ISSN: 0974-5823 Vol. 7 (Special Issue, Jan.-Feb. 2022)

International Journal of Mechanical Engineering

Effect of germination on the physicochemical properties of buckwheat

Harnoor Kaur Kohli, Dr. Aparajita Bhasin

School of Agriculture- MSc. Nutrition and Dietetics

Lovely Professional University

Lovely Professional University, Jalandhar - Delhi G.T. Road, Phagwara, Punjab (India) - 144411

Abstract: -

Buckwheat is a traditional food that is widely consumed around the world.

Buckwheat has a high concentration of nutritionally beneficial components and may have many properties as a functional food. Because of its health benefits, buckwheat is becoming increasingly popular. The fact that its seeds are gluten-free, high in protein, and contain bioactive compounds with health-promoting properties is the most appealing aspect of them. The purpose of this research was to see how different processing methods affected the nutritional and physicochemical properties of buckwheat, which would then be used to make a variety of new products. Germination has the potential to improve the nutritional quality of flours while also altering their physicochemical properties. The current study investigated the effect of germination on the physicochemical properties of buckwheat over a range of time periods. Buckwheat grains' nutritional value increased during germination. Following germination, changes in their nutritional, physicochemical, and in vitro digestion characteristics were evaluated. Buckwheat is a potential candidate for such products, and this paper examines the functional and physicochemical properties of common buckwheat (Fagopyrum esculentum). After germination, the color of buckwheat flour increased. Germination had an effect on the physicochemical properties, but it had a different effect on protein digestibility. These findings have implications for the use of germination in the production of nutritionally rich flour with altered physicochemical properties.

Keywords: **-** Buckwheat, Germination, Physicochemical Property, Celiac Disease Buckwheat-based products.

1. Introduction: -

Cereal-based foods are the foundation of human nutrition all over the world. Their primary goal is to provide nutrition and energy because they are high in polymer carbohydrates, primarily starch. There is a wide range of cereal species that have been and could be used for human nutrition, as well as starch-rich seeds that can be used in the same way as cereals, known as pseudo cereals (Schoenlencher, 2016). Pseudo cereals are seeds that function and are composed similarly to cereals. Pseudo cereals include amaranth, quinoa, and buckwheat. Most cereals, including wheat, rice, and barely, are monocotyledonous, whereas pseudo cereals are dicotyledonous. The Indian government has designated two pseudo cereals, amaranth and buckwheat, as "Nutri Cereals" with high nutritive value for both production and consumption.

Buckwheat (Fagopyrum esculentum Moench) is a member of the polygonaceae family and contains rutin, a phytochemical that strengthens capillary walls. In Europe, dried buckwheat leaf under the brand name "Fagorutin" has been manufactured for use as herbal tea. Similar effects are associated with the inclusion of resistant starch in the diet, which aids in the prevention of colon cancer. Because nanotechnology has opened new vistas in the field of plant sciences, and interest in its exploration is growing, these beneficial traits may be positively regulated using nanotechnology (Cossins 2014). Buckwheat (Fagopyrum esculentum) is a pseudo cereal with a short growth period and higher pest resistance than other cereals. Because of its balanced macronutrient composition and high content of bioactive compounds, buckwheat is now recognized as an important gluten-free functional food ingredient. Buckwheat seeds have a protein content comparable to wheat grain, but with a higher biological value due to their balanced, lysine-rich amino-acid composition and low storage prolamin content(Gálová et al., 2019) Buckwheat seeds contain a high concentration of phenolic compounds, particularly flavonoids like rutin,(Bai et al., 2015) orientin, vitexin, and isovitexin, all of which have been linked to a variety of health benefits (Rauf et al., 2017, Lam et al.,2016, Peng et al., 2021 and He et al.,2016).All of these factors must be explained in advance for our study to get a clear picture of the Buckwheat and its properties on which we conducted our research.

1.1. Buckwheat: -

Buckwheat (Fagopyrum esculantum Moench) of the Polygonaceae family is classified as whole grain in the United States Department of Agriculture's pyramid serving’s database. Because of its gluten-free status, bioactive nutrients, and numerous health benefits, it has grown in popularity as a popular ingredient used in a variety of recipes (products). Buckwheat has significantly higher protein content (8.5118.87%) than rice, wheat, sorghum, maize, kidney bean, and chickpea as a protein source. It also has a well-balanced amino acid profile, which can complement other vegetable proteins with high lysine and arginine content (Zhu et al., 2016). Aside from high-quality proteins, buckwheat is also high in bioactive polyphenol components (e.g., rutin, quercetin, catechin, caffeic acid, etc.), which have gained popularity due to the numerous beneficial effects observed in vitro and in vivo (Li et al., 2017; Kreft et al., 2017). Several studies have found that buckwheat's polyphenols provide a wide range of beneficial effects (J lp et al., 2015).

Buckwheat is used as a common food source as well as a traditional medicine all over the world, including Japan, China, and Korea. It contains a variety of nutrients and bioactive phytochemicals, making it not only an important source of basic nutrition, but it may also provide other positive health benefits. Many buckwheat species are grown around the world, but common buckwheat (Fagopyrum esculentum) and tartary buckwheat (Fagopyrum ataricum) are among the most widely cultivated for use as a human food crop

(Ahmed et al., 2014). Buckwheat whole grains are typically dehulled to produce groats, which are then milled into flours or used directly for human consumption, typically as a breakfast cereal (Zielinski et al., 2009; Zhang et al., 2012). Buckwheat's bioactive compounds are mostly found in the hulls and bran (Li et al., 2013). Buckwheat and buckwheat-enriched foods have a wide range of biological and pharmacological activities, including hypocholesterolemic and hypoglycemic effects, as well as anticancer and anti-inflammatory properties (Zhang et al., 2012). Buckwheat's presence of total dietary fiber, C-gluco flavones, and D-chiro-inositol, among other things, makes it useful in the treatment of diabetes, obesity, cancer, and polycystic ovarian syndrome (PCOS). Buckwheat proclaims differ from barely, wheat, and rye proclaims in characteristics, allowing the buckwheat grains to be used in gastrointestinal tract diseases such as celiac disease. The benefits have been linked to buckwheat nutrients with high antioxidant capacity. Germination can be sped up by increasing antioxidant capacity. Buckwheat must be germinated and functional products must be produced to produce a potentially functional buckwheat food of nutritional quality.

1.2. History of Buckwheat: -

Buckwheat is derived from the Anglo-Saxon words boc (beech) and whoet (wheat) due to its resemblance to the beech nut (Ahmed et al., 2014). It is classified as pseudo cereal because of its use and chemical composition resemblance to traditional cereals. Buckwheat (Fogopyrum esculentum Moench) was popular during the 17th-19th centuries and was later permitted in western countries due to competition with wheat because of its similarity in use and chemical composition. Buckwheat had a promising future on a global scale as a result of discoveries of its multi-food use with improved nutritional qualities and application in food industries as a functional food (Cowoy et al., 2009).

