

POSSIBLE REVOLUTIONARY SUBSTITUTE TO WHEAT: A REVIEW ON NUTRIENT RICH AND HEALTHY DIET DEVELOPMENT BY PSEUDO CEREALS

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Abstract: People of modern age are very health and diet conscious. Various plants have been used as source of nutrition by human beings. Cereals have been one of them. But due to health problems (Celiac disease, WDEIA and baker's asthma) and allergens present in cereals such as by wheat gluten, people are looking for alternative diet. Population is increasing day by day and to provide them a healthy nutritious diet free of allergens is uphill task. Researchers are looking to exploit various alternative plant sources. Recent findings suggest that pseudo cereals are best alternative to wheat. Buckwheat, Amaranth and Quinoa (pseudo cereals) were underutilized crops. Now, people are gaining more interest in Pseudo cereals for their excellent nutrition profile and gluten free products. They contain essential amino acids, carbohydrates, dietary fibers, minerals, vitamins and other important biological compounds in their nutrition profile. Important biological compounds present in pseudo cereals like phenolics impart beneficial health impacts on human beings. Keeping in view the extra ordinary benefits of consuming pseudo cereals, they must be grown at commercial level. It will make sure availability of diet full of nutrition and free from health risks.

Keywords: pseudo cereal, celiac disease, WDEIA, protein, buckwheat, amaranth, quinoa

Introduction

Wheat is one of the most consumed cereal as well as staple food of many countries including Pakistan, India and Bangladesh (De Punder & Pruijboom, 2013). It also makes up considerable part of human diet. Recent research findings placed wheat among top six food allergens of the world as it is associated with several dietary intolerances in people. Wheat grain contain gluten that can trigger many allergic reactions and disorders in human. Due to the large demand of gluten-free and low FOODMAP products, the food industry is shifting towards other cereal grains i.e. pseudo cereals. Pseudo cereals are ill-defined group of plant species including buckwheat, amaranth and quinoa. These are not true cereals but due to resemblance of many of their properties with cereals i.e. starchy endosperm, high protein contents and a balanced profile of amino acids are grouped

into cereals (Alvarez-Jubete et al., 2010). Pseudo cereals also contain high amount of lysine that is limiting factor and negatively correlated with grain yield in true cereals. According to taxonomic classification, pseudo cereals are dicotyledons, that oppose to all true cereals which are monocotyledons (Alvarez-Jubete et al., 2010). As for as botanical description both buckwheat and quinoa attain a height like wheat while amaranth is typically twice the height of wheat. Pseudo cereals have tap root system rather than fibrous as in true cereals (Anonymous). As compared to true cereals, the cultivation and utilization of pseudo cereal is very low and due to lack of research on the nutritive profile of pseudo cereals. They are neglected globally. But from last few decades, due to the emergence of different kind of cereal allergens (intestinal inflammation, baker asthma and WDEIA) people have become diet conscious and the demand

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of non-allergic diet has been increasing day by day. Now a day's pseudo cereals are widely recognized by food scientist and food producer due to their nutritional value as they contain high quality protein, large amount of starch and high quantities of micro nutrients such as minerals and vitamins (Mir et al., 2018). Moreover, they are gluten free which make them suitable for those people who are suffering from various gluten intolerance (Léder, 2009). Intensive study based on the nutritional profile of pseudo cereals reveal that it could play significant role in the human diet for those who have allergies from traditional cereals. The present study provides the detail properties based on nutritional profile of three best-known pseudo cereals including buck wheat (*Fagopyrum esculentum*), grain amaranth (*Amaranthus L*) and quinoa (*Chenopodium quinoa*) that are best alternatives to wheat for dietary intolerance.

