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Nutritional and Phytochemical Insights into Quinoa: The Ancient Grain with Modern Health Benefits

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Abstract

Quinoa is crop developed regularly as an oat feast. Concerning the most fundamental supplements, it is viewed as the world's perhaps the most popular wellbeing nourishments. Quinoa has over the top nutritive esteem and can acquire food security around the world. The 2013th year was considered as "The International Year of the Quinoa". Quinoa helps to reduce the risk of various diseases like cardiovascular diseases, type-2 diabetes some cancer, high blood pressure, obesity and is additionally a good option for people who are allergic to certain food groups. Quinoa is also a rich source of functional ingredients, such as polyphenols, flavonoids, and active peptides, which has increased the application prospects of this cereal and its products in food and pharmaceutical industries.

Major phytoconstituents in the quinoa seed powder were tested according to standard methods. Minerals and Vitamins were analysed with an atomic absorption spectrophotometer. A large number of minerals found in quinoa seeds powder had the content of Magnesium, Zinc, Chromium, Manganese, and Vanadium. Incorporation of quinoa in our diet not only increases the nutritive value alternatively will also minimize the risk of various health illness like cardiovascular diseases, type 2 diabetes, etc. Use of quinoa represents a promising region of research as its use in our daily diet can enhance the consumption of certain essential nutrients and phytochemicals which caters important health benefits.

Keywords: Quinoa, phytochemicals, vitamin and minerals

Introduction

Quinoa (*Chenopodium quinoa* Wild*)* was known to the Incas as "the mother of all grains" and was believed to be sacred. The Tamil name of Quinoa is Seemaithinnai. 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 "super food".

Quinoa also helps to reduce the risk of various diseases like cardiovascular diseases, type-2 diabetes some cancer, high blood pressure, obesity and is additionally a good option for people who are allergic to certain food groups. Its biodiversity and ability to sustain in adverse climatic conditions makes it an ideal crop to cultivate worldwide especially in under developing countries of Asia and Africa, where food production is threatened by global climatic changes. Hence, it is a requirement of present world to increase the awareness regarding the various functional benefits of quinoa to combat one amoung the world's major crises, that is, hunger and malnutrition.

Quinoa is a species of the goose foot genus. It's a crop grown primarily for its edible

seeds. Being high in various important nutrients, it is considered as world's one of the most popular health foods. 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. Being highly nutritious, quinoa also imparts various health benefits which makes it an excellent example of "functional food" (Gordillo-Bastidas *et al.,* 2016) [12]

Quinoa is also a rich source of functional ingredients, such as polyphenols, flavonoids, and active peptides, which has increased the application prospects of this cereal and its products in food and pharmaceutical industries (Ceyhun Sezgin and Sanlier, 2019 [23], Ren *et al*., 2023) [21]. Increasing *in vivo* and *in vitro* evidence suggests that phytochemicals derived from quinoa may have numerous potential health benefits (Abdel-Wahhab *et al*., 2021 [1], Cao *et al*., 2020 [7], Capraro *et al*., 2020, Ren *et al*., 2023 [21], Stikić *et al*., 2020). In addition, the long-term consumption of premium gluten-free quinoa contributes to the prevention and treatment of various diseases, including inflammation, obesity, diabetes, cancer, cardiovascular disease, and celiac disease, and improves the health of individuals.

Current research on quinoa germination has gradually attracted the interest of an increasing number of researchers. This technology can be used to soften the tissue structure of quinoa and enhance its nutritional and functional properties, thereby expanding the use of quinoa in food development.

History of quinoa

Quinoa was known to the Incas as "the mother of all grains" and was first cultivated over 5000 years ago. It had been considered as a gift from their gods and was even used for medicinal purposes. It was staple for the Incas and is still a prominent food source for his or her indigenous descendants, the Quechua and Aymara people. The legends states that the first quinoa seeds were ceremoniously planted per annum by the Incas emperor (Simranpreet *et al.,* 2017).Earlier, quinoa seeds were added to soups, used as cereal and was even fermented intobeer or chichi (traditional drink of the Andes). Traditionally, widely consumed in the highlands of the Andes in South America, quinoa has attained popularity as health food inNorth America, Europe, Australia, Japan and India. Today, quinoa is presently cultivated or tested in 95 countries of the world as mentioned (Cooper., 2015) [8].

