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CHARACTERIZATION OF BUCKWHEAT AND ITS POTENTIAL APPLICATION AS GLUTEN-FREE FLOUR IN CHAPATTI

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ABSTRACT

Buckwheat relates to the family of crops Polygonaceae which has the property of free of gluten. It is rich in health-promoting phytonutrients because of its high nutritional content and potential to improve health, buckwheat is being included in diets as a substitute crop. The Flour of Buckwheat helps with hypercholesterolemia, obesity, hypertension, and diabetes according to studies conducted on animal models. The grains and other tissues of buckwheat contain many nutraceutical substances. These are abundant in dietary fiber, antioxidants, proteins, carbohydrates, and trace elements. Buckwheat comprises different types of bioactive compounds like vitamins, minerals, proteins, polysaccharides, fatty acids, flavonoids (such as rutin), and dietary fiber. Because of these bioactive components, buckwheat has a high nutritional value. Numerous

gluten-free buckwheat products (BGFPs) have been produced, such as beer, pasta, breads, noodles, and pastries. This review aims to explore the current knowledge about buckwheat, its nutritional constituents, and the impact of Buckwheat on the characteristics of products and its potent application of diabetic-free products and buckwheat flour with high nutritional value for preparing free gluten chapatti with high nutritional value to overcome the health-related diseases as well as to target celiac illness people about (1.4% of the world population)

1 Introduction

Buckwheat is a non-gluten-pseudo cereal grain belonging to the family Polygonaceae and genus Fagopyrum that is well known for its excellent nutritional value and flexibility in culinary preparation. Despite its name, buckwheat is not similar to wheat but it is naturally gluten free making it viable for alternate for gluten sensitive and celiac disease patients (Bhat et al., 2022). Buckwheat contains protein, fiber and flavonoids which act as antioxidant (Ma et al., 2020). It is a type of functional food with highly nutritional food components, has many health-related benefits, and is used worldwide (Huda et al., 2021). Buckwheat is widely grown in America, Europe, and Asia but originated in China (Ji et al., 2019; Sinkovič, Kokalj, Vidrih, & Meglič, 2020). The top producer countries of buckwheat are Kazakhstan, China, Russia, Poland, Brazil, Japan, France, Ukraine and Nepal. The genus Fagopyrum includes around 19 species of buckwheat (Z.-L. Zhang et al., 2012). Two types species of buckwheat have been mostly grown around the globe for ages including common buckwheat called Fagopyrum esculentum Moench) and Tartary buckwheat known as (Fagopyrum tataricum) (Alvarez-Jubete, Arendt, Gallagher, & Technology, 2010; Bahmanyar, Hosseini, Mirmoghtadaie, & Shojaee-Aliabadi, 2021). It was discovered that Tartary buckwheat and common buckwheat have identical proximate compositions (Qin et al., 2010). The rising frequency of gluten-related illnesses, such as celiac disorder and gluten intolerance has increased the need for flour-free substitutes in the food sector (Borovaya & Klykov, 2020)This study attempts to investigate the current understanding regarding buckwheat and its essential contents and the impact of Buckwheat on the attributes of products and its valuable application of gluten-free items and buckwheat flour with high nutritional value for preparing free gluten chapatti with high nutritional value.

2 Diversity of growing aspect of Buckwheat

The cultivation of buckwheat offers several benefits over other grain crops, including a shorter growing season (70–90 days) and less expensive maintenance required throughout the process. Its grain's high concentration of substances with antioxidant qualities allows it to be kept for an extended period without changing. Most of the world's wheat has been grown in Eastern Europe, including Japan. Reliable rainfall during the growing season is necessary for it to grow at its optimum in temperate or subtropical climates.

Adapted and revised from Sofi *et al*., (2023)

One of the many neglected grains, buckwheat is the oldest cultivated crop from Central America, Europe and Asia. It is mostly used as a staple meal, particularly in dry parts of the globe. Although the origins of buckwheat are thought to be in Central Asia, its domestication began in South China around 4,000–5,000 years ago.(Gondola & Papp, 2010). Buckwheat may be grown under a wide range of climate including rocky and marginal locations. It can even adapt to poor soil conditions and thrive there. Buckwheat requires 70–90 days to complete its life cycle, making it a short-season crop. Buckwheat flour has the potential to have more protein than other commonly consumed cereals such as The grain rice, wheat, and sorghum, millet, and corn. The crude protein present in buckwheat grains is high in arginine and lysine, which are generally absent from other cereals. Because the ratio of arginine to lysine in buckwheat protein is low, it has a significant hypolipidemic effect. The dicotyledonous, broadleaved plant that is native to China and Central Asia bears irregular, triangular seeds (Sofi et al., 2023).

