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# Neutraceutical and Pharmaceutical Potential of *Fagopyrum esculentum* (Linn.) Moench.

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## ABSTRACT

Buckwheat is a gluten-free pseudocereal grown annually in hilly regions of India. It belongs to family Polygonaceae and genus *Fagopyrum*. Buckwheat is adaptable to extreme cold temperature, stress conditions of water making it a sustainable crop. In India, twenty species of buckwheat are cultivated across various hilly regions. Out of these only nine species have desirable nutritional value and two are commonly grown. They are *Fagopyrum esculentum* (Common buckwheat) and *Fagopyrum tartaricum* (Tartary buckwheat). Buckwheat has good amount of nutrients and many health benefits. Buckwheat has been used in the gluten free diet for those suffering from celiac disease. It can be used for the prevention of obesity and diabetes as they have high total dietary fibre and soluble dietary fibre. It is commonly used grain in the name of *Kuttu* in Indian society during fasting. The present study aims at establishing the Neutraceutical and Pharmaceutical utility of potential alternative to conventional food grains as mentioned in the contemporary texts.

**Key words:** Buckwheat, *Fagopyrum esculentum*, *Kuttu*, Neutraceutical, Pseudocereal.

## INTRODUCTION

*Ayurveda* is an ancient medical system that has a holistic approach. There are two fundamental principles of *Ayurveda*, first is to conserve the health and second to cure the disease. In *Ayurvedic* classics, *Dravya* has been classified into two broad categories viz. *Aahra* and *Aushadha Dravya*. *Aahra Dravya* conserves health and *Aushadha Dravya* fight against diseases. Based on *Panchmahabhuta* Theory, Scholars

of *Ayurveda* have proclaimed that there is no *Dravyas* in this Universe which cannot be used as medicine, on the condition that they are used rationally. Along with *Aushadha*, Sages of *Ayurveda* has given prime importance to *Ahar*.

Maximum number of grains used as staple food to meet nutritional requirements are derived from the plants belonging to family Poaceae. There are various other non-poaceous grains also used to meet nutritional requirement being utilized by ethnic groups across the country like seeds of Chenopodium, Amaranthus and *Fagopyrum* which are pseudocereals. Seeds of *Fagopyrum* are very famous in the countryside as food material during fasting and festivals.

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Table 1: Nutritional profile of Pseudocereals (%)<sup>[1]</sup>

General Nutritional profile of pseudo-cereals in %		
Carbohydrates	Starch, fructose Arabinose, Xylose	50-80
Fibers	Cellulose, Xyloglucans, Lignin	10-25

<b>Proteins</b>	Globulins, Albumins, Glutellins, Prolamins	10-21
<b>Fatty acids</b>	Linoleic, Oleic, Palmitic	3-7
<b>Vitamins &amp; Minerals</b>	Potassium, Phosphorus, Magnesium, Calcium, Vit.B6, Folate, Lutein	0.8-2.8
<b>Bioactive compounds</b>	Phenolic acid, Phytosterols	

The *Fagopyrum esculentum* (Buckwheat) is a gluten free pseudocereal. It contains a broad spectrum of nutrients, the most important of which are carbohydrates, proteins, dietary fibre, lipids, rutin, polyphenols, microelements and macroelements. Buckwheat has an extremely high nutritional value. It is commonly known as *Kuttu*, considered as a rich food because of its protein quality, high mineral content, healthy and balanced food quality. The flour from buckwheat is commonly called as *Kuttu Ka Atta* in the northern parts of India which is mainly used as diet during the fasting occasion in some festivals. It is preferred over other dietary substances available during fasting.

Buckwheat is often farmed in North India as a rainy season crop, planted in July, and harvested in October. It is typically sown in *Nilgiris* in April and harvested in August.

## METHODOLOGY

To know nutritional properties of grain *Fagopyrum esculentum* (buckwheat), a literary search on online databases, online and offline books were done. To evaluate and study classical aspect of Buckwheat, all classical texts available in institutional library were also explored. Research websites and databases like Pub med, Research gate inspected closely for pharmacological properties and nutritional properties investigated for buckwheat.