Botanical and Scientific Classification of *Chenopodium quinoa*

Quinoa (*Chenopodium quinoa* is a flowering plant in the Amaranthaceae family. It is a herbaceous annual plant grown as a crop primarily for its edible seeds; the seeds are rich in protein, dietary fiber, B vitamins, and dietary minerals in amounts greater than in many grains (Tanwar B *et al., 2019)* [29]. Quinoa is not a grass, but rather a Pseudocereal botanically related to spinach and amaranth (Amaranthus spp.), and originated in the Andean region of north western South America. It was first used to feed livestock 5.2–7.0 thousand years ago, and for human consumption 3–4 thousand years ago in the Lake Titicaca basin of Peru and Bolivia. Today, almost all production in the Andean region is done by small farms and associations. Its cultivation has spread to more than 70 countries, including Kenya, India, the United States, and several European countries. As a result of increased popularity and consumption in North America, Europe, and Australia, quinoa crop prices tripled between 2006 and 2013.

Scientific Classification of *Chenopodium quinoa*

Class: Dicotyledonae
Order: Caryophyllales
Family: Amaranthaceae
Genus: *Chenopodium*
Species: *quinoa*

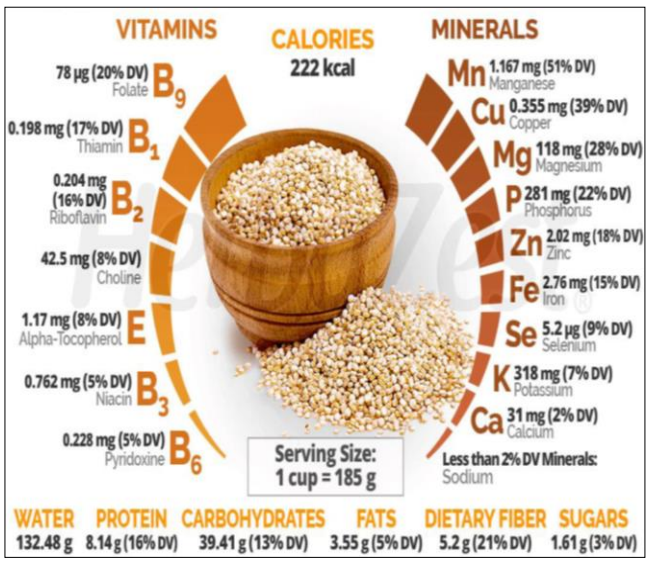
Nutritional aspects of quinoa

Consumption of quinoa not only provides various nutrients to our body but also contributes to various health benefits. It is a great food not only for vegetarians or vegans 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.

Minerals in quinoa are found in outer bran layers at concentrations greater than that reported for most grain crops. Iron (81 mg/kg), calcium (874mg/kg) and phosphorus levels are higher in quinoa than those of maize and barley.

Minerals like phosphorous, potassium and magnesium are located in theembryo of quinoa, while Ca and P in the pericarp are associated with pectic compounds ofthe cell wall (Konishi *et al.,* 2004) [16]. Sulfur is found uniformly distributed within the embryoof quinoa. Iron in quinoa has been reported as highly soluble and thus could be easilyavailable to anemic populations.

Vitamins are essential nutrients required in small amounts by organisms. Presence of significant amount of "tocopherol enhances its antioxidant properties. Beta carotene concentrations (0.39 mg/100 g dry weight) in quinoa have been found to be higher as compared to cereals like wheat (0.02 mg/100 g dry weight) and barley (0.01 mg/100 g dry weight) (Adamczewska-Sowińska K *et al., 2025*) [3].



