REVIEW ARTICLE

QUINOA IS BENEFICIAL TO THE COMPREHENSIVE NUTRITIONAL VALUE OF POTENTIAL HEALTH

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ABSTRACT: The quinoa herb belongs to the family of *Chenopodiaceae* in which spinach and beet also originate. It is South America local herb, and Chenopodium has 250 different kinds all over the world. Quinoa is a pseudo-cereal with high phytochemical substances verified biological and nutritional significance. Quinoa is consumed and used as daily essential food throughout the world due to its higher amount of protein in relation to general cereals. Quinoa contains ascorbic acid, vitamin E tocopherols and B complex vitamins niacin, folic acid, thiamine. Minerals (calcium, potassium, iron, manganese, magnesium, phosphorus), it also contains isoflavones and the best type of triglyceride. A functional perspective of quinoa plant is of great importance as are being used in the treatment and prevention of different health problems. The study will elaborate physiochemical, rheological and functional properties of quinoa. Bread will be prepared from quinoa and its textural, sensory attributes and chemical composition will be determined by standard method and the result obtained from the recent study will be analyzed according to standard procedure.

Keywords: Quinoa, Gluten-free, nutritional value, Chenopodium quinoa wild.

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INTRODUCTION

The American continent has an ancient crop known as quinoa. If we studied historical archeological data then we always read about that quinoa was used even earlier then 3000 BC (Uncu *et al.*, 2017). In early days, quinoa was divided into different groups based upon colors of plant and fruit but still, quinoa has been taken as an individual species. Due to some specific characters, quinoa is considered as a special individual crop as maize (Duchene *et al.*, 2019). Quinoa has different native names but most common is quinoa (Vega-Gálvez *et al.*, 2010). Incas named this plant is the mother grain and also used to treat health problems. It is also considered that this plant is given by God as a gift. In some countries, it is a tradition to add quinoa into different soups used to make beer, like cereal, and to make a traditional drink of the Andes (Cooper, 2015). when Spanish separate from South America, local citizens selected quinoa as food for them. So, a social image was created against quinoa that it is a source of food for poor people. When news reached to catholic church that quinoa was used to make a holy drink (mudai) in ethnic religion then catholic ordered to inhibit the cultivation of quinoa. That is why quinoa only occurs where Europeans do not persist (Vega-Gálvez *et al.*, 2010). At the time of harvesting, quinoa height reaches 1 to 3m. Quinoa can grow easily in salty, acid or alkaline and can tolerate weather conditions like too hot or too cold (Sezgin and Sanlier, 2019). Quinoa is not a true-grain and considered as a fruit because it is a dicotyledon which is pseudo-grain. The shape of seed is flat and round and diameter is about 1.5-4mm and colors are shades of grey, black, violet, yellow, reddish and purple (Maughan, 2009).

Protein: If we compare different cereals then we can say quinoa contains more nutrients. Quinoa seeds have a remarkable difference in protein value from 8-22% but these values are very much greater as compared to wheat, maize, barley, and rice. although other plants have less than 50%protein content in legumes and pulses. If we talk about quinoa protein content mostly occurred in the embryo(Garcia-mazcorro *et al.*, 2016). Quinoa contains two valuable proteins known as globulins and albumin. Peoples which are sensitive to some kind of gluten can easily take quinoa as food happily. Off course, Quinoa contains different amino acids in large quantity as compared to other cereals but especially have lysine which is not abundantly present in other vegetable plants. We can take quinoa along with other cereals which are deficient in methionine and cysteine ratio. Different studies are done on the nutritional evaluation of quinoa. Interestingly in raw quinoa protein efficiency ratio (PER) is from 78-93%that of casein. After cooking these PER value increase to 102-105% that of casein (Valencia-Chamorro, 2003). The protein content of quinoa is 14-20

