Passiflora quadrangularis

Scientific Name

***Passiflora quadrangularis* L.**

Synonyms

Passiflora grandiflora Salisb., *Passiflora macrocarpa* M.T. Mast., *Passiflora quadrangularis* L. var. *variegata* hort., *Passiflora sulcata* Jacq., *Passiflora tetragona* M. Roem.

Family

Passifloraceae

Common/English Names

Baden, Barbadine, Giant Granadilla, Giant Grenadilla, Granadille True, Granadilla, Grenedilla, Grenadine, Square Stalked Passion Flower, Square-Stem Passion Flower.

Vernacular Names

Bolivia: Quijón, Granadilla Real, Parcha Granadina, Parcha De Guinea, Sandia De Pasión;
Brazil: Maracujá-Açu, Maracujá-Assú, Maracujá De Caiena, Maracujá-Grande, Maracujá-Mamao, Maracujá-Melão, Maracujá-Suspiro, Maracuya-Acu, Maracuja Silvestre;
Chinese: Da Guo Xi Fan Lian;
Columbia: Badea, Corvejo;
Cook Islands: Kūkuma, Maratini, Maratini, Papatini, Pāpatīni, Pāpatīni, Pārapōtini (Maori);
Czech: Mučenka Obrovská;
Danish: Kæmpegranadil, Barbadin;
Dutch: Djari Markoesa, Granadilla, Markiza, Markoesa, Vierhoekige Passiebloem;
Eastonian: Suureviljaline Kannatuslill;
Ecuador: Tumbo, Tambo, Tumbo Costero;
El Salvador: Granadilla Grande, Granadilla De Fresco, Granadilla Para Refrescos;
French: Barbadine, Grenadille Géante, Passiflore Quadrangulaire;
German: Granadilla, Granadillas, Melonengranadille, Königs-Grenadille, Riesen-Grenadille, Riesen-Königsgranadille;
Hungarian: Óriás Passiógyümölcs;
Indonesia: Gardanela (Alfurese, N Sulawesi), Ansimon Bolanda, Antjimon Eropa, Buah Eropa, Labu Europa (Batak), Sumangga (Boeol, Sulawesi), Labu Belanda (Jambi), Manisah, Markisa, Markisat (Java), Air Bis, Bis, Kerebis, Rebis (Lampong), Kerbis (Lingga), Manesa, Markesah (Madurese), Erbis, Kerbis, Belewa (Malay), Rubis (Palembang), Erbis (Singkep), Erbis, Herbis, Markisat (Sundanese);
Italian: Passiflora Quadrangolare;
Mangarevan: Para Patini;
Malaysia: Timun Belanda, Timun Hutan, Akar Mentimun, Telur Dewa, Gendola;
Mexico: Sandía De Le Pasión;
Niuean: Palasini, Palatini, Vinē Palasini;

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Palauan: Kudamono; *Peru*: Tumbo, Tambo, Tumbo Costero;
Philippines: Kasaflora, Paróla (Illoko), Granadilla (Tagalog);
Portuguese: Guassú, Guassú, Maracujá Açú, Maracujá Assu, Maracujá Cascudo, Maracujá De Caiena, Maracujá De Quatro Quinhas, Maracujá Do Igapó, Maracujá Do Pará, Maracujá Grande, Maracujá Mamão, Maracuja Melão, Maracuja -Caiana, Uauaçu, Martírio Quadrangular;
Samoan: Pasio;
Spanish: Badea, Badera, Corvejo, Granadilla De Fresco, Granadilla Grande, Granadilla Para Refrescos, Granadilla Real, Parcha De Guinea, Parcha Granadilla, Parcha Granadina, Pasionaria, Quijón, Sandía De La Pasión;
Sri Lanka: Seemaisora Kai;
Surinam: Grote Markoesa, Groote Markoesa;
Swedish: Barbadin;
Tahitian: Para Pautini;
Taiwan: Da Guo Xi Fan Lian;
Thailand: Ma Thuarot (Lamphun), Sao Warot, Sukhon Tharot (Bangkok), Taeng Kalaa (Chiang Mai);
Tongan: Pasione;
Tongarevan: Pālapōtini, Pārapōtini;
Venezuela: *Badea,* Parcha Granadina;
Vietnam: Chum Bao Duá Duá Gang Táy.

