Combretum indicum

Scientific Name

***Combretum indicum* (L.) DeFilipps**

Synonyms

Combretum indicum (Linnaeus) Jongkind nom illeg., *Kleinia quadricolor* Crantz, *Mekistus sinensis* Loureiro ex B. A. Gomes, *Quisqualis bracteata* P. Beauv., *Quisqualis glabra* N. L. Burman, *Quisqualis grandiflora* Miquel, *Quisqualis indica* L., *Quisqualis indica* var. *oxypetala* Kurz, *Quisqualis. indica* var. *villosa* (Roxburgh) C. B. Clarke, *Quisqualis longiflora* C. Presl, *Quisqualis loureiroi* G. Don, *Quisqualis madagascariensis* Bojer inval., *Quisqualis obovata* Schumacher & Thonning, *Quisqualis pubescens* N. L. Burman, *Quisqualis sinensis* Lindley, *Quisqualis spinosa* Blanco, *Quisqualis villosa* Roxburgh

Family

Combretaceae

Common/English Names

Burma Creeper, Chinese Honeysuckle, Drunken Sailor, Liane Vermifuge, Love and Innocence, Rangoon Creeper

Vernacular Names

Bangladesh: Basantilata, Begunlata, Madhabilata, Modhumalati, Modhumanjuri, Ranganbel

Burmese: Hta:Wèý-Mheing

Chinese: Bing Gan Zi, Dong Jun Zi, Liu Qiu Zi, Se Gan Zi, Shan Yang Shi, Shih Chun Tze, Shi Jun Zi, Wu Leng Zi

Czech: Hranoplod Indický

German: Quisqualis

India: Madhumalti, Madhumanjari (Bengali), Madhu Malti, Madhumalti (Hindi), Akar Dani, Udani (Malayalam), Parijat (Manipuri), Vilayati Chambeli (Marathi), Irangan Malli (Tamil), Radha Manoharam (Telugu), Ishq Pechaan (Urdu)

Indonesia: Ceguk, Cekluk Kacekluk, Kecukluk, Wedani (Javanese), Kunji Rhabet, Rabet Dani, Rhabet Besi, Saradengan (Madurese), Udani (Malay), Udani (Sumatra), Bidani (Sundanese)

Japanese: Shikunshi

Khmer: Dong Preah Phnom, Khua Hung Sa Mang Vor Romiet Nhi

Korean: Saguncha

Laotian: Dok Ung, Kheua hung, Sa Mang

Malaysia: Akar Dani, Akar Cucur Atap, Akar Setanduk, Ara Dani, Akar Pontianak, Bunga akar dani, Redani, Selimpas, Setanduk

Nigeria: Ọ̀gàn Fúnfún, Ọ̀gàn-Igbó (Yoruba)

Philippines: Kasunbal, Tanglon, Tañgolon, Tañgulo (Bikol), Balitadham, Pinion, Piñones (Bisaya), Talulong, Talulng (Ibanag),

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Talolong, Tartarau, Tartaraok (Iloko), Tauñgon (Manabo), Bonor (Panay Bisaya), Niog-Noigan, Tagarau, Tagulo, Talolong, Tañgolon, Totoraok (Tagalog)
Polish: Cudacznik Indyjski
Portuguese: Arbusto-Milagroso
Spanish: Quiscual
Thai: Cha Mang (Northern), Thai-Mong (Karen-Mae Hong Son), Lep Mue Naang (Central, Peninsular)
Tongan: Kaloni Kakala
Togo: Gargu (Anyi-Anufo)
Vietnamese: Cha ro, Chúa sá nằng, Dây Giun, Dây quân tử Hoa Giun, Quả nấc, Sứ Quân Tử

Origin/Distribution

The plant is indigenous to India, Southeast Asia (Kampuchea, Laos, Myanmar, Thailand, Vietnam, Malaysia, Papua New Guinea and the Philippines) and tropical Africa (Benin, Ivory Coast, Ghana, Mali, Nigeria, Sierra Leone, Togo, Tanzania, Zaire and Angola). It is now widely cultivated as ornamental and naturalized in the tropics. The plant is cultivated in China and Taiwan and has naturalized in northern Queensland and the northern parts of the Northern Territory, in New Caledonia, Southeastern United States (i.e. Florida) and the Caribbean (e.g. Puerto Rico and the Virgin Islands).

