Molineria latifolia

Scientific Name

Molineria latifolia **(Dryand. ex W. T. Aiton) Herb. ex Kurz.**

Synonyms

Aurota latifolia (Dryand. ex W.T.Aiton) Raf., *Curculigo latifolia* Dryand. ex W.T.Aiton (basionym).

Family

Hypoxidaceae, also placed in Amaryllidaceae, Liliaceae

Common/English Names

Curculigo, Lemba, Lumbah, Weevil Lily.

Vernacular Names

Indonesia: Marasi (Sundanese), Keliangau (Bangka), Doyo, Lemba (Kalimantan), Helai, Kah Kuhue Manak, Kehoang, Kohoang, Kuhueng Lumpoa, Kuhuang Manak, Mangih Tana, Lekuhoe, Louku Huang, Rou' Kuhoa Manak, Rou' Kuhoe, Rou' Kuhue, Rou' Lakuhoeng, Rou' Lekuhoe, Rou' Lekuhue, Rou Lekuhueng, Rou' Parakuwang, Rowei Lekuhong, Teung Lekuhve, Merap, (Kalimantan),Bangit Tanuk, Lekuan, Lekuhan, Lumpa (Daun Panjang), Lumpa Manuk, Luva, Luva', Luva Manuk, Luva Uuk Pla, Luwah, Luwak, Tuban Tlop, Uru' Luva' (Punan, Kalimantan), Congkok, Ketari;
Malaysia: Kelapa Puyoh, Lamba, Lemba, Lemba Kilat, Lumbah, Lumbah Padi, Lumbah Rimba, Nyiur Lember, Pinang Puyuh;
Thailand: Chaa Laan, Ma Phraao Nok Khum (Northern), Phraa Nok (Peninsular);
Vietnamese: Cồ Nốc Lá Rộng, Sâm Cau Lá Rộng.

Origin/Distribution

The species is found from China (Guangdong) to Malesia – Malaysia (Perak, Pahang, Sarawak, Sabah), Indonesia (Sumatra, Bangka, Lingga, Java, Kalimantan) and the Philippines (Palawan, Balabac, Samar).

Agroecology

In its native range, the plant is found in wet areas near streams in primary and secondary forests, from near sea level to 1,100 m altitude. It is a shade-loving plant, thriving under partly shaded or sunless conditions, with abundant water supply. It prefers fertile, well-drained soils, rich in organic matter.

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Edible Plant Parts and Uses

The fruit is edible and taste like sweetened cucumber and is believed to increase appetite. The fruit also has taste modifying properties due to the presence of the protein neoculin (previously called curculin). After consumption of neoculin, water, sour solutions and substances taste sweet, for example a lemon eaten after taking neoculin elicits a sweet taste lasting for about 10 minutes. Neoculin is heat labile, high temperatures of above 50°C degrades the protein and destroys its "sweet-tasting" and "taste-modifying" properties, Thus, it is not suitable for use as sweetening agent in hot or processed foods. However, below this temperature both properties of neoculin are unaffected in basic and acidic solutions, so it has potential for use in fresh foods, frozen foods and as a table-top sweetener.

Food and soft drinks high in sugar content are significantly contributing to the problem of diabetes and obesity and related cardiovascular diseases. The use of artificial, low calorie or zero calorie sweeteners has become a dietary option in many nutritional guides and diet plans. Additionally, there is a need of a natural, low calorie or zero calorie sweetener. A great potential exists with natural sweet proteins, such as neoculin, to fill this multi-million dollar niche.

