

An Overview on Ethnopharmacological and Phytochemical properties of *Thunbergia sp.*

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Abstract

The worldwide emergence of multidrug resistance, unavailability of drug in the developing Countries and side effect of drug raises the necessity of alternative herbal medicine as drugs. So, researchers are trying to find out the effective herbal medicinal plants for different medical health issues. The ethnomedicinal importance of common *Thunbergia* species, their pharmacological properties and also some bioactive compounds regarding their pharmacological properties has been reported in this review. Genus *Thunbergia* belongs to the Acanthaceae family. More than 100 species of *Thunbergia* has been included in this genus. Antibacterial, antifungal and anthelmintic activity of *Thunbergia grandiflora*, anti-inflammatory, antitumor, antioxidant antinociceptive activity of *Thunbergia laurifolia* due to presence of rosmarinic acid and also antidiabetic and hepatoprotective activity of *Thunbergia laurifolia* has been reported in the present review article.

Keywords: *Thunbergia*; Antibacterial; Antifungal; Anti-inflammatory; Antitumor; Antioxidant; Antidiabetic; Hepatoprotective; Rosmarinic acid

Introduction

Thunbergia is a genus of flowering plant of Acanthaceae family, native to tropical regions of Africa, Madagascar, Australia and South Asia. *Thunbergia* species include some 100 species of annuals, perennials and shrubs. There are many twinning climbers, as well as some shrubby types in this variable genus. Retizius named the genus *Thunbergia* in 1780 in honours of Carl Peter Thunberg, a Swedish Physician and Botanist employed in the Dutch East India Company [1,2].

The attractive climbers are a varied group usually with pointed oval to heart-shaped leaves, sometimes lobed or toothed. They occur in many colours, but are most often yellow, orange and purple-blue shades. Many of the *Thunbergia* species prefer full sun and well-drained soil but can bloom in partial shade also. A sunny location is required as they can receive direct sunlight for six or more hours a day. Regular and deep watering is needed for the plants, allowing the soil to dry slightly between watering (but total dry soil will cause wilting and premature flower drops). Most of the plants of this genus have ornamental value but some of them have medicinal value also.

Classification of *Thunbergia*

Class: Equisetopsida

Subclass: Magnoliidae

Order: Lamiales

Family: Acanthaceae

Genus: *Thunbergia*

Some of the common *Thunbergia* species are as follows [1,2]:

Thunbergia alata

Thunbergia annua

Thunbergia battiscombei

Thunbergia coccinea

T. cordata

T. erecta

T. elegans

T. fragrans

T. grandiflora

T. gregorii

T. gibsonii

T. ikbaliana

T. laurifolia

T. lutea

T. mysorensis

T. vogeliana

Description

Species of *Thunbergia* are different from each other based on their general characteristics such as their geological distribution, height, plant physiology and blooming season mentioned in the tables. Besides these, basic requirement of plant such as soil, water and sun exposure may vary from species to species of *Thunbergia* plant [2-4].

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Received October 22, 2015; **Accepted** November 19, 2015; **Published** November 23, 2015

Citation: Sultana KW, Chatterjee S, Roy A, Chandra I (2015) An Overview on Ethnopharmacological and Phytochemical properties of *Thunbergia sp.* Med Aromat Plants 4: 217. doi:10.4172/2167-0412.1000217

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Distribution	Native to Tropical Africa, Brazil, Hawaii and Eastern Australia
Common name	Black-eyed Susan vine
Height	About 8 feet
Plant type	Perennial climbing vine
Leaf arrangement	Opposite
Leaf surface	Upper surface hairless (i.e. glabrous) or slightly hairy (i.e. puberulous)
Leaf margin	Toothed/dentate and acuminate, Acute or mucronate (pointed tips)
Leaf shape	Ovate/hastate (arrow-shaped)
Leaf venation	Reticulate
Flower	Bright yellow, white or orange with brownish purple tube like centre, salverform with five petals
Blooming season	Spring, summer
Fruit	Loculicidal capsule
Soil for cultivation	Rich, well-drained best for fast growing
Water requirement	Moderate
Sun exposure	Full sun to partial shade

Table 1: *Thunbergia alata* characteristic features.



Figure 1: *Thunbergia alata*.

