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Mandhare LL
Department of Food Business Management, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

More DR
Department of Food Business Management, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Nagulwar MM
Department of Food Business Management, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Corresponding Author:
Mandhare LL
Department of Food Business Management, College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra, India

Quinoa a wonder grain: A review

Mandhare LL, More DR and Nagulwar MM

Abstract
Quinoa has extraordinary and promising nutritional and cultivation features, therefore supplementing or replacing of common cereal grains with quinoa carries high potential benefits to consumers worldwide. Quinoa is considered as pseudo-cereal 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 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. Quinoa can be used to make novel, healthy, extruded, snack-type food products. 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.

Keywords: Quinoa, nutritional, pseudo-cereal, novel, snack food

Introduction
Quinoa (Chenopodium quinoa willd) is a pseudo-cereal native to the Andean region of South America. (Maticevich *et al*., 2006) [19]. Quinoa belongs to the chenopodiaceae family, genus chenopodium. Its botanical name is Chenopodium Quinoa Willd, (Valencia- Chamorro 2003) [36].

Quinoa (pseudo-cereal) is one of the oldest crops in 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) [13].

In 1996, quinoa was catalogued by FAO as one of the most promising crop 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) [11]. The quinoa plant was widely cultivated in the whole Andean region in Columbia, Equator, Peru, Bolivia and Chile before the Spanish conquest. However, the habits and traditionally foods of natives were replaced with foreign crops such as Wheat and Barley. Therefore quinoa was cultivated either in small plantations in rural areas for domestic consumption or as borders for other crops such as potatoes or maize. For this reason, it was classified as food for poor people, (Valencia-Chamorro 2003) [36]

Classification
The classification of quinoa was first made from the colour of the plant and fruits. Subsequently, it was based on the morphological types of the plant. Quinoa collected in Equador, Peru and Bolivia has been classified into 17 races, however more races may exist. Two types of Inflorenscence have been described, (Valencia-Chamorro 2003) [36].

1. Glomerulus's- small groups of flowers (glomeruli) originating from tertiary axes.
2. Amaranthiformes- have glomeruli originating mainly from secondary axes.

Quinoa grows in the altitudes from the sea level to the Andean highlands. Thus the most useful classifications is that describing five ecotypes: sea-level, valley, subtropical, salar and antiplanic, (Valencia-Chamorro 2003) [36].

Cultivation
Quinoa is a dicot plant that can grow from 1-3 m high; it is considered a pseudo-cereal, not a true- grain but rather a fruit. The seeds are round and flat, about 1.5-4.0 mm in diameter and their colour varies from white to grey and black, with tones of yellow, rose, red, purple and violet. Quinoa has demonstrated a strong tolerance to salty, acid or alkaline solids, in both cold (-5 ^{0}C) or hot climates (up to 35 ^{0}C), (Vaga-Galvez *et al*., 2010 [37] and Jancurova *et al*., 2009)

[12] This grain has been authorized to be sown in Europe, North America, Asia and Africa. In Europe the project "Quinoa: a multipurpose crop for the European community" was approved in 1993, (Vega-Galvez *et al.*, 2010) [37].

Quinoa tolerates a wide range of acidic condition of the soil, from PH 6.0 to 8.5. The plant is not affected from around -1˚C. However, it tolerates high temperatures up to 35˚C. Quinoa is drought resistant. It is able to develop even in regions where the annual rainfall is in the range of 200-400 mm. The planting season varies from August in the Andean highlands, extending through December and in some areas from January to March. Seeds may be spread, but the weeds control and mechanized practices are used, (Valencia-Chammoro 2003) [36]. Quinoa is harvested at physiological maturity. The grains become dry and hard, making it difficult to break them with a finger nail. Physiological maturity may be reached within 70-90 days after flowering. Depending on the variety plants take between 5 and 8 months of mature. The yield of quinoa can be in the range of 45-500 g/m^2 depending on the variety and growing conditions.

Nutritional profile

The effects of globalization and urbanization have influenced dietary patterns and lifestyle behaviors among population groups throughout the world. Traditional food patterns rich in complex carbohydrates, micronutrients, fiber and phytochemicals are being replaced with diets high in animal fats and refined carbohydrates and oils, a situation that has made a direct impact on the prevalence of certain chronic disease, (Schaffer-lequart *et al.*, 2015) [29].