Agroecology

In its native range, it is found along edges of primary forests; in secondary forests, woodlands and hillsides; and alongside riverbanks from sea level up to 1,500 m. Elsewhere it is also found in disturbed habitats, thickets and rice fields and along roadsides and railway tracks. The plant is also cultivated in gardens as fences/hedges and in parks. The plant grows and flowers best in full sun. Although fairly drought tolerant, it requires moderate watering during the hot dry seasons. It grows on a wide range of soils, including poor soils, and does best in well-drained, moist soil rich in humus.

Edible Plant Parts and Uses

The plant has edible fruit that tastes like almond, and the flowers are eaten in Thailand (Wessapan et al. 2007; Wetwitayaklung et al. 2008). In tropical Africa and parts of Southeast Asia, it is cultivated for production of the drug (fruits and seeds) and as a leafy vegetable. In Indonesia, very young reddish-brown leafy shoots are eaten raw or steamed as 'lalab'.

Botany

A deciduous, sub-woody climber or scrambling shrub with pubescent terete branches and reaching lengths of 3–8 m. Leaves simple, oblong-elliptic to elliptic, 5–18 cm by 3–7 cm, with acuminate tips, obtuse to rounded base sand entire margin, abaxially brown pilose and adaxially glabrous, rarely tomentose of both surfaces (Plate 1). Inflorescences in lax terminal racemes, 10–15 cm long, with linear-filiform to ovate, brown pilose deciduous bracts (Plates 1 and 2). Flowers fragrant, bisexual, pentamerous and tubular; calyx tube yellow pilose with five deltoid lobes 1.5–2.5 mm long with acuminate apices; petals 5 obovate to oblanceolate, 8–16 mm long, with obtuse apices, white turning to pink or red; stamens 10 in two rows, adherent, scarcely exserted, ovary inferior, style filiform and stigma knob shaped. Fruits dry capsule, 3–4 cm long,

Plate 1 Inflorescences and leaves

Plate 2 Close view of flowers

red turning to dark chestnut brown when ripe, narrowly ellipsoid to fusiform and sharply 5 ridged and usually one seeded.

Nutritive/Medicinal Properties

Flower Phytochemicals

Rutin and pelargonidin-3-glucoside have also been isolated from flowers (Nair et al. 1979). The major components detected in the flower extracts included *E*- and *Z*-linalool oxides (furanoid form); 2,2,6-trimethyl-6-vinyl-3-keto-tetrahydropyran; 2,2,6-trimethyl-6-vinyl-3-hydroxy-tetrahydropyran (linalool oxide pyranoid form); (*E,E*)-α-farnesene, *Z*-3-hexenyl benzoate and benzyl benzoate; and a tentatively identified compound quinoline carbonitrile along with some waxy components (Rout et al. 2008). Tannin (gallic acid), flavonoid (quercetin and rutin) and terpenoids (β-sitosterol and lupeol) were isolated from leaves and flowers of *Quisqualis indica* (Bairagi et al. 2012b).