Minerals and Vitamin

Vitamins and minerals are micronutrients required by the body to carry out a range of normal functions. However, these micronutrients are not produced in our bodies and must be derived from the food we eat.

Minerals are inorganic elements present in soil and water, which are absorbed by plants or consumed by animals. While you're likely familiar with calcium, sodium, and potassium, there is a range of other minerals, including trace minerals e.g. copper, iodine, manganese and zinc) needed in very small amounts.

Zinc

Zinc is a vital trace mineral that plays numerous crucial roles in the human body, including supporting the immune system, promoting growth and development, and aiding in wound healing. It is involved in various bodily functions, from cell division and protein synthesis to the senses of taste and smell.

Magensium

Magnesium is an essential mineral that plays a vital role in numerous bodily functions, including muscle and nerve function, blood sugar regulation, and bone health. It is involved in over 300 biochemical reactions within the body, and deficiency can lead to various health issues. Magnesium is naturally found in many foods, can be taken as a supplement, and is also used in some medications like antacids and laxatives.

Chromium

Chromium increases insulin's ability to bind to cells, increases insulin receptor numbers on cells, and improves insulin's ability to detect glucose molecules within the blood. Often diabetic individuals are deficient in chromium. Restoring levels in these individuals, especially those with steroid-induced diabetes, improves their blood glucose levels enough for them to decrease or completely explode their medications, effectively reversing their illness. It is also used for high cholesterol, athletic performance, bipolar disorder, and many other purposes, but there is no good scientific evidence to support most of these uses.

Manganese

Manganese is an essential trace element that is naturally present in many foods and available as a dietary supplement. Manganese is a cofactor for many enzymes, including manganese superoxide dismutase, arginase, and pyruvate carboxylase. Through the action of these enzymes, manganese is involved in amino acid, cholesterol, glucose, and carbohydrate metabolism; reactive oxygen species scavenging; bone formation; reproduction; and immune response. Manganese also plays a role in blood clotting and hemostasis in conjunction with vitamin K (Buchman AR.,2014) [6]

Vanadium

Vanadium might act like insulin or help to increase the effects of insulin. People use vanadium for preventing vanadium deficiency. It is also used for prediabetes, diabetes, athletic performance, cancer, and many other purposes. Vanadium is believed to enhance the consequence of insulin and may also be included during a mineral supplement to support balanced glucose metabolism. Vanadium could also be therapeutic for Type 2 diabetics that have sufficient levels of insulin, as vanadium only enhances insulin function rather than mimic it completely.

Vitamins can be divided into two categories: fat soluble and water soluble. The fat-soluble vitamins A, D, E, and K dissolve in fat and may be stored in our body. The water-soluble vitamins C and the B-complex vitamins (such as vitamins B6, B12, niacin, riboflavin, and folate) need to dissolve in water before our body can absorb them. Due to this, body can't store these vitamins. Any vitamin C or B that our body doesn't use as it passes through our system is lost. So, we need a fresh supply of those vitamins every day.

Vitamin – D

Vitamin D was a necessary nutrient for humans. People usually do not pay attention to supplementing vitamin D, since vitamin D are often produced when their skin is exposed to the daylight. Vitamin D deficiency has been shown to change insulin synthesis and secretion in both humans and animal models may predispose to glucose intolerance, altered insulin secretion and T2DM. Vitamin D is a fat-soluble vitamin that plays a crucial role in calcium absorption, bone health, and overall well-being. It helps the body maintain proper levels of calcium and phosphorus, which are essential for building and maintaining strong bones. The body produces vitamin D when exposed to sunlight, and it can also be obtained through certain foods and supplements.

Vitamin - E

Vitamin E is an antioxidant. It may help protect your cells from damage. This essential nutrient occurs naturally in many foods. It's also available as a dietary supplement. Sometimes, it's in processed foods. Vitamin E is a fat-soluble. This means your body stores and uses it as required. The term "vitamin E" describes eight different compounds. Alpha-tocopherol is that the most active one in humans. Vitamin E may reduce the risk of cardiovascular (CV) events and of microvascular complications in people with diabetes. It protects cells from damage caused by free radicals, supports the immune system, and is important for healthy vision, skin, and blood. It also helps form red blood cells and wide blood vessels to prevent clotting (Vilcacundo *et al.*2017*)* [27].