Buck wheat

Buck wheat is not an ancient crop as for as wheat. It is originated from china at least 1500 years ago. In Japan it is considered as one of the most important grain crops after rice. It contains 15 species distributed all over the world i.e. in UK, France, Germany, Hungary, Poland and Russia (Kreft, 2016). It has been significantly cultivated in China, Japan, Nepal and Russia. The wild *Fagopyrum cymosum* is considered one of the ancestors of buckwheat (Li and Zhang, 2010). The *Fagopyrum esculentum* also known as sweet buckwheat is an excellent source of protein in term of amino acid composition. In past, buck wheat was known as “food of poor” because it contains health preserving components (rutin and flavonoids). Buck wheat is herbaceous, erect growing annual plant belonging to Poligonaceae family having basic chromosome number $n=8$. It is an early maturing and a short duration crop (2-3 months) mainly grown in higher altitude of Pakistan. It likes to grow in warm climates and low humidity (Cawoy et al., 2008). It can germinate on almost all types of soils except sandy soil. The kernel of buckwheat is known as acene having a single seed tightly packed inside the pericarp (Belton & Taylor, 2002). The acene is triangle, angles being acute and is in the form of pyramid. The color of pericarp varies from gray to brown or black, very hard and thick having polished and shiny surface. A large embryo is present at the center of kernel which separates the endosperm in two parts. The kernel is surrounded by hard layer known as Testa that is light yellowish to green in color. The seeds are brown in color and have irregular shape. The seeds of buckwheat are smaller than soya bean (Campbell, 1997). Buckwheat grain is used in various forms such as for human food consumption, for animal feed, as a green manuring crop and for medicinal purposes. It is an excellent source of protein in term of amino acid composition

especially lysine. It has the potential for the prevention of diabetes and reduction of cholesterol.

Amaranthus

Amaranthus is one of the oldest food crops originated from South America and Mexico about 6700 BC. It is now being considered important grain crop in the different parts of the world i.e. Pakistan, China, Nepal and India. *Amaranthus* consist of approximately 70 species most of them used as grain, as a nutritive vegetable and few of them are used as ornamental purposes (Osuna-Castro & Paredes-López, 2003). *Amaranthus* (*Amaranthus L*) is annual, herbaceous, erect to spread growing plant belonging to amaranthaceae family having basic chromosome no $n=16,17$. *Amaranthus* is drought tolerant and it likes to grow in warm and dry climate. It has wide adaptation throughout the temperate zone. It can grow in all types of soil including marginal soil, but gives better yield in fertile, well drained and deeper soil. The color of flower, leave and stem is varying species to species but, maroon color is most common in all three plant parts. Grain *Amaranthus* has long, thick, tough stem just like sunflower. The leaves are pediculate on alternative position of slender stem. The flower is green to purplish in color present in the form of cluster on the tip of elongated branches. The seed are usually shiny black in color. There are three main grain producing species of grain A. Hypochondriacs, *A. caudatus* and *A. cruentus*. One school of thought told that these species are of new world origin but, other school of thought said that these species are cultivated in south Asia from prehistoric period (Das, 2016). Leaf *Amaranthus* is used as a steamed and fresh vegetable. it also contain high amount of protein (13-18%) high in lysine an amino acid that is low in other grain cereals (Belton & Taylor, 2002). It is also a rich source of calcium, potassium, vitamin A and C (Valcárcel-Yamani & Lannes, 2012).

Quinoa

The historical and archeological evidences indicate that quinoa originated from the Lake Titicaca in Peru and Bolivia. And has been important food crop of Andean region of South America (Bhargava & Srivastava, 2013). It is considered as one of the oldest food crops of the world. Existing historical evidence also indicate that the domestication of quinoa has occurred between 3000 to 5000 BC years. During its domestication quinoa underwent many morphological changes i.e. more compact inflorescence, increase in the size of seed and stem and more amount of pigments in the plant. Quinoa is dicotyledonous, annual, herbaceous erect growing plant having chromosome no $n=18$ belonging to Chenopodiaceae family. The height of plant varies from 100-300 cm depending upon the genotype and climatic condition. The leaves are generally lobbed,

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present on alternate position on the stem. The color of stem varies from light to dark green and sometimes purples in color. The flowers are sessile and present in the form of cluster. The seed of quinoa is known as achene. Seed is found in a variety of color white to yellowish and sometimes purple to brownish in color. It has taproot system usually branched and a number of rootlets are present on them. It can grow on hot and dry climate. It is among those few grain crops that can grow in extreme environmental condition. It can withstand temperature ranging from -4 to 38°C. It grows well both in acidic as well as basic soil. It can grow on marginal soil lacking nutrients without loss in their productivity. Its seed contains 12-18% protein which is better than other cereals. Quinoa is used for cooking and baking as many of their gluten free products is used worldwide by those peoples who have allergy from other cereals (Bhargava & Srivastava, 2013).