Thunbergia alata (Table 1 and Figure 1)

Thunbergia coccinea (Table 2 and Figure 2)

Thunbergia erecta (Table 3 and Figure 3)

Thunbergia fragrans (Table 4 and Figure 4)

Thunbergia grandiflora (Table 5 and Figure 5)

Thunbergia laurifolia (Table 6 and Figure 6)

Ethnomedicinal Importance of *Thunbergia* Species [5-19]

Antibacterial activity

Jenifer et al. have evaluated the antibacterial activity of Chloroform stem extract of *Thunbergia alata* against *Pseudomonas aeruginosa* and significant antibacterial activity of higher concentration of ethanolic leaf extract of *Thunbergia alata* against *Salmonella typhi* [20]. Methanolic crude extract of *Thunbergia grandiflora* leaves against some Gram positive and Gram-negative bacteria showed significant antibacterial activity [21]. Methanolic extract of flower of *Thunbergia grandiflora* showed antibacterial activity against *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, *Bacillus cereus*, *Proteus mirabilis* and *Streptococcus pyogenes* due to the presence of phenols, alkaloids and flavonoids in the flower extract of that plant [22].

Antifungal activity

Chowdhury et al. have evaluated the antifungal activity of methanolic crude extract of *Thunbergia grandiflora* leaves [21]. It is reported that the decoction of leaves of *T. fragrans* used in fungal infection [23].

Distribution	Native to India and Myanmar
Common name:	Scarlet vine, Red clock vine
Height:	3-8 metres
Plant type:	Perennial climbing vine
Root system	Tuberous
Leaf arrangement	Opposite
Leaf surface:	Both surfaces pubescent
Leaf margin	Dentated
Leaf shape	Ovate or lanceolate
Leaf venation	Pinnate
Flower	Salmon-red tubular flower
Blooming season:	January to April
Fruit	Loculicidal capsule (glabrous)
Soil for cultivation	Moderately moist soil sandy-loamy or gritty-loamy soil
Water requirement	Moderate
Sun exposure	Full sun to partial shade

Table 2: *Thunbergia coccinea* characteristic features.

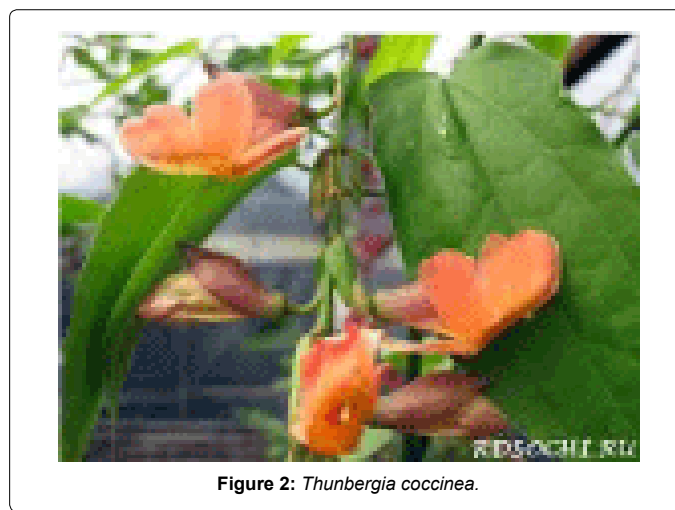


Figure 2: *Thunbergia coccinea*.

Distribution	Native to Western Africa
Common name	Bush Clock vine, King's Mantle
Height	4 to 6 Feet
Plant type	Shurb
Root system	Tuberous
Leaf arrangement	Opposite/sub opposite
Leaf surface	Pubescent
Leaf margin	Entire
Leaf shape	Elliptic (oval)/Ovate elliptic
Leaf venation	Bowed: Pinnate
Flower colour	Yellow throated tubular Purple flower having five petals
Blooming season	Spring to summer
Fruit	Loculicidal capsule
Soil for cultivation	Moist but well drained loamy
Water requirement	Moderate
Sun exposure	Full sun to shade

Table 3: *Thunbergia erecta* characteristic features.

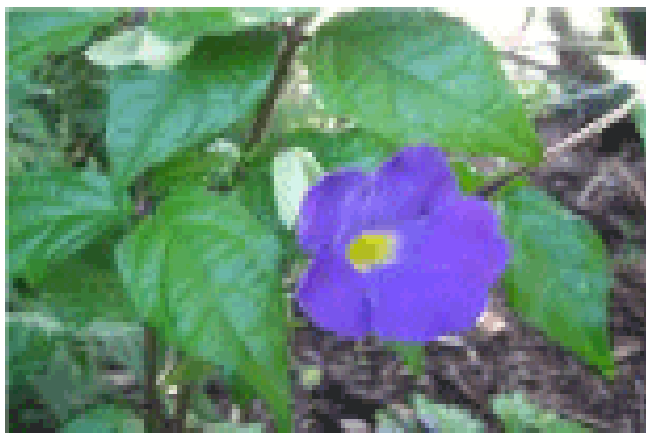


Figure 3: *Thunbergia erecta*.