## OBSERVATIONS

**Distribution:** Common buckwheat is one of the oldest domesticated crops from Asia. It is reported to be first domesticated in South China between 4,000 and 5,000

years back. Cultivated buckwheat was introduced from Southern China to other Asian nations, Europe, Africa, and North and South America.<sup>[2]</sup> Presently the plant is distributed in Africa (Kenya, Tanzania, Uganda, Ethiopia, Zimbabwe, South Africa, Zaire, Reunion and Botswana); Asia (China, Japan, Korea, Kazakhstan, Mongolia, Russian Federation, Iraq, India, Nepal, Pakistan, Myanmar, Thailand and Vietnam); Europe (Belarus, Latvia, Lithuania, Russian Federation, Ukraine, Poland, Austria, Germany, Denmark, Sweden, Bulgaria; Australia (Australia and New Zealand); Northern America (Canada and United States) and Southern America (Brazil and Cuba)<sup>[3]</sup>, however, China, Russian federation, Ukraine, Republic of Moldova, Kazakhstan, France, USA, Poland, Brazil, Japan, Canada, Korea and Bhutan produced the larger quantities of buckwheat in the World from 1961-2010.<sup>[4]</sup>

It is believed to be a native of Central Asia. In India, Buckwheat is grown majorly as minor grain crop particularly in the higher altitudes of Himalayas from Kashmir (Udhampur, Ladakh) to Sikkim, Khasi hills, Manipur, in Nilgiris up to 620-3700 m altitude, Himachal Pradesh, Uttarakhand (Pithoragarh, Almora and Chamoli).

**Morphology:** This is an annual herb, up to 1 m tall, branched and glabrous. Leaves are petiolate, blades are ovate-triangular to triangular, 2-8 cm long, with acuminate tips, bases are cordate; upper leaves are smaller, sessile. Inflorescences are terminal and auxiliary, branch in dense corymbose or paniculate cyme. Flowers are white or pink, 6 mm in diameter; pedicel is 2-3 mm long, articulate; perianths are 3 mm long. Fruit a 3 cornered achene, 0.2 – 0.4 inch long with keeled edges, varying in colour from silvery grey to brown or black.<sup>[5]</sup>

## Taxonomic classifications:

- **Kingdom:** Plantae
- **Subkingdom:** Viridiplantae
- **Super division:** Embryophyta
- **Division:** Tracheophyta
- **Subdivision:** Spermatophytina

- **Class:** Magnoliopsida
- **Superorder:** Caryophyllanae
- **Order:** Caryophyllales
- **Family:** Polygonaceae
- **Genus:** *Fagopyrum*
- **Species:** *Fagopyrum esculentum* Moench

#### Traditional Uses

1. Common buckwheat is consumed in many different preparations in different countries.
2. It is primarily eaten as a noodle soba in Japan.
3. Buckwheat flour is typically used with wheat flour in Europe and North America to make pancakes, biscuits, noodles, cereals, and is also used as a meat extender.
4. In Southeast Asia buckwheat is a staple food in many hilly areas. The flour is used to make chapattis, it is utilized during fasts and religious events.
5. Buckwheat is used to make alcoholic drinks.
6. The liquor made from Tartarian buckwheat is said to have therapeutic properties.
7. According to reports, buckwheat is utilized in China to make vinegar.<sup>[6]</sup>
8. Buckwheat is consumed by humans and animals in different forms corresponding to different types of preparations like flour, whole seeds, sprouts, shoots and honey.
9. Buckwheat farming produces a lot of honey, which has a strong flavour and a dark colour. Foods are sweetened with it, primarily pastries. One hectare of buckwheat typically yields 125 kg of honey and the best cultivars produce 150 to 300 Kg/ha.
10. Young shoots can be eaten 10 days after germination, while sprouts can be eaten in salads two days after germination.
11. Patients with anaemia were given leaves cooked in an iron vessel. The cooked leaves were also used to cure constipation.