For this reason, many researchers devote their efforts to analyzing food or food components that may prove to be healthy for human consumption, (Jancurvoa *et al*., 2009) [12]; one example is the work of Healthgrain consortium, which of notes has included quinoa in its list of healthy grains,(Van der Kamp *et al*., 2014) [38]. In comparison to most cereals, quinoa seeds have a higher nutritional value, (Matiacevich *et al*., 2006) [19].

Protein

The protein content of quinoa seeds varies from 8% to 22%, which is higher on average than that in common cereals such as rice, wheat, and barley. In quinoa most of the protein is located in the embryo, (Valencia-Chamorro 2003) [36]. (Repo-Carrasco *et al.*, 2003) [23]. Contains higher amount of lysine and act as a good complement for legumes, which are deficient in methionine and cysteine.

The nutritional evaluation of debittered raw quinoa has reported protein efficiency ratio (PER) of 78-93% that of casein and was found greatly improved post cooking and became 102-105% of casein, (Valencia-Chamorro 2003) [36].

As per the FAO/WHO pattern suggested for preschool children, quinoa containing all essential amino acids with no deficiency of any of them, considered to have the best amino acid profile. Quinoa is also good source of histidine, isoleucine, phenyl alanine, tyrosine, leucine and tryptophan contents, (Beatriz and Suzana 2012) [4].

Lipid

The lipid content of quinoa ranges from 5.2 to 9.7%, approximately two times higher than cereals like maize and wheat, (Alvarez-Jubete *et al*., 2010 (a)) [1] and Valencia-Chamorro 2003) [36] also reported fat content ranging from 2-10%. The high lipid content and the fatty acid profile of quinoa similar to that of maize and soybean oil makes it a suitable alternative for oilseeds, (Koziol 1992) [16].

The most abundant fatty acid in quinoa is linoleic acid (omega-6) ranging from 48.2-56.0% followed by oleic acid ranging from 24.5-26.7% and palmitic acid from 9.7-11.0%, constituting 14% (Beatriz and Suzana 2012) [4] of total fatty acids, (Alvarez Jubete *et al.*, 2009 (a) [2]; Bruni *et al*., 2001 [5] and Ruals *et al*., 1994(a) [26]. Inspite of high amount of lipids, quinoa lipids are stable against oxidation because of the α-tocopherol (Vitamin-E 0.59-2.6 mg/100g,) (Riyan *et al*., 2007) [25] naturally occurring in it, (Koziol *et al*., 1992 [16] and Schoenlechner *et al*., 2008) [30].

Carbohydrate

The starch content of quinoa ranges from 58.1 to 64.2% with a granular diameter of 2 µm and is smaller than the size of starch of common grains, (Repo-Carrasco *et al.*, 2003) [23]. The amylose content ranging from 3.5 - 22% (Qian and Kuhn 1999(b)) [22] and Schoenlechner *et al*., 2008) [30] found in quinoa starch.

Gelatinization temperature of quinoa ranges from 55.5-72.0 ˚C, (Bacigalupo and Tapia 1997) [6] and contains free sugars in small quantities, (Repo-Carrasco *et al*., 2003) [23]. About 12.88 to 14.20% dietary fiber is present in quinoa, particularly in the embryo, (Beatriz and Suzana 2012) [4] and its soluble fiber can be reduced be cooking and autoclaving without affecting in insoluble fiber, (Ruales and Nair 1994(a)) [26].

Minerals

Quinoa is a good source of minerals, which is about 2 times of the mineral content in cereals. Ca, Mg, Fe, and Zn are found in fairly high amount in quinoa, (Repo-Carrasco *et al*., 2003) [23]. Gluten free diets are generally deficient in Ca, Mg and Fe that makes the use of quinoa as an aid to reduce the deficiency, (Alvarez-Jubete *et al.*, 2010(a)) [1] as it is found to be rich in these elements.

Vitamins

The composition of vitamins in quinoa resembles that of cereals, (Taylor and Parker 2002) [34]. Adequate amount of thiamine varying from 0.29 to 0.36%, riboflavin ranging from 0.30-0.32%, vitamin B6, 0.487% and total folate 0.18% are present in quinoa, while niacin level found was very low. Ascorbic acid found in quinoa varies from 4.0 to 16.4 mg/100 g, (Koziol 1992) [16]. The quinoa grains are stable towards oxidation owing to the presence of vitamin E and vitamin C that acts as potential antioxidants, (Riyan *et al*., 2007) [25].

