AgriCos e-Newsletter
ISSN: 2582-7049
Volume: 02 Issue: 06 June 2021 Article No: 34

Quinoa-an Excellent Functional food, its Properties and Good Agricultural Practices (GAPs)

Chamling N.[1], Gurung N.[2], Subba P.[3], Shivakoti I. P.[3] and Bhutia T. T.[3]
[1]Deputy Project Director ATMA, South Sikkim, Government of Sikkim
[2]Scientist, Indian Agriculture Research Institute, Regional Research Station, Kalimpong, W.B.
[3]Senior Officials, Agriculture Department, Government of Sikkim

SUMMARY

Quinoa has earned the "superfood" nickname, because of its nutrient-dense attributes. The protein quality and quantity in quinoa seed is often superior to those of more common cereal grains. Quinoa grain has higher calcium, phosphorus, magnesium, potassium, iron, copper, manganese and zinc than wheat, barley or corn. Quinoa is used as whole grain that is cooked separately as rice, to make flour, soup, breakfast cereal and alcohol. Quinoa flour can be used for making biscuits, bread and processed food. Studies in the Himalayas and the plains of Northern India have shown that the crop can successfully produce high yields in those areas where the diet is based on rice and wheat, quinoa would be an effective alternative to combat "silent hunger" and low protein diets.

INTRODUCTION

Quinoa is a species of the goosefoot genus (*Chenopodium quinoa*), a grain crop grown primarily for its edible seeds. It is a pseudocereal rather than a true cereal, as it is not a member of the true grass family. As achenopod, quinoa is closely related to species such as beetroots, spinach and tumbleweeds. As a member of the Amaranthaceae family, it is related to and resembles amaranth, which is also a pseudocereal. It is high in protein, and is tolerant of dry soil. 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), archaeological findings in Peru and Argentina indicate presence of quinoa seeds around the beginning of the Christian era (Heisser and Nelson, 1974). Quinoa seeds contain essential amino acids like lysine and acceptable quantities of calcium, phosphorus, and iron. After harvest, the seeds must be processed to remove the coating containing the bitter-tasting saponins. The seeds are in general cooked the same way as rice and can be used in a wide range of dishes. The leaves are eaten as a leaf vegetable, much like amaranth, but commercial availability of quinoa greens is limited.

Photo 1. Variability of Quinoa panicles and grain colour

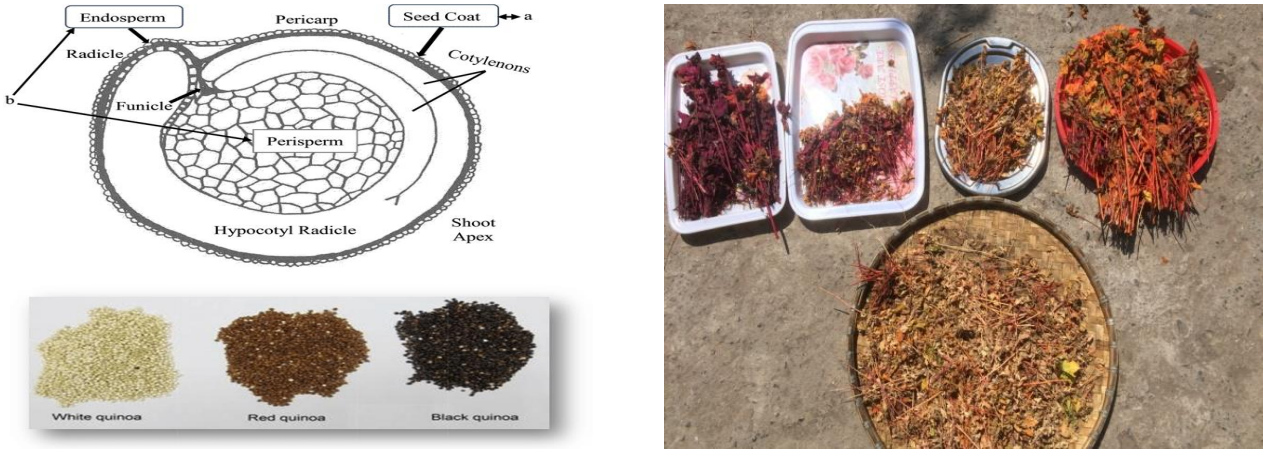

Photo 2. Seed structure and diversity of quinoa seeds grown in Sikkim State, India

