IJBPAS, November, Special Issue, 2021, 10(11): 233-243
ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)
'A Bridge Between Laboratory and Reader'

www.ijbpas.com

PHYTOCHEMICAL EVALUATION AND PHARMACOLOGICAL ACTIVITIES OF *Thunbergia species* - A COMPREHENSIVE REVIEW

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Received 19th July 2021; Revised 20th Aug. 2021; Accepted 29th Sept. 2021; Available online 1st Nov. 2021

https://doi.org/10.31032/IJBPAS/2021/10.11.1017

ABSTRACT

Medicinal plants have been used from the ancient time to prevent and treat various health problems. Plants are still an independent source of medication in the contemporary health care delivery system. Their role is two-fold in the development of medicines and served as a natural blue print for the development of new drug. As some synthetic drugs display several limitations, including side effects and costs, medicinal plants and their phytochemical compounds have been considered and used to treat many diseases. 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. *Thunbergia* is a category of flowering plants that appertain to the *Acanthaceae* family, native to tropical provinces of Africa, Madagascar, Australia, and South Asia. Remarkable kinds of Thunbergia are *Thunbergia laurifolia, Thunbergia coccinea, Thunbergia fragrans, Thunbergia erecta, Thunbergia grandiflora*, *Thunbergia mysorensis, Thunbergia annua, Thunbergia battiscombei, Thunbergia gregorii*, and many more which have numerous medicinal attributes. The variable ethnomedicinal applicability encapsulates the numerous healings and biological characteristics of *Thunbergia*, have reviewed scientifically by the study on its phytochemicals, and therapeutic features in this study.

Keywords: *Thunbergia sp*, Secondary metabolites, Biological activities

1. INTRODUCTION

The term "medicinal plants" refers to a category of plants that are used to heal a variety of ailments. For thousands of years, plants have played an important role in sustaining human health and improving the quality of life. According to the World Health Organization, traditional medicine is used by 80 percent of the world's population, and the majority of this therapy involves the use of plant extracts or active components. As a result, the treatment approach of many traditional medicines is more comprehensive **[1]**. Researchers have been attempting to uncover and validate plant-derived compounds for the treatment of various ailments for the past few years. Surprisingly, more than 25% of current medicines are thought to be sourced directly or indirectly from plants **[2-3]**. This makes plants a rich source of pharmacologically active substances that are frequently used in home remedies against numerous ailments. *Thunbergia* species is reviewed to discuss its phytochemical properties, ethnomedical use as well as pharmacological properties.

Thunbergia, a genus of flowering plants in the family *Acanthaceae*, is native to tropical regions of Africa, Madagascar, Australia, and South Asia. Genus species include hundreds of kinds of annuals, perennials, and shrubs. There are number of twinning climbers as well as shrubby varieties within this variable genus. The elegant climbers come in a wide range of leaf shapes, ranging from pointed oval to heart-shaped, and are sometimes lobed or serrated. They come in a variety of colours, however the most common are yellow, orange, and purple-blue hues. Many *Thunbergia* species thrive in full sun and well-drained soil, although they can also thrive in moderate shade. Different species of *Thunbergia* are *T. alata, T. annua, T.battiscombei, T. coccinea, T. cordata, T. erecta, T. elegans, T. fragrans, T. grandiflora, T. gregorii, T. gibsoniiT. ikbaliana, T. laurifolia, T. lutea, T. mysorensis* and *T. vogeliana* possessed various biological activities **[4]**. Various ethnobotanical reviews and scientific literature had pointed outthe indications, phytochemicals and therapeutic efficacy of *Thunbergia* species.

Classification of *Thunbergia*

Class	**Equisetopsida**
Subclass	**Magnoliidae**
Order	**Lamiales**
Family	**Acanthaceae**
Genus	***Thunbergia***

Phytoconstituents of *Thunbergia* sp

The phytochemistry of *Thunbergia sp*has been studied by various researchers **[5 -9]**. It revealed that the presence of alkaloid,

flavonoid, cardiac glycoside, saponin, glycoside, tannin and phenolics compounds. Suwannakud *et al*. **[7]** observed that the Phytol, squalene, stigmasterol, γ-sitosterol, oleamide were identified in combination of methanol extract of leaves of *Thunbergia alata* and *Thunbergia erecta*.