Fruit Phytochemicals

The fruit was found to contain the following amino acids: arginine, aspartic acid, glutamic acid, serine, glycine, proline, leucine, valine, alanine, threonine, asparagine, histidine, lysine, an acidic amino acid named quisqualic acid along with γ-amino butyric acid and trigollenine (Takemoto et al. 1975c). The structure of quisqualic acid was proposed as β-(3,5-dioxo-1,2,4-oxadiazolidin-2-yl)-L-alanine (Takemoto et al. 1975b). A new hydroxyureido derivative, 2-amino-3-(1-hydroxyureido) propionic acid, was obtained by an alkaline treatment of quisqualic acid, and isoquisqualic acid [β-(3,5-dioxo-1,2,4-oxadiazolidin-4-yl)alanine] was also synthesized. Quisqualic acid was synthesized from 3,5-dioxo-1,2,4-oxadiazolidine and from methyl 3-chloro-2-benzoxycarbonylaminopropionate (Takemoto et al. 1975a). Related compounds are the following: D-L-2-amino-3-(1-hydroxyureido)propionic acid and L-2-amino-4-(3-hydroxyureido)-butyric acid were also synthesized. Quisqualic acid was also found in the seeds (Flippen and Gilardi 1976). A new acylglycosyl sterol, 3-*O*-[6′-*O*-(8Z-octade-cenoyl)-β-D-glucopyranosyl]-clerosterol, plus 4 known compounds clerosterol, betulinic acid, methylursolate and α-xylofuranosyluracil were isolated from the methanol extract of *Quisqualis* fruit (Kwon et al. 2003). The peel of *Quisqualis* fruit was found to contain trigonelline (Iang and Tian 2004). Twelve compounds were isolated from the ethanol extracts of *Quisqualis indica* fruit (Huang et al. 2006). The compounds were glyceryl monosterate, glyceryl monopalmitate, clerosterol, 1-linoloyl-3-palmitoylglycerol, stigmasterol, methylursolate, betulinic acid, ethyl gallate, gallic acid, butanedioic acid, benzoic acid and sucrose.

Fixed oil extracted from the fruits could be stored for a year in bottles with charcoal as desiccants and covered with polythene sheets without appreciable loss of quality (Quitana et al. 1983). However, there were significant changes in some parameters such as acid value, saponification ester values which represented degradation indices that began at 6 months but were not expressed in terms of off-flavour/odour. After a year storage, crude oil content changed from 38.347 to 30.25 %, pure fixed oil from 28.30 to 26.78 %, moisture content 7.25 to 7.83 %, weight 628 to 4.88 g, oxygen 20.64 to19.82 %, specific gravity (25 °C)s 0.924 to 0.904, refractive index (28 °C) 1.48 to 1.514, acid value 1.047 to 5.552, saponification value 201.11 to 153.89 and ester value 208.07 to 148.34.

The oil yield from *Quisqualis* fruit was 27.70 % (Wang and Chen 2004). Among the fatty acids, oleic acid, linoleic acid and palmitic acid were dominant. The unsaturated fatty acids accounted for 63.93 % of the total fatty acids, and the major saturated fatty acid was palmitic acid.

Leaf Phytochemicals

Four crystalline constituents were isolated from the leaves of shih-chun-tze, *Quisqualis indica* and identified to be nicotinic acid methylbetaine (trigonelline), L-proline, L-asparagine and potassium quisqualate (Fang and Chu 1964). Two cysteine synthase isoenzymes A and B were purified from the leaves (Murakoshi et al. 1986). Both isoenzymes catalyze the formation of cysteine from *O*-acetyl-L-serine and hydrogen sulphide, but only isoenzyme B catalyzes the formation of L-quisqualic acid. Two ellagitannins, quisqualin A and quisqualin B, were isolated from the fruits (Lin et al. 1997). Twenty-one additional tannins were isolated from either the fruits or leaves including 11 ellagitannins (2,3,-(*S*)-HHDP-D-glucose; 2,3-(*S*)-HHDP-4-galloyl-D-glucose; 2,3-(*S*)-HHDP-6-galloyl-D-glucose; 2,3-(*S*)-HHDP-4,6-di-*O*-galloyl-D-glucose, pedunculagin; punicalagin; eugeniin; 1-desgalloyleugeniin; casuariin;5-desgalloylstachyurin; and castalagin), five gallotannins (6-*O*-galloyl-D-glucose; 1,6-di-*O*-galloyl-β-D-glucose; 2,3 di-*O*-galloyl-D-glucose; 3,4-di-*O*-galloyl-D-glucose; and 4,6-di-*O*-galloyl-D-glucose), four phenol-carboxylic acids (gallic acid, ellagic acid, falvogallonic acid and brevifolin carboxylic acid) and one hydrolyzable tannin (punicalin). *Q. indica* leaves were reported to have 8 % moisture content, 9 % total ash, 12.5 % acid-insoluble ash, 6.55 % water-soluble ash values and 5.45 % sulphated ash (Singh et al 2011). Alcohol-soluble extractive value and petroleum ether-soluble extractive value of the leaves were observed to be 10, 3 and 1% w/w, respectively. The phytochemical test revealed the presence of alkaloids, slight amount of glycosides, tannins, flavonoids and protein in both extracts.