% (g/100g dry basis) and provide high-quality protein because quinoa has a very high amount of lysine and methionine amino acids. They also have other nutritional components such as carbohydrates, fat, minerals, and vitamins. (Miranda *et al.*, 2015). Quinoa protein is a great root of histidine and lysine. Studies have shown that quinoa has a low percentage of prolamine but have two main proteins globulin and albumin. We can easily relate to the digestibility of quinoa protein with supplementary foods (Matiacevich *et al.*, 2006). Quinoa has similar fatty acid composition as soybean. It also has a high-quality value of edible oil, when we compare the quinoa with another foodstuff. It has high value of minerals and vitamins (Bertazzo *et al.*, 2011). Proximate analysis of quinoa shows that it contains 10-18% protein, 4.5-8.75% crude fat, 54.1-64.2% carbohydrate, ash value from 2.4-3.65% and crude fiber value from 2.1-4.9% Aminoacid value is higher as compared to wheat and maize and a greater amount of lysin makes quinoa superior to other cereals (Bertazzo *et al.*, 2011). The key component of Chenopodium and Amaranthus is the lesser granule sized (< 1 micron) starch (Vilche *et al.*,2003). The percentage of Starch is 52–60 of the grain weight. The content of amylase in quinoa starch is approximately 7%. The comparative crystallinity of starch are 35.0% (Tari, 2002; Abugoch *et al.*, 2008).

Carbohydrate: Maximum content of quinoa is known as carbohydrates and value is about 74% on dry matter base, 52-60% starch, a starch found in the peri-sperm of seed and starch present in a round-shaped structure. The amylose portion is 11%, which is lesser than in cereals including barley (26%), rice (17%) and wheat (22%). Starch is the major carbohydrate element of quinoa and is present in the range of 52% to 74% (González-García *et al.*, 2018). Quinoa starch granules are usually polygonal, lesser in proportions than ordinary grains, using a diameter of 0.6 to 2.2 μm (Kamp *et al.*, 2014). Being rich in amylopectin, they have brilliant freeze-thaw constancy which improves its functional property to be utilized to be a thickener in frozen foods (Schlick, 1993). The dietary fiber can be near to the value with in grains (7 to 9.7% dm), where the level of germ is higher than in the endosperm (Abugoch *et al.*, 2008). Dietary fiber has many beneficial properties associated with its indigestibility in the small bowel. Fiber in the quinoa improves digestion in large intestine hence, in turn, improve absorption of other nutrient content in quinoa (Bazile *et al.*, 2014).

Minerals and vitamins: Quinoa supply different types of minerals. It include zinc, magnesium, iron, and calcium as linked to cereals, particularly the iron percentage is high. The mineral percentage reduced 12-15% of iron, zinc, and potassium, 27% of copper and 3% loss of magnesium due to polishing and washing of quinoa seeds. It has a higher quantity of riboflavin and α-tocopherol as compared to rice, barley or wheat. It can also supply vitamin E. this is a good way to obtain thiamin (0.4mg/100g), folic acid (78.1mg/100g) and ascorbic acid (16.4mg/100g) (Martín *et al.*, 2014). It include double quantity of gamma-tocopherol (5.3mg/100g) instead of alpha-tocopherol (2.6mg/100g) and greater concentration of calcium (874mg/Kg), phosphorus (5.3g/Kg), magnesium (2.6 mg/100g), iron (81mg/Kg), zinc (36 mg/Kg), potassium (12 g/Kg), and copper (10 mg/Kg) than cereal grains, but the concentration of mercury, lead and cadmium will be low in terms of the intake of the components. Values will be represented on a the basis of dry weight (as the amount will be higher for oleic and linoleic acid). Vitamins and minerals content reduced to some extent due to saponins removal from seeds. Value is high in case of potassium and comparatively low in circumstance of iron and manganese (Rodríguez *et al.*, 2012).