3 Chemical composition of buckwheat

The Crop, buckwheat is a nutritious cereal with a great content of nutrients that is perfect for treating malnutrition and celiac disease. Buckwheat pseudo cereals are suggested for use in commercial food formulations, either in place of cereal grains to avoid gluten or as an addition to cereal crops to boost nutritional value. Buckwheat is plentiful in resilient starch and fiber for digestion and high-quality proteins with a good balance of key amino acids like lysine, etc (Taylor, 2017). Buckwheat is composed of approximately 70% starch, with the remaining components being protein (12.1%), lipids (3.2%), ash (2.6%) and dietary fibers (10.2%). Buckwheat also contains a variety of trace elements that have nutritional value, including vitamins, polyphenols, and D-chiro-inositol (Zhu & Technology, 2021). Beyond its unique features as a grain, Buckwheat has high-

quality protein and carbs. Additionally, It is abundant in vitamins, minerals fiber, and other beneficial compounds that have positive medicinal effects on human beings such as phytosterols, flavonoids, phenylpropanoid glycosides myoinositol, and free and bound phenolic acids. Therefore, over the last few years, Buckwheat's importance has increased due to its gluten-free potential in foods as a functional food has increased (Z.-L. Zhang et al., 2012). Buckwheat has most health-related advantages like anti-inflammatory, anti-cancer, hypoglycemic, antioxidant, and anti-hypertensive characteristics for human health (Zhu & Technology, 2021). Therefore, BW has more possibility to use it as a functional food source due to its digestible and medicinal qualities. For those with celiac disease, buckwheat is the recommended pseudo-cereal because it is high in nutrients and free of gluten protein.

The potential application of Buckwheat as gluten-free flour in chapatti is a potential material due to its formulation of low glycemic index food. Buckwheat flour is rich in vitamins, minerals, soluble and insoluble dietary fiber as well as polyphenolic compounds having powerful antioxidant potential (Costantini et al., 2014). Chapati, an unleavened round flatbread which is made from flour of whole buckwheat is popular in most Asian homes, particularly in India and Pakistan. Past studies have documented the benefits of switching from wheat chapatti to gluten-free Chapatti of buckwheat flour and other cereal flour for improving the nutritional and therapeutic status of individuals with diabetes, celiac disease, and gluten sensitivity (Yadav, Mishra, Sheikh, & Sciences, 2013).

Table.1. Chemical characteristics of buckwheat

Parameters	Wheat(I) Buckwheat(II)	
Protein (%)	13.07	13.15
Carbohydrates (%)	56	57.40
Lipid/Oil (%)	2.52	3.84
Fiber Content (%)	11.94	10.60
Ash Content (%)	1.67	2.70
Other Compounds (%) (Carbolic cpds, organic acids, Soluble carbohydrates, and other unknown cpds)	14.83	18.42

Abbreviations: cpds, compounds

(a)Adapted and revised from Antonio *et al.,* (2015)

3.1 Protein

The grain buckwheat's protein content ranges from 8.4% to 17.9%, based on cultivar, manufacturer, and weather (Dziadek et al., 2016). Buckwheat proteins include prolamin (1–7%), albumin and globulin (50–60%), glutelin (12–20%), and various components (5–10%)(Joshi et al., 2020). The overall percentage of proteins in buckwheat varies depending on the type, fertilization, and application of pesticides. Buckwheat flour contains 8.5% to almost 19% proteins. Buckwheat contains four important amino acids: lysine (5.68%), proline (7.93%), arginine (11.16%), and glutamic acid (19.38%) (Christa & Soral-Śmietana, 2008).

3.2 Carbohydrates

In buckwheat grains, starch is the main storing agent. As an energy source, it is required for the growth of the plant and it accumulates in the endosperm. The percentage of starch ranges from up to over 70% of the dry mass in the whole buckwheat grain Buckwheat starch contains 25 and 75 percent amylose and amylopectin, respectively. For instance, buckwheat dough that had been cooked showed a strong correlation between its starch and amylose levels and its springiness, most likely as a result of gelling (Zhu & Technology, 2016).