12. The buckwheat leaf was also traditionally used for choking, ulcers, haemostasis, soaking wounds, improving the functions of sight and hearing.

13. The plant was also traditionally used to cure diabetes, periodontitis, high blood pressure, and gum bleeding.<sup>[7]</sup>

#### Phytochemical Analysis

- The preliminary phytochemical analysis of *Fagopyrum esculentum* showed that it contained alkaloids, amino acids, anthraquinones, carbohydrates, flavonoids, phlobatannins and tannins.<sup>[8]</sup>
- The fruits and leaves were found to contain 1.3 and 4.7 percent rutin, respectively.<sup>[9]</sup>
- Average mineral and vitamin contents of buckwheat were: calcium 110 mg/100g, iron 4 mg/100g, magnesium 390 mg/100g, phosphorus 330 mg/100g, potassium 450 mg/100g, copper 0.95 mg/100g, manganese 3.37 mg/100g, zinc 0.87 mg/100g, thiamine 3.3 mg/kg, riboflavin 10.6 mg/kg, pantothenic acid 11.0 mg/kg, choline 440 mg/kg, niacin 18.0 mg/kg, pyridoxine 1.5 mg/kg and tocopherols 40.0 mg/kg.<sup>[10]</sup>

#### Nutritional Potential

When compared to other cereals, buckwheat has a good number of nutrients and is an outstanding source of macronutrients, micronutrients, and bioactive substances. The nutritive value (%) of buckwheat in comparison with most commonly consumed crops in India is given in following table. (Table no. 2)

**Table 2: Nutritive values (%) of buckwheat and other Major Crops.<sup>[11]</sup>**

Nutritive Component	Buckwheat	Wheat	Rice	Jowar	Bajra	Ragi
Carbohydrate	71.5	64	77.2	73.8	60.5	59.0
Protein	13.3	14.4	7.5	12.1	14.5	7.3
Lipids	3.4	2.3	2.4	4.6	5.1	1.3

Dietary Fibre	10.0	12.1	3.7	11.8	7.0	19.1
Ash	2.1	1.9	0.6	1.8	2.0	3.0
Energy	343.0	322.0	356.0	334.0	348.0	321.0

**Starch** - Starch is a major content of buckwheat ranges from 59% to 69% of the grain composition, with 15%-25% of amylose and 7%-35% resistant starch and the remaining proportion is Amylopectin.<sup>[12]</sup>

**Protein** - Buckwheat has a protein composition that ranges from 11% to 14% and contains an adequate amount of each necessary amino acid.<sup>[13]</sup> Buckwheat is rich in lysine, arginine and aspartic acid.<sup>[14]</sup> Due to its high quantity of amino acids including lysine (5% - 6%), threonine, arginine (9.2% -10%), tryptophan, and sulphur-containing amino acids. buckwheat protein has a high digestibility coefficient of 80%.<sup>[15]</sup>

**Lipids** - The overall lipid content of buckwheat ranges from 1.5% to 3.7%, with the embryo making up the majority (7 - 14%) and the hull the minority (0.4% - 0.9%).<sup>[16]</sup> The major amount of fatty acids in Buckwheat is 95% of Palmitic, Oleic and Linoleic acid.<sup>[17]</sup>

**Vitamins and minerals** - Buckwheat is rich in minerals especially Calcium, Magnesium, Potassium, Phosphorous, Iron, Manganese, Selenium, Copper and Zinc. Additionally, it also contains a good concentration of Thiamine, Riboflavin, Niacin, Pantothenic acid, Pyridoxin, folate and ascorbic acid.<sup>[18]</sup>

**Flavonoids** - Flavonoids are the secondary metabolites and naturally occurring antioxidants in the food which have physiological health benefits. The major flavonoid present in Buckwheat is Rutin, also called as Vitamin P, which is present in a higher concentration in Tartary Buckwheat as compared to the Common Buckwheat. The other flavonoids in Buckwheat are quercetin, vitexin, orientin, isovitexin and isoorientin. The amount of flavonoid in a plant relies on a number of variables, including the growth phases of the plant, soil location, environmental fluctuations, climate changes, size and shape of the seed, colour of the flower, and time of sowing.<sup>[20]</sup>