Distribution	Native to India, Malaysia, Thailand, Indochina
Common name	White lady, sweet clock vine
Height	6-8 feet tall
Plant type	Perennial climbing, creeper plant
Root system	Tuberous
Leaf arrangement	Opposite/ sub opposite
Leaf surface	Both surfaces pubescent to subglabrous or rarely glabrous
Leaf margin	Entire, slightly lobed to crenate or almost entire (i.e. sub-entire)
Leaf shape	Ovate or triangular with hastate shaped, lanceolate
Leaf venation	Pinnate
Flower	White tubular flower, sweet fragrance
Blooming season:	Throughout year, mostly during summer and autumn
Fruit	Subglobose capsule with a long thick beak
Soil for cultivation	Moist well-drained loamy soil
Water requirement	Moderate
Sun exposure	Full sun to partial shade

Table 4: *Thunbergia fragrans* characteristic features.

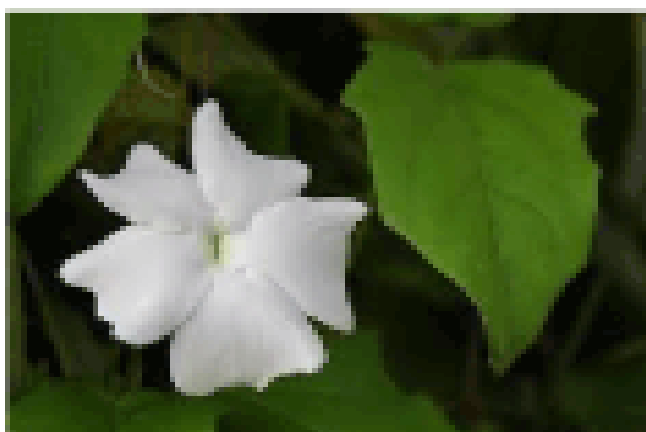


Figure 4: *Thunbergia fragrans*.

Anthelmintic activity

The anthelmintic activity of methanolic extract of *Thunbergia grandiflora* on *Tubifex tubifex* worm due to presence of Proanthocyanidin tannin content was reported [24].

Anti-inflammatory activity

Ethanol and hexane extract of leaves of *Thunbergia laurifolia* plant showed anti-inflammatory activity against carrageenan-induced paw edema in mice [25]. Rosmarinic acid was found in ethanolic extract of *T. laurifolia* leaf and was isolated, which showed the anti-inflammatory effect on two mouse models of carrageenan-induced paw edema and cotton pellet-induced granuloma formation [26]. Anti-inflammatory activity of *Thunbergia coccinea* plant was observed [27].

Antipyretic and analgesic activity

Both analgesic and antipyretic activity of methanolic extract of leaves of *Thunbergia coccinea* Wall was observed in rats [28].

Antidiabetic potency

Administration of aqueous extract of dried *Thunbergia laurifolia* leaves in alloxan-induced diabetic rats showed hypoglycemic effect [29].

Antidote and detoxification activity

Leaf extract of *Thunbergia laurifolia* is reported as an antidote against poisonous insecticide [30]. Tejasen et al. also demonstrated that the cholinergic effect on rats is reduced after administration of aqueous extract of *T. laurifolia* and mortality rate of rats treated with folidol

Distribution	Nepal, China, India, Burma, Indochina, Australia and America
Common name:	Bengal trumpet vine, Bengal clock vine, Sky vine, and Sky flower
Height:	About 15 meter
Plant type:	Perennial climbing plant
Root system	Tuberous
Leaf arrangement	Opposite have petioles
Leaf surface:	Rough surface, hairy (i.e. pubescent)
Leaf margin	Dentated, lobed or entire
Leaf shape	Triangular or ovate, deltoid, saggitate lobed
Leaf venation	Pinnate
Flower	Blue to mauve with yellow tube inside
Blooming season:	Spring, fall
Fruit	Loculicidal capsule, pubescent
Soil for cultivation	Moist loamy
Water requirement	Moderate
Sun exposure	Full sun to shade

Table 5: *Thunbergia grandiflora* characteristic features.



Figure 5: *Thunbergia grandiflora*.

