

# BUCKWHEAT : AN ADVANCING CROP FOR FUTURE GENERATIONS(A REVIEW)

## Abstract

Common buckwheat is most widely cultivated and utilized, while Tartary buckwheat is mainly grown and consumed in China. It is consumed in the form of groats and flour, which are used as food items. Raised in short season and as the second crop. Most reliable summer season crop. Antioxidant activity is the fundamental prophylactic property important for the human organism. A variety of biological functions, e.g. antimutagenic, anticarcinogenic, and antiaging, originate from that property. The molecular basis for the technological and textural characteristics of buckwheat products has recently been studied and has wider applications in future generations

**Keywords:** buckwheat, season crop, summer weeds, gluten-free product

## INTRODUCTION:

Buckwheat (*Fagopyrum esculentum*) is one of the most important green manure crop and semi-succulent dicot plant which belong to the genus *Fagopyrum* and the family Polygonaceae (Cai and Corke., 2004.). Hence its name. It is a pseudocereal crop (seeds that are consumed in the same way cereal grains but are not grown on grasses) and there are two cultivated species, i.e., common buckwheat (*Fagopyrum esculentum*) (USDA 2014) and Tartary buckwheat (*Fagopyrum tataricum*). Common buckwheat is most widely cultivated and utilized, while Tartary buckwheat is mainly grown and consumed in China. It is consumed in the form of groats and flour, which are used as food items. Raised in short season and as the second crop. Most reliable summer season crop. It establishes quickly, which suppresses summer weeds. Björkman; Bellinder; Hahn & Shail 2008).

Buckwheat tea, known as memil-cha in Korea and soba-cha in Japan, is a tea made from roasted buckwheat (Kim and Dakota, 2015). Buckwheat is rich in protein of excellent quality as well as starch. In addition, it also contains high levels of fiber, minerals, vitamins, and flavonoids with positive therapeutic effects on the human body. Buckwheat has increasingly attracted attention because of its positive effects on some chronic diseases conditions, such as hypertension, hypercholesterolemia, diabetes, and other cardiovascular diseases. It is also used as a functional food source. (Cai and Corke, 2004).

30 In India, it is called kuttu ka atta and is eaten in Navratris. It is a non-cereal flour commonly used for  
31 making parathas, and pakodas in Indian families.( Bhaduri, NitiPathak; Prajneshu, Meenakshi 2016). It is  
32 cultivated for its nutritious triangular seeds and is a cover crop. The grains are usually brown and irregular  
33 in shape. It's a completely gluten-free product. Buckwheat has been used as a substitute for other grains in  
34 gluten-free beer (Carolyn Smagalski 2006). 0Buckwheat consumption is linked with several health  
35 benefits, including improved blood sugar control, hypertension, hypercholesterolemia, diabetes, and other  
36 cardiovascular diseases. It also has anti-inflammatory properties. It's a gluten-free crop and is safe for  
37 people with celiac disease. Roasted buckwheat groats, called kasha. Buckwheat has more protein than  
38 cereals. High amounts of essential amino acids lysine and arginine are present which are deficient in  
39 major crops. Its unique amino acid profile gives buckwheat the power to boost the protein value of beans  
40 and cereal grains eaten the same day which is a key advantageous feature for us. Buckwheat contains no  
41 gluten. Nevertheless, buckwheat may have gluten contamination(Ciacciet al.2015). Buckwheat flower  
42 produces honey of good quality. Tahir et al (1989) studied that Buckwheat can become an important crop  
43 in the feeding of mankind and domestic animals to meet the ever-increasing demands of a rapidly  
44 expanding population. It has the ability to prevent or reduce weed growth.(Mazurek and Wielgo 2001).

#### 45 **ORIGIN AND HISTORY:**

46 The wild ancestor of common buckwheat is *F. esculentum* ssp. *ancestrale*. *F. homotropicum* is interfertile  
47 .Yunnan in China has a common distribution of *f.esculentum*.The wild ancestor of Tartary buckwheat is  
48 *F. tataricum* ssp. *Potanini*. (Ohnishi, Matsuoka, 1996).The oldest remains found in China so far date to  
49 circa 2600 BCE, while buckwheat pollen found in Japan dates from as early as 4000 BCE. Buckwheat  
50 was one of the earliest crops introduced by Europeans to North America. (OSHINI 1998). Also called  
51 beech wheat, which resembles the much larger seeds of the beech nut from the beech tree.("Online  
52 Etymology Dictionary". Etymonline.com. Retrieved 2022-11-24.)