Plate 1 Top view of leaves

Plate 2 Leaves with long petioles

Botany

A tufted, stemless, andromonoeciou herb with erect rhizome and creeping stolons and thick, fibrous roots. Leaf long-petioled (10–100 cm), lanceolate to oblong-lanceolate, 18–40 × 3–8 cm, usually glabrous, both ends tapering, lateral nerves parallel to mid-rib, penni-nerved (Plates 1 and 2). Flowers yellow, inconspicuous, in axils of a large lanceolate, hairy bract, in densely several flowered 1.5–3 cm racemes. Lower flowers hermaphrodite, sessile to subsessile with long styles, upper flowers staminate with shorter styles and long-pedicelled. Flower perianth yellow; segments suboblong, 8–12 mm with involute margin (Plates 3, 4 and 5); stamens slightly shorter than perianth segments; ovary cylindric, 1.5 cm long; style slender, subequaling stamens with subcapitate stigma. Berry is ovoid to oblong-ovoid, 2.5 cm, white, slightly hairy; beak 6–7 mm, pulp is sweet and edible. Seeds small, ribbed and verruculose.

Plate 3 Flowers arising from the base

Plate 4 Flowers and dried inflorescences

Nutritive/Medicinal Properties

Fruits of *Molineria latifolia* (*Curculigo latifolia*) was found to contain neoculin previously called curculin (Shirasuka et al. 2004; Masuda and Kitabatake 2006), Neoculin is a sweet-tasting protein that also has taste-modifying activity to convert sourness to sweetness (Yamashita et al. 1995; Kurihara 1992; Suzuki et al. 2004). Neoculin is considered to be a high-intensity sweetener, with a reported relative sweetness of 430–2,070 times sweeter than sucrose on a weight basis (Yamashita et al. 1990, 1995; Kurihara 1992). After consuming curculin, water elicited a sweet taste, and sour substances induced a stronger sense of sweetness (Yamashita et al. 1990, 1995). The maximum sweetness induced by 0.02 M citric acid or deionized water after curculin dissolved in a buffer of pH 6.0 was held in mouth for 3 minutes was equivalent to that of 0.35 M sucrose (Yamashita et al. 1995). The taste-modifying activity of curculin was unchanged when curculin was incubated at 50°C for 1 hour between pH 3 and 11.

Plate 5 Flowers with yellow tepals

Neoculin was found to be a large heterodimeric protein composed of an N-glycosylated acidic subunit (NAS) and a monomeric basic subunit (NBS), conjugated by disulfide bonds (Nakajima et al. 2006a; Shimizu-Ibuka et al. 2006; Okubo et al. 2008). Okubo et al. (2008) using protein gel blot analysis revealed the presence of a non-glycosylated NAS species. This suggested the presence of multiple NAS–NBS heterodimers in one cultivar. The neoculin acidic subunit (NAS) was found to consist of 113 amino acid residues weighing 12.5 kDa, while the neoculin basic subunit (NBS) consisted of 114 amino acid residues weighing 12.7 kDa (Suzuki et al. 2004; Shimizu-ibuka et al. 2006). Although these residues were different, 77% of the amino acid sequence was identical. The overall crystal structure of neoculin was found to be quite similar to those of monocot mannose-binding lectins (Shimizu-Ibuka et al. 2006, 2008). However, crucial topological differences were observed in the C-terminal regions of both subunits. In both subunits of neoculin, the C-terminal tails bent up to form loops fixed by inter-subunit disulfide bonds that were not observed in the lectins. In addition, distribution of electrostatic potential on the surface of neoculin was found to be unique and significantly different from those of the lectins, particularly in the basic subunit (NBS). The scientists found a large cluster composed of six basic residues on the surface of NBS, and speculated that it might be involved in the elicitation of sweetness and/or taste-modifying activity of neoculin. Hemagglutination assay data demonstrated that neoculin had no detectable agglutinin activity (Shimizu-Ibuka et al. 2008). DNA microarray analysis indicated that neoculin had no significant influence on gene expression in Caco-2 cell, whereas kidney bean lectin (*Phaseolus vulgaris* agglutinin) greatly influenced various gene expressions. These data strongly suggested that neoculin had no lectin-like properties, promoting its practical use in the food industry (Shimizu-Ibuka et al. 2008). Immunoblot analysis indicated that antiserum to curculin was faintly reactive with miraculin, but not with thaumatin or monellin (Nakajo et al. 1992).