Bioactive compounds

Saponin are steroid and triterpenoid glycosides found in varies plant species, (Repo-Carrasco *et al.*, 2003) [23]. They are the major anti-nutritional factors in quinoa with their values ranging from 0.2-0.4 g/kg in bitter types, (Masterbroek *et al.*, 2000) [20] concentrated mostly in the pericarp that gives it a bitter taste, (Repo-Carrasco *et al*.,2003) [23]. Threshold value for the bitter taste in quinoa is 100 mg /100 g, (Koziol 1991 [15] and Taylor and Parker 2002 [34]). Saponin can be eliminated by either dry methods (toasting and subsequent rubbing of the grains to remove the outer layers and wet methods (washing and rubbing in cold water), (Risi and Galwey 1984) [28].

Quinoa is also a very good source of flavonoids which comprise mainly of glycosides of flavonoids, kaempferol and quercetin, (Dini *et al*., 2004) [8]. The antinutritional factor, phytic acid, has been reported to present from 0.7 to 1.2%, (Ruales and Nair 1994(b) [27] and Koziol 1992 [16]) which can be reduced up to 30% by soaking and germination, (Valencia *et al*., 1999) [40].

Utilization

Similar to rice, its seeds are consumed in soups, by puffing them to make breakfast cereals, or by flouring them to produce baked products like cookies, bread, biscuits, pasta, crisps, tortilla and pancake, (Bhargava *et al*., 2006) [3]. Quinoa leaves are consumed in a similar way to those of spinach, (Oleke *et al*., 1992) [21] and its sprouts are added to salad, (Schlick and Bubenheim 1996) [31].

In addition, quinoa seeds can be fermented to make beer or a kind of traditional alcoholic drink used for religious ceremony called chichi in South America, (FAO 2011) [11]. Gluten free spaghetti type product was produced using quinoa and corn, (Caperuta *et al*., 2001) [7]. (Schoenlechner *et al*., 2004) [33] Produced gluten free pasta using buckwheat and quinoa. Popped or extruded amaranth and quinoa were used to produced granola bars and muesli with good sensory characteristic, (Schoenlechner, 1997) [32] and Weche *et al*., 1996) [41].

The use of quinoa as a rice displacement, hot breakfast cereal and infant food boiled in water. Soil state fermentation of quinoa with *Rhizopus oligosporus saito* provides a good quality tempeh, (Valencia- Chamorro 2003) [36].

Quinoa flour can be mixed with maize or wheat flour. Several levels of quinoa flour substitution have been reported, for instance, in bread (10-13% quinoa flour), noodles, pasta (30-40% quinoa flour), and sweet biscuits (60% quinoa flour), (Valencia-Chammoro 2003) [36]. The seeds are boiled like rice or used to thicken soup or as porridge. Quinoa flour was made into noodles. Such a use is, however, complicated due to the bitter taste of seeds because of their saponin content which forms a soapy solution in water.

Studies on the stability of vanillin entrapped within the spherical aggregates obtained from Amaranth (*Amaranthus paniculatus* L.) Quinoa (*Chenopodium quinoa* willd), Rice (*Oryza sativa* L.) and Colocassia (*Colocassia esculenta* L.) in the presence of Arabic gum, carboxymethyl cellulose (CMC) and Carrageenan at 0.1-1.0% as bonding agents, were carried out using spray drying of 20% starch dispersion at 120%. Vanillin was used at 5% based on starch, (Tarai *et al*., 2003) [35].

Prepared quinoa beverages from raw, soaked, germinated and malted quinoa seeds and investigated their antioxidant activity, anti-diabetic and antihypertensive potential using in vitro model, (Kaur and Tanwar 2016) [17].

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, (Lorusso *et al.*, 2017) [18]. Prepared gluten free tarhana by using different ratios (40:30:30, 50:25:25, 60:20:20%) quinoa flour, rice flour and potato starch instead of wheat flour and found that quinoa flour affected the colour of gluten free tarhana, (Demir 2014) [9].