3.3 Dietary Fiber

Dietary fiber ingredients are mostly found in cellular membranes of starchy endosperm, aleurone, germ coats, and hulls and buckwheat's dietary fiber consists of fractions including cellulose, complex carbohydrates, and lignin (Ahmed et al., 2014a). Total Dietary Fiber in buckwheat varies from 7% to 11.9% (Boukid et al., 2018). Dietary Fiber demonstrates one or more positive health benefits like decreased blood glucose, and blood cholesterol, and helps to maintain bowel movements (fecal bulking, regularity, and increased frequency and softness) (Report, 2001).

3.4 Lipids

The percentage of fatty acids in common buckwheat is around 3.8% (H. J. B. F. Li & Foods, 2019). The hull of buckwheat is heavily concentrated in saturated fatty acids, while the embryo is mostly composed of unsaturated fatty acids. More linoleic acid, an important fatty acid, is found in the coat of buckwheat seeds than in any other organ. Each portion of the buckwheat seed has a varied lipid content: the hulls, endosperm, and embryo have 0.4–0.7%, 2.0–3.0%, and 9.6–19.7% of lipid respective. The whole grain of both Tartary and Common buckwheat has a total lipid content that ranges from 1.3% to 4.3% (Subedi, 2018).

3.5 Vitamins and Minerals

Although buckwheat lacks vitamin A, it is high in thiamine (also called vitamin B1), niacin (a form of vitamin B3), and vitamin B6, also known as vitamin K, and also rich in choline (Subedi, 2018). In general, common buckwheat has a larger quantity of vitamin E than Tartary buckwheat, while Tartary buckwheat contains a great concentration of vitamin B group. When it comes to vitamin B, buckwheat flour is a more dependable source than rice and maize flour (Joshi et al., 2020). Each portion of the buckwheat seed, including the hull, has a different mineral content. The majority of the minerals are found in the aleurone tissues and embryo, whereas buckwheat has 3.6–6.5 mg Fe and 70.14 mg Ca per 100 g correspondingly (Subedi, 2018). When compared to other cereals, buckwheat has a noticeably greater concentration of metal trace elements such as P, K, Ca, Fe, Mg, Zn, and Co (H. J. B. F. Li & Foods, 2019). In buckwheat seeds, the mineral content and physical distribution vary between 2.0 and 2.5%, 1.8–2.0%, 2.2–3.5%, 0.80–9%, and 3.2–4.6% for Whole grains with a germ coat, dehulled grain kernels, wheat flour, and hulls that are, in that respective order. (Christa & Soral-Śmietana, 2008).

4 Bioactive compounds in Buckwheat

4.1 Bioactive Peptides

The biopeptides, along with other active substances like flavonoids and phenolic acids, have received attention because of their potential in medicine and therapy, particularly in controlling food intake(Dougkas, Reynolds, Givens, Elwood, & Minihane, 2011). The activity of the peptide is determined by its series, arrangement, structure, charge, and hydrophobicity, which range from 3 to 50 amino acid residues on average (Saadi, Saari, Anwar, Hamid, & Ghazali, 2015). Grain buckwheat has a greater protein content than cereal crops (Bobkov, 2016). Bioactive peptides have therapeutic properties such as antibacterial, antioxidant, cholesterol-lowering, hypoglycemic, and anticancer activity. To enhance human health and prevent illness, protein hydrolysates, and bio peptides may be utilized as components in functional meals and medications due to their safety profiles and potential benefits for human health (Nasri & research, 2017).

4.2 Flavonoids

Rutin (Flavonoid-3-beta-d-rutinoside) is a glycoside combining flavone quercetin with rutinose as a disaccharide component. The compound Rutin concentration increased in the leaves, stalks, grains, and buckwheat plant's inflorescence. Additionally, Rutin has anti-inflammatory, antioxidant and anti-carcinogenic property can lessen blood vessel fragility in hypertension and hemorrhagic illness in humans (Ahmed et al., 2014a). Rutin has also been demonstrated to possess anti-inflammatory, anti-cancer, and antioxidant qualities(Negahdari et al., 2021). Quercitrin possesses anti-inflammatory, antioxidant properties and antimicrobial properties especially when paired with other flavonoids found in buckwheat (Chen, Zhu, & Qin, 2022) (González-González et al., 2020), and prevents buckwheat plants from the phototoxicity of fagopyrins and other naphthodianthrones found in buckwheat plants (Fabjan et al., 2003). The most significant functional markers of buckwheat are these flavonoids because of their diverse physiological effects.