Nakajima et al. (2006b) found in sensory tests, when acetate buffers with different pH values were placed on the tongue after tasting neoculin, a higher intensity of sweetness was detected at lower pH. The sweetness was also suppressed with the addition of lactisole. These results suggested that both the sweetness and the taste-modifying activity were mediated via the human sweet taste receptor hT1R2/T1R3. Koizumi et al. (2007) demonstrated that hT1R3 was required for the reception of neoculin and that the extracellular amino terminal domain (ATD) of hT1R3 was essential for the reception of neoculin. Kurimoto et al. (2007) found that the curculin heterodimer exhibited sweet-tasting and taste-modifying activities through its partially overlapping but distinct molecular surfaces. These findings suggested that the two activities of the curculin heterodimer were expressed through its two different modes of interactions with the human T1R2-T1R3 heterodimeric sweet taste receptor. Nakajima et al. (2008) found that the acid-induced sweetness of neoculin was ascribed to its pH-dependent agonistic-antagonistic interaction with human sweet taste receptor. At acidic pH, neoculin acted as an hT1R2-hT1R3 agonist but functionally changed into its antagonist at neutral pH. Findings by Morita et al. (2009) suggested that the sweetness of neoculin depended on structural change accompanying the pH change, with histidine residues playing a key role.

Northern blot analysis showed that the mRNA for curculin was first detected in *Curculigo latifolia* fruits at 2 weeks after pollination and remained at a constant level for the following 4 weeks (Abe et al. 1992). The content of curculin in the fruit of *Curculigo latifolia* was found to increase gradually until 3 weeks after artificial pollination and dramatically at 4 weeks, to finally reach 1.3 mg per fruit (Nakajo et al. 1992) The neoculin content of the fruit was high for 10 weeks after flowering, following which the yield decreased gradually (Okubo et al. 2008). The optimal period for harvesting the fruits with sensory activity coincided with this 10-week peak period during which the amount of neoculin was 1–3 mg in the whole fruit and 1.3 mg/g of pulp. Immunohistochemical staining showed that neoculin occurred in the whole fruit, especially at the basal portion. Okubo et al. (2010) found that *C. latifolia* exhibited self-incompatiblity. The rate of fruit setting was shown to be 45% by cross-pollination and 4% by self-pollination. To improve the rate of fruit setting of *C. latifolia*, it was found necessary to pollinate compatible pollen by around the 15th day after the first flowering.

A quinone-ester gentisylquinonyl-2,6-dimethoxybenzoate was isolated from *Molineria latifolia* (Piyakarnchana et al. 1995). *Curculigo latifolia* var. *latifolia* was found to contain arbutin (1.10 mg/g) which is used as an ingredient in skin whitening creams (Thongchai et al. 2007).

Traditional Medicinal Uses

In Peninsular Malaysia, decoction of the rhizome with *Areca catechu* is drunk for menorrhagia or with *Hibiscus rosa-sinensis* used as a lotion for ophthalmia. Roots are prescribed as internal medicine for fever and fever with delirium. The leaves, shoot tips and roots are used as infusions in water. Flowers and roots are used as stomachic and diuretic in genito-urinary disorders.

Other Uses

In Peninsular Malaysia and Borneo, the tough, light-weight leaf fibres are made into fishing nets. In Borneo, they are also used to make ropes, twines, sarongs, rice bags, garments and fabrics. The cloth made from the fibres is known as ‘lemba cloth’. The leaves are also used for wrapping fruits, vegetables and food in Indonesia and Malaysia. The leaves are also rolled into strings for tying. In Borneo, the leaves are used in magical healing ceremonies. The plant is also grown as an ornamental in southeast Asia, India, Africa, Europe and the United States.

Comments

C. latifolia is best propagated using rhizomes and corms as the seeds have a low and slow germination rate (Abdullah et al. 2010).

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