Quinoa is a rich source (>20% of the Daily value, DV) of the B vitamins thiamine, riboflavin, vitamin B6, and folate and is a rich source of the dietary minerals iron, magnesium, phosphorus, and zinc. Quinoa is also a good source (10-19% of DV) of the B vitamins niacin and pantothenic acid, vitamin E, and the dietary mineral potassium. The pseudo cereal contains a modest amount of calcium, and thus is useful for vegans and those who are lactose intolerant. It is gluten-free and considered easy to digest. Because of these characteristics, it is being considered a possible crop in NASA's Controlled Ecological Life Support System for long-duration human occupied space flights. Quinoa can be eaten as a rice replacement, as a hot breakfast cereal, or can be boiled in water to make infant cereal food. The seeds can even be popped like popcorn. Seeds can be ground and used as flour, or sprouted. The sprouts need to get green before they can be added to salads (Valencia-Chamorro, 2003). Although quinoa is a fully domesticated species, its seed still contain saponin, removal of toxic saponins is necessary before they can be consumed (Mujica, 1992; Heisser and Nelson, 1974). The saponin content in quinoa varies between 0.1 and 5%. The pericarp of the quinoa grain contains saponin, which gives a bitter taste and must be eliminated so that the grain can be consumed. Saponins are organic substances of mixed origin, as they come from both triterpenoid glycosides (with a slightly acid reaction), as well as steroid derivatives of perhydro 1.2 cyclopentano phenanthrene. These molecules are concentrated in the hull of the grain and represent the main antinutritional factor. Saponins have no well-defined chemical formula for the dual source explained above, however, in general, the following basic skeleton is suggested: CnH2n-8O10 (with $n \geq 5$). It has a notably short germination period: only 2–4 hours in a glass of clean water is enough to make it sprout and release gases, as opposed to 12 hours with wheat. This process, besides its nutritional enhancements, softens the seeds, making them suitable to be added to salads and other cold foods.

Table 1. Chemical properties of quinoa in comaparison to other cereals

Energy value	Quinoa	Wheat	Rice	Maize
Kcal/100g	350.00	309.00	353.00	338.00
Protein/100g	13.81	11.50	7.40	9.20
Fat/100g	5.01	2.00	2.20	3.80
Carbohydrates/100g	59.74	59.40	74.60	65.20
Calcium mg/100g	66.60	43.70	23.00	15.00
Phosphorus mg/100g	408.30	406.00	325.00	256.20
Magnesium mg/100g	204.20	147.00	157.20	120.00
Potassium mg/100g	1040.0	502.00	150.00	330.00
Iron mg/100g	10.90	3.30	2.60	-
Manganese mg/100g	2.47	3.40	1.10	0.48
Zinc mg/100g	7.47	4.10	-	2.50

Source: Quinoa: A Nutritional Healthy Grain. International Journal of Advanced Research. Sharma et al. (2015).

Table 2. Nutritional properties of quinoa in comaparison to other staple foods (%)

Components (%)	Quinoa	Meat	Eggs	Cheese	Cow Milk	Human Milk
Proteins	13.00	30.00	14.00	18.00	3.50	1.80
Fats	6.10	50.00	3.20	-	3.50	3.50
Carbohydrates	71.00	-	-	-	-	-
Sugar	-	-	-	-	4.70	7.50
Iron	5.20	2.20	3.20	-	2.50	-
Calories per 100 g	350.00	431.00	200.00	24.00	60.00	80.00

Source: Agrifood Report, 2009, MDRT-BOLIVIA.