Buckwheat is primarily grown in Russia, China, Kazakhstan, and Ukraine, as illustrated in the figure (Gimenez-Bastida and Zielinski, 2015). It is widely cultivated in India, particularly in the high-altitude areas of the North East hilly region. Only two buckwheat species are grown for human consumption, and these two species are common buckwheat Fagopyrum esclentum grown at lower altitudes and Tartary buckwheat Fagopyrum tataricum grown at high altitudes due to its frost tolerance properties.

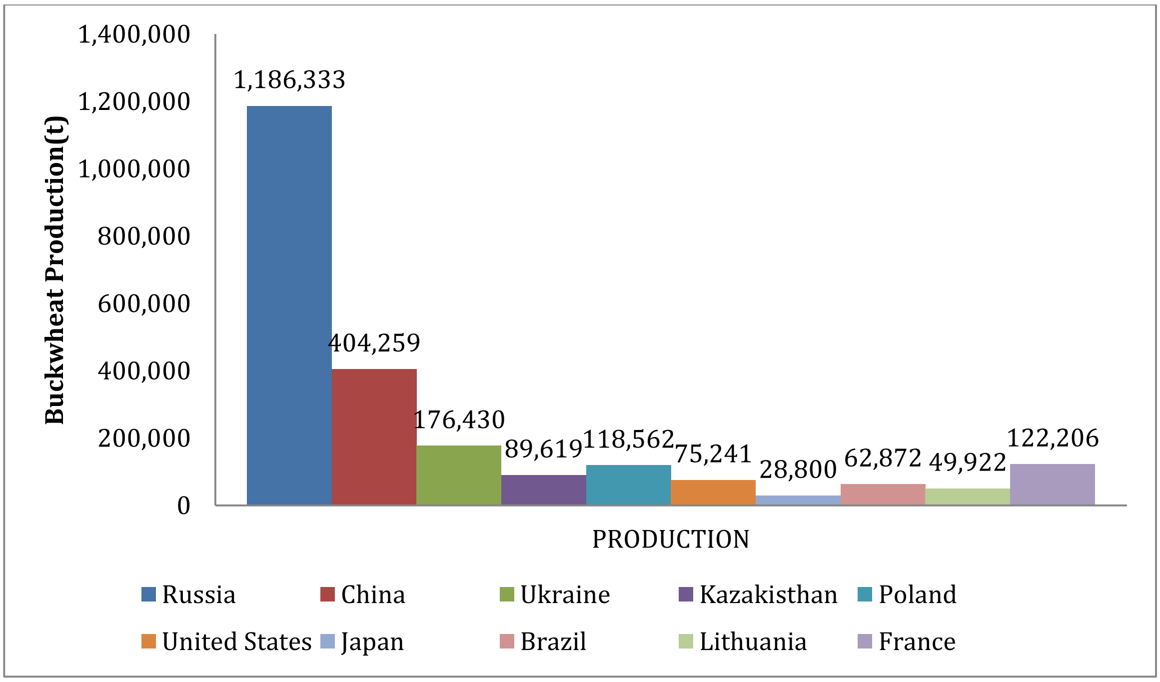

Fig1. World's Largest producer of Buckwheat

1.3. Celiac disease: -

Celiac disease (CD) is a genetically predisposed chronic T-cell-mediated enteropathy caused by dietary exposure to the storage proteins of wheat, rye, barley, and some varieties of oats (referred to as gluten in the field of CD) (Caio at al., 2019; Lindfors et al.,2019; Rej at al., 2020 and Lebwohl et al., 2021). Epidemiological data show that CD has a prevalence of about 1% in the general population of Western countries, Australia, and New Zealand, but it is also found in North Africa and large parts of Asia. CD is currently uncommon in Sub-Saharan Africans (Kelly et al., 2021). Precipitating gluten is composed of hundreds of different proteins that are roughly classified as alcohol-soluble prolamins and alcohol-insoluble glutelins (García et al., 2019). Cereal-specific names for gluten proteins include wheat gliadins (prolamins) and glutenins (glutelins), rye secalins, barley hordeins, and oat avenins. They are all structurally distinct by distinct repetitive amino acid sequences high in glutamine and proline, both of which are commonly thought to be CD triggering factors (Wieser et al., 2020). The high proline content of these proteins, in particular, makes them resistant to complete digestion, ensuring that long-chain immunogenic peptides reach the intestinal mucosa. Gluten-free diets complicate and limit the lives of CD patients. As a result, non-compliance with a GFD is a daily occurrence, delaying or preventing the patient's healing. Compliance with a GFD among CD patients has been found to range between 45 and 90 percent in recent studies (Muhammad et al., 2019). A strict GFD, on the other hand, usually results in immediate relief of clinical symptoms, whereas small bowel mucosal repair can take years (Fernández-Bañares et al.,2021). A strict GFD is now recommended in all cases of symptomatic CD, as well as for asymptomatic patients. Most affected individuals achieve long-term clinical remission when strictly adhered to a gluten-free diet (GFD), which must be followed indefinitely due to the genetic basis of this illness.

1.4. Nutritional composition of buckwheat: -

Buckwheat grains are high in protein, polysaccharides, dietary fiber, lipids, rutin, polyphenols, and micro and macro elements. The total component content is determined by a number of environmental factors.

The performance of white flour, dark flour, and whole grain from common buckwheat was evaluated. The results showed that white flours are mostly starch (79.2-87.2), whereas dark flours are high in proteins (37.1-38.7%), ash (5.49-5.99%), dairy fibre (15.2-22.0%), and fagopyritols (1420-2220 mg/100g) (Hatcher et al., 2008).

A minor component of common buckwheat foods is iminosugar D-Fagomine, which ranges from 1 to 25 mg/kg or mg/L. It is biosynthesized during sprouting and remains stable during bioling, frying, fractionation, and backing. D-Fagomine reduced blood glucose levels in a dose-dependent manner when combined with sucrose or starch, without stimulating insulin secretion (Amezqueta et al., 2013).

The physical and chemical properties of germinated and ungerminated buckwheat. Carbohydrate, total sugar, reducing sugar, and protein content increased from ungerminated floor to germinated 71.23 percent to 61.21 percent, 2.40 percent to 4.85 percent, 0.80 percent to 0.97 percent, 1.60 percent to 3.49 percent, and 12.4 percent to 13.1%, respectively, while starch content decreased (Devarajan et al.,2017).

Five common buckwheat seeds, each grown in a different location. By using high performance liquid chromatography and spectrophotometry, researchers discovered that the amino acid content of common buckwheat ranged from 1.79 to 12.65 percent (farina) and 5.74 to 7.89 percent (bran). Buckwheat had higher rutin (0.05 percent 1.35 percent) content than quercetin (Bai et al., 2015).

The antioxidant properties and polyphenol composition of buckwheat were found to be affected by backing and sprouting results showed that total phenol content and antioxidant activity were found to increase in the sprouting process while decreasing in the backing process (Alverez-Jubete et al., 2010).