Fats and lipids: It has been shown that quinoa seed lipids engraved a massive sum of neutral lipids between all the seed parts. Compared with total lipids, the ratio of free fatty acid components in whole buckwheat seeds and shells was 18.9% and 15.4%, respectively. Triglycerides contribute in a captivating fraction of 50% of neutral lipids. Triglycerides are present in throughout the seeds and occupy a portion of 20% of the neutral lipid fraction. As for as, phospholipids observation is concerned Lysophosphatidic ethanolamine was the most adequate and accounts for 45% of all polar lipids (Chen *et al.*, 2019). Phosphatidylcholine was in second-grade point representative of phospholipid and played a role of 12% of whole seeds of phospholipids. A noticeable fluctuation in phospholipids has been apparent between various fractions. However, quinoa seed products have the same fatty acid arrangement as another grain, with linoleic acid, oleic acid and palmitic acid present as the main acid (Kilinc *et al.*, 2016). Quinoa provides 2 to 10% body fat. Quinoa and soya oils show off the same type of structure, thus quinoa is a healthy way to obtain essential fatty, for example, linolenic and linoleic (Valencia-Chamorro, 2003). Neutral lipids present in a large quantity in quinoa seeds as lipids and fatty acids separated from quinoa seeds were compare from lipids and fatty acids classes. Free Fatty acids are also present in quinoa seeds accounting for 18.9 and 15.4 percent of total lipids. Triglycerides are also present in large quantity. (Pereira *et al.*, 2019);(Tang *et al.*,2015). Triglycerides are present throughout the seed and contribute 20% towards the neutral lipid portion. Among phospholipids analyzed, lysophosphatidylethanolamine is the most copious and is around 45% of the total polar lipids. A large difference in phospholipids has been evident between several parts. However, the total fatty acid structure of entire quinoa seeds is same to other reported grains, with linoleic acid,

oleic acid and palmitic acid present as most important acids (Goyat *et al.*, 2018).

Uses of quinoa: Quinoa is high in protein, full of vitamins/minerals, so it can be used as a rice replacer. This cereal can also be used in breakfast, provides energy and aids in weight loss. To make infants food, boil quinoa in water, so it can be easily digested. As quinoa is high in fiber content, it can be popped to make popcorn. Popcorn is an easy source to reduce weight and helps in digestion. These seeds used as flour and before we make a salad of these seeds, it is essential that their sprouts must be green. Maize or wheat flour could be mixed with Quinoa flour. Some amount of quinoa flour replacement have been stated, such as bread (10–13% quinoa flour), noodles and pasta (30–40% quinoa flour), and sweet biscuits (60% quinoa flour) (Valencia-Chamorro, 2003; Goyat and Handa, 2018; Li *et al.*, 2018). In all cases, high-quality products including flour, drum-dried and extruded are obtained and given good physical, and nutritional qualities. Quinoa flour is good for baking and the reason behind it that it's high in protein and fiber. It is great for gluten-free baking, gluten is a protein found in wheat, barley. When boiled, used as rice and this flour can also be added in the soup to thicken it. As Quinoa flour made into noodles, this activity is complex because of saponin content in these seeds. Saponin protects quinoa against insects and some other threats. They're bitter in taste, so it can be usually eliminated by soaking in water, washing and roasting before cooking. All this helps in to get rid of its bitterness. As saponins are a diverse group of chemicals, and the name 'saponins' comes from the Latin word "Sapo" which means soap. Because saponins have the unique properties of blowing agents and emulsifiers. They form a stable soapy foam when shaken in aqueous solution. Limited research and limited data available on amino acids composition and protein-bound tryptophan in quinoa. The main reason for this research is to verify this nonprotein tryptophan in bovilian quinoa as compared to the flour of common grains (Comai *et al.*, 2007). The ratio of buckwheat protein to carbohydrates is high - bacteria account for about bacteria. 60% of the grain is associated with wheat, where the germ accounts for less than 3% of the wheat grain. High protein levels help maintain satiety. Therefore, if you consume for this purpose, it can help a person lose weight. Studies have established that products made from buckwheat contain more antioxidants than typical gluten-free products made with rice or potato or corn flour. In addition, by adding buckwheat to a diet or snack in a gluten-free diet, nutrients are most significantly improved, with an increase in protein, iron calcium and fiber (Kahlon, 2016). Compared with wheat, quinoa is more closely related to sugar beet and tumbleweed. It is a functional and nutritionally beneficial plant with many subspecies; buckwheat is grown along the coast of South America. quinoa naturally tolerates such large amounts of soil stress, climate and other natural environmental factors (Kamp *et al.*, 2014). Different types of quinoa have been adapted to cold climates, barren lands, high temperature, and nutrient-deficient soil (Alvarez-Jubete, 2010). There are many types of quinoa, only a few types are traded to the United States and most of which are of the same genome. Native Bolivians have altered different varieties of quinoa to persist on mountains with deficient soil and high winds, but it can be enhanced and harvested to live in most types of soil and climate conditions. One of its consequence that, quinoa grows best in low nutrient, thin soil. (Matt, 2011). Developing countries and less developed countries may use quinoa to provide adequate nutrition for their populations, rather than using large tracts of land to rise livestock. Quinoa is said to be more nutritious than other types of cereals and provides nutrients not found in animal-derived products. There is a good argument that Quinoa will provide more nutrients for the land used. Quinoa protein content is 12-18%, much greater than most grains. It is a good origin of soluble fiber and phosphorus and it is greater in magnesium and iron. Quinoa is usually gluten-free and easy to absorb (Garcia-mazcorro *et al.*, 2016). Quinoa is not only rich in protein, but the protein it provides is a complete protein, which means it contains all nine important amino acids. The amino acid account of buckwheat is not only balanced, making it a good quality for vegetarians to properly consume protein, but buckwheat is particularly suitable for amino acid lysine, that is important for muscle growth, development and repair (Alvarez-Jubete, 2010). Contrary to the protein quinoa also has much more benefits to health of the human being. As quinoa is a excellent origin of manganese and a good way to obtain magnesium, iron, copper, and phosphorus, this "pseudocereal" could be associated with migraines, diabetes Mellitus, cardiovascular disease, and especially atherosclerosis. In relationship with wheat, yellow corn and, barley quinoa has been found to be greater in calcium, phosphorus, magnesium, potassium, iron, copper, manganese and, zinc and has been lesser in sodium than the other grains (Jancurova *et al.*, 2009).