**Table no. 3: Vitamin and Nutrient Profile of Grains (mg/100g)<sup>[21]</sup>**

Vitamin	Buckwheat	Wheat	Rice	Jowar	Bajra	Ragi
Thiamine (Vit.B1)	0.003	0.41	0.41	0.38	0.84	0.42
Riboflavin (Vit .B2)	0.01	0.1	0.04	0.15	0.25	0.19
Pantothenic Acid (Vit.B5)	0.011	-	1.09	1.25	1.7	-
Choline	0.44	-	-	-	-	-
Niacin (Vit.B3)	0.018	5.1	4.3	4.3	2.8	1.1
Pyridoxine (Vit.B6)	0.0015	0.57	-	0.21	0.76	-
Tocopherol (Vit.E)	0.04	-	19.0	12.0	1.0	22.0
Ca	110.0	-	-	-	42.0	320.0
Fe	4.0	-	-	-	11.0	9.5
Mg	390.0	138.0	90.0	171.0	137.0	137.0
P	330.0	-	-	-	296.0	180.0
K	450.0	284.0	-	131.0	390.0	408.0
Cu	0.95	0.68	0.14	0.46	1.5	0.47
Mn	3.37	2.29	0.59	0.78	3.3	5.49
Zn	0.87	2.7	1.4	1.6	3.1	2.3

### Pharmacological Potential

#### Antidiabetic effect

Buckwheat bran extracts inhibited sucrase activity in vitro more effectively than buckwheat. Balb/c mice pretreated with buckwheat bran extracts showed dose-dependent reductions of blood glucose, greater



than those observed with control mice, within 60 min following oral sucrose administration. Blood glucose levels in mice pretreated with buckwheat extracts were also significantly lower compared to those in control mice within 30 min following oral administration of sucrose. Rutin, the abundant polyphenols of buckwheat bran extracts, did not lower blood glucose level.<sup>[22]</sup>

#### Antistress effect

The antistress potential of extracts of *Fagopyrum esculentum* (100 mg/kg) was evaluated using forced swimming endurance test. It was found that extracts significantly ( $p < 0.001$ ) increase swimming time in rats. They also showed significant ( $p < 0.001$ ) decreased in blood glucose, cholesterol, triglyceride, plasma cortisol and BUN levels as compared to control stress group.<sup>[23]</sup>

#### Wound healing effect

The efficacy of an ointment of honey bee and *Fagopyrum esculentum* was evaluated in the management of large dermal wound in a male rabbit. The wound was covered entirely by honey and then the fine powder of buckwheat grains was added. The treatment was applied once a day until complete epithelization has taken place. The results showed a complete resorption of inflammatory exudate of wound at 4<sup>th</sup> day. The percentage of wound contraction has shown a rate of 5.55% at the 4<sup>th</sup> day, increased to 32.22 and 71.48% at days 7 and 11 and it reached 99.53% at the. The epithelization period was 27 days with a mean healing rate of 200 mm<sup>2</sup>/ day.<sup>[24]</sup>

#### Antioxidant

The methanolic extract of the grains showed in vitro antioxidant activity as evidenced by scavenging of DPPH, ABTS, FRAP assay and reducing power assay. The activity was compared with gallic acid.<sup>[25]</sup>

#### Antibacterial

The essential oil from the leaves in different dilutions (1:100, 1:250, 1:500 and 1:1000) exhibited dose dependent antibacterial activity against the tested bacteria viz., *Bacillus subtilis*, *Bacillus pumilus*, *Bacillus anthracis*, *Staphylococcus albus*, *Staphylococcus aureus* and *Vibrio cholerae*.<sup>[26]</sup>

#### Effect on memory

The protective effects of buckwheat hull extract were investigated against toxicant-induced spatial memory impairment and hippocampal neuron injury in rats. The impairment of spatial memory and the decrease in the hippocampal weight were observed after the, trimethyltin administration (8 mg/kg bw, orally to 6-week-old rats). Prolonged supplementation of buckwheat hull extract seemed to reverse these, trimethyltin -induced toxic effects, and also improved the spatial memory of rats.<sup>[27]</sup>