1.5. Germination process

The germination of edible seeds is a well-known method for increasing the nutritional value of seeds (Gan et al., 2017; Rico et al., 2020; Kim et al., 2020 and Arouna et al., 2020). Germinated seeds of many plant species are becoming more popular due to their higher nutrient content and availability when compared to dry seeds, as well as the associated health benefits (Nelson et al., 2013; Penãs et al., 2020; Cid-Gallegos et al., 2020; Baenas et al., 2016 and Li et al., 2017). As a result of dynamic changes during germination, macronutrients like carbohydrates, proteins, and lipids can be broken down.

Furthermore, the levels of polyphenols, vitamins, and other bioactive compounds rapidly increase during germination as a result of de novo synthesis and transformation, enhancing the health-promoting properties of seeds (Wang et al., 2016; Hübner et al., 2013; Chaturvedi et al., 2011 and Marton et al., 2010). The moisture content of grain or seeds can be increased to 43 to 45 percent by soaking them in water (Muoz-Insa et al., 2013). Several studies on the effects of germination on the TPC, AA, and phenolic composition of buckwheat seeds have been conducted (Terpinc et al., 2016 and Beitane et al., 2018).

2. <u>Germination: -</u>

Germination is used to increase the nutrient availability of grains. Temperature, light, moisture, and time all have an effect on the germination process.

Buckwheat seeds with a moisture level of 14.08 percent were separated into multiple groups (each weighing approximately 200 g) based on germination time. Each group's seeds were washed and soaked in room temperature water for 1 hour. The soaked seeds were drained, laid out on wet gauze in plastic baskets (40 cm long, 30 cm wide, 10 cm high), and covered with another piece of moist gauze. Germination took place at 25 °C and 90% relative humidity for 0 (control), 12, 24, 36, 48, 60, and 72 hours in the dark in a germination cabinet. During germination, the seeds were sprinkled with water on a regular basis to maintain the gauze moist. For each germination time period, the germinated seeds were lyophilized in a Labconco freeze-drier (Kansas, USA) and crushed to a fine powder in an IKA-A11 grinder (Stauffen, Breisgau, Germany). The powder was kept at 20°C until it was time to conduct the analysis.

Cereals are high in protein, fat, and carbohydrates. Buckwheat has crude fat, carbohydrate, and protein contents of 1% to 5%, 65 percent to 75 percent, and 11 percent to 15 percent, respectively (Li and Zhang 2001; Ahmed and others 2013). Fat and carbohydrate were typically destroyed during germination to provide energy for seed expansion, resulting in decreased fat and carbohydrate content.

Buckwheat crude lipid content reduced from 30.68 1.00 mg/g in the control to 25.26 0.98 mg/g in buckwheat germinated for 72 hours (P 0.05). At 12 hours after germination, the decreasing sugar content showed no significant change. After 12 hours of germination, the content increased dramatically from 3.14 0.31 to 73.66 3.35 mg/g (P 0.05), about 20 times greater than the control. Because of the breakdown of carbohydrates caused by the activation of amylase during the germination phase, the concentration of reducing sugar increased considerably. As a result, buckwheat's taste and digestibility can be improved.

- **The inhibition phase: -**

It is a preliminary stage that can occur in inert, dead, or viable seeds. It is attributed to passive water uptake and absorption by seed colloids as well as into the crevices and interstices of the seed cover and tissues. Water uptake becomes an active process near the end of this phase and the beginning of the transition phase because it is temperature dependent, there is an increase in respiration rate, and in some cases, it becomes light sensitive (Rai, 2013).

- **The transition phase: -**

The transition to this lag phase is indistinguishable and can occur in dormant and non-viable seeds. It is also known as the pause phase because major metabolic events occur during this time in preparation for radicle emergence. Any condition that affects the hydration level attained during imbibition may slow or even prevent germination (Rai, 2013).

- **The growth phase: -**

It can only be found in living, non-dormant seeds. It interacts with radicle profusion and is thus associated with the establishment of cellular division and extension, as well as a rapid increase in water uptake rate. Non-president cotyledons do not reach the water growth phase, and their water content gradually decreases as they degrade (Rai, 2013).

- **Seeding establishment phase: -**

It is distinguished by a decrease in stored reserves, cotyledon disintegration, and an increase in photosynthesis. The duration of each of these phases is determined by inherent properties like hydrable substrate levels, seed coat permeability, seed size, oxygen uptake, and hydration conditions (Rai, 2013).

Further, Germination and sprouting process, the effect of time, temperature and light; their Physicochemical properties are explained below: -

2.1. Germination and sprouting: -

By sprouting the seeds in mineral-rich solutions, the germination process increased the mineral content of the buckwheat seeds. Sprouting is a simple and potentially effective method of obtaining a product with significantly increased antioxidative capacity, most likely derived from rapidly biosynthesized low molecular antioxidants and phytochemicals (Alvarez-Jubete et al., 2010). Antioxidant capacity can be increased during the germination process.

Buckwheat has previously been used to make sprouts and microgreens (Kou et al.,2013), which are widely regarded as a good source of bioactive compounds Obtaining groats is necessary for the production of ready-to-eat buckwheat sprouts, which necessitates the removal of the seed hull. The traditional thermal processing method for seeds is not an option if high germination rates are to be maintained. Buckwheat seeds are easily damaged during dehulling in comparison to other hulled cereals, making it difficult to obtain intact groats with high germination rates.

2.2. Effect of time and temperature on germination: -

Before germination, the hulled and dehulled seeds were soaked in water for 8 hours, with 15-minute breaks every hour. After soaking, the seeds were placed in a thin layer on moistened filter paper in glass Petri dishes. Germination occurred in a 20°C thermo stated growth chamber with moistened filter papers to maintain high humidity (relative humidity, >95 percent). The filter papers were kept moist by spritzing them with distilled water as needed. The sprouts were harvested for analysis 24 hours, 48 hours, 72 hours, and 96 hours after they began soaking.

2.3. Effect of light on germination: -

Buckwheat seeds were germinated at three different temperatures (20, 25, and 30 degrees Celsius) for 6, 12, 18, 30, and 36 hours, respectively, until rootlets appeared, with a constant soaking time of 12 hours. Physical characteristics include germinated, abnormally germinated, and non-germinated seeds, as well as radical size.

The presence of phenolic moities in the molecular structure of natural antioxidants frequently aids in the enhancement of their antioxidant activity. Plant antioxidant capacity is thought to be phenolic compounds such as tannis and flavonoids. These antioxydants have a wide range of biological activities, including anti-inflammatory, anti-atherosclerotic, and anti-carcinogenic effects (Hager A.S. et al., 2014).