Amino acids and Proteins are essential macromolecules which perform a role of structural components as catalysts in many enzyme reactions, source of energy and synthesis of protein in the animal body. The biological value of a protein showed the quantity of protein absorbed from the diet then incorporates the protein in the body. The organic value of buckwheat is as high as 73%, which is equivalent to 74% of beef and greater than those of white rice 56%, wheat 49%, and corn 36%. Quinoa also includes ten important amino acids with a protein content of 12.9% to 16.5%. The main importance is the high lysine value and absent in numerous grains. It can be an necessary amino acid ,

and is less in many legumes (Díaz-rizzolo *et al.*, 2016). Carbohydrates play a role in signaling molecules, structural constituents and energy sources. For instance carbohydrate, starch is the main cause of physiological energy within the human diet. The percentage of starch in buckwheat is 58.1% to 64.2% of dry matter, of which 11% is amylose. In addition, buckwheat has great levels of D-xylose and maltose as well as low levels of glucose and fructose. 100 grams of buckwheat contains 1.70 mg of glucose, 0.20 mg of fructose, 2.90 mg of sucrose, and 1.40 mg of maltose. In addition, studies have shown that quinoa polysaccharides have antioxidant properties. Quinoa has a GI range of 35-53, depending on cooking time; 150 grams of buckwheat is cooked, chilled and heated in a microwave for another 1.5 minutes with a GI of 53. Overcooking do not effect quinoa quality. (Alvarez-Jubete, 2010; Filho, 2017).

Lipids are a concentrated source of energy and a structural component of the cell membrane that the body uses to perform various normal functions. Higher vegetable intake is related with less chances of type-II diabetes because they have higher un-saturated contents of fat, that is linked with lowering the level of infection. Lipid quality is essential. For example, omega-6 is known to stimulate inflammatory activity in vivo, while omega-3 has an anti-inflammatory effect (Chen *et al.*, 2019). A lower proportion of omega-6, omega-3 fatty acids is more suitable for reducing the chance of heart disease, cancer, inflammation, and auto immune disorder. The content of total lipid in buckwheat can be 14.5%, and about 70%-89.4% is certainly unsaturated (38.9%-57% for linoleic acid, 24.0%-27.7% for oleic acid, and 4% for α-linolenic acid). The vitamin E can be protected by unsaturated fatty acid content of plants. The ratio of omega-6 to omega-3 in buckwheat is approximately 6 (Rodríguez *et al.*, 2012);(Tang *et al.*, 2015)

