Desert farming — Quinoa

Dr NK Rao and Dr Mohammed Shahid,
Plant Genetic Resources Program
International Center for Biosaline Agriculture (ICBA)

Crop diversification is key to agricultural productivity because it enables risk management. In the UAE, where soils are nutrient-poor, identification of crops adapted to local environment is especially important. ICBA's Genetic Resources Program has been studying a range of salt-tolerant crops for their ability to produce economic yields, and ultimately to introduce them to local farmers.

Quinoa (*Chenopodium quinoa* Willd.) is native to the Andes Mountains of Bolivia, Chile and Peru. It is an annual herb that reaches 1-2m height and matures in 5-6 months. It produces white or pink seeds in large sorghum-like clusters. Although the seeds are very small, they comprise 30% of the dry weight of the plant.

Quinoa is one of the few crops grown in the salt beds of southern Bolivia and northern Chile. According to the International Potato Center (CIP), which is based in Lima, Peru, quinoa can germinate in a mixture of one third seawater, which averages 25,600 parts per million (ppm) and two thirds fresh water. CIP also reported that quinoa can be grown under extremely dry conditions with as little as 200 mm rainfall in sand. Clearly, this is a crop with excellent potential for both drought-prone and saline areas.

Quinoa is also a highly nutritious food. The nutritional quality of the seeds is comparable to that of dried whole milk and the protein quality and quantity is often superior to better-known cereals (Table 1). Quinoa is higher in lysine than wheat, and its amino acid content is well balanced for both human and animal nutrition, on a par with casein *(Table 2)*.

Although quinoa grain has low sodium content, its calcium, phosphorus, magnesium, potassium, iron, copper, manganese and zinc content is higher than those of wheat, barley or maize (Table 3).

Quinoa seeds are generally used to make flour, soup and breakfast cereal. They can also be used for brewing beer and for animal feed. Quinoa flour works well as a starch extender when combined with wheat flour or with corn meal for making biscuits, bread, and processed food. Quinoa leaves can be eaten as a leafy vegetable like spinach, and its leaves and stalks can be fed to ruminants. In poultry feeding trials, chicks fed with a ration containing cooked quinoa made equal gains to those receiving maize and skimmed milk.
Quinoa seed coat usually contains bitter tasting compounds, mainly saponins. However, these can easily be removed by washing in cold water. Cooking also removes the bitter taste.

The ICBA genebank acquired about 120 germplasm accessions from the United States Department of Agriculture (USDA)

While quinoa grain compares favorably with major cereal crops in nutritive value, when it comes to tolerance for salinity it has few equals.

An additional bonus: accessions with colored foliage and panicles makes quinoa appropriate as an ornamental plant for home gardens and general landscaping.

Crop	% dry weight					
	Water	Crude protein	Fat	Carbohydrates	Fiber	Ash
Quinoa	12.6	13.8	5.0	59.7	4.1	3.4
Barley	9.0	14.7	1.1	67.8	2.0	5.5
Buckwheat	10.7	18.5	4.9	43.5	18.2	4.2
Corn	13.5	8.7	3.9	70.9	1.7	1.2
Pearl millet	11.0	11.9	4.0	68.6	2.0	2.0
Oat	13.5	11.1	4.6	57.6	0.3	2.9
Rice	11.0	7.3	0.4	80.4	0.4	0.5
Rye	13.5	11.5	1.2	69.6	2.6	1.5
Wheat	10.9	13.0	1.6	70.0	2.7	1.8

Table 1. Comparisons of the nutritional quality of quinoa with other crops.

Amino Acid	Amino Acid Content (g/100g protein)			
	Quinoa	Wheat	Soy	Skim milk
	%			
Cystine	2.4	2.2	1.4	0.9
Isoleucine	4.0	3.8	4.7	5.6
Leucine	6.8	6.6	7.0	9.8
Lysine	5.1	2.5	6.3	8.2
Methionine	2.2	1.7	1.4	2.6
Phenylalanine	4.6	4.5	4.6	4.8
Threonine	3.7	2.9	3.9	4.6
Tryptophan	1.2	1.3	1.2	1.3
Tyrosine	3.8	3.0	3.6	5.0
Valine	4.8	4.7	4.9	6.9

Table 2. Essential amino acid pattern of quinoa compared to wheat, soy and skim milk.

Crop	Ca	P	Mg	K	Na	Fe	Cu	Mn	Zn
	%				ppm				
Quinoa	0.19	0.47	0.26	0.87	115	205	67	128	50
Barley	0.08	0.42	0.12	0.56	200	50	8	16	15
Corn	0.07	0.36	0.14	0.39	900	21	-	-	-
Wheat	0.05	0.36	0.16	0.52	900	50	7		14

Table 3. Comparisons of the mineral content in quinoa grain with barley, maize and wheat.

Quinoa, which is a native of the Andes in South America, is eminently suitable for landscaping in arid regions. It is extremely varied and quite beautiful in appearance.

in 2001. Recently, these materials were grown on the ICBA farm using drip irrigation with municipal water (1800 ppm). Many of the accessions grew extremely well. Considerable variation was observed for many morphological traits, especially the foliage and panicle colors. Based on its performance on the farm, its high nutritive value, its tolerance for drought and its capacity for being irrigated with seawater, quinoa appears to hold great promise for crop diversification in the Middle East and North Africa.

ICBA plans to conduct further studies to identify locally adapted genotypes and to develop suitable agronomic and management practices for commercial production.

The data used in the tables was extracted from an article entitled *Quinoa* by Oelke et al. 1992, which appeared in the Alternative Field Crops Manual, a co-publication of the University of Wisconsin and the University of Minnesota.