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Nutritional composition, health benefits and its phytochemical screening of mother of all grains quinoa (*Chenopodium Quinoa*)

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Abstract
Quinoa (*Chenopodium quinoa* Willd*)* was referred to the Incas as "the mother of all grains" and was believed to be sacred. It has been consumed in the form of food as well as medicine for the last 5000 years. Quinoa, a pseudo cereal, is recognized as one of the world's healthiest foods due to its high nutritional value along with its potential to cater various health benefits. Being a good source of complete *protein* (contains all the nine essential amino acids), unsaturated fatty acids, minerals, vitamins, fibre and antioxidants, it is considered as "superfood". Quinoa also helps to reduce the risk of various diseases like cardiovascular diseases, type-2 diabetes, some cancer, high blood pressure and obesity. The main aim of this work was to evaluate the Phytochemicals, Minerals and Vitamins content in quinoa seeds. In addition to assess the willpower of the Nutritional composition and its potential Health benefits.

Keywords: quinoa, nutritional content, health benefits, phytochemicals

Introduction

In present world, food security and great well-being has become one of the major significant issues in all countries particularly the developing countries. Due to ongoing change in our ecosystem and different climatic changes, lot of pressure is on reliable food production to provide good health to the world's growing population. In present era, about 1 in 8 individuals already suffers from chronic under nourishment. Along with that, diabetes, obesity and other metabolic disorders have also reached global epidemic proportions [1, 2]. It is a well-known fact that food which we intake provides nutrients to our body, that they need to function properly. If proper food is not taken our metabolic process suffers and health declines which leads to the onset of various diseases. Grain based food gives 30-70 percent energy the human requirements consistently. This emphasize the scope of using cereal grains or cereal grains like more other functional foods for utilization. Quinoa is one such food gaining popularity nowadays.


Scientific Classification of *Chenopodium quinoa*
Class: Dicotyledonae
Order: Caryophyllales
Family: Amaranthaceae
Genus: *Chenopodium*
Species: *C. quinoa*

Quinoa is a species of the goosefoot genus. It's a yield developed principally for its eatable seeds. Being high in different significant supplements, it is considered as world's quite possibly the most well-known wellbeing food sources. The Food and Agricultural Organization of the United Nations (FAO) officially declared the year 2013 as "The International Year of The Quinoa". FAO declared quinoa as a food with high nutritive value, vast biodiversity and as a food which can have an important role to play in the achievement of food security worldwide [3]. Being highly nutritious, quinoa also imparts various health benefits which makes it an excellent example of 'functional food' as suggested [4].

The Nutritional and functional properties of quinoa not only provide various nutrients to our body but also contributes to various health benefits. It is a great food not only for vegetarians but also for people who want to cut down the intake of cholesterol, sugars and add more health beneficial nutrients like protein, good fat, certain important vitamins, minerals and fibre. The protein quality of quinoa is even comparable to the high-quality protein from the dairy products, called casein [5-7]. Since it contains all the nine fundamental amino acids, it is considered as a total protein rich food When most of the grains lack adequate amount of amino acids lysine and isoleucine then quinoa has significantly greater amount of both lysine and isoleucine (especially lysine), which allows quinoa to serve as complete protein source. A higher intake of vegetables is associated with a reduced risk of type 2 diabetes, due to their high unsaturated fat content, which is associated with lower inflammation [8, 9].

Quinoa is considered as a valuable source of certain health supportive fats. About 28 % of quinoa's fatty acids is oleic acid, a monounsaturated fat, which is good for heart and about 5 % comes as alpha-linolenic acid, the omega-3 fatty acid, associated with decreased risk of inflammatory diseases. The diet of people lacks in many nutrients,

particularly some very important minerals like magnesium, potassium, zinc and iron. The absence of iron is perhaps the most well-known sustenance inadequacies. It keeps our red blood cells healthy and carries oxygen from one to another cell and also increases brain functions along with another important functions in our body. Quinoa is a good source of calcium, iron, potassium, magnesium and zinc when compared to daily mineral recommendations. It can be said that on an average quinoa is a better source of minerals than most grains. Quinoa is also a good source of B vitamins riboflavin and folic acid. Riboflavin improves energy metabolism within brain and muscle cells, and folic acid plays crucial role for proper brain function and is important for good mental and emotional health. It is very important vitamin for pregnant women as it lowers the risk of neutral birth defects [10].

