Factsheet
Botanical Data: Sacha Inchi

Plukenetia volubilis L.

Project

Drafting botanical monographs (factsheets) for five Peruvian crops

Factsheet – Botanical Data: Sacha inchi - Plukenetia volubilis L.

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Proyecto Perúbiodiverso – PBD:

Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH: Programa Desarrollo Rural Sostenible – PDRS

Secretaría de Estado de Economía Suiza – SECO

Ministerio de Comercio Exterior y Turismo – MINCETUR

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I. BOTÁNY

Genus. *Plukenetia* belongs to the Euphorbiaceae family, comprises nineteen species (7, 9), and is pantropically distributed; twelve of its species grow in South and Central America with the other seven flourishing just in the Old World. *Plukenetia* species are climbing plants or lianas; only rarely are they creeping, perennial herbs.

Habitat includes tropical rain forests and pluviseasonal forests or shrublands. Genus is characterized by ovaries with four carpels, a totally or partially connate style, and a frequent climbing habit. The most conspicuous feature for identifying them on the ground is the presence of basilaminar, round, or elliptical glands on the adaxial side of the leaf and the tetramerous fruit.

Morphology. *P. volubilis* is a climbing, monoecious, deciduous plant (7, 8, 11). Leaves are opposite and simple. Leaf blade is triangular-ovate, 6 cm – 13 (-20) cm long and 4 cm – 10 (-12) cm wide, with a truncate or cordate base. Margin is crenate or serrulate; there is one glandular protuberance on the adaxial side at the tip of the petiole.

Inflorescence, 5 cm – 18 cm long, is racemose, elongated, and monoecious (bisexual). Flowers with pistils are solitary at base nodes; stylar column is partially or totally connate, 15 mm – 30 mm long; numerous sub-globular masculine flowers are grouped on distal nodes; there are 16 – 30 conical stamens (0.5 mm long) with visible filaments.

Capsules are tetra- or pentamerous, glabrous, and 2.5 cm – 6 (- 7) cm in diameter. Seeds, 1.5 cm – 2 cm x 0.7 cm – 0.8 cm, are lenticular, laterally compressed, and brown colored with irregular darker splotches.

Taxonomy. Area with the highest variability in *P. volubilis* is on the eastern slopes of the Peruvian Andes along the border with Brazil (7). Shape of floral morphology of some collections from the department of San Martin present differences from typical *P. volubilis*. Collections in Cusco, Junin, and Pasco (ranging in elevation from 1600 m to 2100 m) are also morphologically different and might represent new species or as yet unknown ones in Peru.

Fruit morphology from collections in the Mendoza Province of the department of Amazonas supports the hypothesis that at least four different species exist in that region, one of which seems to be new to science (15). Reviewing the taxonomy of *Plukenetia* would be exceedingly advantageous so as to be able to name species correctly and to compare them in cultivation. Besides, there are some specimens with five or six unusually large carpels (and seeds) than generally come from cultivation areas. These collections frequently demonstrate a remarkably serrated leaf margin.

II. DIAGNOSTIC FEATURES AND POSSIBLE CONFUSIONS

Closest related species to *P. volubilis* is *P. stipellata*. Both can be deemed a complex of species (7). *P. stipellata* is unlike its relative in the shape and size of the style and stamens (normally five sepals instead of six) and because it presents a pair of small stipules at the tip of the petiole. *P. stipellata*, however, grows only in Central America and even today has never been reported in Peru.

Apart from *P. volubilis*, three other *Plukenetia* species are recognized in Peru: *P. polyandenia* Muell., *P. loretensis* Ule, and *P. brachybotrya* Muell. *P. volubilis* can be confused with *P. polyandenia*, which does belong to the same group as the former (informally known as "*Cylindrophora*"). Except for capsule size, other diagnostic features are the shape of the leaf base and the staminodes as well as stylar column length (see Table 1).

Table 1. Diagnostic features of Peruvian *Plukenetia* species.

