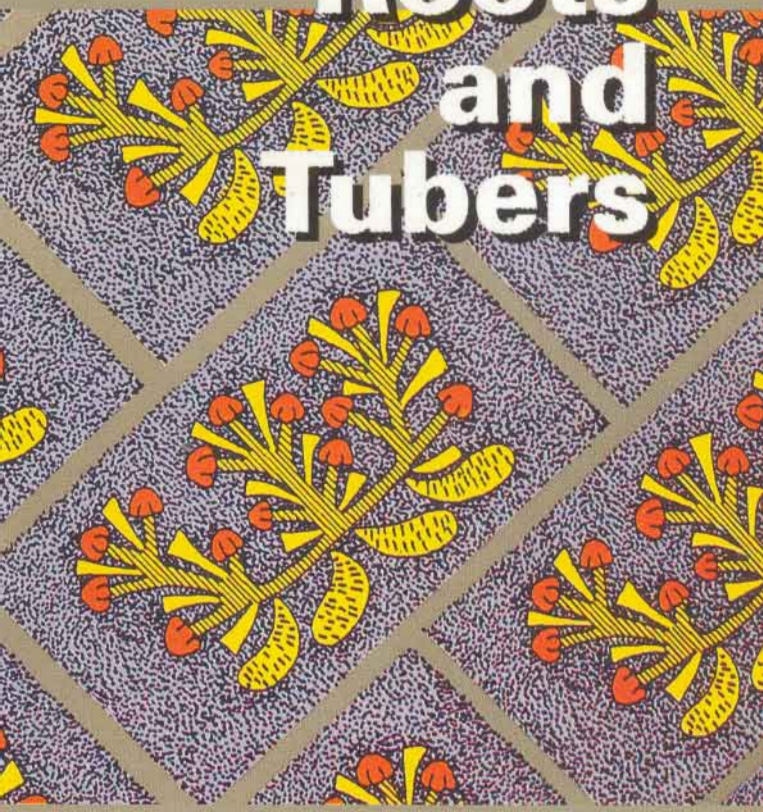
Pocket Guide to
Nine Exotic

Andean Roots and Tubers



Foreword

Three months before the Earth Summit (United Nations Conference on Environment and Development) held in Rio de Janeiro in 1992, Paul Egger of the Swiss Agency for Development and Cooperation (SDC) came to the International Potato Center to discuss the startup of what later became the Consortium for the Sustainable Development of the Andean Ecoregion, called CONDESAN. Now, thanks to funding from SDC, CONDESAN partners work in a collaborative program on Andean root and tuber crops to conserve genetic diversity and invigorate the region's research capabilities to address issues related to these crops.

Historically, farmers in the Andes domesticated some 25 species of edible roots and tubers. These have helped sustain generations of Andean populations and some of them continue to be cultivated in the region. While they may be commonplace in the Andean highlands, they are truly exotic elsewhere. Like potato, these crops could have an important role worldwide.

This booklet, prepared by CONDESAN partners, is intended as a field identification guide for extension agents, researchers, and the general public. It describes nine exotic Andean root and tuber crops, and includes information on their use. Many Andean researchers, especially Carlos Arbizu, Miguel Holle, and Mario Tapia, have contributed to this publication, and their cooperation is greatly appreciated.

José Luis Rueda
Coordinator, CONDESAN

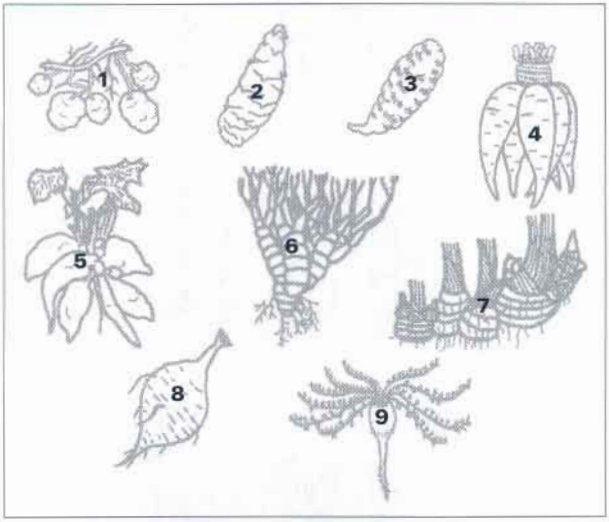
Andean Roots and Tubers

Andean tubers (ulluco, oca, mashua) and roots (arracacha, yacón, mauka, achira, ahipa, maca) provide food and income for poor mountain farmers across the Andean highlands. These crops have extraordinary pest and disease tolerance and nutrient efficiency, and they adapt to marginal environments. They yield well on poor soils and under adverse climatic conditions. As a result, an extremely complex mosaic of Andean agroecologies has evolved for these crops. Over time, farmers have selected them to fit a range of elevations, with diverse farming conditions, by using different agronomic practices.