Antioxidant Activity

Four edible flower extracts including *Q. indica* elicited antioxidant activity in ABTS assay with the trolox equivalent antioxidant capacity (TEAC) of 0.15–0.70 (Wessapan et al. 2007). Of 24 edible Thai flowers, both dried flowers and crude extract of *Quisqualis indica* gave the highest total phenol contents and showed the highest antioxidant activities (Wetwitayaklung et al. 2008). The antioxidant activity of *Q. indica* was (TEAC = 0.70, IC_{50} = 13.26 µg). Total polyphenol in terms of g/100 g dried flower was 7.71 g, and 31.49 g/100 g crude extract and percent polyphenol yield was 24.47 %.

The amount of total phenolic content varied for different partitionates ranging from 22.95 to 39.45 g of GAE/100 g of dried *Q. indica* bark extract (Kaisar et al. 2009). The highest total phenolics were found in chloroform-soluble partitionate (CSP) (39.45 g of GAE/100 g of dried extract) and the lowest in the n-hexane-soluble partitionate (HSP) (22.95 g of GAE/100 g of dried extract). Total phenolic content of carbon tetrachloride (CTP) and aqueous soluble partitionates (ASP) were found to be 30.81 and 29.87 g of GAE/100 g of dried extract, respectively. Among the partitionates tested, the most potent fraction was found to be CSP. Free radical scavenging activity of the CSP was highest having IC_{50} value of 30.65 µg/ml. CTP, ASP and HSP demonstrated moderate free radical scavenging activity with the IC_{50} value of 68.46, 72.20 and 84.23 µg/ml, respectively, as compared to the standards, i.e. *tert*-butyl-1-hydroxytoluene (BHT) (IC_{50} = 24.35 µg/ml) and ascorbic acid, ASA (IC_{50} = 5.80 µg/ml).

Antidiabetic Activity

The methanolic flower extract of *Quisqualis indica* at doses of 200 and 400 mg/kg, p.o. elicited significant decrease in the biochemical parameters, glucose, triglyceride, total cholesterol, HDL-cholesterol and LDL-cholesterol levels in alloxan-induced diabetic rats as compared to

untreated diabetic control group (Bairagi et al. 2012a). The extract at both doses was also effective in normalizing the levels of triglyceride and cholesterol levels in heart homogenates as compared with diabetic control.

Antihyperlipidemic Activity

Co-administration of the methanolic or aqueous extract of aerial parts (100, 200 mg/kg) to high-cholesterol diet-induced hyperlipidemic rats reduced total cholesterol, triglycerides, low-density lipoproteins (LDL) and VLDL and increased high-density lipoproteins (HDL) (Sahu et al. 2012a). The methanol extract was more effective than the aqueous extract and was comparable to atorvastin. The extracts were found to contain glycosides, alkaloids, saponins, flavonoids, carbohydrates and fixed oil.

Acetylcholinesterase Inhibition Activity

Wetwitayaklung et al. (2007) demonstrated that the methanolic flower extract of *Q. indica* exhibited acetylcholinesterase inhibition activity (Wetwitayaklung et al. 2007). The extract inhibited electric eel acetylcholinesterase in a dose-dependent manner with an IC_{50} value of 0.77 µg/ml.

