Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(4): 1488-1489
Received: 01-05-2017
Accepted: 02-06-2017

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Nutrition facts and functional potential of quinoa (*Chenopodium quinoa*), an ancient Andean grain: A review

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Abstract
In this era of ever-increasing world population, newer food and feed crops that have been hitherto neglected are gaining recognition. The rejection of such lesser-known food crops has been due not to any inferiority but to the lack of research resources in the place of origin and often to their being scorned as “poor people’s plants.” The genus Chenopodium supplies tasty and nutritious leaves as well as pink- to cream-coloured edible seeds. Tolerance to cold, drought, and salinity and the high lysine content of the seed protein are the attractive features of quinoa (*Chenopodium quinoa*), the most frequently consumed species in the Andean regions of South America, Africa, some parts of Asia, and Europe. This review compares and evaluates the nutritional and antinutritional constituents of the seeds of *C. quinoa*.

Keywords: *Chenopodium quinoa*, Pseudocereals, Antioxident.

Introduction
The Indian subcontinent is a large land mass covering India, Pakistan, Nepal, Sri Lanka and Bangladesh and it sustains 20% of the world’ population. The area is prone to degradation of its natural resources due to intensive cultivation leading to declining soil fertility, changes in water table depth, deterioration in the quality of irrigation water, and rising salinity in the region. Much of the population has little access to a protein-rich diet, since wheat and rice are the principal food grains grown and consumed in the area. The growing population necessitates increased food production combined with a shift towards environmentally sound sustainable agriculture. It is therefore important to select crops requiring fewer inputs while able to respond to the nutritional deficiency prevalent in the region. Quinoa is still an “underutilized” crop, given its nutritional superiority over traditional crops and its wide adaptability to diverse agronomic conditions, and its commercial potential in South Asia has remained untapped. Quinoa, seed plant of *Chenopodium quinoa* is an annual broad-leaved plant, 1-2 m tall with deep penetrating roots which can be cultivated from sea level upto an altitude of 3800 m. It is a grain with intrinsic outstanding characteristics. Aspects like exceptional nutritional quality, genetic variability, adaptability to adverse climate and soil conditions, and low production cost constitutes quinoa as a strategic crop with potential contributor to food security and sovereignty. Quinoa adapts to desert, hot and dry climates. This crop can grow with relative humidity from 40% to 88%, and survive with temperatures from -4 °C to 38 °C. It is resistant to low soil moisture, and can produce acceptable yields even with precipitations from 100 to 200 mm. Due to its ability to adapt to adverse climate and soil conditions where other crops are unable to grow, harvest can be obtained at altitudes from sea level to 4000 m. The cultivation of quinoa provides an alternative for countries with limited food production. The history of its human consumption reaches back 5000 years (Ando *et al.* 2002; Oelke *et al.* 2012) [1, 13]. Quinua (*Chenopodium quinoa*) has been cultivated in the Andean region for several thousand years, being one of the main grain crops supplying highly nutritious food.

Quinoa is an important food source for human consumption in the Andean region and has immense industrial value (Bhargava *et al.* 2006; Fuentes and Bhargava, 2011) [3, 8]. The crop grows in different ecological zones, from sea level to 2 000– 4 000 m asl (Bazile *et al.* 2013; Fuentes and Bhargava 2011) [2, 8]. Quinoa has been selected by FAO (2014) [7] as one of the crops destined to offer food security in the 21st century, because the quinoa plants are tolerant to salinity and drought stress, and can grow on marginal regions (Jacobsen *et al.* 2003) [10]. The edible seeds of quinoa are small, round and flat. Seed colors can range from white to grey and black, or can be yellow and red.*Chenopodium quinoa* was considered as the mother of cereals.

Today everyone knows that it is one of the oldest crop plants, included in the group of the so-called 'pseudo cereals'. Seeds of this species are distinguished by high nutritive value because of its very good chemical composition, high proportion of vitamins, microelements, fat, including essential unsaturated fatty acids (EFA), mainly linoleic and linolenic acids (Coulter and Lorenz 1990) [5]. However, the greatest advantage of this plant is the content and quality of protein. Quinoa seed have a high protein content (about 15%), and its essential amino acid balance is excellent, because of a wider amino acid spectrum than cereals and legumes (Ruales and Nair, 1993) [16], with higher lysine (5.1–6.4%) and methionine (0.4–1.0%) contents. Quinoa contains lysine, methionine and cysteine higher than common cereals and legumes making it complementary to these crops. Quinoa's protein quantity ranged from 10.4% to 17.0% depending on its variety.

The seeds are an excellent example of functional food, defined as lowering the risk of various diseases and exerting health-promoting effects (Repo Carrasco *et al.* 2011; Vega-) [11]. Besides nutrients, quinoa contains bitter and toxic compounds (saponins) especially in the hull. Therefore, quinoa in most cases is dehulled/polished and washed (Lopez Garcia, 2007) [12]. Research is focusing on developing effective dehulling methods to remove saponins and on cultivating new 'sweet' cultivars that contain less saponins (Galwey *et al.* 1990; Koziol, 1992; Reichert *et al.* 1986) [9, 11, 14].

Quinoa farming and consumption in India is still at a nascent stage however recent impetus in this direction has already been taken. One of recent project "project Anantha" by Andhra Pradesh was sought to push quinoa, with its lower water intake, as an alternative crop in the dry terrain of Anantapur district. The United Nations has declared 2013 the International Year of Quinoa, which aims at focusing global attention on the role it can play in contributing to food security, nutrition and poverty eradication and policies (Burlingame *et al.* 2012; FAO, 2013) [4, 6]. The worldwide popularity of quinoa and initial promising reports from Asia make it an important candidate as an alternative crop in this region. And this could be achieved only by an integrated effort at all levels: information, awareness, popularization, research and marketing.

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