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Physico-chemical and nutritional properties of quinoa seed: A review

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Abstract
Quinoa is considered as pseudo-cereals crop, it is a broad leaf plant with starchy dicotyledonous seed and therefore not a cereal. Quinoa grains have an established excellent nutritional food quality and were also called "the mother grain". Quinoa is one of the oldest crops in the Andean Region, with approximately 7000 years of cultivation history, great cultures like the Incas and Tiahuanacu had domesticated and conserved this ancient crop (Jacobsen, 2003). Quinoa is a complete food with high-nutritional value due mainly to its high content of good quality protein. Besides protein content, many studies have been made of their lipids, starch, minerals and saponins it also contains minerals and vitamins like vitamin B, vitamin C and vitamin E. Quinoa flour is low in gluten due the low contents of prolamines and glutamines. It is usually used to enhance baking flours in the preparation of biscuits, noodles, and pastries, and for the preparation of baked foods to maintain the moisture and give an agreeable flavor (Vilche *et al.* 2003).

Keywords: Physico-chemical, nutritional, quinoa seed

Introduction
Quinoa (pseudo-cereals) is one of the oldest crops in the Andean Region, with approximately 7000 years of cultivation history, great cultures like the Incas and Tiahuanacu had domesticated and conserved this ancient crop (Jacobsen, 2003) [9]. Botanically, quinoa belongs to the class Dicotyledoneae, family Chenopodiaceae, genus *Chenopodium*, and species *quinoa*. The full name is *Chenopodium quinoa Willd.* It is a very interesting food due to its complete nutritional characteristics. Quinoa is a complete food with high-nutritional value due mainly to its high content of good quality protein. In 1996, quinoa was catalogued by FAO as one of the most promising crops for the humanity, not only for its great properties and its multiple uses, and it is also considered an option to solve human nutrition problems (FAO, 2011) [5]. Quinoa is considered one of the best vegetal protein sources, as its protein levels are similar to those found in milk and higher than those present in cereals such as wheat, rice and maize. Quinoa flour is low in gluten due the low contents of prolamines and glutamines. It is usually used to enhance baking flours in the preparation of biscuits, noodles, and pastries, and for the preparation of baked foods to maintain the moisture and give an agreeable flavor (Vilche *et al.* 2003) [14]. There are some gluten-free products without good baking properties for celiac groups, and quinoa provides an opportunity to develop gluten-free cereal-based products (Gallagher *et al.,* 2004) [6]. Dogan and Karwe (2003) [4] showed that quinoa can be used to make novel, healthy, extruded, snack-type food products.

Quinoa as a novel food ingredient
Yamani and Lannes (2012) [15] reported that the use of quinoa (*Chenopodium quinoa* Willd.) and amaranth (*Amaranthus* spp.) is of great nutritional interest because of their peculiar composition and the minor components present in these grains. Sharma *et al.* (2015) [13] reported that quinoa (*Chenopodium quinoa Willd.*), which is considered a pseudo-cereal or pseudo-grain, it is highly nutritious due to its outstanding protein quality and wide range of minerals and vitamins. Jancurova *et al.* (2009) [10] reported that amaranth, buckwheat, and quinoa are high nutritious and dietary quality meets the demands of the food industry and consumers. Graf *et al.* (2015) [8] reported that quinoa contains a high content of health-beneficial phytochemicals, including amino acids, fiber, polyunsaturated fatty acids, vitamins, minerals, saponins, phytosterols, phytoecdysteroids, phenolics, betalains, and glycine betaine. Alvez *et al.* (2010) [1] reported that The quinoa is an excellent example of 'functional food' that aims at lowering the risk of various diseases. Functional properties are given also by minerals, vitamins, fatty acids and antioxidants that can make a strong contribution to human nutrition, particularly to protect cell membranes, with proven good results in brain neuronal functions.