#### Antimicrobial effects

An antifungal peptide with a molecular mass of approximately 4 kDa was isolated from buckwheat. It inhibited mycelial growth of *Fusarium oxysporum* and *Mycosphaerella arachidicola* with an IC<sub>50</sub> of 35 and 40 microM, respectively. Its antifungal activity was stable between 0 and 70 degrees C, and between pH 1.0/2.0 and 13.<sup>[28]</sup>

#### Therapeutic potential

- Buckwheat contains high-nutritional protein, dietary fiber, resistant starch, rutin, D-chiro-inositol, vitamins, and minerals that are linked to the prevention of mammary and colon cancers by lowering serum estradiol and reducing cell proliferation.<sup>[29]</sup>
- Buckwheat protein extracts have the potential to be employed as a functional food to treat constipation, celiac disease, obesity, hypertension, and alcoholism.<sup>[30]</sup>
- In gastrointestinal tract illnesses, starch, fiber, a high concentration of polyunsaturated essential fatty acids like linoleic acids, vitamins (B1, C, and E), minerals, well-balanced amino acids, and a low prolamin content play a preventative function.<sup>[31]</sup>
- Protein products of buckwheat to diets significantly lower the levels of cholesterol in serum, liver and gallbladder of hamsters and suppress the formation of gallstones by altering cholesterol metabolism.<sup>[32]</sup>

### Toxicity

Buckwheat allergy can sometimes cause severe reactions which is an IgE-mediated immediate type reaction. Most known cases are in young children in Japan. In a screening of 92,680 children, 0.22% had a buckwheat allergy. Buckwheat-allergic patients are often associated with complain about urticaria (nettle rash), dyspnea (difficulty with breathing), facial angioedema, wheezing, asthma, anaphylactic shock and gastrointestinal symptoms such as vomiting and abdominal pain.

In addition, people who are daily in contact with buckwheat or buckwheat products are likely to become allergic to buckwheat. It has been reported that health shop workers, bakers using buckwheat flour and buckwheat noodle makers showed allergic symptoms when handling buckwheat. Besides asthmatic symptoms, buckwheat is the cause of various skin disorders. Because buckwheat is a food often consumed by celiac patients, the incidence of buckwheat allergy among celiac sufferers has been established. Patients with celiac disease combined with other food allergies have an increased buckwheat intolerance of 30%. Normal celiac sufferers show a buckwheat allergy of 1%.<sup>[33]</sup>

Fagopyrin is naturally occurring substances in the *Fagopyrum*. Fagopyrin can act as photosensetizers that can cause fagopyrism, which is phototoxic to livestock and humans. Fagopyrin can cause irritating skin disorders i.e., redness and itching of lightly pigmented skin and also digestive upset, neurological disorders and death have been reported. If the affected animal is kept in shade, symptoms usually disappear within days. Fagopyrin is mostly concentrated in leaves. Levels in seeds are low and much of that fagopyrin is concentrated in the hulls. Fagopyrism mainly occur in sheep and pigs especially after heavy consumption of buckwheat silage.

### CONCLUSION

*Fagopyrum esculentum* is an ideal plant for multiple therapeutic uses due to its chemical constituents and therapeutic properties. Gluten-free diets that remain

natural and high in nutrients have been growing increasingly popular. Buckwheat is a minor crop in India, but its consumption increases during Hindu fasting days when people avoid cereal and legume-based diets. Traditional buckwheat grains, however, cannot be used for manufacturing commercial-scale products such as breads and cakes due to a lack of gluten. In most regions of the world, it is included in ethnic recipes or in combination with additional components. Considering requirement of alternative food grains to fight malnutrition, Year 2023 has been observed as International Year of Millets. Buckwheat, a pseudomillet has a potential to alleviate mal-nutrition and may be considered as alternative food grain.

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