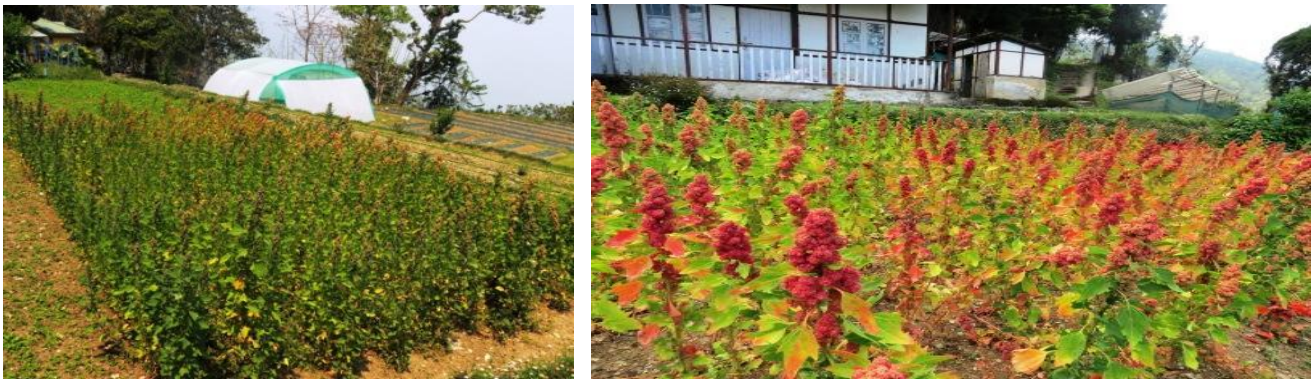

Photo 3. On Farm Trials (OFTs) being carried out at different KVKs of Sikkim

Good agricultural practices for Quinoa

Quinoa has potential agronomic importance because it can adapt to produce high yields under adverse conditions and contribute to food security in different regions worldwide (Wilson, 1985). Studies in the Himalayas and the plains of Northern India have shown that the crop can successfully produce high yields in this region (Bhargava *et al*., 2006). In this area, where the diet is based on rice and wheat, quinoa would be an effective alternative to combat "silent hunger" and low protein diets.

1	***Growth Habit***	Grows 1.5 to 6.5 feet (46 to198 cm) in height. Colours vary from white, yellow, pink, dark red, purple and black. Seeds can be black, red, pink, orange, yellow or white in colour.
2	***Climate***	Requires short daylights and cool temperatures for good growth. Temperature should not exceed 35^0C. Tolerant to very low temperature. Quinoa will flower earlier when grown in areas with short day lengths.
3	***Soil***	Grows well on sandy loam to loamy sand soils.
4	***Seed germination***	Germination occurs within 24 hours after planting when adequate moisture is present, and seedlings emerge in three to five days. Quinoa seeds may not germinate if conditions are warm and may need to be refrigerated for a week (vernalized) to obtain adequate germination.
5	***Seedbed preparation***	Quinoa requires a level, well-drained seedbed in order to avoid water logging.
6	***Varieties***	Blanca de Juli, Kcancolla, La Molina 89, Sajama, Ancovinto, Cancosa, Cahuil, Faro, Regalona and Villarrica

7	***Method and Rate of Seeding***	Seeds should be planted at a depth of 1/2 to 1 inches (1.2 to 2.5 cm). Row width can vary, but rows should be spaced by a minimum of 14 inches (36 cm). Seeding rates are usually doubled when growing conditions are not optimal. Better stands are obtained when seed is planted in a moist soil, instead of irrigating after planting prior to emergence. Increasing plant density results in a slightly earlier maturity, greater seed yield, and less - branching of plants.
8	***Fertility Requirements***	Quinoa responds well to nitrogen fertilizer. Maximum yields are possible when 68 to 82 kg N/acre is available. Yields declines when greater levels of available nitrogen are present due to a slower maturity and more intense lodging.
9	***Water Requirements***	This crop is somewhat drought tolerant with a water requirement of 10 to 15 inches (25 to 38 cm) per year (precipitation and irrigation combined on sandy-loam or loamy-sand soils). Application of lower amounts of water reduces plant height by 50% with only an 18% reduction in yield. Plants should not be irrigated until the two or three leaf stage. Excessive irrigation after stand establishment usually produces tall, lanky plants with no yield improvement. Damping off and severe stunting of plants will occur with excessive irrigation in the seedling stages.
10	***Weed control***	Weed control in quinoa fields is difficult since plants grow slowly during the first two weeks after emergence. Lambs quarters have been the most common weed. Wild mustard and sunflower can be a problem since it is not possible to separate them from quinoa seed. Competition from weeds is greater when quinoa is planted later in the growing season.
11	***Diseases***	Disease and pest problems may arise after a crop like quinoa is introduced to a new production area. Viruses found on spinach or beets have been observed in quinoa fields too. Many of these viruses are transmitted by aphids or leafhoppers. Several of the viruses tested produce symptoms, yet research needs to be conducted to determine if any cause significant damage. Several fungal diseases also attack chenopods in Himalayas downy mildew (*Peronospora* sp.), damping off (*Sclerotium* sp.), leaf blight (*Cercospora* sp.), etc. (Partap & Galwey 1995). Bacterial blight (*Pseudomonas* sp.) can occur and cause significant losses.
12	***Insects Pests***	Flea beetles, aphids and a wide variety of caterpillars (insect larvae) are the pests of quinoa. Since this crop requires little water, the soil will crack and allow aphids access to the roots. The "quinoa plant bug" (*Melanotrichus* sp.) and the beet armyworm (*Spodoptera exigua*) have also reduced yields in some research fields. *Bacillus thuringiensis*, a naturally occurring bacterium that controls certain insect larvae, can be used to control the defoliating caterpillars. Seed in the panicle is subject to feeding losses by birds.