#### 53 **GEOGRAPHICAL DISTRIBUTION:**

54 In 1993, history played a record in making Russia the largest producer of buckwheat. It is reported that in  
55 1990, buckwheat yield per hectare reached 3400 kg in Russia. China has the longest history (since the  
56 seventh century AD) of buckwheat cultivation, and now ranks second in world production with an  
57 average annual cultivation area of 1.33Mha. Buckwheat grows mainly in the northern hemisphere,  
58 notably in Russia, China, Japan, India, Kazakhstan, China, Poland, Ukraine, Canada, and the USA.  
59 Buckwheat is also planted in the southern hemisphere, e.g., in Brazil, Australia, and South Africa.(Cai  
60 andCorke.,2004). Globally Russia is the leading producer of buckwheat. As of 2016, it remains a key  
61 cereal.(Steve Rosenberg 2019).

62 Table 1. Producer of buckwheat

Russia	1,186,333
China	404,259
Ukraine	176,430
France	122,206
Poland	118,562
World	2,395,822

63 Ref:faosat of united nation

64 In India, the crop is widely cultivated in Jammu and Kashmir), Himachal Pradesh, Uttarakhand (Uttar  
 65 Kashi, Chamoli, Pauri, Almora, and Pithoragarh), West Bengal, Sikkim, Meghalaya, etc. In South India,  
 66 it is sporadically grown in the Nilgiris and Palni hills, {aditnandanyadav 2017}

67 Shah (2013) studied explored buckwheat in North West Jammu & Kashmir. Kump and Javornik, (2002)  
 68 report states that it is grown as a minor grain crop in high-altitude areas in India. (1600-4000 m above  
 69 mean sea level). It's cultivated in the hills of the states of Jammu & Kashmir, Himachal Pradesh,  
 70 Uttaranchal, Sikkim, Manipur, and Arunachal Pradesh under low input conditions and gets exposed to  
 71 harsh environments. Most important crop for the people of the Uttarakhand state. However, the  
 72 productivity of buckwheat is quite low (4.5 q/ha) in Uttaranchal. Two species of buckwheat are prevalent  
 73 in Uttaranchal viz., common buckwheat (*Fagopyrum esculentum*, Moench) locally called Ugal, and tartary  
 74 buckwheat (*F. tataricum* Gaertn.) locally known as Phapar. VPKAS, Almora developed and released a  
 75 variety of *F. esculentum* (VL Ugal 7) in 1991. However, this variety performs well only in mid-altitude  
 76 areas (1000-1500 meters above mean sea level). About 800 years ago tartary buckwheat appeared  
 77 suddenly on 47-60° northern latitude.

78 **NUTRITIONAL VALUES:**

79 The main storage protein of buckwheat grains is 13S globulin (Aubrecht&Biacs 1999; & Zhang 2001).  
 80 Important microelements such as Zn, Cu, Mn, and Se are were found (Stibilj et al. 2004), and the major  
 81 elements are potassium, sodium, calcium, and magnesium (Wei et al. 2003). The average albumin content  
 82 is 21%, whereas the highest one reaches 30–33% (Bharali&Chungoo 2003). Mistunaga et al. (1986) first  
 83 isolated the thiamin-binding proteins (TBP) from the grains of buckwheat. The main reason for