Origin/Distribution

The species is reported to be indigenous to tropical America, but its exact origin is uncertain probably northern South America. It has become naturalized in moist habitats in tropical lowlands especially in central and south America. It is cultivated all over in South and Central America, Hawaii, Southeast Asia, India, Australia, West Africa, the Pacific islands and other tropical regions.

Agroecology

Giant Granadilla has become naturalised in many tropical countries particularly in wet forests and thickets. It is truly a topical species requiring warm diurnal temperatures and high humidity. It grows from near sea level to 1,000 m altitude but in Ecuador it also grows up to 2,000 m. It is cold sensitive and will be killed by cold winters. It grows on a wide range of soils from alluvial, sandy, loams, loamy clays, volcanic and granitic soils but does best in deep, fertile, humus-rich, moist and well drained soils.

Edible Plant Parts and Uses

Ripe fruit flesh is eaten fresh after removal of the inner skin. Since it is rather bland it is often added to papaya, banana or pineapple slices in fruit salad flavoured with lime or lemon juice. The flesh is also cooked with sugar or honey and eaten as dessert or is canned in syrup or candied. In Indonesia, the flesh and arils are eaten together with sugar and shaved ice or used in rujak. In Australia, the flesh is eaten by adding orange juice and cream. Flesh and arils are also stewed and used as pie fillings.

The aril (pulp) is the primary product enjoyed fresh eaten with seeds intact scooped with spoon, with ice cream, or processed into fruit juice, frozen sherbets, syrup or canned nectar. The fruit can be juiced to prepare refreshing chilled drinks. Granadilla juice or nectar is often blended with orange, pineapple, guava or papaya juice. It is also made into cordials and squashes and carbonated beverages. The juice and nectar is bottled in Indonesia and served in restaurants. In Australia, the whole ripe fruit is also processed into wine by mashing and adding brandy and allow the mixture to ferment for a few weeks. The young, unripe fruit may be prepared into a savoury *sayur* or *sambal goreng* or steamed or boiled and served as a vegetable in *sayur* or eaten as *lalab* in Indonesia. The young fruit may be cut up into finger-sized slices, breaded and cooked in butter with milk, pepper and nutmeg for the Europeans in Java. The roots of old vines is baked and eaten as a substitute for yam in Jamaica but the roots and also leaves have been stated to be poisonous (Burkill 1966).

Botany

Giant Granadilla is a robust, perennial tendrilled vine with thick, yellowish green, quadrangular (4-angled) stem, glabrous when young becoming fistular when old, 5–50 m long, woody at the base. Tendrils are axillary, to 30 cm long, coiled, flanked by ovate to ovate-lanceolate stipules, 2–3.5 cm long (Plate 3). Leaves are alternate, ovate to broadly elliptic-ovate (Plate 2), 7.8–13 cm long, 6–10.2 cm wide, glabrous, margins entire, base shallowly cordate, apex abruptly acuminate, glabrous on both surfaces, pinnatinerved with 10–12 pairs of nerves prominent abaxially, dark green adaxially and pale green abaxially, petioles long, trigonous, with 4–6 usually paired, globose nectaries 1–2 mm in diameter. Flowers are solitary, pendulous, shortly stalked, fragrant, showy, large, campanulate, 7–10 cm across, hypanthium 0.6–0.9 cm long; bracts 3 on top of peduncle, ovate and sessile, sepals 5 and petals 5, white or white tinged pink or purple; corona at the margin of the hypanthium in 4–5 rows, innermost rows consisting of short, unequal threads red with white blotches, outer 2 rows consisting of 3 cm long, radiating, erect threads, reddish-brown below and lilac blotches above (Plate 1). Stamens 5, connate with gynophore into a column (gynophore), marked with yellowish green and violet dots. Ovary yellowish –green, ellipsoid, 1.2–1.5 cm long, glabrous, longitudinally furrowed, 1 locule with numerous parietal ovules, stigma reniform or cordiform. Berry very large, ovoid-oblong or ellipsoid, 15–30 cm long by 10–20 cm across with rounded ends, yellowish green or pale green or tinged with pink (Plates 1, 4 and 5). Beneath the rind is the fleshy edible mesocarp, 2–3 m thick, spongy, juicy, sweetish, white or yellowish white. The central

Plate 1 Flowers and granadilla fruit

Plate 3 Terminal shoot with axillary tendrils and stipules

Plate 2 Leaves and angular stem

Plate 4 Giant granadilla fruit

Plate 5 Granadilla fruit halved

cavity contains some juice and masses of flattened-obovoid, 1.25 cm long, purplish-brown seeds. Each seed is enclosed by whitish, yellowish, partly yellow or purple-pink, sweet-acid, edible aril.