Distribution	Native to India, Thailand and Malaysia
Common name:	Blue trumpet vine, Blue-sky vine and Laurel clock vine
Height	15 metre in height
Plant type	Perennial climbing, creeper plant
Root system	Tuberous
Leaf arrangement	Opposite
Leaf surface:	Pubescent
Leaf margin	Entire or slightly toothed (crenated), hairless (glabrous) and acute or acuminate apex
Leaf shape	Oval (i.e. elliptic) to narrowly egg-shaped in outline (ovate-lanceolate)
Leaf venation	Pinnate
Flower	Blue, violate or purple trumpet-shaped flowers have a pale yellow or whitish coloured throat
Blooming season:	Summer and autumn
Fruit	Loculicidal capsule
Soil for cultivation	Moist but well-drained
Water requirement	Moderate
Sun exposure	Full sun to shade

Table 6: *Thunbergia laurifolia* characteristic features.



Figure 6: *Thunbergia laurifolia*.

(an organophosphate insecticide) is decreased due to detoxification property of *T. laurifolia* [29]. Aqueous leaf extract of *T. laurifolia* supplied to rats in drinking water showed significant protectivity against Cadmium (heavy metal) toxicity from structural damage of kidney and liver tissues of rats [30].

Tetrodotoxin, a potent heat stable neurotoxin, which blocks the Na⁺ channel, and cause paralysis of diaphragm and cause death due to respiratory failure. A significant anti-tetrodotoxin effect of aqueous extract of *T. laurifolia* was studied in ICR mice [31].

Wutythamawech et al., have reported the use of crude extract of *T. laurifolia* leaves to treat drug-addicted people [32] and methanolic extract of *Thunbergia laurifolia* leaf increases the cerebral activity in drug-addicted patients [33].

Pb (lead), is a neurotoxicant, causes cognitive and behavioral defects, and inhibits acetyl-cholinesterase activity of brains. Aqueous leaf extract of *T. laurifolia* showed protection against Pb induced acetylcholinesterase dysfunction of brain in mice [34].

Antitumor activity

Aqueous extract of *Thunbergia laurifolia* exhibited inhibitory and antitumor or antiproliferative effects on MCF-7 breast cancer cells of human using multiple cellular and molecular approaches [35].

Antioxidant activity

Ethanol extract of *Thunbergia laurifolia* leaf have antioxidant activity [36]. Microwave dried leaf extract of *Thunbergia laurifolia* showed more antioxidant activity [37]. Oonsivilai et al. 2008 evaluated the antioxidant activities and total phenolic content of *Thunbergia laurifolia* extracts using free radical scavenging, ferric reducing antioxidant power assay (FRAP) and the Folin-Ciocalteu methods. Aqueous extract of *T. laurifolia* leaf exhibited highest antioxidant activity, while ethanol and acetone extracts of *T. laurifolia* leaves showed moderate antioxidant activity. All of these mentioned extract have high phenolic acids content as caffeic acid, gallic acid, protocatechuic acid and flavonoids as apigenin showing antioxidant activity [38]. Rosmarinic acid isolated from 95% ethanolic extract of dried *Thunbergia laurifolia* leaves has antioxidant activity [39]. Potential antioxidant activity of methanolic extract of *Thunbergia coccinea* leaves was observed [40].

Cytotoxicity

The aqueous extract of *T. laurifolia* leaf showed low cytotoxicity (>200 ug/ml concentration) to L929, BHK (21) C13, Caco-2 and HepG2 cell lines when compared between other extracts such as ethanol and ether and this report suggested the application or use of aqueous extract of *T. laurifolia* leaf due to its low cytotoxicity to kidney cells and human liver cell lines [38].

Hepatoprotective activity

The hepatoprotective activity of aqueous extract of *Thunbergia laurifolia* against ethanol induced liver injury in rat hepatocytes was observed by Pramyothin et al. [41].

Antinociceptive activity

Administration of Rosmarinic acid isolated from ethanolic extract of *T. laurifolia* showed significant antinociceptive activity in the hot-plate test and rosmarinic acid at 50 and 100 mg/kg significantly showed its reducing activity on acetic acid induced writhing by 52% (p<0.01) and 85% (p<0.001) respectively and also on formalin-induced pain in the early and late phases. These results indicated both central and peripheral antinociceptive activities of rosmarinic acid [38].

