled and eaten cold with sauce (Hatcher, et al. [50]). Soba noodles often have additional ingredients, such as green tea powder (Haraguchi, et al. [51]), shiitake mushroom or sea-weed (Yoon, et al. [52]). The texture of food constitutes an important quality at-tribute which affects consumer acceptance and preference for a particular food product (Hatcher, et al. [50]). It has been described that texture of noodle depends primary on its starch, fibre and protein contents. (Hatcher, et al. [50]) described a superior noodle texture elaborated with a tartary buckwheat blend, which showed lower protein content, yet higher quality (Van Hung, et al. [53]). used a gradual milling method in which whole buckwheat grains, from outer to in-ner parts, were used for noodle making, substituting the 40% of wheat flour.

(Hatcher, et al. [27]) compared the potential of different buckwheat varieties for elaborating soba noodles, and the effect of buckwheat flour refinements (white flour, whole groat, and dark flour) on the composition, appearance and texture of the products. Noodles prepared with white flour were marked by the best chewiness and springiness, while those elaborated with dark flour contained considerably higher amounts of minerals, proteins, dietary fibre, and fagopyritols. Similar results were documented by (Bilgiçli, et al. [54]) who described an increase in K, Mg, and P amounts in darker noodles after addition of 40% whole buckwheat flour to Turkish noodles. Further-more, the final product was appreciated by the panelists, es-pecially noodles containing up to 25% of whole buckwheat flour.

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(Ma, et al. [55]) indicated that common buckwheat noodles, compared to the faint yellow of tartary buckwheat. In a recent study it has been reported that incorpo-ration of buckwheat into the noodles resulted in product with softer texture, less color and higher content of rutin and quer-cetin (Choy, et al. [56]). In regard to the rutin content, dur-ing processing, attention should be put to the factors which may decrease the concentration of this compound. (Kreft, et al. [2]) showed a decrease in the concentration of rutin in buckwheat noodles after processing. This reduction was associated with the hydrothermal treatment, combination with other molecules, and/or presence of rutin degrading en-zyme flavonoid 3-glucosidase. In contrast, Yoo et al. (2012) documented that hydrothermal treatment minimized rutin loss in tartary buckwheat flour and in noodles containing hydrothermally-treated buckwheat flour. (Ono, et al. [57]) reported that superheated steam, a type of saturated (dry) steam gener-ated by the addition of sensible heat to saturated (wet) steam (Head, et al. [58]), unaffected the color tone of buckwheat flour or the sensory characteristics of buckwheat noodles, suggesting that this treatment may be useful for process-ing this product with a view to increasing flavor and pres-ervation. (Li, et al. [59]) improved the textural and cooking quality of fried instant buckwheat noodles using Triglycerides (TG). (Hara, et al. [60]) described that addition of buck-wheat sprouts to the buckwheat noodle formula resulted in decreasing of resistance to the mastication.

The flavor generation mediated by lipase and peroxidase in buckwheat flour was analyzed by (Suzuki, et al. [61]) in order to select varieties with improved flavor and to increase desirable flavor of buckwheat products. (Bilgiçli, et al. [54]) showed that after fermentation of buckwheat grains by fungi Rhizopus oli-gosporusthe amount of amino acids, minerals was higher and allergenic proteins were reduced as compared to non-fermented material. Buckwheat honey is a reddish brown product with a strong animal aroma (Vit, et al. [62]) and low viscosity (Juszczak, et al. [63]). Comparative studies described that buckwheat honey has higher antioxi-dant capacity, as well as flavonoid and total phenolic content than other honeys (Nagai, et al. [64-67]), 2006; Vit et al., 2010; compared 10 buckwheat honey samples with p-coumaric acid (29.5%) and p-hydroxibenzoic acid (21%) being the main components. Buckwheat honey has been used as a protective agent against lipid oxidation in ground turkey (McKibben, et al. [68]).