Antimicrobial Activity

Methanol flower extracts of five edible flowers including *Quisqualis indica* exhibited antibacterial effect in-vitro against *Staphylococcus aureus* with MIC at 50–800 µg/ml (Wessapan et al. 2007). *Candida albicans* was inhibited by flower extracts from *Sonneratia caseolaris* and *Quisqualis indica*, with MIC at 50 and 800 µg/ml, respectively (Wessapan et al. 2007). Four diphenylpropanoids: 1-(4-hydroxy-3-methoxyphenyl)-2-(4-allyl-2,6-dimethoxyphenoxy) propan-1-ol (1); 1-(3,4-dimethoxyphenyl)-2-(4-allyl-2,6-dimethoxyphenoxy)propan-1-ol (2); 1-(3,4- dime thoxyphenyl)-2- (4-al lyl-2,6-dime thoxyphenoxy)propan-1-ylac e tat e (3); and 1-(4-hydroxy-3,5-dimethoxyphenyl)-2-(4-allyl-2,6-dimethoxyphenoxy) propan-1-ol (4) were isolated from the chloroform-soluble fraction of a methanol stem bark extract of *Quisqualis indica* (Jahan et al. 2009). All compounds were tested for their anti-staphylococcal activity against a total of five multidrug-resistant (MDR) and methicillin-resistant *Staphylococcus aureus* strains, and the minimum inhibitory concentrations (MICs) were in the range of 128–256 µg/ml. Studies showed that the methanol dry flower extract of *Quisqualis indica* showed highest antimicrobial property than other flowers (*Calotropis gigantea* and *Polianthes tuberosa*) studied (Kiruthika et al. 2011). *Q. indica* methanol flower extract showed significant in-vitro antibacterial activity against the microbes *Klebsiella pneumoniae, Pseudomonas aeruginosa, Proteus mirabilis, Escherichia coli,* methicillin-resistant *Staphylococcus aureus* and *Bacillus subtilis*. Sanguri et al. (2011) found that *Q. indica* leaf extracts were more effective on fungal species *Alternaria porri, Aspergillus flavus, Aspergillus niger, Aspergillus oryzae* and *Penicillium chrysogenum* than bacterial species. The methanol extract was more effective than aqueous extract.

Antiinflammatory Activity

Oral administration of the hydroalcoholic flower extract at the doses 100 and 150 mg/kg body weight to rats elicited dose-dependent and significant antiinflammatory activity in acute (acetic acid-induced vascular permeability) and chronic (cotton pellet granuloma) inflammatory models (Yadav et al. 2011a).

Immunomodulatory Activity

Oral administration of the hydroalcoholic flower extract at the doses 100 and 150 mg/kg body weight elicited an immunomodulatory response in rats (Yadav et al. 2011b). Administration of the flower extract was found to increase phagocytic

activity by stimulation of macrophages, total WBC and differential leukocytes count. Delayed-type hypersensitivity reaction was also stimulated by *Quisqualis indica* at the higher dose significantly indicating that the extract could stimulate the haematopoietic system.

Antitumour Activity

Efferth et al. (2008) identified 25-*O*-acetyl-23,24-dihydro-cucurbitacin F as a cytotoxic constituent of *Quisqualis indica* that possessed activity against tumour cells.

Anthelminthic Activity

Quisqualic acid (from *Q. indica* fruits) at 0.1 and 0.2 % w/v and kainic and α-allokainic acid at 0.025 and 0.05 % w/v were effective in causing cessation of movement but did not kill the worms (Ishizaki et al. 1973). Pyrantel pamoate at 10–6 and 10–4 w/v had a similar effect but was also proteolytic and fatal. Quintana et al. (1983) reported that clinical tests found that adults eating 8–10 dried seeds as a single dose significant reduced ova counts of *Ascaris* and *Trichiuris;* for 9–12-years-old 6–7 seeds; for 6–8 years old 5–6 seeds; for 4–5 years old 4–5 seeds; and that children below 3 years old should not be treated with the seeds.

Forty subjects with intestinal ascariasis., aged 2–12 years old, comprising 82 % with purely *Ascaris lumbricoides* ova and 17.5 % with mixed *Ascaris lumbricoides* ova and *Trichuris trichiura* ova, were assigned to *Quisqualis indica* (niyog-niyogan) treatment and pyrantel pamoate (combantrin) treatment group at random (Carpio 1997). Follow-up fecalyses after 7 days posttreatment revealed complete cure of 85 % for *Quisqualis indica* and 90 % for pyrantel pamoate. A second dose of the corresponding antihelmintic was given which resulted in complete eradication of ova. Ten percent of the *Quisqualis indica* group developed side effects as compared to 55 % of those given pyrantel pamoate. In a randomized double-blind controlled trial involving 135 children 3–7 years old, treatment of ascariasis using ipil-ipil (*Leucaena glauca*) and niyog-niyogan (*Mesua ferrea*) plant medicines significantly produced a change in the number of ova count before and after treatment (Bonagua 1998). Both ipil-ipil and niyog-niyogan were almost similar in their effectiveness with pyrantel pamoate. The treatment was safe without any untoward effects noted.