13	***Harvesting***	Plants have a sorghum-like seed head at maturity. Harvest usually begins when the seed can barely be dented with a fingernail and plants have dried, turned a pale yellow or red color, and leaves have dropped. The seed should thresh easily by hand at this time. Field dry down is usually acceptable and a fanning mill and gravity separator is usually necessary to remove trash from the seed after combining. Grain must be dried before storage. Rain during harvest will cause problems since mature seed will germinate within 24 hours after exposure to moisture.
14	***Drying and Storage***	The seed must remain dry during storage. Prior to using quinoa in food processing, the saponins in the pericarp are removed by soaking them in water or by mechanical methods, such as with a rice polisher or a machine similar to those used to remove wheat bran (preferably dehuller machine).
15	***Yield Potential***	An average yield from an acre is about 454 kilograms.

CONCLUSION

Quinoa is a highly nutritious food. According to the USDA, one cup of cooked quinoa has 2.8 grams of iron, or 15% of our daily recommended intake. That is four times the amount of iron per serving than brown rice. It also has 10 times more folate, a nutrient women have a difficult time finding. It can be grown from sea level to an altitude of 4000 meters, and can withstand temperatures from minus eight to 38 degrees celsius. Hence, owing to its nutritional benefits and its ability to withstand unfavourable conditions to some extent, this crop can be taken up in our country through on farm trials and frontline demonstrations and the varieties that perform well can be taken up at farmer's field in a large scale.

REFERENCES

Bhargava, A., S. Shukla, and D. Ohri. 2006. Chenopodium quinoa-An Indian perspective. *Industrial crops and products*. 23:73-87.

Heisser, C.B. and Nelson, D.C. (1974). On the origin of the cultivated chenopods (*Chenopodium*). *Genetic*. 78: 503-505.

Jacobsen, S. E. (2003). The Worldwide Potential for Quinoa (*Chenopodium quinoa* Willd.). *Food Reviews International*. 19:167-177.

Mujica, A. 1992. Granos y leguminosas andinas. In: J. Hernandez, J. Bermejo y J. Leon (eds). Cultivos marginados: otra perspectiva de 1492. Organización de la Naciones Unidas para la Agricultura yla Alimentación FAO, Roma. 129-146.

Partap T., Galwey, N.W. 1995. Chenopods. *Chenopodium* spp. Promoting the conservation and use of underutilized and neglected crops. IPGRI 22:63.

Sharma V, Chandra S , Dwivedi P and Parturkar M (2015). Quinoa (*Chenopodium quinoa Willd*.): A Nutritional Healthy Grain. *International Journal of Advanced Research*. 3 (9): 725 – 736.

Valencia-Chamorro S.A (2003). Quinoa. In: Caballero B.: Encyclopedia of Food Science and Nutrition. *Academic Press*. 8: 4895–4902.

Wilson H D (1985). Chenopodium quinoa Willd: variation and relationships in southern South America. *National Geographic Society and Research Reports*. 19: 711-721.