Some of the nine crops have been favored more than others, so the intensity of domestication and the range of biodiversity in these roots and tubers vary from crop to crop. All of them can be historically equated to Indian culture, and all of them have remained traditional and unimproved. These crops are largely unknown outside of the Andean region.

The following sections of this guide summarize some of the differences and similarities within the Andean region and between varieties. Common names are given for these tubers and roots, and their crop adaptation is characterized. Information is also given on their nutritional value, and on typical and potential uses.

Common Name	Scientific Name	Family
Tubers		
1 Ulluco	*Ullucus tuberosus*	Basellaceae
2 Oca	*Oxalis tuberosa*	Oxalidaceae
3 Mashua	*Tropaeolum tuberosum*	Tropaeolaceae
Roots		
4 Arracacha	*Arracacia xanthorrhiza*	Apiaceae
5 Yacón	*Polymnia sonchifolia*	Asteraceae
6 Mauka	*Mirabilis expansa*	Nyctaginaceae
7 Achira	*Canna edulis*	Cannaceae
8 Ahipa	*Pachyrhizus ahipa*	Leguminosae
9 Maca	*Lepidium meyenii*	Cruciferae



Plant

Tubers

Flower

Ulluco

Common Names	
ulluco, ulluku (Quechua)	Peru
papa lisa	Bolivia
lisas	Peru
chigua, olluco	Colombia
ruba, timbo, mucuchi	Venezuela
melloco	Ecuador, Colombia
ulluma, ulluca	Argentina

Crop Adaptation. Ulluco is grown in scattered pockets from Venezuela to northern Argentina, usually between 3,000 and 4,000 meters above sea level. In Peru, the crop can now be grown in lower valleys, between 1,000 and 2,000 meters. The plant prefers soils that are rich in organic matter. The period between planting and harvest varies from 140 to 200 days, depending on the variety, latitude, and altitude. Ulluco is the most important and commercially viable of the nine Andean roots and tubers described in this guide.

Varieties. Ulluco tubers have many shapes, colors, and sizes in the Andes. There are two types of plants: a sprawling plant with red-tinted stalks and leaves, and an upright plant, smaller in size, with large, intensely green leaves.

The Ecuadorian government released two ulluco varieties in 1994, the first time that an Andean root or tuber received official recognition.

Nutritional Value. Ulluco has high water content (more than 75%), about 1% protein, depending on the variety, and 10-14% carbohydrate. Its mineral content is low, though it is rich in vitamin C.

Uses. Cooked tubers are used in several dishes. The most popular in Peru is the "olluquito con charqui." Ulluco is also added to soups and stews. The boiled leaves, rich in calcium and carotene, are used as a vegetable. Some women in the Andes believe that eating ulluco will ease childbirth.

Oca

Common Names	
ibia	Colombia
ciuba	Venezuela
oca	Colombia, Ecuador, Peru
oqa	Peru
apilla	Bolivia
miquichi	Argentina

Crop Adaptation. A perennial herb, oca is the second most widely cultivated tuber after potato. It grows from Venezuela to Argentina and Chile. Because of its high yield and good taste, it is frequently used in rural Andean cuisine. Oca grows between 2,800 and 4,000 meters. It is known for its resistance to frost damage. The crop prefers sandy soils. It yields up to 40 tons per hectare, though there are reports of up to 60 tons.

Varieties. Oca cultivars range from early (170 days) to late (230 days) in maturity. The tuber's flesh can vary from white to yellow to orange. Campesinos differentiate between sweet ocas (called "keni") and ones that are bitter (called "luki") because of their higher content of oxalic acid.

Nutritional Value. The oca tuber has a high content of water (80%), 1.1% protein, and 13% carbohydrate. Vitamin content is variable, but can include significant amounts of retinol (vitamin A). Protein content in dehydrated oca can reach 11%. Campesinos have found several ways to eliminate or reduce oxalic acid content.