Quinoa also contains significant amount of vitamin E, which acts as antioxidant. Another very important benefit of quinoa is that it is high in fibre content. It contains almost twice as much fibre as most other grains. Fibre not only helps relieve constipation, it also helps prevent heart disease by reducing high blood pressure and diabetes. Fibre also reduces cholesterol and glucose levels along with lowering the risk of developing hemorrhoid and helps lose weight. Glycemic index is a measure of how quickly foods raise blood sugar levels. Utilizing a size of 0-100, glycemic scores are isolated into three gatherings low, moderate and high. Any food with a score of 55 or less falls in the low glycemic range, 56-69 in moderate and 70 or above in high glycemic category. Low glycemic index food improves glucose and lipid levels and weight control. They also reduce insulin resistance and risk of cardiovascular diseases, diabetes and some cancers [11]. Quinoa has glycemic index score of 53, based on a 150g serving, or a little less than 1 cup of cooked quinoa as it contains 32g of total carbohydrate, including 1 g of sugar.

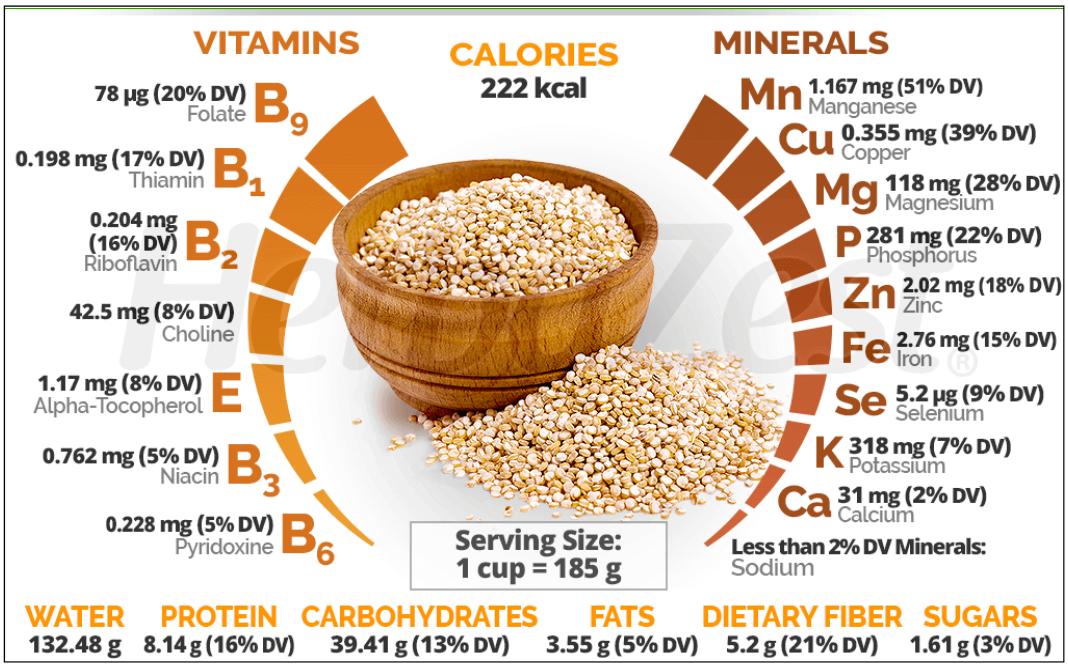

Fig 1

Quinoa seeds (Chenopodium quinoa) contain critical measures of phytochemicals including: flavonoids, phenolic acids, squalene, phytosterol, saponins, fat-solvent nutrients, unsaturated fats, minor components and different mixtures which can impact biochemical boundaries. The present was intended to evaluate the effect of Phyto chemical investigation in Quinoa seeds.