Current nutritional guidelines are based on Dietary Reference Intakes (DRIs). DRIs, established in 1998, expand on the previously used Recommended Dietary Allowances (RDAs). DRIs are composed of four values: the RDA, the Adequate Intake (AI), the Estimated Average Requirement (EAR), and the Tolerable Upper Intake Level (UL) (O'Connell., 2001). Maximum values are based on Food and Drug Administration (FDA)values, the World Health Organization (WHO), BBC Health values, the European Union Directive (based on FDA values) and values from various other governmental and private agencies in the USA and the UK.

Table 2: Nutritional Guidelines based on Recommended Dietary Allowances (RDAs)

Vitamins/Minerals	RDI	Role in Diabetes	UL	Causes
Zinc (Zn)	15 mg	Trace metal (i.e) Directly involved in the synthesis, storage and secretion of insulin	> 25 mg	Anaemia and Copper defeciency
Magnesium (Mg)	350 mg	Essential ion involved on multiple levels in insulin secretion	>400 mg	Stomach problems and Diarrhoea
Chromium (Cr)	120 µg	Trace element, increase insulin binding to cells by increasing insulin receptor numbers.	>200 µg	Toxic and may cause concentration problems and fainting
Manganese (Mn)	5 mg	Component of free radicals protect beta cells in the pancreas produce insulin	Excess	May hinder iron adsorption
Vanadium (Va)	<1.8 mg	Act as insulin mimetric agent, enhance insulin activity and increases insulin sensitivity.		No information found
Vitamin - D	5 µg	To help boost insulin sensitivity, which is vital for blood glucose regulation	>50 µg	Disorientation coma and death
Vitamin – E	10 mg	To fight toxins and improve the activity of insulin	>1000 mg	Blood Clotting, Haemorrhage

RDI – Recommended Daily Intake, UL – Upper tolerable limit

Materials and Methods

Preparation of the extract for Phytochemical Screening

Quinoa seeds (*Chenopodium quinoa)* were 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).

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 Resins

One ml of the extract was treated with few drops of acetic anhydride solution followed by one ml of conc. H_2SO_4. Resins give colouration ranging from orange to yellow.

Test for Anthraquinone Glycosides (Hydroxyanthraquinone test)

To 1ml of extract, few drops of 10% potassium hydroxide solution were added. The appearance of red colour confirms the test.

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 Indole alkaloid
To 0.1 ml of test solution was treated with conc. H_2SO_4 and 1 ml of Potassium dichromate. The colour change indicates the positive result.

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 Oxalate
To 3 ml of test solution, were added a few drops of ethanoic acid glacial. A greenish black colouration indicates the presence of oxalates.

Test for Leucoanthocyanin
To 5 ml of isoamyl alcohol was added to 5 ml of test solution, upper layer appearing red in colour indicates the presence of Leucoanthocyanin.

Test for Coumarins
0.5 g of the moistened quinoa seed powder was taken in a test tube. The mouth of the tube was covered with filter paper treated with 1 N NaOH solution. Test tube was placed for few minutes in boiling water and then the filter paper was removed and examined under the UV light for yellow fluorescence indicated the presence of coumarins.

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.

Test for Phlobatannins
An aqueous extract of the sample was boiled with 1 percent aqueous hydrochloric acid. Deposition of red precipitate as a confirmation for the presence of Phlobatannins.

Test for Gum and Mucilage
About 10 ml of the extract was slowly added to 25 ml of absolute alcohol under constant stirring. Precipitation indicates the presence of gum and mucilage.

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 Carotenoids
1 gm of sample was dissolved in 10 ml of chloroform and shaken vigorously then the mixer was filtered and 85 % H_2SO_4 was added. The blue color at the interface showed the presence of carotenoids.