It has been also used as an inhibitor of heterocyclic aromatic amine formation in fried ground patties (Shin, et al. [69]), fried beef steak and chicken breast (Shin, et al [70]). In addition, it has been described to be a po-tent inhibitor of the growth of foodborne pathogens and food spoilage organisms (Mundo et al., 2004; (Nagai, et al. [64,71]) described an increase ininhibitory activity of buckwheat honey against Bacillus subtilisand Esch-erichia coliafter 3–6 months of storage. (Wang, et al. [72]) indicated that processing dramatically reduced antioxidant capacity of buckwheat honey by 33.4% as compared to raw ones. Additional reduction of antioxidant capacity of processed honey was noted after storage for a long period, for example 6 months. Similar results were observed by Kowalski (2013) who reported a decrease in the antioxidant capacity of buckwheat honey after different thermal treatments (Wang, et al. [72]). proposed that the reduction in the antioxidant capacity may be due to the reduction in phenolics. Other compounds generated during thermal treatment of buckwheat honey, such as hydroxymethylfurfural (HMF), melanoidins, and other Maillard reaction products, may in-fluence the antioxidant activity (Brudzynski, et al. [73]) and should be taken into account.

Buckwheat tea is a popular health product in Asian and European countries (Qin, et al. [74,75]) Buckwheat tea can be made of common or tartary buckwheat (Zielińska, et al. [74,76]). Park et al. (2000) investigated the effect of boiling on rutin con-tent in tea made from flowers and dried leaves of different species of buckwheat. Furthermore, buckwheat hulls, a by--product derived from the production of buckwheat prod-ucts, has been also used for elaborating infusions (Zielińska, et al. [74]). The content of rutin and the inhibitory activity against formation of advanced glycation end prod-ucts (AGEs) was higher in tartary buckwheat tea (Zielińska, et al. [73,75]) than in common buckwheat tea (Zielińska, et al. 75]). Higher buckwheat flour addition levels negatively affected fermentation loss, color val-ues, water and oil absorption capacity of tarhana, being 40% of the optimal concentration to yield a product with adequate physical, functional and sensorial properties (Bilgiçli, et al. [77,78]). Sprouting is a simple way to obtain a product with highly enhanced antioxidative capacity, stemming most likely from rapidly biosynthesised low molecular antioxidants and phy-tochemicals (Kim, et al. [79,80]). Increased level of phytochemicals in sprouts is important for aiding in the prevention of human diseases and/or in health maintenance (Brinskin, 2000; (Espín, et al. [79,81]). used the mass production system to harvest buckwheat sprouts.

Grains in the genus Fagopyrum are an excellent gluten-free raw material and contain a range ofnutrients including bioactive carbohydrates, essential amino-acid, proteins, phytosterols, vitamins, carotenoids, and minerals. Buckwheat, compared to other cereals, has both the highest content and distribution of essential amino-acid for humans (Chen, et al. [82]), resulting in balanced nutrition without excesses or deficiencies. Furthermore, buckwheat has a higher content of albumin protein and starches resistantto digestion, resulting in the sustained release of nutrients, which is very important for people with diabetes and other diseases. Most importantly, buckwheat has the highest content of rutin with multiple phenolic hydroxyl groups in cereals (Komori, et al. [83]). Which can provide protection from diseases such as cardiovascular disease and cancer. In a traditional agricultural production model, the establishment of annual crops has both economic and agronomic implications such as high seed and nutrient inputs, ploughing, and may involve a number of sowings each year. Perennial crops have an important property, that is, "plant once and harvest always", indicating a lower seeding cost and workload.

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Agriculture based on perennial crops may provide a model with high output and with lower inputs (Chen, et al. [84]).