Larvicidal Activity

Quisqualis indica was reported to have larvicidal activity against *Aedes aegypti* mosquitoes but at comparatively high doses (LC_{50}>263 ppm and LC_{90}>562.3) (Kaushik and Saini 2009).

Central Nervous System CNS Activity

Quisqualic acid, an excitatory amino acid, had been reported to be an agonist for both AMPA ((S)-2-amino-3-(3-hydroxy-5-methyl-4-isoxazole) propionic acid)-subtype glutamate receptors and metabotropic glutamate receptors such as mGluR1, mGluR3 and mGluR4 (Jin et al. 2002; Kuang and Hampson 2006; Zhang et al. 2006). These receptors are tetrameric ion channels that mediate most of the fast excitatory synaptic transmission in the mammalian central nervous system. Quisqualic acid causes excitotoxicity and is employed in neuroscience to selectively damage cholinergic neurons in the brain or spinal cord (Unger and Schmidt 1992; Muir et al. 1993; Giovannelli et al. 1998). Quisqualic acid had been reported to cause neuronal damage and seizures in animals (Zaczek and Coyle 1982). Quisqualic acid induced neuronal necrosis and glial infiltration in the stratum and hippocampus of 7-day-old rat (pups) when intracerebrally injected (Silverstein et al. 1986). An intrahippocampal injection of quisqualic acid induced hippocampal seizure in unanesthetized cats (Funda et al. 1985). The authors suggested that a mild but constant epileptogenic potency of quisqualic acid had an advantage for an experimental model of temporal lobe epilepsy in man.

Kaijima et al. (1987) found that microinjection of quisqualic acid into unilateral amygdala in chronically implanted cats resulted in various types of limbic seizures. They asserted the strict dose dependency of quisqualic acid in the production of limbic seizures to be a valid advantage for an experimental model of a complex partial epilepsy in man. Numerous wet-dog shakes were associated with limbic seizures in the course of focal epilepsy induced by kindling stimulations or local injections of kainic or quisqualic acid and progressively disappeared during generalization (Rondouin et al. 1987). Addae and Stone (1988) found that pentobarbital and diphenylhydantoin blocked the effect of quisqualic acid in the rat cerebral cortex but only at concentrations higher than the therapeutically relevant levels. Studies showed that the chloroform fraction of a hot aqueous water extract of *Quisqualis indica* inhibited cyclic AMP phosphodiesterase by about 80 % (Thein et al. 1995).

Hippocampal CA1 pyramidal cell neurons were found to be sensitized over 30-fold to depolarization by L-2-amino-4-phosphonobutanoic acid (L-AP4) following exposure to L-quisqualic acid; the phenomenon was termed the QUIS effect (Subasinghe et al. 1992). Replacement of the oxadiazolidinedione ring of L-quisqualic acid with several other types of heterocyclic rings yielded the following quisqualic acid analogues: maleimide 2, *N*-methylmaleimide 3, *N*-(carboxymethyl)maleimide 4, succinimides 5A and 5B and imidazolidinedione 6, but none of these analogues were able to mimic the effects of L-quisqualic acid and sensitize hippocampal CA1 neurons to depolarization by L-AP4. Also none of the analogues were able to preblock or reverse the QUIS effect.

Antipyretic Activity

The methanolic leaf extract of *Quisqualis indica* was found to possess significant dose-dependent, antipyretic activity against brewer's yeast induced pyrexia in Wistar rats (Singh et al 2011). The animal group that received methanolic extracts 100 and 200 mg/kg showed significant decrease in rectal temperature from 38.40 to 37.44 and 38.99 to 37.49, respectively, as compared with the group that received aspirin, the standard drug.