Vitamins are substance vital for the fitness of human beings. Quinoa provides numerous supplements, with 100g of the grains comprising;

Thiamine : 0.4mg
Folic acid : 78.1mg folic acid,
Vit. C : 1.4mg
Vit. B6 : 0.20mg
Pantothenic acid: 0.61mg.
Vit. E varies from approximately 37-60 μg/g.
Tocopherol isoforms are also found:
Gamma-tocopherol: 47-53μg/g,
Alpha-tocopherol: 17-26 μg/g
β- and δ-tocopherol: less than 5μg/mg (Filho, 2017).

Dietary minerals are important as they maintain electrolyte and glucose level, nerve impulses transmission and enzyme co-factors in the animal body. Level of different minerals like Calcium, Mg, and potassium in quinoa is enough to balance the human diet. (Semra, N., and Senliar 2016) .

Gluten is present in the largest amount of food. Gluten is made up of proteins gliadin and glutenins. Immune-mediated disease celiac disease occur due to gluten in which inflammation of small intestine occurs. Therefore patients of this disease should consume gluten-free food (Kahlon, 2016). Some gluten free foods have more salt and saturated fat but contain less vitamins and minerals (Naqash *et al.*, 2017). Quinoa is a gluten free and healthy diet. It also contain extraordinary range of vitamins and minerals as well quinoa complies using the Codex Aliment Arius nomenclature of gluten-free products that is gluten content minor than 20 mg/Kg (Jancurova *et al.*, 2009).

Nutritional Profile and Antioxidant Potential of Quinoa Varieties: Razzeto *et al.*, 2019 studied the nutritional composition, identifies some antinutritional factors and antioxidant compounds, and evaluated their antioxidant activity in four advanced lines of quinoa seeds obtained in experimental plots. For that purpose, proteins, total lipids, fiber, moisture, ash, and carbohydrates, as well as fatty acid composition and mineral content, were determined in whole meal flours. The presence of trypsin inhibitors, saponins, nitrates, oxalates, and phytate was also evaluated, as well as total phenols and antioxidant activity. The new quinoa varieties have shown good nutritional properties, with higher contents of protein as compared to that of cereals. In that work, the examination of the proximate and mineral profile of quinoa indicated that the pseudocereal has a similar profile but considerably higher than rice, a traditional cereal. Quinoa is a rich in Mg, iron, manganese, copper, and molybdenum, which are elements that are incomplete in almost all gluten-free cereals. The tests performed on the evaluated antinutrient compounds resulted within the acceptable values for human consumption (Razzeto *et al.*, 2019). Quinoa seeds are also considered to have a large nutritional health benefit because they increase the amount of compounds beneficial to human well being, such as proteins, poly-unsaturated fatty acids, carotenoids, fiber and minerals. Extracts of these plants with various solvent mixtures containing ethanol and water has been formed using a microwave apparatus. Following UHPLC examination and photo-diode range can be used to quantify biologically active substances such as 7-sopentenyloxycoumarin, auraptene, umbelli-prenin and 4′-geranyloxyferulic acid. Ethanol is proved to be the optimum solvent with regards to extractive yields as well as the above-mentioned phyto-chemicals has been recorded within the concentration range 2.01–49.22 μg/g dried extract. Results shown here discovered that quinoa is a excellent source of oxyprenylated umbelliferone and ferulic acid derivatives (Fiorito *et al*, 2019). Studies reported that quinoa verities are safe for human consumption and beneficial due to the content of

nutrients and bioactive compounds that exert protection against many diseases (Razzeto *et al.*, 2019).

Conclusions: Quinoa is consumed and used as daily essential food throughout the world due to its higher amount of protein in relation to general cereals because it contains ascorbic acid, vitamin E tocopherols and B complex vitamins niacin, folic acid, thiamine. Minerals (calcium, potassium, iron, manganese, magnesium, phosphorus), it also contains isoflavones and the best type of triglyceride. A functional perspective of the quinoa plant is of great importance as are being used in the therapeutics and control of different health related issues.

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