84 immunological disorders is low molecular weight proteins, particularly those with digestible starch  
 85 (SDS), and molecular weights of 15, 22, or 26 kDa(Yoshioka et al. 2004; Handoyo et al. 2006; Morita et  
 86 al. 2006). From the nutritional point of view, there exist three fractions of starch: rapidly digestible starch  
 87 (RDS), and slowly resistant starch (RS). It could show a similarity to dietary fiber. In uncooked  
 88 buckwheat grains, RS continents of dietary fiber are found. Total dietary fiber (TDF) is classified into 2  
 89 types insoluble dietary fiber (IDF) and soluble dietary fiber (SDF). In general, IDF includes cellulose,  
 90 lignins, and certain non-cellulosic polysaccharides, while SDF includes pectins and some associated non-  
 91 cellulosic polysaccharides (Asp et al. 1993; Brennan 2005; Young et al. 2005). The whole grains contain  
 92 7% TDF, while the bran with hull fragments has 40% TDF (Steadman et al. 2001). Dietary fiber consists  
 93 also of oligosaccharides, polysaccharides, and other hydrophilic derivatives (Gibson et al. 2000).  
 94 Polyunsaturated fatty acids (PUFA), such as n-3 and n-6, are often referred to as factors provoking the  
 95 modulation of the immunological system in humans (Jelińska 2005). Buckwheat grains were also  
 96 demonstrated to contain vitamins: B1, B2, and B6 (Fabjan et al. 2003). Antioxidant activity is the  
 97 fundamental prophylactic property important for the human organism. A variety of biological functions,  
 98 e.g. antimutagenic, anticarcinogenic, and antiaging, originate from that property (Holasová et al. 2002).  
 99 Rutin, quercetin, orientin, vitexin, isovitexin, and isoorientin were identified in buckwheat hulls  
 100 (Dietrych-Szóstak&Oleszek 1999, 2001). Catechins and phenolic acids are also present in buckwheat  
 101 grains.(Przybylski et al. 1998).The unique amino acid profile gives buckwheat the power to boost the  
 102 protein value of beans and cereal grains eaten the same day.

103  
 104  
 105  
 106 **Table 2. The nutritional content of buckwheat in 100g**

Name	Amount
Water	9.75 g
Energy	343 kcal
Energy	1435 kj
Protein	13.25 g
Total lipid[fat]	3.4 g
Ash	2.1 g
Carbohydrate,by difference	

107

Fiber,total dietary	10 g
Calcium	18 mg
Iron	2.2 mg
Magnesium	231 mg
Phosphorous	347 mg
Potassium	460 mg
Sodium	1 mg
Zinc	2.4 mg
Fatty acids,totalmonosaturated	1.04 g
Fatty acids,totalpolysaturated	1.039 g
18:2	0.961 g
18:3	0.078 g
aspartic acid	1.133 g
Glutamic acid	2.046 g
Glycine	1.031 g

108

109 Acceptable for consumption in Hindu fast especially during Navratri. Buckwheat pancakes, with yeast,  
110 are tasty. They are light and foamy... Buckwheat noodles play a major role in the cuisines of Japan (soba)  
111 ( P. S. Belton; John Reginald Nuttall Taylor 2002). Buckwheat flour is also used to make Nepali dishes  
112 such as dhedo and kachhyamba. buckwheat starch a jelly called memilmuk is made in Korea. Buckwheat  
113 is a good honey plant, producing dark, strong monofloral honey.( Buckwheat%20-%20Wikipedia.html)

114 Note: Eriogonum, a genus of wild North American plants also known as buckwheat

115 The anti-oxidative potential is high, mainly in buckwheat leaves, because of the presence of tocopherols  
116 and phenolic substances, such as 3-flavonols, flavonol, rutin, phenolic acids, and flavonoids (Oomah et al.  
117 1996; Watanabe et al. 1997; Holasova et al. 2002; Kalinová et al. 2011; Shao et al. 2011). Only crops  
118 containing rutin i.e in high quantities (Fabjan 2003; Sun and Ho 2005; Brunori et al. 2009; Vojtišková et  
119 al. 2012). This compound has anti-oxidative and anti-inflammatory actions and reduces blood vessel  
120 weakness (Pisha and Pezzuto 1994; Hagels 1999). Rutin content represents 2-10% of the dry weight of  
121 the plant in buckwheat and is essential. Seeds of buckwheat are richer in rutin than albumen.(Hagels  
122 1999; Park et al. 2000; Kreft et al. 2003; Baumgertel et al. 2010; Gulpinar et al. 2012; Vojtišková et al.  
123 2012). Rutin helps to limit blood platelet coagulation (Kawakami et al. 1995 ). Pollinated flowers with a  
124 normal-sized gynoeceium that do not set seeds after pollination are the main contributors to the low seed

125 set in buckwheat that do not set seeds after pollination are the main contribution to the low seed set in  
126 buckwheat.

### 127 Effect of climate on buckwheat :

128 Based on the variation in altitude Tartary buckwheat has frost tolerance capacity since it is grown  
129 at higher altitudes and common buckwheat is grown in lower altitude conditions. Gaberscik et al.  
130 (1986) found little frost resistance when they tested buckwheat in a climatic chamber at optimal  
131 humidity of 60-80%. Buckwheat thrives well on sandy, well-drained soils. In limiting moisture it  
132 is sensitive to high wind conditions. A condition called 'blasting results in the loss of flowers.