4.3 Phenolic Acids

Buckwheat contains both free and bound phenolic chemicals in the cell wall (Alvarez-Jubete, Wijngaard, Arendt, & Gallagher, 2010). Phenolic chemicals, such as protocatechuic, syringic, and caffeic acids, are widely recognized to be present in buckwheat(Z.-L. Zhang et al., 2012). Buckwheat's phenolic compounds have been demonstrated to have antioxidant activity, which has been linked to a minimized chance of cancer, heart disease, and age-associated deterioration processes(Gimenez-Bastida, Zielinski, & chemistry, 2015; Sedej et al., 2012).

5 Differences between Common wheat and Buckwheat

Wheat (Triticum) is considered the oldest grain in the world. Humans have grown this agricultural species since 10,000 BC. Wheat can form gluten that's why it is the most often used flour for bread production globally. Wheat is a popular common food item globally contributing significantly to daily calorie, fiber, and vitamin consumption. However, certain wheat components may also cause harmful bodily responses in sensitive individuals, such as gluten-related disorders

like celiac sprue and gluten allergy (Uthayakumaran & Wrigley, 2010).

Buckwheat (BW) is recognized as a pseudocereal that is free of gluten from the family Polygonaceae. BW grain is a very nutritious dietary ingredient that has been demonstrated to have a variety of positive impacts. BW may help avoid chronic illnesses. BW's high antioxidant action may assist in reducing triglyceride and Genetic oxidation which prevents the onset of long-term disorders including inflammatory conditions, high cholesterol levels, cancer, and disorders of the brain (J. A. Giménez-Bastida & Zieliński, 2015). Buckwheat has a rightful position in these goods these days, one of the most valuable food product categories is gluten-free goods. The use of buckwheat in gluten-free product development raises its value within the gluten-free market. It reduces the risk of several diet-related illnesses and provides gluten-free diet alternatives for 1.4% of the global population (Juan Antonio Giménez-Bastida, Piskuła, Zieliński, & Technology, 2015). Its popularity is due to its excellent nutritional value in addition to the fact that it doesn't contain gluten. This is significant since research indicates that shortages in protein, dietary fiber, minerals, and vitamins affect 20%–38% of individuals with celiac disease (Belton et al., 2002).

6 Health Benefits of Buckwheat

Buckwheat contains a high concentration of micronutrients and bioactive components, which improves its medicinal potential. Buckwheat consumption has been linked to various health benefits, including a lower risk of being overweight, diabetes, certain kinds of cancer, and cardiovascular disease. The remedial capacity of buckwheat is given below:

6.1 Antioxidant Capacity

Buckwheat grain has a strong antioxidant capacity due to its significant phenolic content, particularly rutin. Other than that Bioactive compounds like peptides and polyphenols exhibit antioxidant activity. Peptides from hydrolysis of albumin by alkaline protease; Peptides from hydrolysis of 13S globulin. Three peptides of GEVPW (MW, 587 Da), YMENF (MW, 703 Da) and AFYRW (742 Da) showed strong antioxidant capacities against OH and DPPH radicals, and lipid peroxidation • Pre-treating the cells with the peptides protected the antioxidant enzymes' activities of HepG2 cells, while maintaining the balance of redox status (Zhu & Technology, 2021). Free radicals, which are produced by human metabolism, are responsible for cardiovascular illnesses, cancer, aging, and degenerative disorders (Ahmed et al., 2014b; Papadopoulou et al., 2021). Buckwheat flavonoids' molecular arrangement confirms the idea of a strong polyphenol hydroxyl compounds group, able to scavenge harmful radicals and combat cardiovascular disease, aging, degenerative conditions and carcinogenic diseases (F. Li et al., 2017).

6.2 Anticancer Activity

Cancer is the main cause of mortality in financially developed countries and ranks as the second highest reason for death in developing nations (Jemal et al., 2011). Another of the century's key worldwide challenges is the development of nutrient-rich foods to avoid persistent illnesses such as cancer. Consuming a range of diets, including buckwheat, was found effective in lung cancer risk factors (Shen et al., 2008).