Test for Oil and Fat (Stain test)
Small quantity of extract was pressed between two filter papers. An oily stain on filter paper indicates the presence of fixed oil.

Test for phenols (Ferric chloride test)
A fraction of the extracts was treated with aqueous 5% ferric chloride and observed for the formation of deep blue or black colour.

Test for Diterpenes (Copper acetate test)
Extracts were dissolved in water and treated with 10 drops of copper acetate solution; formation of emerald green colour indicates presence of diterpenes.

Test for Emodins
2 ml of NH_4OH and 3 ml of benzene was added to the extract, appearance of red colour indicates presence of emodins.

Test for terpenoids (Salkowski test)
A total of 5 ml of the extract was mixed in 2 ml of chloroform, and concentrated H_2SO_4 (3 ml) was carefully added to separate the 2 layers distinctly. A reddish-brown coloration of the interface was formed to confirm the presence of terpenoids.

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 Anthocyanin
2 ml of aqueous extract was added to 2 ml of 2N HCl & NH_3. The appearance of pink red turns into blue violet indicates presence of anthocyanin.

Estimation of Ash (AOAC., 1995)
The total ash content of a substance is the percentage of inorganic residue remaining after the organic matter has been ignited. 2g of the pulverized organic and normal quinoa seeds samples was placed in a crucible and ignited in a muffle furnace at 550° C for 6 hours. It was then cooled in a desiccator and weighed at room temperature to get the weight of the ash.
Crude ash (%) = $(W2-W1) / Weightofsample \times 100$
Where: W1 = weight of empty crucible, and W2 = weight of crucible with ash.

Estimation of Moisture (AOAC., 1995)
The Petri dish was washed thoroughly and placed in oven to dry. 5g of sample was placed in a pre-weighed Petri dish, and then placed in a oven to dry at 105° C for two hours.

The dish and dry samples were transferred to a desiccator to cool at room temperature before, being weighted again. The experiments were repeated until constant weight was obtained.

Calculation

Moisture (%) = (W1- W2) *100 / W1- W

Were,

W1 = Weight in gm of the dish with the material before drying

W2 = Weight in gm of the dish with the material after drying

W = Weight in gm of the empty dish

Estimation of Crude fibre (AOAC., 1995)

5g of quinoa powder sample were taken 200 ml of 1.25% H_2SO_4 were taken 100 ml of 1.25 % H_2SO_4were heated for 30 minutes and filtered with a Buchner funnel. The residue was washed with distilled water until it was acid free. 200 ml of 1.25 % NaOH was used to boil the residue 30 minutes, it was filtered and washed several times with distilled water until it was alkaline free. It was then rinsed once with 10% HCl and twice with ethanol. Finally, it was rinsed with petroleum ether three times. The residue was peel in a crucible and dried at 105°C in an oven overnight. After cooling in a desiccator, it was ignited in a muffle furnace at 550°C for 90 minutes to obtain the weight of the ash.

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

Phytochemical Analysis

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

Table 1: Phytochemical analysis of *Chenopodium quinoa*

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	Resins	Precipitate Test	+	+
8	Anthraquinone glycosides	Hydroxyanthraquinone Test	-	-
9	Acidic Compounds	-	5.0	5.0
10	Protein	-	+	+
11	Aminoacids	-	+	+
12	Steroids	-	-	-
13	Indole Alkaloids	-	+	+
14	Carbohydrates	-	+	+
15	Oxalate	-	-	-
16	Leucoanthocyanin	-	-	-
17	Coumerins	-	+	+
18	Phytosterols	Libermann-Burchards Test	+	+
19	Quinones	-	+	+
20	Phlobatannins	-	-	-
21	Gum and Mucilage	-	-	-
22	Starch	-	-	-
23	Carotenoids	-	+	+
24	Oil and fat	Stain Test	-	-
25	Phenols	Ferric Chloride Test	-	-
26	Diterpenes	Copper Acetate Test	-	-
27	Emodins	-	-	-
28	Terpenoids	Salkowski	-	-
29	Cholesterol	-	-	-
30	Anthocyanin	-	-	-

Raw Quinoa seeds showed high levels of nutritional compositions and pharmaceutical components, offering potential candidates for improving human healthy as well as serving as a good source of mass production of pharmaceutical and medicinal components. The results obtained for chemical composition of quinoa seeds flour indicated that ash content 1.2 %, moisture content 11.2 % and Crude fiber 9.5%. The results showed that Quinoa seeds flour is a good source of vitamins such as Vitamin D < 10.0 and Vitamin E47 ppm.