Antitremor Activity

Studies in mice showed that systemic administration of excitatory amino acids, kainic acid and quisqualic acid could modify drug-induced tremor (Shinozaki et al. 1987). Kainic acid enhanced the tremor induced by tremorine but depressed the tremor induced by harmaline. Quisqualic acid depressed the tremor induced by both tremorine and harmaline in a dose-dependent manner. Kainic acid shifted the frequency of each component of the tremor induced by tremorine to the high-frequency side, but quisqualic acid did not affect the frequency of tremor of the tremor induced by tremorine. The frequency of tremor of the tremor induced by harmaline was shifted by both excitatory amino acids to the low-frequency side.

Toxicity Studies

Quisqualis indica seed has long been used in folk medicine as an ascaricide. Studies by Chivapat et al. (1998) found that mice receiving water extract equivalent to *Quisqualis indica* seed at the dose of 20.0 g/kg/day orally showed no acute toxicity and therefore LD_{50} was more than 20.0 g/kg/day. The subacute toxicity study in Wistar rats by administration of water extract equivalent to the seed at the doses of 0.2, 2.0, 6.0, 10.0 and 20.0 g/kg/day for 60 consecutive days showed that after receiving the extract equivalent to the seed of 6.0, 10.0 and 20.0 g/kg/day for 2 days, the animals showed abnormal clinical signs; the notable ones were clonic with tonic seizures followed by respiratory arrest and death. The percentages of rats presenting toxic symptoms and death at the doses of 6.0, 10.0 and 20.0 g/kg/day in male were 26, 53 and 80, respectively, and in female were 0, 6 and 80, respectively. All rats died after receiving the highest dose only for 3 consecutive days. The growth rate and feed

consumption of the survived rats receiving the extract for 60 days were not different from control group.

Traditional Medicinal Uses

In Vietnam, the fruits are used for treatment of ascariasis and oxyuriasis in children and for treating infantile malnutrition due to intestinal parasitosis; a decoction of the fruit is used as gargle for toothache (NIMM 1999). In Thailand the seeds are used as anthelminthic and leaf for healing of abscesses (Wetwitayaklung et al. 2008). In the Philippines, the fruit is used as vermifuge and the plant as cure for cough (PBI). According to BPI, seeds macerated in oil are applied to parasitic skin diseases in China, and seeds are also used as vermifuge. In the Moluccas and India, the seeds are given with honey as an electuary for the expulsion of entozoa in children; ripe seeds are roasted and administered for diarrhoea and fever (Chopra et al. 1986; Kirtikar and Basu 1989). In Malaysia, the fruits and leaves are used as vermifuge and the roots as so in Java (Burkill 1966). A plant decoction is used for diarrhoea in children. The Malays used the leaf juice as a lotion for boils and ulcers and the leaves are applied directly for headaches. Ripe seeds are sweet and if the ovary wall and seed coat are removed are pleasant to eat but there are cases of people becoming ill on eating only two or three. Excess causes drowsiness as the seeds are soporific. The fruits and the seeds are used in Nigeria, Ivory Coast and Gabon for their anthelmintic properties and to cure diarrhoea (Burkill 1985).

Other Uses

The plant is widely grown as a medicinal plant; as an ornamental over fences, pergolas and trellises; and as hedges in gardens and parks. In West Africa, the long, flexible stems are used for basketry, fish weir and fish traps (Dalziel 1955). The plant extract exhibited mild repellency against the female oriental fruit fly *Dacus dorsalis* (Areekul and Sinchaisri 1988) *Q. indica* extract exhibited anticoccidial effect against *Eimeria tenella* in chicken (Youn and Noh 2001).

Comments

Quisqualis indica can be propagated by leafless stem cuttings with at least three nodes: air layering and root division. Propagation from seed is easy, but fruits and seeds are seldom formed.

The plant is regarded as an emerging environmental weed in Northern Queensland and the northern parts of the Northern Territory and is a potential environmental weed or 'sleeper weed' in other warmer and wetter parts of Australia.

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