Properties of pseudo cereals

The Pseudo cereals (Amaranth, buck wheat and quinoa) are starch rich dicotyledons plants unlike cereals that are monocotyledonous. Amaranth has admirable nourishing value; hence there is need to elaborate the physical, chemical and nutritive properties to consume it in our daily diet. Amaranth encompasses some important proteins i.e.; albumin & globulin and some essential amino acids like tryptophan, Sulphur containing amino acids and lysine etc. The peptide fraction in amaranth has potential to treat hyper-tension (high blood pressure) problems due to AC (angiotensin converting) enzyme activity (Alvarez-Jubete et al., 2010). Amaranth is treasured pseudo cereal to maintain immune system, liver function, glucose level and cholesterol level. Protein concentration ration in amaranth is high than other crops like rice and corn and contain several essential amino acids. Amaranth is a pseudo cereal that is a good option to consume, moreover amaranth leaf contains high amount of protein, besides omega-6, omega-3, Oleic, Palmitic and Stearic acids, also other nutraceutical constituents as squalene (Venskutonis & Kraujalis, 2013). Amaranth seed contains several relevant nutrients in a balanced proportion for human diet, therefore its starch has been used to prepare healthy food. Squalene is an important nutraceutical constituent than omega-3 and omega-6. Several nutrients that are required for human diet are present in the seeds of amaranth and its starch is used to prepare healthy food (Mendonça et al., 2009).

Quinoa is another pseudo cereal with laudable nutritional value and tremendous health benefits because of presence of minerals, fatty acids, large number of polyphenols, fibers & proteins (Valcárcel-Yamani & Lannes, 2012). In comparison to cereals like rice and wheat, quinoa has more protein content ranging from 13.81% to 21.9%. Quinoa has ability to eradicate harmful toxic compounds from body and maintain cells bioactivity. High fiber content of this plant is serendipitous to lower blood cholesterol level and avert heart problems. Antioxidant power in quinoa is very beneficial for skin. However, dark colored grains of this pseudo cereal have more antioxidant qualities than the bright colored grain (Li & Zhang, 2001). It has influential ability of antibacterial, anti-inflammatory and anti-fungal activities due to saponin chemical compound. High concentrations of calcium, magnesium and potassium are also attractive qualities of this plant. Hence, regular intake of quinoa in daily diet could overcome malnutrition problems.

Buck wheat is also gluten free pseudo cereal like amaranth and quinoa. As compared to true cereals, it has high contents of important amino acids methionine, cytosine and lysine but starch amount is almost the same as in cereals. Buck wheat contains high concentration of amylose content. Hence, it is more resilient to gelatinization. Buck wheat also has medicinal value and adventitious properties for soil conservation and animal feed (Zondag, 2003). There are variety of nutrients in the seeds of buckwheat. The main components are polyphenols, lipids, dietary fibers, micronutrients (minerals and vitamins), rutin and proteins (Ikeda, 2002). It is also containing *myo*-inositol, fagopyritols, *d-chiro*-inositol, flavonoids, and phytosterols. The grains of buckwheat are very nutritive. The buckwheat proteins possess globulins, prolamins, albumins and glutelin. It does not contain gluten (Bobkov, 2016). The hulls of buckwheat are the source of natural antioxidant (Hromádková and Ebringerová, 2003). Buckwheat is also a source of protein and protein content in buckwheat varies from 8.51% to 18.87%. in addition to it buckwheat contains more protein as compare to maize, rice and millet (Bobkov, 2016).

Keeping in view the properties of pseudo cereals, there is need to make efforts for consumer acceptance and incorporation of these plants specially in developing countries to compete with malnutrition issues.