2.4. Effect of germination in Physicochemical properties: -

Germination had an effect on the physicochemical properties and in vitro starch digestibility of Buckwheat flours, but not on their protein digestibility. Buckwheat had a protein digestibility content of 49.02 percent in vitro, while germinated buckwheat had a protein digestibility content of 49.41 percent. The protein's digestibility was increased by 0.79 percent. In comparison to the control, the processing effect of germination increased the mineral content of the GBW. The sodium and potassium content increased by 65.48 percent and 20.90 percent, respectively. Buckwheat sodium content increased from 3.1mg/100g to 5.13mg/100g. Buckwheat's potassium content has been increased from 427.6 to 517mg/100g.

The impact of phycochemical changes in germinated buckwheat (Fagopyrum esculentum Dur). With the action of germination, the starch content has decreased from 55.8 to 51.6 percent, while the total and reducing sugar content has increased from 2.40 to 4.85 percent and 0.80 to 0.97 percent, respectively (Devarajan et al., 2017).

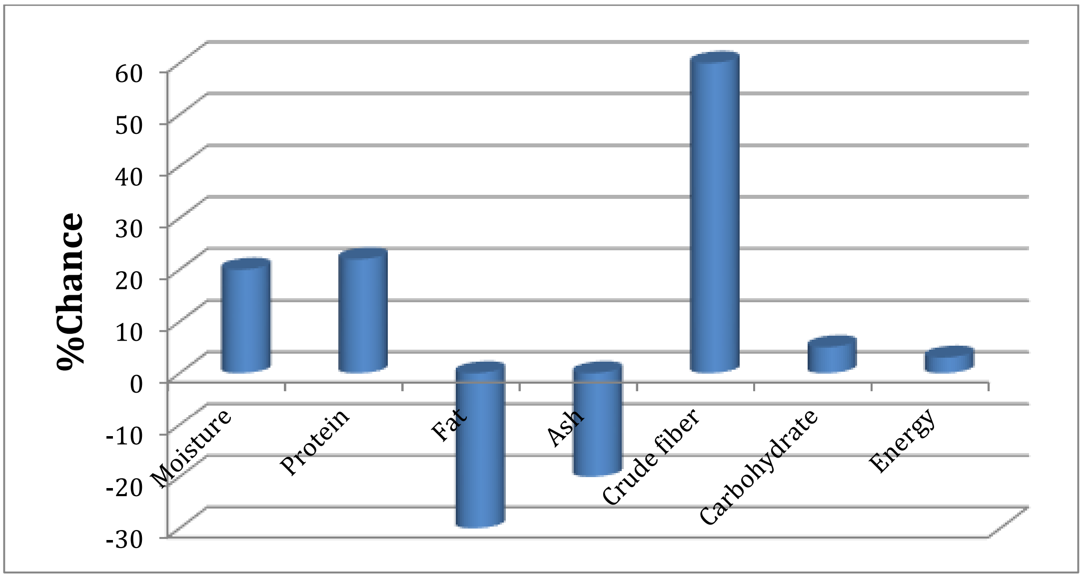

Fig3. Change in proximate composition of germinated buckwheat as a percentage

2.5. Physicochemical changes on different flours supplemented with germinated buckwheat: -

Physicochemical, also known as photo nutrients, are naturally occurring substances found in plants. These substances have been discovered to be beneficial to human health and to have antioxidant properties. Physicochemical have the potential to act as antioxidants and anti-inflammatory agents. It is essential for the detoxification of the body's harmful and deleterious chemicals (Parveena et al., 2014). The preliminary physicochemical screening for bioactive components in methanol extracts of selected germinated buckwheat flours, such as alkanoid, tennins, phenols, terpenoids, and flavanoids, was carried out.

2.6. Development of germinated buckwheat-based products: -

The influence of buckwheat on the physical properties, texture, colour, and sensory characteristics of extruded corn snacks. Buckwheat flour was added to the extruded corn in amounts ranging from 10% to 50% of the total amount of buckwheat flour added, which increased durability, decreased hardness, and increased tractability (Wojtowicz et al., 2013). The addition of 30% whole buckwheat flour to lavas bread increased the amount of ash, crude fiber, phytic acid, Fe, K, Mg, and P. With the addition of 40% whole buckwheat flour, the elasticity and chewiness were increased over the control (Yildiz Gand Bilgicl et al., 2012). Boiling buckwheat in water increased the content of phenols and total dietray fibre (Hes et al., 2014). When compared to the control, the additions of buckwheat flour (30%, 40%, and 50%) to ginger nut biscuits were rated higher in terms of sensory attributes, softness, and tracitibility. Protein, Zn, total polyphenols, antioxidant and chelating activity increased significantly (p0.05) in the substituted buckwheat biscuit. These improved biscuits have the potential to provide 18-22 percent of the estimated daily average of total polyphenol intake (Filipcev et al., 2011). The inclusion of additives such as sodium stearoyl-2 lactylate and transgultaminase, in addition to whole buckwheat flour, has improved the rheological and sensory properties of breads (Atalay et al., 2013).The addition of 30% buckwheat to wheat bread increased antioxidant activity by 2.36 and 3.64 folds, respectively, as measured by FRAP and DPPH. Buckwheat has higher antioxidant activity than other pseudo cereals like amaranth and quinoa (Chlopicka et al., 2012). In some studies, gluten-free cookies were made with rice and buckwheat flour in three different ratios. An increase in buckwheat content from 10% to 20% resulted in higher sensory scores for flavour, chewiness, and rupture (Torbica et al., 2012).

2.7. Buckwheat Allergy: -

Food allergies are a severe health issue, and their prevalence is rising around the world. "An unpleasant reaction to food in which immunologic processes have been shown," according to the definition of food allergy (Muraro *et al.* 2014). Since buckwheat (Fagopyrum esculentum Moench) is a highly nutritious pseudocereal that contains nutrients like proteins, dietary fibre, vitamins, and minerals (Gimenez-Bastida and Zielinski 2015).

Buckwheat allergy is uncommon; only 0.22 percent of Japanese schoolchildren have been documented to have developed allergic responses to common buckwheat. Despite this, common buckwheat is regarded to be a major food allergy since it can produce severe symptoms in some patients, such as anaphylaxis. Buckwheat allergies have been observed frequently in Asian nations such as Japan, Korea, and China (Lee et al. 2016) One cause for the high prevalence of buckwheat allergy in these nations could be that Asians eat common buckwheat instead of staple dishes like noodles, dumplings, or porridges. Because of the danger of allergic reactions, common buckwheat must be listed as an ingredient on food labels in Japan and Korea (Taylor and Baumert 2015). After a correct diagnosis, the idea of food allergy treatment is to avoid the causative foods. Excessive avoidance of foods suspected of being food allergies might result in stunted growth and nutrient deficiencies. As a result, an accurate diagnosis of food allergy is required in order to prevent the onset of allergic symptoms by removing the smallest number of causative items from the diet. In vitro allergen-specific IgE (sIgE) testing with patients' sera, skin prick tests (SPTs), and oral food challenge (OFC) tests, as well as medical interviews, are used in traditional allergy diagnosis (Muraro *et al.* 2014).