Buckwheat includes nutrients such as selenium, cadmium, and zinc which work as an immune-boosting agent against chemotherapy (Wang et al., 2015).

Flavonoids reduce lipid peroxidation because flavonoids in buckwheat may efficiently bond with metal ions. It reduces cell damage because of its anti-inflammatory along with free radicals scavenging properties, which results in anti-carcinogenesis (Hou, Hu, Yang, Chen, & function, 2017). Buckwheat and its bioactive compounds were investigated, indicating that TB phenolics are responsible for the anticancer activity against human breast cancer MDA-MB-231 cells in a dose-dependent manner, through the induction of cell apoptosis by p38/MAPK pathway. Additionally, TB flavonoids exhibit a remarkable anticancer activity against human gastric cancer MGC80-3 cells, which is mediated by the promotion of the expression of apoptotic proteins, such as caspase-8 (Y. Zhou, Zhao, Jiang, Wei, & Zhou, 2019).

6.3 Immuno-stimulant Activity

Inflammation is a natural physiologic reaction to tissue damage and infections by microbes and chemical pollutants that lead to cancer development. Buckwheat's flavonoids and phenolic acids have significant anti-inflammatory effects (Gimenez-Bastida et al., 2015). Buckwheat contains phenolic acids like p- coumaric and feluric which can reduce inflammatory mediators like inducible nitric oxide synthase interleukin-6, chemokine (C-C motif) ligand 2 knowns as (CCL2) and cachectin. This inhibits inflammation reactions and lipopolysaccharide-induced inflammation activity (Sofi et al., 2023).

6.4 Antidiabetic Activity

Diabetes is a chronic illness that results from inadequate insulin synthesis or inefficient activity of insulin, resulting in a rise in blood glucose levels (Collares et al., 2013). Buckwheat-based products decrease fasting blood sugar and increase insulin levels, lowering the risk of diabetes. Buckwheatflavonoids, both digested and undigested, boost glucose intake and glycogen levels (Ruan et al., 2022). Buckwheat is a food with a low glycemic index (GI) diet that has been linked to benefits in preventing the avoidance and management of diabetes (Ajala, English, & Pinkney, 2013). Rutin inhibits polyphenolic chemicals, dietary fiber, and other non-starch components, glucosidases, and amylase enzymes, resulting in food pattern effects and decreasing the glycaemia of buckwheat-made food items (Sofi et al., 2023).

Recently, the anti-diabetic effects of a soluble dietary fiber (SDF) extracted from TB bran in diabetic mice have been systematically investigated. The dietary SDF administration of SDF could reduce the levels of fasting blood glucose, improve oral glucose tolerance, increase the levels of liver glycogen and insulin, and improve both serum and hepatic lipid profiles in diabetic mice (Wu, Li, Qin, Qiu, & Research, 2021). In conclusion, these results suggest that the antidiabetic activity of TB is mainly attributed to its bioactive components, such as flavonoids (mostly rutin and quercetin), D-chiro-inositol and its derivatives, and polysaccharides.

6.5 Other Effects:

Celiac disease is a condition that is mediated by the immune systemic condition caused by the consumption of gluten or similar prolamines in genetically sensitive individuals (Olivares, Laparra, Sanz, & chemistry, 2011). The only efficient treatment for celiac disorder is a demanding gluten-free diet

throughout the patient's whole life. Approximately 21–38% of celiac patients have certain deficiencies in nutrients including protein, vitamins, dietary fiber, and minerals (Saturni, Ferretti, & Bacchetti, 2010). The rise in celiac disease cases over the past few decades and the current trend toward the consumption of non-allergenic components have made the gluten-free product category in the food industry highly demanding. The occurrence of celiac disease has elevated in recent years, and a new illness known as non-celiac gluten sensitivity (NCGS) has just been found and verified (Sosa, Califano, Lorenzo, & Technology, 2019).