Materials and methods

Preparation of the extract for Phytochemical Screening

Quinoa seeds (*Chenopodium quinoa)* was obtained from the online supermarket. The dry seeds were powdered and packaged in moisture proof containers and stored in a freezer. They were conditioned at room temperature before use.

Phytochemical screening

Major Phytoconstituents in the test plant extracts such as alkaloids, saponins, tannin, steroids, flavonoids, glycosides, terpenoids and anthraquinone were tested according to standard methods (Md Tariqul Islam *et al.*, 2016). [12]

Test for alkaloids

A total of 0.5 g quinoa seed powder was mixed with methanol containing 1% HCl, and then boiled and filtered. A total of 2 ml of 10% ammonia and 5 ml of chloroform was added to 5 ml of the filtrates and shaken gently to extract the alkaloidal base. The chloroform layer was extracted with 2 ml of acetic acid, and Mayer's reagent was added. The formation of cream (with Mayer's reagent) or presence of turbidity was regarded as the presence of alkaloids.

Test for flavonoids

To 1 ml of test solution, 5 drops of 5% Sodium hydroxide was added. An increase in the intensity of yellow coloured solution is seen which become colourless on the addition of few drops of 2M Hydrochloric acid. A yellow coloration was investigated for the presence of flavonoids

Test for saponins

Two grams of quinoa seed powder was boiled in 20 ml of water in a water bath and filtered. A total of 5 ml of the

filtrates were mixed with 3 ml distilled water in a test tube and shaken vigorously. Frothing, which persisted on warming, it was considered preliminary evidence for the presence of saponins. A few drops of olive oil were added to the extract and shaken vigorously. The appearance of formation of soluble emulsion in the extracts was indicative the presence of saponins.

Test for tannins

Water extracts of quinoa seed powder were treated with 15% ferric chloride test solution. A blue colour in the mixtures signified the presence of hydrolyzable tannin. For confirmation, 0.5 g of the extracts were added to 10 ml of freshly prepared potassium hydroxide (KOH) in a beaker and shaken to dissolve. A dirty precipitate was indicative the presence of tannin.

Test for Glycosides

Five ml extract were hydrolysed separately with 5 ml each of conc. HCl and boiled for few hours on a water bath and hydrolysates were subjected to the following test. A small amount of alcoholic extract of samples was dissolved in 1ml water and then aqueous 10% sodium hydroxide was added. Formation of a yellow colour indicated the presence of glycosides.

Test for cardiac glycosides (Keller-Killani test)

A total of 2 ml of extract was treated with 2 ml glacial acetic acid containing one drop of ferric chloride solution. This was underlaid with 1 ml of concentrated sulfuric acid. The formation of a brown ring of the interface was indicative of the presence of a deoxy sugar of cardenolides.

Test for Acidic Compounds

A quantity of (0.1g) of quinoa seed powder was placed in a clear dry test tube and sufficient water was added. These were warmed differently in a hot water bath and cooled. A piece of water wet litmus paper was dipped into the different filtrates and observed for color change. Acidic compounds turned blue litmus paper into red.

Test for Proteins (Ninhydrin Test)

Few drops of Ninhydrin reagent and 1 ml of extract were added. Appearance of blue color indicates the presence of proteins.

Test for Amino acids (Xanthoproetic test)

To 1 ml of concentrated nitric acid was added to 3 ml of the test solution, shaked and heated for 1 minute and cooled. Yellow colour (acid media) was changed to orange colour (alkaline media) by adding 1 ml of 40 % NaOH solution.

Test for steroids

To 2 ml of acetic anhydride was added to 0.5 g of test solution, of sample with 2 ml of H_2SO_4. The colour change was observed from violet to blue or green that indicated the presence of steroids.

Test for carbohydrates

1 gm of sample was added with 1 ml of Fehling's reagent A and B kept in boiling water bath for 5 minutes. A brick red precipitate indicates the presence of carbohydrates.

Test for Starch

5ml of test solution was treated with starch. The appearance of a purplish blue color indicates the presence of starch.

Test for cholesterol

2 ml of the extract and 2 ml of chloroform was added in a dry test tube. 10 drops of acetic anhydride and 2 to 3 drops of concentrated H_2SO_4 was added along the sides of the test tubes. A red rose colour was changed into blue green colour.