133

134 1. **Temperature:**Seed maturity is reached after an average of 3 months of cultivation in temperate  
135 regions.it is frost sensitive so there are very less crops at low altitudes.10°C is the optimal  
136 temperature for germination(Jakimenko 1982 in Kalinová and Moudr2003). The developmental  
137 stage most sensitive to frost is one to two expanded leaves. At this stage, exposure for 4 to 6 h to  
138 temperatures between -1 to -3°C is lethal (Kalinová andMoudr2003) Pollen viability is similarly  
139 dependent on temperature and on relative humidity. At 23°C in dry air pollen lose its viability in  
140 one hour. (Adhikari and Campbell 1998).

141

142 2. **Water:** A quantity of 225-315 kg of water is needed to produce 1 kg of seeds (Gang and Yu  
143 1998). Plants quickly wither under drought conditions because of their shallow root system  
144 (Marshall and Pomeranz 1982; Myers and Meinke 1994; Berglund 1997; Campbell 1997).water  
145 supplied at the reproductive phase is more beneficial than at the reproductive phase (**Revise**).  
146 Flooding for more than 10 days at the flowering stage or more than 3 days during the maturation  
147 stage affects seed weight (Sugimoto and Sato 2000).

148 3. **Photoperiod:**photosensitive varieties should preferentially be cultivated under short photoperiods  
149 in order to gain larger yields.

150 Buckwheat generally is not attacked by a disease or pest but some of the diseases were recorded.**Bugg**  
151 **and Ellis (1990)** noted that insect visitation to buckwheat was low during afternoons, whereas insects  
152 continued to visit white-sweet clover. Pellett (**1976**) states that nectar production is stopped by  
153 buckwheat in the afternoon.

154 Table 3. List of **diseases** in Buckwheat reviewed by Joshi and Paroda (1991).(sun he hu et al. 2010)

Name of Disease	Causal Organism
Brown leaf spot disease	Ascochytaitalica
Chlorotic leaf spot disease	Alternariaalternate
Downy mildew disease	Peronosporaducumet
iLeaf spot disease	Septoriapolygonicola
Powdery mildew disease	Erysiphepolygoni
Root and collar rot disease	Sclerotinialibertiana
Root and stem rot disease	Phytophthorafagopyri
Root rot disease	Fusarium spp.
Rust disease	Pucciniafagopyri
Smut disease	Sphacelothecafagopyri
Stem rot disease	Botrytis cinerea
Stipple spot disease	Bipolarissorokiniana

155

156 Table 4. List of pests in Buckwheat reviewed by( Joshi and Paroda 1991). (sun he hu et al. 2010)

Name of pests	Causal Organism
Bruchids	Acanthecelidsobtectus
Cutworms	Cirphis spp.
Grain moth	Cephitinea
Storage beetles	SpMycetophagus sp.

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158

159 **BIOTECHNOLOGY:**

160 According to the **researchers' reports**, there is an increase in the numbers of aerobic, mesophilic, and  
161 lactic acid bacteria with buckwheat products. They observed a slight decrease of Enterobacteria and  
162 fewer pathogenic bacteria confirming potential prebiotic components in the human gastrointestinal  
163 tract. During the extrusion process (Fornal et al. 1987a), biopolymers like proteins and starch coming  
164 from several sources underwent physicochemical and structural transformations (Fornal et al. 1985,  
165 1987b). The possibility of small and weak crystallite formation at various levels of aggregation can be  
166 understood by a change in structure. (Soral-Šmietana 1992).

167 Table 5. Country holding germplasm collections (> 5 accessions), storage conditions, evaluation of  
168 germplasm and details of the collections being store.

169

Country	Storage Conditions	Evaluation Collection	Details of collection
India	medium term	402 acc. were evaluated for 31 trait	60 of <i>F. esculentum</i> var. <i>emarginatum</i> , 316 accessions of <i>F. esculentum</i> 197 of <i>F. tataricum</i> , 25 <i>F. tataricum</i> var. <i>himalianum</i> ; 3 <i>F. giganteum</i> ; 5 <i>F. cymosum</i>

170 **(Campbell clayton G1997)**

171 The self-incompatibility of buckwheat is of the sporophytic and dimorphic type. The discovery of flower  
172 forms with reduced styles was done. (Marshall 1969). Some special lines adapted to self-pollination were  
173 developed. Self-incompatibility was thought to be restored by single dominant genes (Sharma and Boyes  
174 1961) or possibly by both single and double restorer genes (multiple genes or complex genes) (Woo et al.