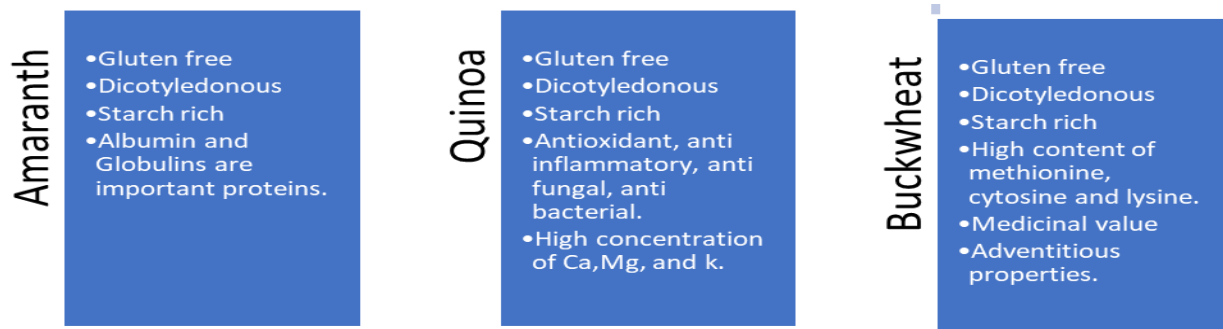


Figure 1. Summary of important Pseudo cereals properties

Wheat related allergens and their health disorder

Wheat is an important cereal crop worldwide and has significant nutritive properties. Some people are seriously affected to wheat allergens. Globulin, albumin, gluten and gliadin are imperative wheat proteins and allergens (harmful/allergenic substance) leading to allergenic reaction in some people when immunoglobulin antibodies act on these proteins. Some of the wheat related disease and allergies are described below:

Celiac disease

The dietary intolerance disease also known as “gluten sensitive enteropathy” in which sensitive person’s immune system becomes impotent for gluten protein (protein present in barley and wheat). Immune system disorder results in malabsorption of certain nutrients and damage to intestinal lining which leads towards serious complications of anemia, diarrhea, bloating and fatigue. In children, it affects the growth and development adversely. Celiac disease shows its symptoms when genes interact after the consumption of gluten containing food. Other environmental factors and bacteria in the gut can also contribute to the severity of disease (Parzanese et al., 2017). This disease can also bruise enamel of teeth that leads to sensitivity in teeth. There may be risk factors of some other disease as a result of celiac disease i.e. Addison’s disease, down and turner syndromes, type 1 diabetics, autoimmune thyroid disease and rheumatoid arthritis. Untreated celiac disease for a long time can lead to serious complications in body like neurological disorders, cancer, lactose intolerance, infertility and loss of calcium from the bones (Mir et al., 2018). Hence, celiac disorder patients must use gluten free food to maintain their body immune system.

• **WDEIA**

It is the abbreviation of “wheat dependent exercise-induced anaphylaxis” in which person experiences anaphylaxis (Hypersensitivity attack) during exercise after the intake of wheat. Due to this food allergic hypersensitivity, person can ensue gastrointestinal problems, respiratory disturbance, cardiovascular disorders and urticaria (Rongfei et al., 2014). There is no accurate mechanism known yet for this disease. However, exercise and augmenting co-factors can induce changes in blood flow, osmolality and gastrointestinal permeability. Gluten and gliadin proteins present in wheat are considered as subunits for allergens of this disease. Gluten containing cosmetics leads to inducement of skin allergic reaction and sensitization. Hence, gluten free food (pseudo cereals or other food) and strict avoidance of wheat before exercise are recommended for patients of WDEIA (Scherf et al., 2016).

Bakers asthma:

As the name indicates, disease mostly induces problems for bakers and the effects of disease can cause severe obstruction in respiration. Wheat flour is primarily the cause of this disease that impels allergic reaction to person sensitive to baker’s asthma. Alpha-amylase is used in bakery products has wide range of allergic reaction in baker’s asthma sensitive patients.