Character	*P. volubilis*	*P. polyandenia*	*P. loretensis*	*P. brachybotrya*
Species group (informal)	*Cylindrophora*		*Euplukenetia*	
Leaf glands Foliar glandular	One promontory gland at the tip of the petiole	One promontory gland at the tip of the petiole	Basilaminar glands and one or more pairs	Basilaminar glands and one or more pairs
Stylar column	Partially or totally connate; 15 mm – 30 mm long	Partially connate; 3 mm – 7 mm long	Connate, narrow, cylindrical; 2 mm – 4 mm long	Connate, compact, spherical
Stamens	16 – 30, with notable filaments (conical); 0.5 mm long	With notable filaments (elongated); 2 mm – 3 mm long	15 – 25, sessile	(24 -) 30 – 50, sessile
Fruit (capsule)	2.5 cm – 6 (-7) cm in diameter	6 cm – 11 cm in diameter	Each carpel with sharp corniculum	Each carpel with a rounded tubercle
Leaf base	Cordate and truncate	Round or obtuse		
Staminodes	Sub-globular	Finely oblong-ellipsoidal		

III. DISTRIBUTION

Worldwide distribution. Distribution area for *P. volubilis* extends from the Lesser Antilles, Surinam, and the northwest sector of the Venezuelan and Colombian Amazon basin to Ecuador, Peru, Bolivia, and Brazil (7, 8, 17).

Distribution in Peru. *P. volubilis* has been reported in the Peruvian departments of Amazonas, Cusco, Junin, Loreto, Pasco, San Martin, and Madre de Dios (3, 7).

Table 2: Estimates of frequency and distribution of *P. volubilis* in Peru, based on herbarium specimens from USM, HUT, HAO, AMAZ, CUZ, HUSA

Region	# of specimens	# of provinces	Estimated frequency
Amazonas	8	3 / 7	Frequent
Cajamarca	1	1 / 13	Rare

Cuzco	4	3 / 13	Rare
Junín	-	0 / 9	Unknown
Loreto	14	2 / 6	Rare
Pasco	4	1 / 3	Rare
Madre de Dios	2	2 / 3	Frequent
San Martin	7	3 / 10	Rare

IV. ECOLOGY AND POSSIBLE CULTIVATION AND HARVESTING AREAS

Habitat. *P. volubilis* natural habitat encompasses areas of altered vegetation or the margins of tropical wet forests or low lands to an elevation of 900 m (7, 16). Species is a rapidly growing liana. Harvesting natural populations should be highly restricted due to limited populations and their widely dispersed distribution.

Growth. Sacha inchi plants grow and mature at a temperature range that characterizes the Peruvian Amazon (minimum = 10º C and maximum = 36º C). Some experiences show higher temperatures increasing nematode reproduction, thereby causing greater infestation (14). Plants in Alto Mayo (in the department of San Martin), where temperatures are rather low, grow without any problems whatsoever. When plants grow in relative humidity of 78% and an average temperature of 25º C, they are practically disease free (6).

Temperature above the maximum causes flowers and small fruits to fall off, especially the recently formed. In low light intensity, plants need a greater number of days to complete the growth cycle. Where plants grow underneath a great deal of shade, flowering diminishes and, hence, production is less.

Plants require water on a constant basis for sustained growth, with uniform rainfall over 12 months being the best (850 mm – 1000 mm). Irrigation is, therefore, indispensible during dry months given that relatively prolonged dry periods and low temperatures cause slow and troublesome growth. On the other hand, excess water will harm plants and increase disease damage.

V. CULTIVATION AND USE

Cultivation. Sowing sacha inchi in the Peruvian Amazon is conditioned by the rainfall regime. Generally speaking, seeds are directly planted in dry conditions at the beginning of the rainy season (between November and December) in order to guarantee good germination; it can be prolonged until March. When land is irrigated, it can be planted any time during the year. Indirect planting or transplanting should, if possible, be carried out sometime between days 45 and 60 before rains begin, between September and November; it can be extended until February (6).

Field preparation should be done according to physical conditions of the soil, gradient, and water needs of the crop. Sacha inchi can be sown on flat, undulating land, and on slopes with good drainage. In the department of San Martin and other areas in the Peruvian Amazon, it is sown the traditional way, i.e. slashing and burning. However, these practices, especially burning, are not recommended since they destroy soil nutrients, interrupt organic material decomposition, and cause texture loss. Soil becomes packed and cannot absorb rain water, whereby most of it runs off the surface and erodes the land. Plowing on level ground to a furrow depth of 0.30 m – 0.40 m is the best system to use. As well, cow or sheep manure should be used to fertilize plants so that soil structure is improved.

Leveling is also an important process to keep water from pooling and, subsequently, causing problems related to excess moisture (6, 12). Once seedlings have taken root, plants should be tended as follows: weed control, pest control, trellis installation, and pruning (for formation and production).