Gluten-related illnesses including wheat allergy, celiac disease, and the NCGS, are currently leading to up to 5% of total global prevalence (Montemurro, Coda, & Rizzello, 2019). So, to produce goods that have positive qualities and are nutritionally balanced, it is essential to include components that have viscoelastic qualities comparable to gluten like gluten-free flour processed from Buckwheat (Jnawali, Kumar, Tanwar, & Wellness, 2016). As a result, for patients suffering from celiac disease, buckwheat is the recommended pseudo-cereal because it is high in nutrients and free of gluten protein (Morales, Miguel, Garcés-Rimón, & nutrition, 2021). Buckwheat protein has a lower glutamic acid and proline content compared to cereal proteins, but it is especially high in lysine, arginine, and aspartic acid (M. Zhang et al., 2010). Buckwheat proteins due to short peptide linkage function similarly to dietary fiber in preventing obesity and constipation. Their biological activities are unique in that they exhibit antihypertensive and cholesterol-lowering properties (X. Zhou et al., 2015). Buckwheat plant's health advantages include lower serum cholesterol levels, anti-inflammatory neuroprotective, anti-cancer, anti-diabetic properties, and improved hypertension symptoms. Buckwheat is also utilized in gluten-free diets for persons with celiac disorder and in the treatment of other prevalent diseases (Noreen, Rizwan, Khan, & Farooq, 2021).

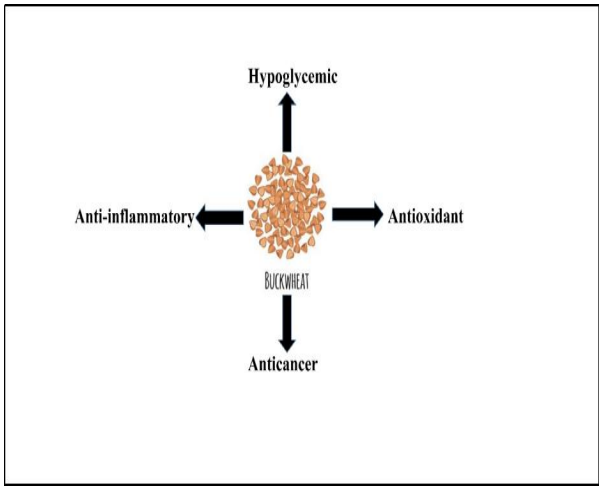

Figure 2. This is a simplified overview of the health benefits that come with consuming buckwheat.

7 Buckwheat as a gluten-free flour

Worldwide, wheat is the cereal most commonly utilized in bread and bakery production methods. Different food items that are made from flour or buckwheat are some of the most popular applications such as gluten-free bread. Buckwheat flour has gained popularity recently due to its high nutritional content and positive health effects when used in meals. the abundance of important minerals, vitamins B1 and B2, necessary fatty acids, and essential amino acids found in buckwheat flour and bread (Guo & Yao, 2006). There may be a health benefit to using buckwheat flour due to its inflammation and hypotensive characteristics as well as its ability to lessen blood vessel fragility so, Rutin, a flavonol glycoside also helps to promote health. The

synthesis of rutin's oxazolone derivative and the generation of nitric oxide (NO) have both been linked to the metabolic reaction of rutin in the stomach (Takahama et al., 2007).

The starch content of buckwheat flour ranges from 70–91% (w/w) depending on the variety. It is composed of 25% amylose and 75% amylopectin. As a result, diabetic patients may benefit from consuming dishes made with buckwheat flour and groats that include hydrolysis-resistant starch(Skrabanja, Liljeberg Elmståhl, Kreft, Björck, & Chemistry, 2001). Protein content in buckwheat and tartary buckwheat flours ranges from 10% to 20% (w/w). The protein is rich in essential amino acids and contains albumin, glutelin, prolamin, and globulin(Guo & Yao, 2006). Both buckwheat and tartary buckwheat flours are high in vitamins B1, B2, and B6, as well as Zinc (20–30 ppm), Iron (60–100 ppm), and Selenium (20–50 ppb). The components of bran are unsaturated fatty acids namely C18:1 (n-9) (oleic acid), C18:2 (n-6) (linoleic acid), and C18:3 (n-6) (linolenic acid)(Bonafaccia, Gambelli, Fabjan, & Kreft, 2003).

The flour made from buckwheat is seen to be a fascinating addition to gluten-free recipes. The addition of buckwheat flour to an experimental gluten-free formulation improved the chappati's technical quality and increased its protein and microelement content, particularly in Cu and Mg (KrUpa-KozaK, Wronkowska, & Soral-ŚMietaNa, 2011). Compared to other pseudocereals, common buckwheat flour has a higher protein and folate content and a more beneficial fatty acid composition, with oleic and linoleic acids predominating. Buckwheat flour's viscoelastic qualities, low baking quality, consumer acceptance, and its use in product creation cause technological issues with chapatti development (Hager et al., 2012).