Nutritive/Medicinal Properties

Nutrient composition of the fruit flesh of barbadine in terms of 100 g edible portion had been reported as: energy 77 cal., moisture %, protein 2.6 g, fat 1.9 g, carbohydrate 15.5 g, fibre 4.9 g, ash 1.0 g, Ca 9 mg, P 36 mg, Fe 0.6 mg, and vitamin C 20 mg (Leung et al. 1968). Another analysis carried out in El Salvador (Morton 1987) provided the following nutrient composition of the flesh per 100 g edible portion: moisture 94.4 g, protein 0.112 g, fat 0.15 g, crude fibre 0.7 g, ash 0.41 g, calcium 13.8 mg, phosphorus 17.1 mg, iron 0.80 mg, carotene 0.004 mg, riboflavin 0.033 mg, niacin 0.378 mg, ascorbic acid 14.3 mg. Food value of the aril and seed is: moisture 78.4 g, protein 0.299 g, fat 1.29 g, crude fibre 3.6 g, ash 0.80 g, calcium 9.2 mg, phosphorus 39.3 mg, iron 2.93 mg, carotene 0.019 mg, thiamine 0.003 mg, riboflavin 0.120 mg, and niacin 15.3 mg.

Free volatile extract of barbadine fruit was characterized as a mixture of 57 components with (5E)-2,6-dimethyl-5,7-octadiene-2,3-diol, (2E)-2,6-dimethyl-2,5-heptadienoic acid, benzoic acid, furaneol, benzyl alcohol, 2,6-dimethyl-5-hepten-1-ol, dimethylheptadienoic acid, and 2,6-dimethylheptenol, as major components (Osorio et al. 2002). Three of those: (E)-2-pentenol, 2,6-dimethyl-5-hepten-1-ol, and (2E)-2,6-dimethyl-2,5-heptadienoic acid, displayed a strong resemblance to the aroma of the fresh fruit. Volatile compounds released by enzymatic hydrolysis of glycosidic and phosphate extracts were all present in the aroma of the fruit pulp. This fact strongly suggests an active role of glycosides and phosphates in the generation of fruit aroma. Furthermore, the new monoterpenoids trans-4-hydroxylinalool 3,6-oxide and cis-4-hydroxylinalool 3,6-oxide were characterized as major transformation products of (5E)-2,6-dimethyl-5,7-octadiene-2,3-diol under acidic conditions. In earlier studies, 3,7-Dimethyl-3(E)-octene-1,2,6,7-tetraol, a monoterpene isolated from *Passiflora quadrangularis* fruit pulp, was established to be a 12:42:14:32 mixture of (2R,6R)-, (2R,6S)-, (2S,6R)- and (2S,6S)-stereoisomers (Osorio et al. 1999). Monoterpenoids (2E)-2,6-dimethyl-2,5-heptadienoic acid, (2E)-2,6-dimethyl-2,5-heptadienoic acid β-D -glucopyranosyl ester, (5E)-2,6-dimethyl-5,7-octadiene-2,3-diol, and (3E)-3,7-dimethyl-3-octene-1,2,6,7-tetrol were isolated from the fruit pulp along with the known 2,5-dimethyl-4-hydroxy-3(2H)-furanone β-D-glucopyranoside (Osorio et al. 2000).

Cyclopropane triterpene glycosides isolated from the methanolic extract of the leaves of *Passiflora quadrangularis* included quadrangu-loside (9,19-cyclolanost-24Z-en-3β,21,26-triol-3,26-di-O-gentiobioside) (Orsini et al. 1985), 9,19-cyclolanosta-22,25-epoxy-3β-21,22(R)-triol-3β-O-gentiobioside and 9,19-cyclolanosta-21,24-epoxy-3β-25,26-triol-3β-O-gentiobioside, together with oleanolic acid-3-sophoroside (Orsini et al. 1987). C-glycosyl flavonoids namely orientin, isoorientin, vitexin and isovitexin were found in the leaves but not in the pericarp of *P quandragularis* (Zucolotto et al. 2011). A set of two diastereomers of phenylcyano glycosides, (7S)- phenylcyanomethyl 1′-O-α-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside and (7R)-phenylcyanomethyl 1′-O-α-L-rhamnopyranosyl-(1→6)-β-D-glucopyranoside were isolated from the methanol extract of dried vines of *P. quadrangularis* (Saeki et al. 2011).