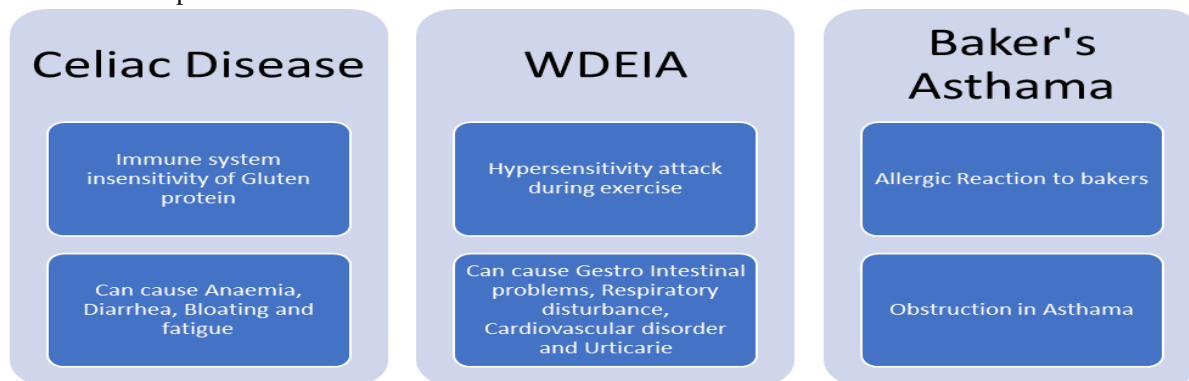


Figure 2. Wheat related allergens and their health disorders

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Gluten free products

In recent past few years, there has been massive talk about gluten free products. Emphasis has been laid out on gluten free diet for CD patients for their nutritional therapy (Thompson et al., 2005). Pseudo cereals are found to be natural source of gluten free diet and they also possess well-balanced nutritional profile (Pagano, 2006). A number of food products

containing pseudo cereals as a composite with wheat are already available in market (Alvarez-Jubete, Arendt, & Gallagher, 2009). But due to presence of wheat only few of those products are gluten free. However, a variety of products of pseudo cereals are being produced now through various processes to make gluten free products.

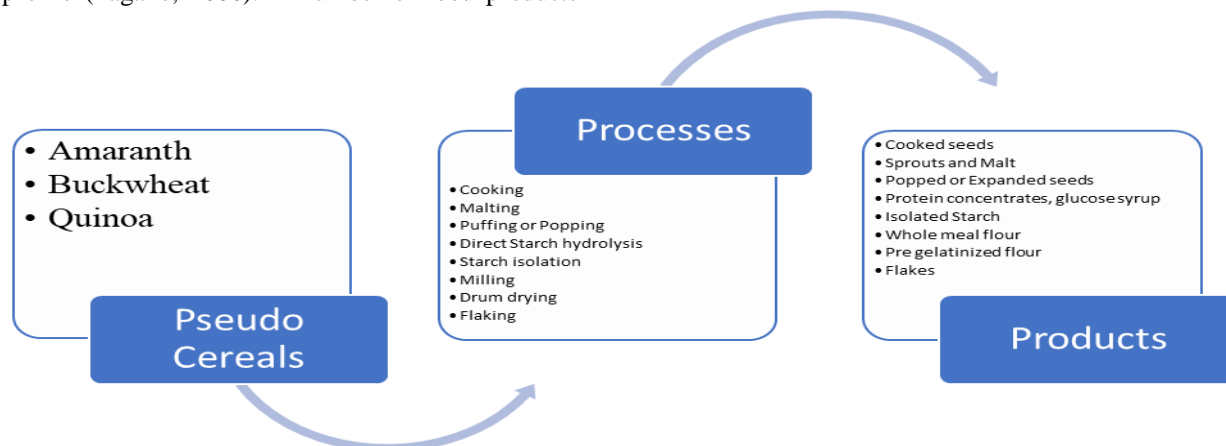


Figure 3. Pseudo cereals products and the processes through which they are produced. Edited and adapted from (Mir et al., 2018).

Nutrient profile of pseudo cereals

Pseudo cereals have emerged out as an important crops and supplement of food instead of wheat because of their nutrition profile. They contain excellent profile for the desired nutrients in the diet. Amino acid composition of the protein is considered very important in regard of requirements in the diet. Those amino acids that cannot be synthesized by the human body known to be essential amino acids are found in excess in pseudo cereals (Mir et al., 2018). The total protein fraction in the pseudo cereals is considered to be higher than the protein profile of other common cereal and found to be highest in the amaranth (Alvarez-Jubete et al., 2010). Common cereals contain prolamin as their storage protein which is also perceived as toxic proteins leading to celiac disease. However, the pseudo cereals contain globulins and albumins instead of prolamin (Alvarez-Jubete et al., 2010; Drzewiecki et al., 2003; Gorinstein et al., 2002).