Because buckwheat allergy can cause serious symptoms, it's critical to pick the right methods/tests for a precise diagnosis. True allergic reactions to ordinary buckwheat are uncommon in buckwheat-specific IgE-positive children, according to (Yanagida et al. 2017); however, when administering the buckwheat OFC test, particular attention to probable anaphylactic reactions is required. In the diagnosis of buckwheat allergy, however, specific IgE antibody titres to buckwheat allergen components are helpful. According to (Tohgi et al. 2011), the Fag e 2-specific IgE test is beneficial for diagnosing buckwheat allergy accurately, and natural Fag e 2 isolated from salt-soluble buckwheat protein is more valuable than recombinant Fag e 2. Using recombinant allergen components generated in Escherichia coli, the relevance of the four types of buckwheat allergen components in the diagnosis of buckwheat allergy was examined, and the measurement of Fag e 3-specific IgE antibody was demonstrated to increase diagnostic accuracy (Maruyama et al. 2016). Furthermore, the Fag e 3-specific IgE test has been shown to predict OFC findings and OFC-induced anaphylaxis (Yanagida et al. 2018).

- **Food Allergens: -**

Several allergens have been identified using the allergy naming system (Pomes et al. 2018). Some of the detected allergens' nucleotide sequences, deduced amino acid sequences, steric structures, and binding sites with the IgE antibodies found in the patients' sera, known as IgE epitopes, have also been determined. A variety of allergy databases have this information. Each database is unique in its own right. For example, Allergy Online is a good allergen database for evaluating novel food proteins that could be cross-reactive (Goodman et al. 2016).

- **Buckwheat allergens in Food:-**

IgE-mediated allergies can affect dogs, cats, and horses in the same way that they can affect humans (Gershwin 2015). Pollen (Jensen-Jarolim et al. 2015) and food (Pali-Scholl et al. 2017) are the two most prevalent allergens in animals, although they've gotten little attention. The signs of allergic reactions in horses include eczema, urticaria, chronic coughing, and recurring airway blockage. Animals are currently being treated for allergy symptoms by injecting allergen extract into their skin.

2.8. Benefits of Buckwheat: -

Buckwheat is abundant in dietary fibre, which has a beneficial physiological effect on the gastrointestinal tract and influences the metabolism of other nutrients. Buckwheat seeds are gluten-free, so they're safe for celiacs. It influences how other nutrients are metabolized. Buckwheat groats are high in resistant starch, which may help prevent colon cancer. Rutin (quercetin-3-rutinosid) is a flavonol glycoside produced by higher plants to protect them from UV radiation and disease. It also lowers blood vessel permeability and has an antioedema effect, as well as lowering the risk of arteriosclerosis, among other things (Vojtíšková et al., 2015).

Buckwheat is growing in popularity as a result of its health benefits. Its seeds, which are gluten-free and high in protein, are especially enticing since they contain bioactive substances with health-promoting properties. Buckwheat and buckwheat-enriched foods have a variety of biological and pharmacological activities, including Celiac disease, anti-cancer, anti-inflammatory disease, and hypoglycemic activity. Neofermented sprouts (neoFBS) were developed as an antihypertensive food by lactic fermentation of buckwheat sprouts. In spontaneously hypertensive rats, lactic fermentation of buckwheat sprouts at 0.010mg/kg reduced both systolic and diastolic blood pressure (SHR). Oral administration of neo-FBS (10mg/kg) significantly reduced angiotensin I-converting enzyme (ACE) activity in the lung, kidney, heart, thoracic aorta, and liver of SHRs (Nakamura et al., 2013). Buckwheat extract has antifungal activity against Aspergillus flavus, Alternaria alternata, and Rhizopus oryzae. At 12.5mg/ml-1 dose, buckwheat extract suppressed Aspergillus flavus and Fusarium culmorum. There is no inhibitory effect on Rhizopus oryzae (Mosovska et al., 2012 and Birosova et al., 2012). The cell viability of the mammary cancer MCF-7 cell was determined by using the MTT assay and in vivo chick chorio allantoic membrane assay to detect the growth inhibitory effect of buckwheat flavonoid content (BWFEs). BWFEs have been shown to have angiogenesis inhabitory activity on the formation of micro-blood vessels. Both have been shown to have potent inhibitory effects on the growth of MCF-7 cancer cells (Zhou et al., 2011). Ribnonuclease from buckwheat inhibited the proliferation of Hep G2(IC50=79.2 uM) and MCF-7(IC50=63.8 uM) breast cancer cells. With an IC50 of 48uM, it inhibited HIV-1 reverse transcriptase activity effectively. (Yuan et al., 2015) Polyphenol- and antioxidant-rich buckwheat extracts It demonstrated the greatest growth inhibitory activity on HeLa cancer cells (up to 50%, extract concentration 100ug/ml) (Danihelova et al., 2013).

3. Conclusion

Buckwheat is a valuable food because it includes high-value proteins with a well-balanced amino acid profile. This will help with not only the prevention and treatment of many human ailments, but also the enhancement of traditional and local buckwheat cuisines, as well as the better utilisation of buckwheat by-products. The right application of buckwheat will also help food makers build new functional foods. Furthermore, germination boosts protein, crude fiber, minerals, total and reducing sugars while decreasing starch, total carbohydrates, and energy. Because germinated buckwheat is gluten-free, it can be used in low-calorie foods for diabetic, hypertensive, and celiac patients. Germination and fermentation have the potential to improve nutritional composition and bioavailability in traditional food designs. The scientists looked into how germination affected the microstructure and physicochemical properties of buckwheat starch. Despite the fact that patients who ate common buckwheat experienced severe allergic reactions, buckwheat allergy study started later than other food allergies. Nonetheless, recent breakthroughs in buckwheat allergy research are impressive.

Traditional food designs could benefit from improved nutritional composition and bioavailability through germination and fermentation. The researchers investigated how germination altered the microstructure and physicochemical properties of buckwheat starch. Buckwheat has a lot of potential as a food ingredient, particularly in the functional and clinical food industries. More research into the effects of buckwheat and its derivatives on humans should be carried out in general.