Four anthocyanin pigments were identified from Giant granadilla flowers: cyaniding 3 monoglucoside, malvidin 3:5 diglucoside, petunidin 3:5 diglucoside and delphinidin 3:5 diglucoside (Halim and Collins 1970).

Some pharmacological activities of Giant granadilla reported are presented below.

Flavonoids and Antioxidant Activity

In callus culture, *P. quadrangularis* turned out to have a faster growth rate and a more friable texture and was selected to investigate its capacity to produce four glycosyl flavonoids (orientin, isoorientin, vitexin, isovitexin). In callus cultures only small amounts of isoorientin were found, while the concentration of the other flavonoids was below the detection limit. UV-B irradiation of calluses was able to increase the production of all four glycosyl flavonoids. After a 7-day exposure of cultures to UV-B light, the production of isoorientin reached concentrations similar to those found in fresh leaves from glasshouse-grown plants. Elicitation with methyl jasmonate also enhanced orientin, vitexin and isovitexin concentrations, even though the stimulation was about 6-fold weaker for orientin and vitexin and about 40-fold for isovitexin, than that exerted by UV-B treatment. Callus cultures treated with the UV-B dose which most enhanced flavonoid production showed a higher antioxidant activity compared to untreated calluses, with an increase ranging from 28% to 76%. Results show that the secondary metabolite biosynthetic capacity of *Passiflora* tissue cultures could be enhanced by appropriate forms of elicitation.

Hemolytic Activity

The leaves were also found to contain haemolysin (Yuldasheva et al. 2005). Hemolytic activity was found in the in n-butanol factions. Hemolysins and cytolysins present in many tropical plants, are potential bactericidal and anticancer drugs. The data suggested that membrane cholesterol was the primary target for this hemolysin and that several haemolysin molecules form a large transmembrane water pore. The properties of the *Passiflora* hemolysin, such as its frothing ability, positive colour reaction with vanillin, selective extraction with n-butanol, HPLC profile, cholesterol-dependent membrane susceptibility, formation of a stable complex with cholesterol, and rapid erythrocyte lysis kinetics indicated it to be probably a saponin.

Anxiolytic Activity

The hydroalcohol extract of *Passiflora quadrangularis* leaves exhibited anxiolytic activity in dosages around 100, 250 and 500 mg/kg, as expressed by elevation of the time spent on the open arms in the plus-maze; a decrease of freezing and an increase of deambulation and rearing in the open field test (De Castro et al. 2007). The hydroalcohol extract showed results similar to diazepam on the holeboard. No positive results were found for the aqueous extract.

Antivenom Activity

Leaves and branches of Giant granadilla also exhibited moderate neutralizing ability (21–72%) against the haemorrhagic effect of *Bothrops atrox* venom at doses up to 4 mg/mouse (Otero et al. 2000).

Traditional Medicinal Uses

Passiflora quadrangularis plant has been used for hypertension in traditional ethno-medicine. The fruit is valued as antiscorbutic and stomachic in the tropics. In Brazilian folk medicine, the fruit flesh is used as a sedative to relieve nervous headache, asthma, diarrhoea, dysentery, neurasthenia and insomnia. The seeds contain a cardiotonic principle, are sedative, and, in large doses, narcotic. The leaf decoction is used as a vermifuge and for bathing skin afflictions. Leaf poultices are applied in liver disorders. The root is used as an emetic, diuretic, vermifuge and narcotic. It is

applied as a soothing poultice when powdered and mixed with oil.

Fermented juice has been used for body cleansing. Giant granadilla is used throughout the Caribbean as a sedative and for headaches. Leaf tea is taken for high blood pressure and diabetes (Seaforth et al. 1983).

Other Uses

The plant is also used as hedge planting.

Comments

The plant is readily propagated by seeds.

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