Buckwheat is a premium, healthful component in gluten-free bread. Pseudocereals increased loaf volume and softened crumb when added in comparison to the control. Buckwheat may be regarded as gluten-free since, regardless its name while not botanically comparable to common wheat. It is historically used in Southeast Asia to produce chapattis, or unleavened flatbread (Alvarez-Jubete, Auty, Arendt, Gallagher, & Technology, 2010). Buckwheat is high in nutrients and can be incorporated into gluten gluten-sensitive diet for gluten-related disorders (Saturni et al., 2010).

8 Buckwheat in Gluten-free products

8.1 Buckwheat Gluten-free Cookies and Biscuits

Bakery goods containing health-promoting functional ingredients, such as buckwheat cookies and biscuits, have demonstrated exceptional product quality and up to 20% customer acceptance (Torbica, Hadnađev, & Dapčević, 2010). The cookies made with buckwheat flour had higher cookie characteristics and contents of protein (4.34%–5.45%), fat (18.81%–20.04%), and fiber (0.39%–0.68%) (Altındağ, Certel, Erem, İlknur Konak, & International, 2015).

8.2 Buckwheat Gluten-free noodles

Noodles made with buckwheat are referred to as soba-type noodles, and they have exceptional texture and cooking functions since 35% of the flour is buckwheat (Hatcher et al., 2011). Buckwheat's nutraceutical

potential has raised the demand for noodles, but because there is not a viscoelastic network so, customers only accept a partially acceptable sensory quality (Han, Lu, Hao, Cheng, & Li, 2012). In contrast to reducing phytic acid and allergenic proteins, noodles made from fermented buckwheat have higher levels of minerals and amino acids (Bilgiçli & Nutrition, 2009).

8.3 Buckwheat gluten-free pasta

The extrusion method produces readily available pasta, very palatable, and requires little preparation. While making gluten-free pasta, buckwheat flour preserves the pasta's excellent texture and dough without changing its cooking properties (Schoenlechner, Wendner, Siebenhandl-Ehn, & Berghofer, 2010). The optimization of buckwheat made flour for the preparation of wheat-free pasta resulted in enhanced firmness as well as a properly formed structure and excellent cooking and taste and flavor attributes (Gao et al., 2018).

8.4 Buckwheat gluten-free Tea:

The majority of Asian and European countries utilize buckwheat tea, which has pharmacological benefits (Zielinska, Szawara-Nowak, & Zielinski, 2013). In Japan, soba cha, or buckwheat tea is a rather popular beverage so preparing the tea, requires several processes like to extract raw seeds from their hulls they are first steeped in water, then boiled in water, and then dried. After that, the dehulled groats are roasted to make tea (Z.-L. Zhang et al., 2012).

8.5 Buckwheat gluten-free beer:

The use of buckwheat in beer production has become the subject of further research in the past few years due to issues about gluten-based grains affecting beer development, as well as the significant amount of amylases and other water-soluble chemicals found in germinated buckwheat grains. Like other cereals like barley, buckwheat may be used to make malt, which can then be used as a catalyst for a mash to brew a beer safe for those with celiac disease or other intolerance to certain glycoproteins (Agu et al., 2012). The buckwheat malt-fermented beer demonstrated a decline in anti-nutritional ingredients but an increase in minerals, nitrogen, and free amino acids (Phiarais et al., 2010).

9 Use of Buckwheat Flour as Gluten-Free Flour in Chapatti

One of the main meals is the chapatti of the Subcontinent (India and Pakistan). The majority of people who consume this type of bread are from south Pakistan. Increased supplementation of basic meals with various grains, pulses, and soya for protein and other nutritional enrichment is becoming more and more popular as awareness for healthy lifestyle. The use of flour made from buckwheat in chapatti formation increases the amount of nutrients, including protein and minerals, which improves the chapatti's nutritional quality (Wronkowska, Haros, Soral-Śmietana, & technology, 2013).