Test for Phytosterols (Liebermann-Burchards test)

The extract was (2mg) dissolved in 2ml of acetic anhydride and heated to boiling, cooled and 1 ml of concentrated sulfuric acid was added along the sides of the test tube. A brown ring was formed at the junction and the upper layer turned to dark green color indicates the presence of phytosterols.

Test for Quinones

A small amount of extract was treated with concentrated HCl and observed for the formation of yellow precipitate.

Determination of Vitamins and minerals in Quinoa Seed

Minerals (Magnesium, Zinc, Manganese, Vanadium and Chromium). Vitamins (Vitamin -D and Vitamin -E) were analysed with an atomic absorption spectrophotometer (AAS; Shimadzu Instruments, Inc., SpectrAA-220. The results were interrupted.

Results and Discussion

Phytochemical Analysis

Qualitative Phytochemical screening of *Chenopodium quinoa* revealed that the presence of alkaloids, flavonoids, saponins, acidic compounds, protein, carbohydrates, phytosterols and quinones. The presence and absence of different Phytoconstituents were summarized in the Table 1.

Table 1: Phytochemical analysis.

S.No	Phytochemical Tests	Specific Test	Hot Water	Cold Water
1	Alkaloids	Wangner's Test	+	+
2	Flavonoids	Alkaline Reagent Test	+	+
3	Saponins	Foam Test	+	+
4	Tanins	Ferric Chloride Test	-	-
5	Glycosides	General test	-	-
6	Cardiac glycosides	Keller - Killiani Test	-	-
7	Acidic Compounds	-	5.0	5.0
8	Protein	-	+	+
9	Aminoacids	-	-	-
10	Steroids	-	-	-
11	Carbohydrates	-	+	+
12	Starch	-	-	-
13	Cholesterol	-	-	-
14	Phytosterols	Libermann-Burchards Test	+	+
15	Quinones	-	+	+

"+ "indicates Positive; "– "indicates Negative.

Raw Quinoa seeds showed high levels of nutritional compositions and pharmaceutical components, offering potential candidates for improving human health as well as serving as a good source of mass production of pharmaceutical and medicinal components. Abugoch

James., 2009 found antioxidant compounds such as polyphenols, phytosterols, and flavonoids in grains of quinoa. These substances might be connected with the impacts of decrease in plasma lipids and glucose levels in the people tried. In one investigation exhibited that the utilization of this grain can likewise be advantageous for expanding the creation of liver cell reinforcement chemicals. [13]

The increase of these enzymes is related with the reduction of harmful effects caused by free radicals on the human body, which it leads to a reduced endothelial alteration (endothelial dysfunction) and decreased oxidation of LDL-C molecules, and hence, reduces the risks for vascular diseases. [14,15]. The Pseudocereal positively influenced the various risk factors for the development of diabetes and vascular diseases, which are the most frequent diseases today.

Determination of Vitamins and minerals in Quinoa Seed

The Food and Agriculture Organization (FAO) observed that quinoa seeds have high quality proteins and higher levels of energy calcium, phosporus, iron, fibre, and B-vitamins. Proximate analysis of quinoa flour has showen the following composition (Table 2).

Table 2: The Minerals and Vitamin Contents of Quinoa Seed Powder.

S.No	Parameters	Unit	Results
	Minerals		
1	Vanadium	ppm	0.51
2	Magnesium	ppm	682.33
3	Manganese	ppm	9.69
4	Zinc	ppm	20.97
5	Chromium	ppm	1.07
	Vitamins		
6	Vitamin D	ppm	< 10.0
7	Vitamin E	ppm	47.0

Large amount of minerals found in quinoa seeds. The present results in Table 2 showed that quinoa seeds powder had content of Magnesium, Zinc, Chromium, Manganese, and Vanadium as follows 682.33 ppm, 20.97 ppm, 1.07 ppm, 9.69 ppm, 0.51 ppm respectively. These minerals are considered to make sufficient balance diet.