4. Reference:-

1. Schoenlechner, R. 2016. Properties of Pseudocereals, selected speciality cereal and legums for food processing with special attention to glutin free products/Verarbeitungeigenschaften von Pseudogetreide ausgewahlten Spezialitatengetriade and Leguminosen mit speziellem Fokuss auf glutenfreie Produkte . Die Bodenkultur : Journal of Land Management, Food and Environment 67(4):239-248
2. Cossins D. 2014. Next generation: nanoparticles augment plant functions. The incorporation of synthetic nanoparticles into plants can enhance photosynthesis and transform leaves into biochemical sensors. Sci, News Opinion March.
3. Gálová, Z.; Rajnincová, D.; Ch ˇnapek, M.; Balážová, Ž.; Špaleková, A.; Vivodík, M.; Hricová, A. Characteristics of cereals, pseudocereals and legumes for their coeliac active polypeptides. J. Microbiol. Biotechnol. Food Sci. 2019, 9, 390–395. [CrossRef]
4. Bai, C.Z.; Feng, M.L.; Hao, X.L.; Zhong, Q.M.; Tong, L.G.; Wang, Z.H. Rutin, quercetin, and free amino acid analysis in buckwheat (Fagopyrum) seeds from different locations. Genet. Mol. Res. 2015, 14, 19040–19048. [CrossRef] [PubMed]
5. Rauf, A.; Imran, M.; Patel, S.; Muzaffar, R.; Bawazeer, S.S. Rutin: Exploitation of the flavonol for health and homeostasis. Biomed. Pharmacother. 2017, 96, 1559–1561. [CrossRef] [PubMed]
6. Lam, K.Y.; Ling, A.P.K.; Koh, R.Y.; Wong, Y.P.; Say, Y.H. A review on medicinal properties of orientin. Adv. Pharmacol. Sci. 2016, 2016, 1–9. [CrossRef]

7. Peng, Y.; Gan, R.; Li, H.; Yang, M.; McClements, D.J.; Gao, R.; Sun, Q. Absorption, metabolism, and bioactivity of vitexin: Recent advances in understanding the efficacy of an important nutraceutical. Crit. Rev. Food Sci. Nutr. 2021, 61, 1049–1064. [CrossRef]

8. He, M.; Min, J.-W.; Kong, W.-L.; He, X.-H.; Li, J.-X.; Peng, B.-W. A review on the pharmacological effects of vitexin and isovitexin. Fitoterapia 2016. [CrossRef]

9. Zhu, F. Food Chem. 203: 231-245. https://doi.org/10.1016/j.foodchem.2016.02.050.

10. Li, S. Q. and Zhang, Q. H. Crit. Rev. Food Sc. 41:451-464. http://dx.doi.org/10.1080/20014091091887

11. Kreft, M. Nutr. Res. Rev. 29: 30-39. https://doi.org/10.1017/S0954422415000190.

12. J lp ‡qh}-Bastida, J. A. and Sci. 68: 181-186. https://doi.org/10.1016/j.jcs.2015.07.005

13. Ahmed, A., Khalid, N., Ahmad, A., Abbasi, N.A., Latif, M.S.Z., Randhawa, M.A., 2014. Phytochemicals and biofunctional properties of buckwheat: a review. J. Agr. Sci. 152, 349-369.

14. Zielińska, D., Turemko, M., Kwiatkowski, J., Zieliński, H., 2012. Evaluation of flavonoid contents and antioxidant capacity of the aerial parts of common and tartary buckwheat plants. Molecules 17, 9668-9682.

15. Zielinski, H., Michalska, A., Amigo-Benavent, M., del Castillo, M.D., Piskula, M.K., 2009. Changes in protein quality and antioxidant properties of buckwheat seeds and groats induced by roasting. J. Agr. Food Chem. 57, 4771-4776.

16. Li, F.H., Ya, Y, Yang, X.L., Tao, S.Y., Ming, J., 2013. Phenolic Profiles and antioxidant activity of buckwheat (Fagopyrum esculentum Möench and Fagopyrum tartaricum L. Gaerth) hulls, brans and flours. J. Integr. Agr. 12, 1684-1693

17. Zhou, X., Wang, Q., Yang, Y., Tang, W and Li, Z. 2012 Anti Infection effects of buckwheat flavnoids effects (BWFES) from germinated sprouts. Journal of medicinal plants Research. 6(1):24-29

18. Ahmed, A., Khalid N., Ahmad A., Abbasi N.A., Latif, M.S.Z and Randhawa, M.A. 2014. Photochemical and biofunctional properties of buckwheat : a review. Journal of Agriculture Science.152:349-369.

19. Cawoy, V., Ledent, J.F., Kinet , J.A and Jacquemart. A.L. 2009. Floral Biology of Common buckwheat (Fagopyrum esculentum Monech). The European Journal of Plant Science and Biotechnology. 3(1):1-9.

20. Gimenez-Bistada, J.A and Zielinski, H. 2015. Buckwheat as a functional food and its effect on health. Journal of Agricultural and Food Chemistry 63:7896-7913.

21. Caio, G.; Volta, U.; Sapone, A.; Leffler, D.A.; De Giorgio, R.; Catassi, C.; Fasano, A. Celiac disease: A comprehensive current review. BMC Med. 2019, 17, 142. [CrossRef]

22. Lindfors, K.; Ciacci, C.; Kurppa, K.; Lundin, K.E.; Makharia, G.K.; Mearin, M.L.; Murray, J.A.; Verdu, E.F.; Kaukinen, K. Coeliac disease. Nat. Rev. Dis. Primers 2019, 5, 3. [CrossRef]

23. Rej, A.; Aziz, I.; Sanders, D.S. Coeliac disease and noncoeliac wheat or gluten sensitivity. J. Intern. Med. 2020, 288, 537–549. [CrossRef]

24. Lebwohl, B.; Rubio-Tapia, A. Epidemiology, presentation, and diagnosis of celiac disease. Gastroenterology 2021, 160, 63–75. [CrossRef]

25. Kelly, C.P.; Dennis, M. Patient Education: Celiac Disease in Adults (Beyond the Basics). Available online: https://www.uptodate. com/contents/celiac-disease-in-adults-beyond-the-basics (accessed on 23 May 2021).

26. García-Molina, M.D.; Giménez, M.J.; Sánchez-León, S.; Barro, F. Gluten free wheat: Are we there? Nutrients 2019, 11, 487. [CrossRef]

27. Wieser, H.; Koehler, P.; Scherf, K.A. The Two Faces of Wheat. Front Nutr. 2020, 7, 517313. [CrossRef]

28. Muhammad, H.; Reeves, S.; Jeanes, Y.M. Identifying and improving adherence to the gluten-free diet in people with coeliac disease. Proc. Nutr. Soc. 2019, 78, 418–425. [CrossRef]

29. Mahadev, S.; Murray, J.A.; Wu, T.T.; Chandan, V.S.; Torbenson, M.S.; Kelly, C.P.; Maki, M.; Green, P.H.; Adelman, D.; Lebwohl, B. Factors associated with villus atrophy in symptomatic coeliac disease patients on a gluten-free diet. Aliment. Pharmacol. Ther. 2017, 45, 1084–1093. [CrossRef] [PubMed]

30. Itzlinger, A.; Branchi, F.; Elli, L.; Schumann, M. Gluten-free diet in celiac disease–forever and for all? Nutrients 2018, 10, 1796. [CrossRef]

31. Fernández-Bañares, F.; Beltrán, B.; Salas, A.; Comino, I.; Ballester-Clau, R.; Ferrer, C.; Molina-Infante, J.; Rosinach, M.; Modolell, I.; Rodríguez-Moranta, F.; et al. Persistent villous atrophy in de novo adult patients with celiac disease and strict control of gluten-free diet adherence: A multicenter prospective study (CADER Study). Am. J. Gastroenterol. 2021, 116, 1036–1043. [CrossRef] [PubMed]

32. Hatcher, D.W. , You, S., Dexte, J.E., Campbell, C and Izydorczyk, M.S. 2008. Evaluation of the performance of flours from crossand self pollination Canadian common Buckwheat (Fagopyrum escumlentum Moench) cultivars in soba noodles. *Journal of Food Chemistry.* 107:722-731.