175 1997)Hairy root cultures have been used as a useful model system to study the production of flavonoid  
176 and a variety of other secondary metabolites. For example, Puerariacandolleihairy root cultures were  
177 established for the production of isoflavonoid(Medina-Bolivar et al., 2007). In another study, peanut hairy  
178 root cultures were developed for testing the bioproduction system for resveratrol.(Udomsuk et al., 2009).  
179 Another example involves the pyrrolizidine alkaloids production in hairy root cultures of  
180 Echimrauwolfii(Abd El-Mawla, 2010). Finally, the Taxus media hairy roots that are transformed  
181 accumulate the taxane compound (Syklovska-Baranek et al., 2009). Producing phenolic compounds in  
182 vitro in hairy root cultures of common buckwheat and tartary buckwheat has been reported (Kim et al.,  
183 2009; Lee et al., 2007; Troitin et al., al., 1993).

184 It is a short-duration crop requiring a moist and cool temperate climate to grow (Joshi and Paroda 1991).  
185 Krotov (1963) reports saythat flowering temperatures above 30°C is resulting in fruit desiccation and  
186 lowering yield. He also found common buckwheat yield increase with high soil moisture. This shows  
187 theincrease in seed size with an increase in soil moisture content. Adequate soil moisture appears to be  
188 essential for good yields .wilting occursin common buckwheat very badly and grows very slowly when it  
189 is affected by low soil moisture. If buckwheat is subjected to high winds and heavy rains it can lodge  
190 badly. Buckwheat does not have a good ability to recover from lodging. The tips of the plants grow  
191 upward but the stem often remains in contact with the soil and often can be subject to disease and rot.(  
192 Clayton G. Campbell 1997).

### 193 **ACHIEVEMENTS:**

194 Fagopyrins levelin buckwheat grains is very low and their isolation processis very difficult. It was  
195 reported that fagopyrins found in buckwheat can be utilized in the treatment of type II diabetes(Li &  
196 Zhang 2001; Bonafaccia et al. 2003; Horbowicz&Obendorf 2005). In New Zealand, biological control  
197 Buckwheat is currently being studied and used as a pollen and nectar source. (Berndt LA, Wratten SD,  
198 Hassan PG 2002). According to Huff and Carroll (1980) and Sugiyama et al. (1985), cholesterol-lowering  
199 effects and a high biological value (BV)are found in buckwheat proteins.protein products addition to diets  
200 significantly lowers cholesterol levels in the liver, and gallbladderand suppresses gallstones formation by  
201 altering cholesterol metabolism (Tomotake et al. 2002), whereas protein extracts are more efficient in  
202 lowering the blood cholesterol level, particularly that of LDL and VLDL (Kayashita et al. 1995;  
203 Misawo&Iwao 1996; Tomotake et al. 2006).Honey obtained from buckwheat flowers increases the  
204 antioxidative potential of human blood serum and in vitro studies indicated that it protects lipoproteins of  
205 blood serum against oxidative processes more effectively than saccharic analogs (Gheldof et al.

206 2003).Buckwheat flour can be also obtained characterized by decreased activities of proteases and  $\alpha$ -  
207 amylase (Fornal 1999)

## 208 FUTURE ASPECTS:

209 Studies on genetic polymorphism of buckwheat have a major scope (Huh and Huh, 2000; Ohnishi, 2000),  
210 on the molecular basis of buckwheat allergy (Wang et al., 2000), and on problems that are commonly  
211 important in the breeding of buckwheat (Wang and Campbell, 2000;Inoue and Ogiwara, 2001), on the  
212 productivity of nectar (Alekseeva and Bureyko, 2000), on quality of buckwheat products (Park et al.,  
213 2000; Ikeda and Asami, 2000).The molecular basis for the technological and textural characteristics of  
214 buckwheat products is recently studied and has wider applications in future generations(Ikeda, 1997). In  
215 future research at Morden, Canada, for example, investigations will be conducted along four directions;  
216 Breeding of reduced allergic protein lines with good agronomic characteristics.

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