The results given in Table (2) indicates that quinoa seeds contain considerable amount of Vitamin E 47.0 ppm and Vitamin D shows the less than limit of 10.0 ppm. Low levels of Vitamin E are related with increased incidence of diabetes, and some research suggests that human beings with diabetes have lower levels of antioxidants.

Some studies have shown that the consumption of dietary fiber may reduce the risk of diseases and can prevent hyper lipidemias, cardiovascular diseases, diabetes, and obesity [16, 17]. The ingestion of dietary grains and fibers has been associated with diminished risk for obesity and diabetes [18]. Other studies related that carbohydrates from quinoa, including insoluble and soluble fiber, can be considered as nutraceuticals because they can help reduce glucose, triglyceride, and free fat acids levels in the blood.

Quinoa contains considerably high vitamin E, iron, zinc and magnesium contents as well as saponins and phyto steroids. These substances have shown hypocholesterolemic effects and increased postprandial sensitivity and release of plasma insulin [19]. The results showed that Quinoa seeds flour is a good source of vitamins such as Vitamin D < 10.0 and Vitamin E 47.0 ppm. The results were indicated a Quinoa high contain of vitamin E and vitamin B6. The results as shown by Kozioł., 1992 that a-tocopherol in Quinoa seeds ranged from 1.5 to 4.5 mg/100 g DM and vitamin B6 from 0.5 to 0.8 mg/100 g DM, when the ascorbic acid levels reach to 0.63 mg/100 g. [20]

More studies on vitamin content of Quinoa seeds are needed in order to have a better view of its vitamins profile. The content of α-tocopherol, as vitamin E, in quinoa is important and it is an excellent source of vitamin E in an amount higher than that of wheat. The vitamin acts as an antioxidant at the cell membrane level, protecting the fatty acids of the membranes against damage caused by free radicals. [21, 22].

The data obtains for minerals content in the table 2 showed that Magnesium, Zinc, Chromium, Manganese and Vanadium were 682.33, 20.97,1.07, 9.69 and 0.51 ppm respectively. Other studies found that the main minerals were Potassium, Phosphorus and magnesium (8819.73, 4112.83 and 1987.23 respectively, in addition to high content of calcium, Iron and zinc.

Quinoa contains high concentrations of various B vitamins like pyridoxine (B6) and folic acid (B9). The adults' daily needs form quinoa of both vitamins was 100 g [23, 24]. On the other hand, Alvarez-Jubete *et al.*, 2010 reported that the levels of vitamins pyridoxine, folic acid and riboflavin in quinoa are higher compared to other grains like oat, corn wheat, barely, rice and rye. Furthermore, quinoa has the highest amount of vitamin E in pseudo-cereal [25]. Daily gain in body weight also followed the same trend where it observed non-significant differences between the treated groups and control group. Several physiological effects on human health of quinoa consumption were investigated in several animal studies. Nowadays, quinoa is well known as a well-balanced diet. In addition, it has a reduction effect on the chronic disease risk. Quinoa has been recently used as a source to maintain sugar levels.

Conclusion

The nutritional excellence of quinoa has been known since ancient times in the Inca Empire. Quinoa has been recognised for its nutritional benefits all over the world, and for its protein, mineral, and vitamin contents. The importance that quinoa could play in the nutritional behaviour has been emphasised, not only in the developing countries but also in the developed world. In recent past few years quinoa has gained popularity- all the way from back shelves of health food stores to supermarket aisles. Incorporation of quinoa in our diet not only increases the nutritive value but will also reduce the risk of various health diseases like cardiovascular diseases, type 2 diabetes, high blood pressure, cancer, obesity. The only main anti-nutritional factor associated with quinoa is saponin, a water-soluble phytonutrient, which can be reduced by washing, soaking, boiling of quinoa. Use of quinoa represents a promising area of research as its use in our daily diet can improve the intake of certain important nutrients and phytochemicals which caters important health benefits. Finally, it can be concluded that by increasing the awareness regarding quinoa's biodiversity, ability to sustain in different cultivation methods, its various culinary uses and most important its ability to cater enormous health benefits, the improvement in health condition of large segment of poor population of this world can be improved.

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