Phytochemical constituents of *Thunbergia species*

Glucosides

Damtoft et al. have isolated two iridoid glucosides named Thunaloside and alatoside from *Thunbergia alata* along with the known iridoid glycosides, stilbericoside, 6-epi-stilbericoside and thunbergioside [42]. Ismail et al. have isolated iridoid glucosides such as isounedoside, which contains C-10 as a carboxylic acid group and grandifloric acid, which contains a rare 6,7-epoxide functional group from *Thunbergia grandiflora* [43]. Kanchanapoom et al. 2002 have isolated two new iridoid glucosides; 8-epi-grandifloric acid and 3'-O-beta-glucopyranosyl-stilbericoside from the methanolic extract of the aerial part of the *Thunbergia laurifolia* plant along with these known compounds such as benzyl-2'-O-beta-glucopyranosyl glucopyranoside, grandifloric acid, E-2-hexenyl-beta-glucopyranoside, hexanol-beta-glucopyranoside and they have also determined the structure of these compounds [44]. Subramanian et al., have reported to contain luteolin-

7-glucoside, malvidin-3, 5-di-glucoside and stilbericoside in flowers of *Thunbergia grandiflora* [45].

Phenolic compounds and others

Plant phenolic compounds include tannin, phenolic acids, flavonoids, naphthalene and other. Kabir et al. have evaluated the total tannin content in *Thunbergia grandiflora*, which indicate the presence of Proanthocyanidin, a condensed tannin compound [24]. Purnima et al. and Kanchanapoom et al. have reported the presence of some bioactive phenolic compounds like delpinidine-3,5-di-O- β -glucopyranoside, apigenin and apigenin-7-O- β -D-glucopyranoside and chlorogenic acid, 6-C-glucopyranosyl apigenin and 6,8-di-C-glucopyranosyl apigenin in the flower and leaf extract of *Thunbergia laurifolia* plants respectively [44,46]. Jansen et al. has reported that phenolic compounds such as caffeoylmalic acid, feruloylmalic acid and *p*-coumaroylmalic acid have found in the leaves of *Thunbergia alata* [47]. Oonsivilai et al. have extracted other phenolic acids such as gallic acid, caffeic acid and protocatechuic acid from the leaf extract of *Thunbergia laurifolia* plants [48]. Chowdhury et al. have purified flavonoid named 5-hydroxy-4',6,7-trimethoxy flavone, C₁₈H₁₆O₆ [21]. Subramanian et al. have reported to contain flavonoids such as apigenin-7-glucuronide, luteolin in flowers of *Thunbergia grandiflora* [45]. Hung et al. have purified and identified eight compounds. The identified compounds are 8-Hydroxy-8-methyl-9-methene-cyclopentane- [7,11]-1, 4, 6-trihydronaphthalene-12-one, named as Thunbergia A (1); 3,4-dihydro-4, 5, 8-trihydroxy-2-(3-methyl-2-butenyl) -naphtha [2,3-b] oxiren-1 (2H)-one (2); 8-(beta-glucopyranosyloxy) -3, 4-dihydro-2-(3-methyl-2-butenyl) naphtha [2,3-b] oxiren-1 (2H)-one (3); galangin (4); quercetin (5); luteolin (6); 5, 6, 3', 4'-tetrahydroxy-3, 7-dimethoxy- flavone (7) and upeol (8) [49]. Rosmarinic acid is present in the ethanolic extract of *Thunbergia laurifolia* [39].

Future Prospects

Purification, identification and characterization of unexplored bioactive compounds showing pharmacological activities of these species will be the area of future work. Production of bioactive compounds from these plant species can be increased since they possess pharmacological activities like antibacterial, antifungal, antidiabetic, antipyretic, anti-inflammatory, anthelmintic, antioxidant, antinociceptive, anti-drug, antidote, antimutagenic, detoxifying, cytotoxic and hepatoprotective which may be advantageous for pharmaceutical industry to explore effective drugs from different species of the *Thunbergia* plant.

Conclusion

This review article reports about the medicinal importance of the most of the species of *Thunbergia*. According to this review article, *Thunbergia*, having the medicinal properties such as antibacterial, antifungal, antidiabetic, antipyretic, anti-inflammatory, anthelmintic, antioxidant, antinociceptive, anti-drug, antidote, antimutagenic, detoxifying, cytotoxic and hepatoprotective activities, can be considered as potential alternative herbal medicine to treat different types of diseases.

Acknowledgement

I want to acknowledge Dr. Indrani Chandra and Dr. Sabyasachi Chatterjee of the Department of Biotechnology in the University of Burdwan for giving me the opportunity to make this review on *Thunbergia* species under their guidance. I am very grateful to them for supporting me. I would like to thank my family for their full support.

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