There are many perennial crop examples in vegetable and fruit crops, but few in grain and oilseed crops. There are some perennial species in the genus Fagopyrum, which have been studied for perennial food crop use for the last decade (Chen, et al. [84]); 2012. Buckwheat, which belongs to the family Polygonaceae, genusFagopyrum, has been a commonly-eaten food in arid and cold regionsin the world. Buckwheat is ubiquitous almost everywhere but growsmainly in the northern hemisphere (Li, et al. [85]). Russia is now the biggest producer of buckwheat. China ranks second in the production of buckwheat with about 10.2 million acres cultivating area and the buckwheat productionfluctuates within the range of 0.6 to 0.95 million tons (Li, et al. [85]). Buckwheat has attracted increasing attention from food scientists for its healing effects over chronic diseases. Buckwheat is the only pseudocereal that contains rutin; hence it is a beneficial source of thisflavonoid. Other phenoliccompounds andflavones such as hyperin, quercitrin, and quercetin have been detected and isolated from immature buckwheat seeds (Koyama, et al. [86]). These compounds are presumed to be involved in many of the health benefits of tartary buck-wheat. They possess special medicinal properties such as antihyperten-sive and antihypercholesterolemic effects at nontoxic concentrations in humans (Li, et al. [87]) Li, Park, et al., 2010). Buckwheat protein is presumed to improve health in various ways, notably reducing serum cholesterol, suppressing gallstones and tumors, and inhibiting the angio-tensin I-converting enzyme (Koyama, et al. [86]). Buckwheat grain is characterised by a high content of starch, protein with an advantageous amino acid composition, a low content of α-gliadin and a high content of dietaryfibre (Dziedzic, et al., [88]). Thebuckwheat grains have excellent nutritional value and are recommended for patientswho suffer fromtyphoidand liver ailments.

More specifically, as buckwheat can be in the production of foods for people with celiac disease, for those subjectswho suffer fromgluten intolerance. Buckwheat tea is a popular health product in Asian and European countries (Qin, et al. [89]). The genus Fagopyrumconsists of about 19 species, recently four new species, Fagopyrum crispatifolium (Liu, et al. [90,91]). were discovered in the genusFagopyrum, and their distribution, taxonomic position and phylogenetic relationship have been clarified (Liu et al. [90-93]). Cultivation of F. esculentum extends from temperate Europe to Japan through the Indo-Myanmar region. F. cymosum (Trevir.) Meissn, the wild species of buckwheat, occurs mostly in the Himalayan foot hills and China. It has been shown that the origin of cultivated tartary buckwheat, the hybrid origin of weedy tartary buckwheat and of the wild populations from central Tibet and northern Pakistan, and the cultivated tartary buckwheat probably originated in northwestern Yunnan in China (Tsuji, et al. [94]). The hardness of the hull depends on the species of the buckwheat (Li, et al. [85]).

Rutin was recognized as the most health protective and has also been proven to be anti-inflammatory and anticarcinogenic (Liu, et al. [85]), Liu, Tang et al., 2008).

The flavonoid content was 40 mg/g in tartary buckwheat seeds as compared to 10 mg/g in common buckwheat seeds (Li, et al. [23]). Quercitrin values were in the range of 0.01–0.05% dryweight (DW) in tartary buck-wheat herb, which was not found in common buckwheat (Fabjan et al., 2003). Rutin and quercetin content in seeds depends on variety and growing conditions (Fabjan, et al. [95]). D-Chiro-inositol (DCI), a naturally occurring iso-mer of inositol, is the main active nutritional ingredient in buckwheat (F. esculentum). As an epimer of myoinositol, DCI is probably the main mediator of insulin metabolism by enhancing the action of insulin and decreasing blood pressure, plasma triglycerides, and glucose concentra-tions (Fonteles, et al. [96,97]). The dehulled groats are then roasted so that the tea can be made (Qin, et al. [74]). The effects of these thermal processing steps on the buckwheat proteins have been found to be dependent upon the lipid content of the buckwheat. While the presence of lipids can help to improve thermal stability of buckwheat proteins, lipids can also disturb the buckwheat globulins. Thus it is suggested that a suitable amount of lipids, such as 6.5%, be present for the maintenance of buckwheat globulins during thermal treatment (Tang, 2007). Another study compared the effects thermal processing by microwave heating, pressured steam-heating, and roasting on the antioxidant properties of buckwheat. Itwas found that pressured steam-heatingwas themost destructive to the antioxidant properties (Zhang, et al. [98-107]).

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