33. Amezqueta, S., Galan, E., Vila-Fernandez, I., Purmarola, S., Carrascal, M., Abian, J and Torres, J.L. 2013. The presence of D-Fagomine in the human diet from buckwheat-based foodstuffs. Food Chemistry. 136(3-4):1316-1321

34. Devrajan, N., Prakash, P and Jindhal, N. 2017. Some physico-chemical properties of germinated and ungerminated buckwheat (FagopyrumEsculentumDur). International Journal of Science, Environment and Technology. 6(2): 1491-1501.

35. Alvarez-Jubete, L., Wijngaar, H., Arendt, E.K and Gallagher, E.2010. Polyphenol composition and in vitro antioxidant activity of amaranth, quinoa buckwheat and wheat as affected by sprouting and baking. Journalof Food Chemistry. 119:770-778

36. Gan, R.Y.; Lui, W.Y.; Wu, K.; Chan, C.L.; Dai, S.H.; Sui, Z.Q.; Corke, H. Bioactive compounds and bioactivities of germinated edible seeds and sprouts: An updated review. Trends Food Sci. Technol. 2017, 59, 1–14. [CrossRef]

37. Rico, D.; Peñas, E.; García, M.d.C.; Martínez-Villaluenga, C.; Rai, D.K.; Birsan, R.I.; Frias, J.; Martín-Diana, A.B. Sprouted barley flour as a nutritious and functional ingredient. Foods 2020, 9, 296. [CrossRef] [PubMed]

38. . Kim, H.; Kim, O.-W.; Ahn, J.-H.; Kim, B.-M.; Oh, J.; Kim, H.-J. Metabolomic analysis of germinated brown rice at different germination stages. Foods 2020, 9, 1130. [CrossRef] [PubMed]

39. Arouna, N.; Gabriele, M.; Pucci, L. The impact of germination on sorghum nutraceutical properties. Foods 2020, 9, 1218. [CrossRef] [PubMed]

40. Nelson, K.; Stojanovska, L.; Vasiljevic, T.; Mathai, M. Germinated grains: A superior whole grain functional food? Can. J. Physiol. Pharmacol. 2013, 91, 429–441. [CrossRef]

41. Penãs, E.; Martínez-Villaluenga, C. Advances in production, properties and applications of sprouted seeds. Foods 2020, 9, 9. [CrossRef]

42. Cid-Gallegos, M.S.; Sánchez-Chino, X.M.; Juárez Chairez, M.F.; Álvarez González, I.; Madrigal-Bujaidar, E.; Jiménez-Martínez, C. Anticarcinogenic activity of phenolic compounds from sprouted legumes. Food Rev. Int. 2020, 1–16. [CrossRef]

43. Baenas, N.; Piegholdt, S.; Schloesser, A.; Moreno, D.; García-Viguera, C.; Rimbach, G.; Wagner, A. Metabolic activity of radishsprout-derived isothiocyanates in Drosophila melanogaster. Int. J. Mol. Sci. 2016, 17, 251. [CrossRef]

44. Li, R.; Song, D.; Vriesekoop, F.; Cheng, L.; Yuan, Q.; Liang, H. Glucoraphenin, sulforaphene, and antiproliferative capacity of radish sprouts in germinating and thermal processes. Eur. Food Res. Technol. 2017, 243, 547–554. [CrossRef]

45. Wang, H.; Wang, J.; Guo, X.; Brennan, C.S.; Li, T.; Fu, X.; Chen, G.; Liu, R.H. Effect of germination on lignan biosynthesis, and antioxidant and antiproliferative activities in flaxseed (Linum usitatissimum L.). Food Chem. 2016, 205, 170–177. [CrossRef]

46. Hübner, F.; Arendt, E.K. Germination of cereal grains as a way to improve the nutritional value: A review. Crit. Rev. Food Sci. Nutr. 2013, 53, 853–861. [CrossRef] [PubMed]

47. Chaturvedi, N.; Sharma, P.; Shukla, K.; Singh, R.; Yadav, S. Cereals nutraceuticals, health ennoblement and diseases obviation: A comprehensive review. J. Appl. Pharm. Sci. 2011, 1, 6–12.

48. Marton, M.; Mandoki, Z.; Caspo, J.; Caspo-Kiss, Z.; Marton, M.; Mándoki, Z.; Marton, M.; Mandoki, Z.; Caspo, J.; Caspo-Kiss, Z. The role of sprouts in human nutrition. A review. Aliment. Hung. Univ. Transylvania 2010, 3, 81–117.

49. Muñoz-Insa, A.; Selciano, H.; Zarnkow, M.; Becker, T.; Gastl, M. Malting process optimization of spelt (Triticum spelta L.) for the brewing process. LWT Food Sci. Technol. 2013. [CrossRef]

50. Terpinc, P.; Cigi´c, B.; Polak, T.; Hribar, J.; Požrl, T. LC-MS analysis of phenolic compounds and antioxidant activity of buckwheat at different stages of malting. Food Chem. 2016, 210, 9–17. [CrossRef] [PubMed]

51. Beitane, I.; Krumina-Zemture, G.; Sabovics, M. Effect of germination and extrusion on the phenolic content and antioxidant activity of raw buckwheat (Fagopyrum esculentum Moench). Agron. Res. 2018, 16, 1331–1340. [CrossRef]

52. Hager A.S.,Makinen, O.E and Arendt , E.K. 2014. Amylolytic activities and starch reservemobilozation during the germination of Chenopodium quinoa. European Food Research and Technology. 239:621-627

53. Parveena, R.J and Estherlydia, D. 2014. Comparative study of physicochemical screening and antioxidant capacity of vinegar made from peels and fruit of pineapple (Ananas comous L.) *International Journal of Pharmaceutical and Biosciences*. 5:394-403

54. Wojtowicz,A., Kolasa, A and Moscik ,L. 2013. Influence of buckwheat addition on physical properties, texture and sensory characteristics of extruded corn snacks. Polish Journal of food and Nutrition Science. 63(4):239-244.

55. Yildiz Gand Bilgicl, N. 2012. Effect of whole buckwheat flour on physical, Chemical, and Sensory properties of Flat Bread , Lavas, Journal of Food Science. 30 (6):534-540.

56. Hes, M., Dziedzic,K., Gorecka, D., Drozdzynska, A and Gujska, E. 2014. Effect of boiling in water of Barley and Buckwheat Groats on the antioxidant Properties and Dietary Fiber composition. Plants food human nutrition. 69:276-282.