Human body harvests energy from carbohydrates through the breakdown of starches. It shows that presence of carbohydrates in our diet is of prime importance. Amylose and amylopectin fractions are considered important. Researchers have been working on cereals to improve the amylose content. At present no other cereal offer amylose content greater as does the quinoa. It contains 11% amylose and total dry matter content ranges from 67-74% (Mir et al., 2018). Fiber in diet is also considered important because of its requirement to maintain good health free of diseases. Pseudo cereals

especially buckwheat can provide excess of dietary fiber. Fiber content in the Buckwheat seed is found to be greater than the true cereals (Alvarez-Jubete et al., 2009).

Pseudo cereals broaden their nutrition profile by the presence of important vitamins and minerals. They contain vitamin B and vitamin E in good quantity. Minerals that are present in little amount in gluten free products such as Ca, Mg and Fe are present in adequate amount in pseudo cereals. Intake of diet containing these minerals can make a person free from diseases like celiac disease, osteoporosis, osteopenia etc. (Alvarez-Jubete et al., 2009). Some other biological important compounds like phenolic compound, phagopyritols, saponins, plant sterols and flavonoids provides beneficial health impact on human body.

Nutritional benefits of amaranth

Protein source

The intake of high-quality protein is necessary which can be obtained from amaranth seed or add in our diet as it provides essential amino acids which play an important role in developing new cells and tissues, which is necessary to perform proper neuronal functions, regeneration of muscles and boost immune system (Guzmán-Maldonado & Paredes-Lopez, 1998).

Reduce inflammation

Amaranth use is helpful to cure many diseases as inflammation because the presence hydrolyzes proteins avoid inflammation by activation of peptides of bioactive molecules that cause reduction in the

expression of many pro inflammatory markers so the intake of pseudo cereals helps in the reduction of inflammation. In this context, it is recommended to include Amaranth seeds in the diet in order to reduce inflammation and may help to prevent chronic

diseases derived from inflammation. By using amaranth seeds in routine diet may help to reduce inflammation and prevent chronic diseases that are produced from it (Alvarez-Jubete et al., 2010).

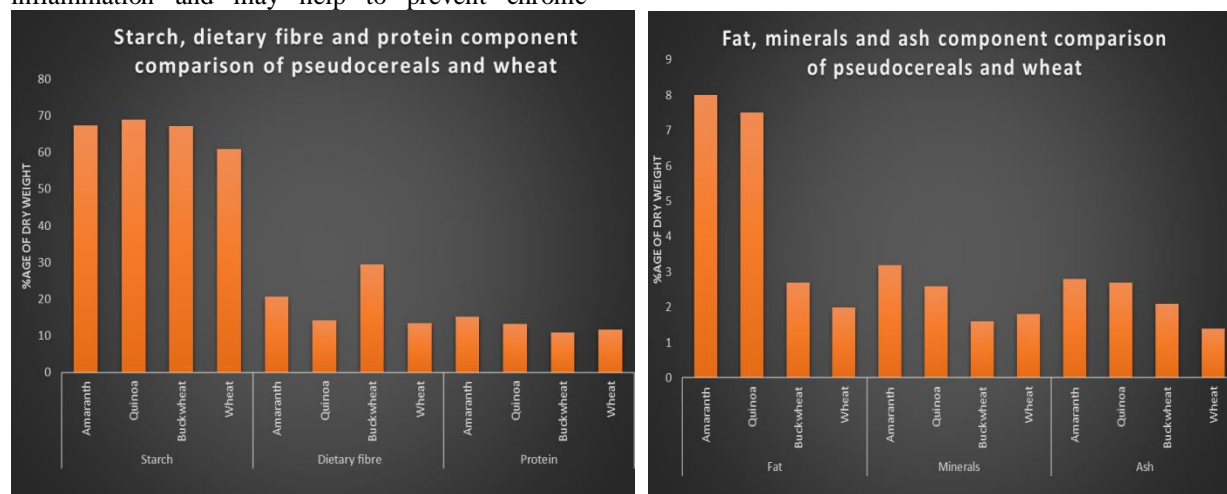


Figure 4 & 5. Important nutritional components comparison of wheat and pseudo cereals, Edited and adapted from (Saturni, Ferretti, & Bacchetti, 2010)

Healthy bones

Calcium is essential to make bones healthy and provide mineralization. Amaranth has large quantity of calcium in seeds; therefore, it is counted as an important food product and help to cure the disease osteoporosis which has valuable role in the development. Calcium is necessary to support healthier bones so amaranth products are helpful to improve the proper intake of calcium (Valcárcel-Yamani & Lannes, 2012).