Sacha inchi can be associated with annual, biennial, and/ or permanent crops in their natural habitat. Farmers have associated it with almost all regional crops: cotton, banana, beans, corn, cassava, fruits, forest species, etc. Yet, some experiences have shown cultivating it with medium and determined growth legumes or species with short growing season (like cow peas or pigeon peas) is preferable (14). When employing a trellis system, it can be associated with short cycle crops, such as peanuts, beans, upland cotton, and other low growing crops, planting them between rows.

Soil. Sacha inchi can adapt to a wide range of different soil types. Best are medium textured soils (sandy clay loam, clay loam, and sandy loam). Less appropriate are heavy clay or very sandy ones. Yet, it is a hardy plant that does not demand high levels of nutrients; it grows in acidic soils (pH 5.5 – 7.8) and with high concentrations of aluminum.

The plant flourishes in dry and wet regions in the department of San Martin known as “shapumbales” (“shapumba” is the local word for brackens – *Pteridium aquilinum* – and the area is covered with them) and others known as “cashucshales” (name for the areas of the widely growing grass *Imperata brasiliensis*) which have good drainage and aeration that eliminate excess surface and ground water (6, 12).

Propagation. Seeds are the main way sacha inchi propagates, although grafting is one possible solution to chief phytosanitary problems (12). Using good quality seeds that have high germination rates is of utmost importance to achieving satisfactory results. Before sowing, it is necessary to disinfect seeds so as to prevent or to control fungal diseases that attack the roots. Disinfection consists of impregnating seeds with a watery paste of dissolved fungicide and insecticide; it is mixed with the seeds until they are uniformly saturated.

Direct sowing entails a precise quantity of seeds: 1.0 kg – 1.5 kg/ ha, where distance between rows is 2.5 m – 3.0 m, distance between plants 3 m, and seed depth 2 cm – 3 cm. Indirect sowing demands nurseries be prepared with washed river sand and seeds sown in rows 10 cm apart and 2 cm deep.

When the third pair of green leaves sprout, seedlings should then be transplanted into black polypropylene bags filled with a substrate of previously prepared rich forest dirt. Then, final transplant is done roughly sixty days after planting and before the guides appear. Better crop management is achieved by using dead stakes or trellises in level, clear fields since they reduce pruning work.

Seedling transplants should be done after installing trellises so plants are not mistreated (6, 12).

There is no greater information available on vegetative propagation of *P. volubilis;* some reports state it can be reproduced using cuttings, but nothing more is discussed on that matter.

Pests and diseases. Sacha inchi is susceptible to nematode attacks from these genera: *Aphelenchus, Helicotylenchus, Meloidogyne, Trichodorus, Tylenchus, and Xiphinema*, many of which target the roots, killing plants by the second year of production (13).

Similarly, significant damage has been reported by fungi from these genera: *Fusarium, Stagonospora, Leptosphaeria, Rhizoctonia,* and *Cronartium,* and the species *Colletotrichum gloeosporioides,* which attacks leaves and stems in seedlings and adult plants associated with damage from the species *Meloidogyne*. There are also citings of slug attacks in marshy soils.

Harvest and yield. Harvesting dry and mature fruits takes place 6.5 – 8 months after final transplant. Post first harvest, plants continue to fruit, so plants are harvested every twenty to twenty-five days with best yield occurring from November to May and reduced yield being from June to October; reduction is related to decreased rainfall during that period (6).

Only brown capsules still attached to the plant are harvested since those that have fallen are contaminated and may damage the lot (4). Manco states that first year average yield ranges from 0.7 tons – 2.0 tons/ ha (12). It is grown in association with cover crops and can live to ten years. Nevertheless, Chacon reports crops producing 1000 kg in the first year with steady increases until the third year (5).