The Proximate analysis of Ash, Moisture and Crude fibre in raw *Chenopodium quinoa* was described as 1.2 %, 11.2 % and 9.5% respectively. The unique benefits of quinoa are associated with its high nutritional value. Further, quinoa is high in fibre, which makes it an perfect food to detoxify the body, eliminating toxins and waste products that may harm

the body. The determination of Minerals (Magnesium, Zinc, Manganese, Vanadium and Chromium). Vitamins (Vitamin -D and Vitamin -E) from the *Chenopodium quinoa* were analysed with an atomic absorption spectrophotometer (AAS; Shimadzu Instruments, Inc., SpectrAA-220. 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.

Table 2: Minerals and Vitamin Present in Quinoa Seed Powder.

S.No	Parameters	Units	Values
1.	Proximate Analysis		
1.a	Ash	%	1.2
b	Moisture	%	11.2
c	Fiber	%	9.5
2	MINERALS		
2.a	Magnesium	ppm	682.33
b	Zinc	ppm	20.97
c	Chromium	ppm	1.07
d	Manganese	ppm	9.69
e	Vanadium	ppm	0.51
3	VITAMINS		
2.a	Vitamin - D	ppm	<10.0
b	Vitamin - E	ppm	47

Discussion

Vandana and Sarita Srivastava., 2020 was reported that raw quinoa grains and processed quinoa grains contained moisture content of 9.28 per cent and 9.32 per cent, respectively. There has been nonsignificant difference in moisture content of raw and processed quinoa grains. Repo-Carrasco and Serna., 2011 observed moisture in quinoa in the range of 10.78- 12.62 per cent. According to Stikic *et al*., 2012 [25] the moisture content of quinoa whole grains was 10.87. Beniwal *et al.,* 2019 [5] reported that raw quinoa flour contains 7.93 per cent moisture. Authors also reported that raw quinoa flour contain 3.5 per cent ash while Alvarez- Jubete *et al.,* 2010 reported that processed quinoa grains (washed, centrifuged and dried) contain 2.7 per cent ash. Stikic *et al.,* 2012 [25] reported the ash content of quinoa whole grains as 7.06 per cent and dehulled grains as 3.59 per cent.

More studies on vitamin content of Quinoa seeds are needed in order to have a better view of its vitamins profile. The content of a-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 Abugoch James., 2009 [2] this vitamin acts as an antioxidant at the cell membrane level, protecting the fatty acids of the membranes against damage caused by free radicals Repo-Carrasco.,2003 [22]. Maksoud., 2017 [18] 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. On the other hand, Alvarez-Jubete *et al*., 2010 [4] 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. 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. Graf *et al*.,2014 [13] who mentioned that when obese, hyperglycemic mice were given a supplement made by leaching nutrients from quinoa seeds, their fasting blood sugar dropped. Similarly, a quinoa-fortified diet decreased blood sugar levels compared to those without quinoa supplementation (Graf *et al.*, 2015) [14].

Conclusion

The quinoa may benefit high-risk group consumers, such as diabetes, obesity, children, the elderly, due to its properties including a high nutritional value, and therapeutic features. These characteristics are considered in my work to be correlated with the existence of the fibre, minerals, vitamins, antioxidants, and especially phytochemicals in quinoa seed powder. Functional properties given by active compounds like minerals, proteins, fibres and phenolic metabolites make of this pseudo-cereal a strong contribution to human nutritional therapy.

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 antinutritional factor associated with quinoa is saponin, a watersoluble 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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