57. Filipcev, B., Simurina, O., Sakac, M., Sadej, I.,Jovanov, P., Mladenka, M and Solarov, M.B. 2012. Feasibility of use of buckwheat as an ingredient in ginger nut biscuit formulation. Journal of Food Chemistry. 125:164-170.

58. Atalay, M.H., Bilgiclin, N., Elgun, A., Demir, M.K 2013. Effect of buckwheat (fagopyrumecsulentummoench) milling products, transglutaminase and sodium stearoyl-2- lactylate on bread properties. Journal of food processing and preservation. 37(1):1-9

59. Chlopicka, J., Pasko, P.,Gorinstein, S., Jedryas, A and Zagrodzki. P. 2012 Total Phenolic and total flavonoid, antioxidant activity and sensory evaluation of Pseudocereal breads. Journal of LWT-Food Science and Technology. 46:548-555

60. Torbica, A., Hadnadev, M and Hadnadev , T.D. 2012. Rice and buckwheat flour characterization and its relation to cookie quality. Food Research International 48(1):277-283.

61. Kou, L.; Luo, Y.; Yang, T.; Xiao, Z.; Turner, E.R.; Lester, G.E.; Wang, Q.; Camp, M.J. Postharvest biology, quality and shelf life of buckwheat microgreens. LWT Food Sci. Technol. 2013, 51, 73–78. [CrossRef]

62. Rai, S. (2013). Assessment of biochemical changes of some underutilized cereal crops (Hordeum vulgare, Fagopyrum esculentum and Fagopyrum tartaricum) during germination. B. Tech. Dissertation. Tribhuvan University, Nepal.

63. Muraro A., Werfel T., Hoffmann-Sommergruber K., Roberts G., Beyer K., Bindslev-Jensen C., Cardona V., Dubois A., duToit G., Eigenmann P. et al. (2014) EAACI food allergy and anaphylaxis guidelines: diagnosis and management of food allergy. *Allergy* 69: 1008–1025. [PubMed] [Google Scholar]

64. Gimenez-Bastida J.A. and Zielinski H. (2015) Buckwheat as a functional food and its effects on health. *J. Agric. Food Chem.* 63: 7896–7913. [PubMed] [Google Scholar]

65. Lee S.Y., Ahn K., Kim J., Jang G.C., Min T.K., Yang H.J., Pyun B.Y., Kwon J.W., Sohn M.H., Kim K.W. et al. (2016) A multicenter retrospective case study of anaphylaxis triggers by age in Korean children. *Allergy Asthma Immunol. Res.* 8: 535–540. [PMC free article] [PubMed] [Google Scholar]

66. Taylor S.L. and Baumert J.L. (2015) Worldwide food allergy labeling and detection of allergens in processed foods. *Chem. Immunol. Allergy* 101: 227–234. [PubMed] [Google Scholar]

67. Yanagida N., Sato S., Takahashi K., Nagakura K.I., Ogura K., Asaumi T. and Ebisawa M. (2017) Reactions of buckwheat-hypersensitive patients during oral food challenge are rare, but often anaphylactic. *Int. Arch. Allergy Immunol.* 172: 116–122. [PMC free article] [PubMed] [Google Scholar]

68. Tohgi K., Kohno K., Takahashi H., Matsuo H., Nakayama S. and Morita E. (2011) Usability of Fag e 2 ImmunoCAP in the diagnosis of buckwheat allergy. *Arch. Dermatol. Res.* 303: 635–642. [PubMed] [Google Scholar]

69. Yanagida N., Sato S., Maruyama N., Takahashi K., Nagakura K.I., Ogura K., Asaumi T. and Ebisawa M. (2018) Specific IgE for Fag e 3 predicts oral buckwheat food challenge test results and anaphylaxis: A pilot study. *Int. Arch. Allergy Immunol.* 176: 8–14. [PMC free article] [PubMed] [Google Scholar]

70. Pomes A., Davies J.M., Gadermaier G., Hilger C., Holzhauser T., Lidholm J., Lopata A.L., Mueller G.A., Nandy A., Radauer C. et al. (2018) WHO/IUIS Allergen Nomenclature: Providing a common language. *Mol. Immunol.* 100: 3–13. [PMC free article] [PubMed] [Google Scholar]

71. Goodman R.E., Ebisawa M., Ferreira F., Sampson H.A., van Ree R., Vieths S., Baumert J.L., Bohle B., Lalithambika S., Wise J. et al. (2016) AllergenOnline: A peer-reviewed, curated allergen database to assess novel food proteins for potential cross-reactivity. *Mol. Nutr. Food Res.* 60: 1183–1198. [PubMed] [Google Scholar]

72. Gershwin L.J. (2015) Comparative immunology of allergic responses. *Annu. Rev. Anim. Biosci.* 3: 327–346. [PubMed] [Google Scholar]

73. Jensen-Jarolim E., Einhorn L., Herrmann I., Thalhammer J.G. and Panakova L. (2015) Pollen allergies in humans and their dogs, cats and horses: differences and similarities. *Clin. Transl. Allergy* 5: 15. [PMC free article] [PubMed] [Google Scholar]

74. Pali-Scholl I., De Lucia M., Jackson H., Janda J., Mueller R.S. and Jensen-Jarolim E. (2017) Comparing immediate-type food allergy in humans and companion animals-revealing unmet needs. *Allergy* 72: 1643–1656. [PubMed] [Google Scholar]

75. Vojtíšková, P., Kmentová, K., Kubáň, V. and Kráčmar, S. (2015). Chemical composition of buckwheat plant (Fagopyrum esculentum) and selected buckwheat products. J. Microbiol. Biotechnol. Food Sci. (1), 1011-1019.

76. Nakamura,K., Naramoto, K and Koyama, M. 2013. Blood pressure lowering effect of fermented buckwheat sprouts in spontaneously hypertensive rats. Journal of functional food. 5(1):406-415

77. Mosovska, S and Birosova, L.2012. Antimycotic and antifungal activities of amaranth and buckwheat extracts. Asian Journal of Plant Sciences. 11(3):160.

78. Zhou, X., Wang, Q., Yang, Y., Tang, W and Li, Z. 2012 Anti Infection effects of buckwheat flavnoids effects (BWFES) from germinated sprouts. Journal of medicinal plants Research. 6(1):24-29

79. Yuan, S., Yan, J., Ye, X., Wu, Z and Ng, T. 2015 Isolation of ribonuclease with antiproliferative and HIV-1 reverse transcriptase inhibitory activities from Japanese large brown buckwheat seeds. Applied Biochemistry and Biotechnology. 175(5):2456-2467.

80. Danihelova, M., Jantova, S and Sturdi, E. 2013 Cytotoxic and antioxidant activitiey of Buckwheat hull extracts. The Journal of Microbiology, Biotechnology and Food Sciences. 1314