Uses. Oca is usually boiled, baked, or roasted. It is often fed to children. Before it is eaten, oca can be left in the sun to sweeten. Oca can be dehydrated and kept for long periods of time as "caya," which is flour made from this sun-dried tuber. Most production is consumed on-farm.

Plant

Tubers

Flower

Plant

Tubers

Flower

Mashua

Common Names	
cubios	Colombia
mashua, mashwa	Colombia, Ecuador, Peru, Bolivia
mashwa (Quechua)	Peru
añu (Quechua)	Peru, Bolivia
isaño, añu	Peru, Bolivia, Argentina
mishwa (Aymara)	Bolivia
apiña mama	Bolivia

Crop Adaptation. Like ulluco and oca, mashua is found in small plots, by itself or intercropped with other plants, from Colombia to northern Argentina. The crop grows best in fields with organic matter and at altitudes between 3,700 and 4,000 meters. Yield can reach 70 tons per hectare. Mashua is particularly widespread in Colombia. It has strong disease and pest resistance.

Varieties. Mashuas are usually white, yellow, red, or purple. Tuber shape and color distinguish the varieties.

Nutritional Value. The nutritional value of mashua is high. Solids can compose up to 20% of the dry matter, of which 11% is protein. Researchers at the University of Ayacucho found a variety with more than 12% protein content.

Uses. Mashua is used for food and in folk medicine. It has a reputation as an antiaphrodisiac, which means that men avoid eating it. Because of its sharp flavor, it does not have a large following. In southern Colombia, mashua is prepared in a dish with onions, peppers, and eggs. In Bolivia and Peru, the tuber is left outside overnight and then eaten the following day with honey. This is called "thayacha."

Arracacha

Common Names

racacha, arracacha	Colombia, Peru, Bolivia
apio criollo	Venezuela
zanahoria blanca	Ecuador
virraca	Peru

Crop Adaptation. Arracacha grows between 1,000 and 3,100 meters, especially in the more humid valleys from Colombia to Bolivia. It is frequently grown with maize and beans, or underneath coffee plants in Colombia. It takes up to 10 months to reach maturity.

Varieties. Arracacha is related to celery and carrot. The main distinction is the color of the root's pulp—white or yellow. Plants can vary from dark green to purple.

Nutritional Value. Fresh arracacha roots contain 26% dry matter, with 23% carbohydrate and less than 1% protein. However, arracacha has 28 mg calcium (four times what the potato has) and 1.1% iron (double the percentage of the potato). The yellow arracacha contains sizable amounts of retinol (vitamin A).

Uses. Arracacha's starchy root flavors many dishes, from soups to desserts. In Brazil, it is being used as a thickener in instant soup and baby food formulas, which are marketed successfully by the private sector. Brazil has developed varieties that grow in seven months; this could benefit breeding for the high Andes.

Plant

Roots

Flowering plant

Plant

Roots

Flowering plant

Yacón

Common Names	
jíquima	Ecuador
yacón, llacón	Peru, Bolivia
llakuma (Quechua)	Peru, Bolivia
aricoma (Aymara)	Bolivia

Crop Adaptation. A distant relative of the sunflower, yacón grows from Venezuela to Argentina at altitudes under 3,300 meters, in climates that are warmer and more humid than those in which other tubers usually grow. Yacón usually grows in small farm orchards in intermontane valleys. The area of the crop has not expanded much in recent decades. In some Andean valleys, yacón is sold at market fairs, especially in November for All Saints' Day.

Varieties. This root has little variability. It mainly has white or yellowish transparent flesh.

Nutritional Value. The root contains 86–90% water and less than 1% protein, and is low in minerals. It contains a type of fructose (inulin) that could be used as a sugar substitute for diabetics or dieters. Because the human digestive system does not have an enzyme to hydrolyze inulin, it is not absorbed by the body.

Uses. Yacón can be eaten raw, just like a fruit. Once the roots have been dried in the sun, they become sweeter. In Cusco, Peru, during the Inti Raymi festivities in June, yacón is traditionally sold under the name of "cocashka."

Mauka

Common Names	
miso, tazo	Ecuador
chago, yuca inca	Peru
mauka	Bolivia

Crop Adaptation. Specialists thought that this root had almost disappeared. Few fields remain. Mauka grows between 2,800 and 3,400 meters. It can be found in Peru (Cajamarca), Ecuador (Latacunga), and Bolivia (Coroico).

Varieties. There are only two varieties of mauka. One has whitish plants and the other reddish plants.