Additional technological and formulation study is required to improve the overall attribute of buckwheat chapatti and provide other objectives that are highly palatable to consumers with celiac disease. The healthy and technical functioning qualities of wheat-

free goods are improved by incorporating buckwheat-made flour. The quality of the chapatti was enhanced by the addition of buckwheat flour, which also increased its protein content, mineral composition, dietary fiber, and texture characteristics (KrUpa-KozaK et al., 2011). Buckwheat flour can improve the protein, insoluble fiber storage life, and overall acceptability of chapatti among consumers when used in dough manufacturing because of its umami flavor and distinct smell (Suzuki et al., 2020). The rutin and antioxidant activities of the bread developed with the use of flour from buckwheat (Vogrinčič, Kreft, Filipič, & Žegura, 2013).

Buckwheat chapatti as compared to oat, quinoa, and amaranth flour-enriched gluten-free bread, is made without gluten has a higher amount of protein, along with other polyphenols, and has characteristics for antioxidants (Chlopicka et al., 2012). A gluten-free bread is made using buckwheat and maize as the basic material and is thought to have a higher phenolic content and a more nutritious profile than bread made with gluten protein. In comparison to bread made without buckwheat flour, they have higher levels of antioxidants, minerals, proteins, and vitamins. Moreover, whole-grain buckwheat flour-containing chapatti showed increased phenolic and antioxidant components (Sakač, Torbica, Sedej, & Hadnađev, 2011; Schoenlechner et al., 2010). Aside from the boost in functionality and nutritional content, buckwheat's low baking quality and low consumer appeal limit its use in bread development (Saturni et al., 2010).

Buckwheat flour behaves differently than wheat flour, making it more efficient to process into wheat flour-like items since buckwheat lacks gluten-forming proteins. The curve's distinctive points show notable differences: Increased dough development periods have been found as compared to regular wheat flour. Buckwheat flour retained more water (66.2%–69.4%) as compared to control wheat (62.1%). These variations are traced to the greater fat and fiber portion of buckwheat flour as compared to conventional flour. Buckwheat proteins had a poorer structure-forming capacity, hence the flour mixtures of both buckwheat flour were less stable (Zheng, Sosulski, & Tyler, 1997).

Buckwheat flour is occasionally combined with the flour of wheat along with different flours before use. Combinations of 35% buckwheat and 65% wheat flour are frequently utilized in domestic units for chapatti production in various regions of the world. We studied several wheat doughs enhanced with buckwheat flour in a 17:2 ratio. So, the composition of flour made up of buckwheat has the same impact as common wheat flour and decreases the strength of the dough. However, it may be due to low water absorption. In this way, the incorporation of buckwheat flour into dough compositions resulted in a reduction in gelatinization. As a result, this might have a favorable impact on the ultimate high-standard product quality and freshness. They concluded that adding buckwheat flour to wheat dough affected its rheological attributes when compared to control wheat dough. Yet no major impact of replacement level was seen. In addition to functioning properly, it is important to research the sensory properties of buckwheat

products (Sedej et al., 2011; Wrigley, Corke, Seetharaman, & Faubion, 2015).

Buckwheat-wheat composite breads have the same look, color, and sensory qualities. When compared to wheat bread, these breads received good ratings for flavor and mouthfeel (Fessas et al., 2008). These buckwheat-wheat composite chapattis also have a greater rutin content, high antioxidant activity, and removal of radicals possibilities. Buckwheat is well-known for its high flavonoid compound content, particularly rutin, which has several biological activities that promote health, including lowering cholesterol levels in the blood, strengthening capillaries, preventing blood coagulation, and putting positive liver-protective properties and reducing inflammation in addition to its antioxidant properties (Kalinová, Vrchotová, & Tříska, 2018). Buckwheat is a suitable alternative for celiac victims since, unlike grain crops, its prolamins do not cause immune responses. Furthermore, buckwheat flour improved important criteria of chapatti qualities (the volume and loaf size) (Lin, Liu, Yu, Lin, & Mau, 2009).

10 Conclusion

Buckwheat is an important pseudo-cereal with a good nutritional profile, high in phytochemicals, vitamins, and minerals. The only approach for curing celiac disease is to eliminate gluten from one's diet. Buckwheat is not only gluten-free, but it also offers an unusual nutritional advantage, thanks to its low glycemic index. However, more research and development are needed to improve gluten-free buckwheat chapatti with a comparative study assessing the qualities of chapattis made with different flour combinations and exploring the physicochemical and sensory properties of buckwheat flour in gluten-free chapatti production to access chapattis, to optimize formulation and enhance consumer acceptance

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