Lowers cholesterol

Its oil is proved to help in reduction of cholesterol which is not beneficial for humans and it is verified on various model animals by Berger, and it also effective in cholesterol metabolism (Mendonça et al., 2009).

Fights diabetes

It is beneficial when used in diet as it contains a large amount of manganese which metabolize levels of sugar in an organism and also helps in gluconeogenesis because it contains adequate amount of manganese and it is also helpful to prevent diabetes. It is proved to be helpful in immunity and also maintains glucose level in blood beside that there are many beneficial effects of sufficient manganese like to cure skin diseases, lowering the cholesterol level to maintain good bone health in glucose and in renal health. If starch of amaranth is taken by patient of Diabetic mellitus type II shown good absorption and its oil consumption is beneficial in to cure cardiac diseases (Venskutonis & Kraujalis, 2013).

Helps pregnant women

Doctors recommends folic acids to pregnant women’s to prevent spina bifid and cardiac disorders.

In the grains of Amaranth containing 88.0 mg of folate that has many benefits of nutrition as it contains folate in it which helps in the development of new cells and bioactive peptides could help to decrease the presence of organism defects.

Prevents constipation

It is helpful to treat constipation as it contains starch that bind with water that helps to maintain a good proportion of insoluble fibers than soluble fibres.

Antioxidants against oxidative stress

During metabolic processes free radicals are produced that has toxic effects if stored in unusual way that may cause oxidative stress that lead to lipids, nucleic acids and proteins that play an important role in the induction of disease symptoms to protect the cell, antioxidant limitation is necessary that has negative effect of oxidative stress and which has the capacity of antioxidants which may effected due to consumption of nutrient rich foods.it proves to be helpful in protection of aerobic organisms against oxidative stress as it’s a good source of antioxidants like phenolic acids, tocopherols and ascorbic acids (Valcárcel-Yamani & Lannes, 2012).

Good nutrition and health

Amaranth is helpful in many biological processes acting as an antioxidant, anti-thrombotic, anti-proliferation, anti-hyper sensitive and many more. It contains vegetable proteins with more nutritional values. it has a capacity to resist against various changes in climate. It has a low cost and also a fast-growing rate under unfavorable environmental conditions so we can count it in a super crop as it supposes (Venskutonis & Kraujalis, 2013).

Nutritional benefits of buckwheat

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Anti-hypertension

The unique composition of buckwheat contributes to several health benefits like anti-hypertension, anticancer, reduce blood sugar, improved heart health, protect against cancer. Moreover, Tartary buckwheat is the most cultivated form of buckwheat that contain bioactive components involved in treating various disorders. Buckwheat is engaged in controlling hypertension as the ACE (angiotensin-1 converting enzyme) involved in contracting blood vessels that may lead to hypertension. so buckwheat control hypertension by inhibiting the ACE activity.

Improve heart health

Buckwheat helps to lower the bad cholesterol, reduce inflammation, or low LDL levels that are necessary to maintain good health and cardiovascular health. Rutin present in it provides the primary function to support cardiovascular health, which is counts as an excellent antioxidant that helps to maintain blood pressure.

Protects against cancer

Buckwheat contains phenolic and antioxidants, which proves to be very beneficial against various types of cancer. Free radicals are very harmful to human's health cause damage to cells. Still, Flavonoids like oligomers are present in buckwheat, which may protect our cells from the free harmful radicals that may sometimes lead to dangerous inflammations.

Anti-Fatigue

Tartary buckwheat, which is the most cultivated form of buckwheat, shows the antifatigue properties. The free radicals lead to the fatigue are removed by the buckwheat, so it acts as an antifatigue agent mostly in male Kunming mice subjected to swimming.

Antidiabetic activity

Nowadays, several incurable chronic diseases are present, and one of them is diabetic Mellitus caused due to the deficiency of insulin secretion that may lead to an increase in the glucose level in blood. Consumption of MW lasagna shows significant effects on health-conscious volunteers. Buckwheat glycemic index is shallow as compared to other pseudo cereals means the absorption of carbohydrates in the blood is deficient and maintains steady flow energy in our body and helps in the management of diabetes.