VII. POST HARVEST.....

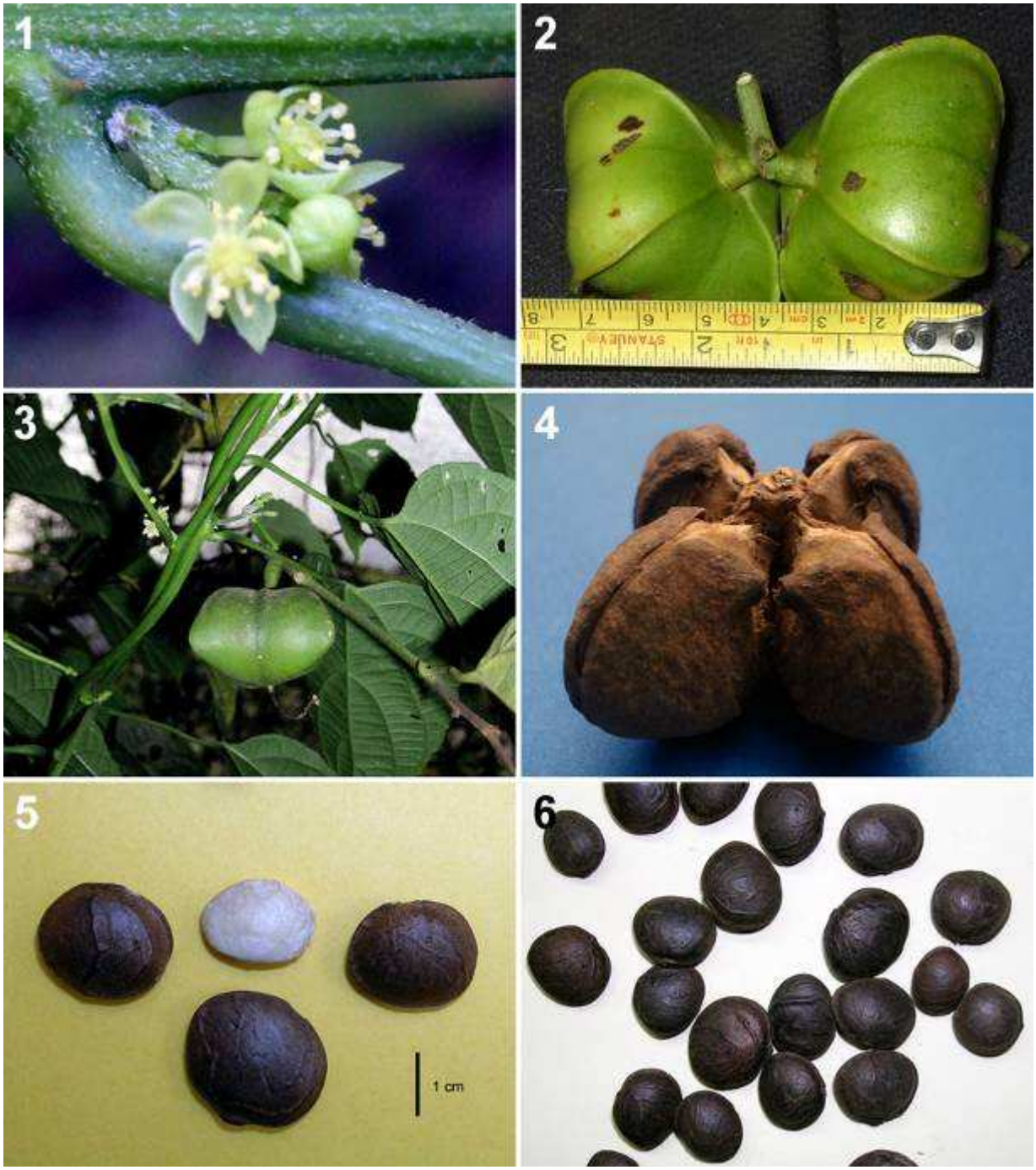
Post harvest, capsules are transported in 25 kg – 30 kg polypropylene, jute, or net sacks for drying and threshing. The former can be accomplished naturally or artificially, according to heat source. Natural drying is under direct sunlight, scattering capsules over a cement surface.

Drying time depends on ecotype or variety since some capsules are thicker and less dehiscent than others, making the threshing process more difficult. Artificial methods employ dryers of different energy sources: solar, wood burning, oil, etc. Not many farmers use that method and only when very large fields are cultivated.

Farmers prefer to wait until summer to dry their crops, or they harvest more capsules while waiting, postponing the drying and threshing until summer. Artificial and solar dryers used to dry annatto, cacao, coffee, corn, turmeric, and other products can be used for sacha inchi. One company recommends just natural drying since dryers can heat capsules too much and alter oil quality in the seeds (14).

Once dry, most of the capsules, or, in some cases, all of them, crack open because of their dehiscent nature. At the moment, some threshers have been adapted to separate capsules from the seeds and even to separate shells from nut. This process results in roughly 55% dry seed and 45% capsule remains.

Seeds can be stored in 50 kg – 70 kg jute sacks in dry places (4, 6). It is advisable not to mix old and new harvests because some seeds can be dry and other fresh, causing the lot to rot (2).



1) Sacha inchi flowers (Mendoza shape)

2) Green capsules (Mendoza shape)

3) Habit

4) Mature, tetramerous capsule

5, 6) Seeds

Photos:

1-2: Rosa Carolina Tellez; 3-6: José Roque;

VIII. LITERATURE

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