Nutritional Value. This colorful root is high in calcium and phosphorus. Both the stems and roots are high in carbohydrate; both have 7% protein.

Uses. In Ecuador, mauka is eaten "salty or sweet." When salty, the root is boiled and then eaten without its outer crust. When eaten sweet, the root is consumed after it has been placed in the ground for a week to concentrate sugar in the roots.

Plants and roots

Roots

Plant

Roots

Flowering plant

Achira

Common Names
achira
canna

Crop Adaptation. Achira is grown from sea level up to 2,000 meters because of its temperature and humidity requirements. It is usually grown in isolated patches in orchards or small fields.

Varieties. There is little information about varieties.

Nutritional Value. The achira rhizome is similar in content to arracacha, with 27% dry matter, less than 1% protein, 24% carbohydrate, and 1.4% ash. Achira has a variable content of sugar, depending on how long it has been stored: 1.3% after eight days, and up to 3.1% after three weeks.

Uses. Achira is prepared in a stew or roasted as a dessert because of its sweetness. It is also used as food for babies and the elderly. Achira starch has large grains that can be seen with the naked eye. Achira is gaining wide acceptance in Colombia, where there is an increasing demand for biscuits made from this root, and in Vietnam, where its starch is used in making high-quality noodles. About 10,000 hectares of achira are grown in Vietnam, mostly in hilly areas.

Ahipa

Common Names	
ahipa	Peru
frijol chuncho, villu	Bolivia
huitoto (Aymara)	Bolivia

Crop Adaptation. Ahipa is grown in family orchards, rarely in larger fields on its own. Although it has been found at sea level, it is more commonly grown between 1,000 and 2,300 meters.

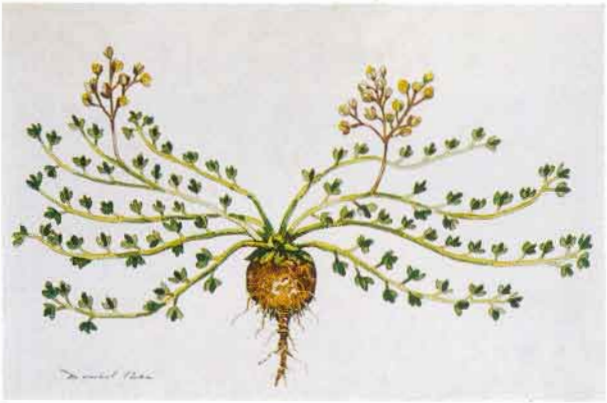
Varieties. This species, known as the Andean *Pachyrhizus*, has little diversity, unlike other related species, such as *P. erosus* in tropical areas.

Nutritional Value. Ahipa resembles yacón, with its high content of water, although it can also be a good source of potassium and vitamin C. Its starch is easily digested.

Uses. This root is eaten after being boiled and accompanies dishes as a substitute for cassava. Because of the likely toxic content of rotenone in its leaves and stems, it could serve as a natural insecticide.

Roots

Pachyrhizus



Plant

Hypocotyls

Maca Andina

Maca

Common Name
maca

Crop Adaptation. This root is adapted to the upper limits of agriculture. It prefers very cold climates with adequate moisture. Found only in Peru, it grows above 4,000 meters although some plantings also flourish at 3,500–3,900 meters. Maca is a biennial plant: in the first year it grows entirely from its botanical seed; the following year the hypocotyl produces one to three branches. In the Meseta de Bombón, Mantaro Valley, central Andes, it is grown on areas of 500–1,000 square meters on the basis of botanical seed.

Varieties. The edible part of maca is its hypocotyl, which resembles a radish. The hypocotyl varies widely in color, from yellow and whitish red to black.

Nutritional Value. Maca is a rich source of protein. The dried hypocotyls can contain 14–16% protein, with a high content of essential amino acids and minerals. Maca has a high amount of antinutritional substances, such as tannin, alkaloids, and small amounts of saponin. The roots are reputed to have fertility-enhancing properties.

Uses. Maca's hypocotyls are boiled in water and then mixed with fruit juice, to which milk can be added, to prepare a thick broth. Besides its reputed fertility-enhancing properties, maca is also said to act as an energizer and antistress agent. A kind of fermented juice is prepared with it and mixed with other liquors or used in dessert-making. Maca has entered the market for nutrient supplements as "Maca Andina," made by dehydrating and grinding the hypocotyl.