References

1. Alvarez-Jubete L, Arendt E, Gallagher E (a). Nutritive value of pseudo-cereals and their increasing use as functional gluten free ingredients. Trends in Food Science and Technology. 2010; 21(1):106-113.
2. Alvarez-Jubete L, Arendt E, Gallagher E (a). Nutritive value and chemical composition of pseudo-cereals as gluten free ingredients. International Journal of food Science and Nutrition. 2009; 60(1):240-257.
3. Bhargava A, Shukla S, Ohri D. Chenopodium quinoa – An Indian perspective. Industrial Crops and Products. 2006; 23(1):73-87.
4. Beatriz VY, Suzana CS. Applications of quinoa (*Chenopodium quinoa* willd.) and Amaranth (Amaranthus Spp.) and their influence in the nutritional value of cereal based foods. Food and Public Health. 2012; 2(1):265-275.
5. Bruni R, Medici A, Guerrini A, Scalia S, Poli F, Muzzoli M *et al*. Willd *Amaranthus caudatus* seed oil, a nutraceutical resource from Ecuadorian flora. Journal of Agriculture and Food Chemistry. 2001; 49(1):5455-5460.
6. Bacigulapo A, Tapia M. Agroindustria Tapia, M., ed, Cultivos Andinos Subexplotados y su Aporte a la Alimentacion. Satiago. Chile: Officina Regional de la FAO para America Latina y el Caribe, 1997.
7. Caperuto LC, Amaya-Farfan J, Camargo RO. Performance of quinoa (*Chenopodium quinoa* willd) flour in the manufacture of gluten free spaghetti. Journal of the Science Food and Agriculture, 2001, 95-101.
8. Dini I, Tenore GC, Dini A. Phenolic constituents of Kancolla seeds. Food Chemistry. 2004; 84(1):163-168.
9. Demir MK. Use of quinoa flour in the production of Gluten free tarhana. Food Science and Technology Research. 2014; 20(5):1087-1092.
10. Dogan H, Karwe M. Physicochemical properties of quinoa extrudates. International Journal of Food Science Technology. 2003; 9(1):101-114.
11. FAO. Quinoa: An ancient crop to contribute to world food security. Technical report of the 37th FAO Conference, Rome. Italy, 2011.
12. Jancurova M, Minarovicova L, Dandar A. Quinoa - a review. Czech. Journal of Food Science. 2009; 27(1):71-79.
13. Jacobsen SE. The worldwide potential for quinoa (*Chenopodium quinoa* willd). Food Reviews International. 2003; 19(1):167-177.
14. Koziol M. Quinoa: A potential new oil crop. In: New crops. Janick J and Simon J.E. Eds. Wiley New York, 1993, 328-336.
15. Koziol MJ. Afrosimetric estimation of threshold saponin concentration for bitterness in quinoa (*Chinopodium quinoa* willd). Journal of the Science Food and Agriculture. 1991; 54(1):211-219.
16. Koziol MJ. Chemical composition and nutritional evaluation of quinoa (chenopodium quinoa willd). Journal of Food Composition and Analysis. 1992; 5(1):35-38.
17. Kaur I, Tanwar B. Quinoa beverages: formulation, processing & potential health benefits. Rom Journal of Diabates Nutritional and metabolic diseases. 2016; 23(2):215-225.
18. Lorusso A, Verni M, Montemurro M, Coda R, Gobetti M, Rizello CG. Use of fermented quinoa flour for pasta making and evaluation of the technological and nutritional features. Food Science and Technology. 2017; 78(1):215-221.
19. Matiacevich SB, Castellion ML, Maldonado SB, Buero MP. Water dependent thermal transitions in quinoa embryos. Thermochimica Acta. 2006; 448(1):117-122.