Physico-chemical and nutritional properties of quinoa seed

Vilche *et al.* (2003) [14] studied physical properties of quinoa (*Chenopodium quinoa Willd.*) seed. In the moisture range from to 4-6 to 25-8% dry basis, the 1000 seed mass increased from to 2-5 to3-1 g, the sphericity from 0-77 to 0-80, the density from 928 to 1188 kgm-3, the porosity from 0-19 to 0-44, the angle of repose from 18 to 258, the static coefficient of friction from 0-14 to 0-27 and the terminal velocity from0-6 to 1-02ms-1. Only the bulk density decreased with moisture content from 747 to 667 kgm^3. Maradini-Filho (2017) concluded that quinoa contains higher amounts of protein and greater balance in the distribution of essential amino acids than cereals, resembling the biological value of milk protein. It exceeds cereals in the amount of lipids, proteins, dietary fiber, vitamins B1, B2, B6, C and E and minerals, mainly calcium, phosphorus, iron and zinc. Gordillo-Bastidas *et al.* (2016) [7] reported that quinoa has potential health benefits and exceptional nutritional value: a high concentration of protein (all essential amino acids highly bio available), unsaturated fatty acids, a low glycemic index; vitamins, minerals and other beneficial compounds; it is also gluten-free; furthermore, quinoa is a sustainable food, as plants exhibit a carbon and water food print that is between 30 and 60 times lower than that of beef. Bhathal *et al.* (2017) [2] studied the effect of processing on the nutritional composition of quinoa. Raw, roasted, boiled and sprouted forms of quinoa grains were nutritionally analyzed. Significant changes innutritional composition of quinoa were observed due to processing. The raw quinoa flour had higher amounts of crude protein (14.02%), crude fat (5.13%) and total ash (3.83%). Likewise, the amounts of lysine (6.5g/100gprotein), methionine (2.37g/100g protein) and tryptophan (0.97g/100g protein), as well as calcium (83.33mg/100g), magnesium (202.17mg/100g), zinc (4.23mg/100g) and acid detergent fibre (27.40%) were also higher in raw flour. Sprouting of quinoa enhanced the crude fibre (4.06%), neutral detergent fibre (77.73%) and the iron (5.67mg/100g) content. Raw flour and sprouted quinoa retained maximum nutrients as compared to other processed forms.

Utilization of quinoa seed flour in value added product

Kaur and Tanwar (2016) [11] prepared quinoa beverages from raw, soaked, germinated and malted quinoa seeds and investigated their antioxidant activity, ant diabetic and antihypertensive potential using *in vitro* models. Among all beverages, malted quinoa beverage (MQB) showed higher protein content (2.9 g/100ml), total phenolic content (2.9 mg Gallic Acid Equivalents (GAE)/ g), antioxidant activity (92%) which was well correlated with higher ant diabetic potential (40% at 150µL) by α-glucosidase inhibition. Very low α-amylase inhibition was exhibited by all the beverages (0.4-1.5 %). ACE inhibitory activity was almost negligible for raw quinoa beverage (RQB), soaked quinoa beverage (SQB), minor for germinated quinoa beverage (GQB) (0.2% at 300µL) and higher for MQB (0.9% at 300µL). Total phenolic content was found to be well correlated with DPPH (1, 1-Diphenyl-2-picryl-hydrazyl), α- glucosidase and α- amylase inhibition activity in all beverages but poor correlation was found in case of ACE inhibition activity. Lorusso *et al.* (2017) [12] prepared Pasta by replacing 20% of semolina with native and fermented quinoa flour and found that free amino acids, total phenols, and the antioxidant activity of pasta prepared with fermented quinoa flour were up to twice as high than the other types of pasta. Demir (2014) [3] prepared gluten-free tarhana by using different ratios (40:30:30, 50:25:25 and 60:20:20%) quinoa flour (QF), rice flour and potato starch instead of wheat flour and found that QF affected the colour (*L**, *a** and *b**) of gluten-free tarhana.

Conclusion

Thus in light of scientific data and litrature it may be concluded that quinoa seed is good source of macronutrient (carbohydrate, protien and fat) and micronutrient (vitamins, mineral) and phytochemicals. The quinoa is considered as gluten free grain and hence open the way of introducing this nutritious and medicinally important grain to daily food items to prevent celliac and other health problem.

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