Antioxidant activity

Antioxidant properties of buckwheat make it a suitable candidate to appreciate its functional and nutritional goods. Buckwheat shows high interventions for human studies. Some investigations are definite about it. Plasma sample shows increasing antioxidant properties when consuming buckwheat honey inn water or after consuming buckwheat enriched wheat bread.

Neurodegenerative diseases

Some neuro degenerated diseases retard mental functions as in the case of Alzheimer's disease in which induction of pro-inflammatory mediators is involved that contribute greatly towards impairment and dysfunction in the services of cognitive. Reactive oxidant species contribute significantly towards neuropathological condition. But the consumption of buckwheat shows neuroprotective effects in animals. Buckwheat consumption also boosts memory. Several studies show that the use of buckwheat Tartary improves memory and reduces lipid peroxidation and NO levels. However, it proves helpful the compounds responsible for this are still not known.

Starch resistance

Resistant starch defined as the type of carbohydrate after the incubation of two hours, not hydrolyzed at room temperature. A significant component of buckwheat is starch. Compared to white wheat, buckwheat bread has low postprandial blood glucose. Buckwheat is rich in retrograded starch. it also helps in the reduction of insulin levels in the blood. Experimental studies show that the toasted buckwheat has a higher concentration of RS level in it.

Buckwheat rutin and human diet

Buckwheat is one of the most important candidates which has bio functional properties because it has very important functional substance like flavonoids, phytosterols, fagopyrins, dietary fibers, vitamins, minerals etc. Rutin of buckwheat considerably great effects on human health as it helps in the reduction and prevention of many cardiovascular diseases. Rutin helps in the reduction of blood pressure which prevent large number of heart disease as the prevent fragility of capillaries. The poly phenol extracts of buckwheat lower the for arteriosclerosis helps in the treatment of patient with renal diseases. Rutin present in buckwheat also prevent the lesion due to gastric.

Nutritional benefits of quinoa**Rich in protein**

Quinoa is rich in protein almost it contains the same composition as in cereals around 13-15% and nutritional value of any food is estimated by its protein composition, important part of macromolecules involved in cellular functions. It has higher quantity of all essential amino acids which must be provided through diet as body cannot synthesize them. Protein efficiency can be enhanced by removing saponin through pre washing in quinoa (Barakat et al., 2017).

Chief source of carbohydrates

Amylopectin a complex molecule is a chief source of carbohydrates in quinoa than amylose like in other cereal grains. So, pseudo cereals are excellent diet choice even for diabetic patients (Satheesh & Fanta, 2018).

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Beneficial in curing autoimmune diseases

Quinoa has higher lipids content than other cereal grains like wheat and maize. They have suitable amount of essential fatty acids such as α -linolenic acid that is quite beneficial in curing many deteriorating ailments like osteoporosis, Alzheimer's, inflammatory and all autoimmune diseases (Kaur, 2006).

Rich source of polyphenolic flavonoids

Seeds of quinoa are rich source of polyphenolic flavonoids. Kaempferol is the main polyphenolic antioxidant present in it. It contains high quantity of vitamin E and an excellent source of B-complex group of vitamins like folate, thiamin, riboflavin, pyridoxine and pantothenic acid. These vitamins enhance immune system, anti-oxidation activity of cell by fighting against free radicals and protect cell from damage and injury (Alvarez-Jubete et al., 2010).

Conclusion

As the pseudo cereals have excellent nutrition profile in their products and they are free from allergens. It should now be used by people for their healthy diet. This will add to their existing dietary diversity in order to fill their nutrition needs in best possible manner. Recent research has let the researcher know the value of pseudo cereals. This knowledge should be made public. So that people may also know the worth of pseudo cereal diet as it provides essential amino acids, dietary fibers and other important biological compounds. More research work and efforts are needed to make pseudo cereals outshine as an important crop at commercial level. On other hand where wheat that is important cereal used worldwide is imparting health risk to some people. For them to replace the wheat in their diet, pseudo cereals are the best alternative given their nutrition profile and health risk free products. In next decade most people will look for health risk free diet that can also complete their nutrition demands. In this regard, pseudo cereals have bright future ahead as a commercial crop.

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