20. Masterbroek HD, Limburg H, Giles T, Marvin HJP. Occurrence of Sapogenins in leaves and seeds of quinoa (*Chenopodium quinoa* willd.). Journal of the Science of Food and Agriculture. 2000; 80(1):152-156.
21. Oelke EA, Putnam DH, Teynor TM, Oplinger ES. Quinoa. Alternative Field Crop Manual. University of Wisconsin-Extension accessed, 1992, 21.04.16. https://www.hort.purdue.edu/newcrop/afcm/quinoa.html.
22. Quian JY, Kuhn M (b). Characterization of Amaranthus Cruentus and *Chenopodium quinoa* starch. Starch/starke. 1999; 51(1):116-120.
23. Repo-Carraasco R, Espinoza C, Jacobsen SE. Nutritional value and use of the Andean Crops quinoa (*Chenopodium quinoa*) and Kaniwa (*Chenopodium pallidicaule*). Food Reviews International. 2003; 19(1):179-189.
24. Ruales J, Nair BM. Content of fat, vitamins and minerals in quinoa (*Chinopodium quinoa*, willd) seeds. Food Chemistry. 1993; 48(1):131-136.
25. Ryan E, Galvin K, O'Connor T, Maguire AR, O' Brien NM. Phytosterols, Squalene, tocopherol content and fatty acid profile of selected seeds, grains and legumes. Plant Food Human and Nutrition. 2007; 62(1):85-91.
26. Ruales J, Nair BM (a). Properties of starch and dietary fiber in raw and processed quinoa (*Chenopodium quinoa*, willd) seeds. Plant Foods Human Nutrition. 1994; 45(1):223-246.
27. Ruales J, Nair BM (b). Effect of processing on in vitro digestibility of protein and starch quinoa seeds. International Journal of Food Science. Technology. 1994; 29(1):449-456.
28. Risi J, Galway NW. The chenopodium grains of the Andes: Inca crops for modern agriculture. Annals of Applied Biology. 1984; 10(1):145-216.
29. Schaffer-Lequart C, Lehmann U, Ross AB, Rogger O, Eldridge AL *et al.*, Whole Grain in Manufactured Foods: Current use, challenges and the way forward. Critical Reviews in Food Science Nutrition (ahead of print), 2015.
30. Schoenlechner R, Siebenhandl S, Berghofer E. Pseudo-cereals. In: Arendt. E.K, Bello F.D. Gluten free cereal products and beverages. Academic press. Chapter. 2008; 7:149-190.
31. Schlick G, Bubenheim DL. Quinoa: candidate crop for NASA's controlled ecological life support systems. In Janick, J. (ED), Progress in New Crops. ASHS Press, Arlington, VA, 1996, 630-640.
32. Schoenlechner R. Entwicklung und Charakterisierung von Convenience-Produkton aus Amaranth and Quinoa. Diplomarbeit, University of Natural Resources and Applied Life Sciences. Vienna. Austria, 1997.
33. Schoenlechner R, Juracková K, Berghofer E. Pasta production from the pseudo-cereals amaranth, quinoa and buckwheat. In proceedings 12th ICC cereal and bread congress. Harrogate. UK, 2004.
34. Taylor JR, Parker ML. Quinoa: In, Belton PS and. Taylor JRN (Eds). Pseudo-cereals and less common cereals: Grain properties and utilization. Berlin. Springer Verlag, 2002, 93-122.
35. Tarai TA, Annapure US, Singhal RS, Kulkarni PR. Starch-based spherical aggregates: screening of small granule sized starches for entrapment of a model flavoring compound, vanillin. Carbohydrate polymers. 2003; 53(1):45:51.
36. Valencia-Chamorro SA. Quinoa. In: Caballero. B. Encyclopedia of Food Science and Nutrition, Academic Press, Master Dam. 2003; 8(1):4895-4902.
37. Vega-Galvez A, Miranda M, Vergara J, Uribe E, Puente L, Martinez EA. Nutritional facts and functional potential of quinoa (*Chenopodium quinoa* willd), an ancient Andean grain: a review. Journal of the Science of Food and Agriculture. 2010; 90(15):2541-2547.
38. Vander Kamp JW, Poutanen K, Seal CJ, Richardson DP. The Healthgrain definition of 'whole grain. Food and Nutrition Research. 2014; 16(1):163-8.
39. Vilche C, Gely M, Santalla E. Physical properties of quinoa seeds. Bio systems Engineering. 2003; 86(1):59-65.
40. Valencia S, Svanberg U, Sandberg AS, Ruales J. Processing of quinoa, Willd: Effects on *in vitro* iron availability and phytate hydrolysis. International Journal of Food Science and Nutrition. 1999; 50(1):203-211.
41. Wesche-Ebeling P, Argaiz-Jamet A, Teutli- Olvera B, Guerro-Beltran JA, Lopez-Malo A. Development of high quality granola containing popped amaranth grain varying in fat content, sweetness and degree of toasting. Institute of Food Technologists. Annual Meeting: Abstracts, 1996, 51.