T. laurifolia contains several kinds of iridoid glucosides **[5],** alkaloids, flavonoids **[10]**, phenolic acids such as caffeic acid, gallic acid, protocatechuic acid, and chlorogenic acid **[11- 12]**. The flavonoids extracted from *T. laurifolia* as apigenin, apelin casmosiin and chorogenic acid **[5]**. A phenolic profiling of aqueous extract of leaves of *T. laurifolia* showed the presence of apigenin and apigenin glucosides, as well as phenolic acids of caffeic, gallic and protocatechuic **[13]**. *Thunbergia mysorensis* possessed the presence of protein, alkaloid, amino acid, carbohydrate, flavonoids, tannin and phenolics was reported by Singh and Kimothi **[8]**. Sterols, tri -terpenes, saponins, alkaloids, carbohydrates, tannin, flavonoids and lactones were reported in leaves of *Thunbergia coccinea* **[6]**.

2. Biological activities of*Thunbergia* species

T. coccinea leaf has asserted for therapeutic uses especially the analgesic, antipyretic, anti-inflammatory and antioxidant properties **[14]**. *Thunbergia* species has also been reported to have antioxidant, antidiabetic, anti-inflammatory, antipyretic, antimicrobial and hepatoprotective properties was reported **[15 -16]**. Likewise, methanol extracts of *T. alata* play an important inhibitory role in the modulation of severe inflammation **[17]**. Three phenolic compounds, caffeoylmalic, feruloylmalic and p-coumaroylmalic acids, were found in the leaves of *T. alata* and their concentrations were different during wounding and salicylic acid treatment and were elicited by salicylic acid **[18]**. *T. erecta* has also been reported to possess important pharmacological effects including antibacterial,anti-inflammatory and anti-arthritic effect **[19]**.

3.1 Antioxidant Properties of *Thunbergia* species

Antioxidants are molecules comprehended to prevent the oxidative damage by neutralizing the ROS, thereby impeding the destruction indicated to the cells of organisms. The non-enzymatic, natural antioxidants include carotenoids, thiols, tocopherols, ascorbic acid, flavonoids and tannins that are attained from natural plant sources. A wide variety of antioxidants from both natural and synthetic origin have been proposed for use in the treatment of several human infirmities mainly related to

heart, neurodegenerative diseases. DPPH radical is widely practiced for measuring the scavenging power of free radicals of phytoconstituents. Reaction mixture along with DPPH was incubated with increasing concentrations of *Thunbergia coccinea* leaf extracts showed a dose-dependent increase in the scavenging potential **[6]**. Singh and Kimothi **[8]** also reported that the presence of phenols and flavonoids makes this *Thunbergia mysorensis* as a source of good antioxidants.

3.2 Antidiabetic activityof *Thunbergia* species

It has been reported **[20]** that the diabetes is a disorder of carbohydrate, fat and protein metabolism caused due to insufficient production of insulin or due to its inhibitory action, which can be considered as a major cause of high economic loss which can in turn impede the development of nations. Before there were drugs from drug companies, natural cures were used and they can still be used today. There are many herbs with strong anti-diabetic properties. The hypoglycemic activity is thought to be due to increased hepatic metabolism. This plant is significantly enhanced liver cell recovery by bringing hepatic triglyceride and transaminases back to normal **[21]**. Similarly, Aritajat *et al* **[22]** studied the effects of *T. laurifolia* leaves. The results showed *T. laurifolia* leave extract included insulin-like substance significantly decreased the levels of blood glucose. In addition, they mentioned *T. laurifolia* leaves extract can recover β-cell structure in the islet of Langerhans of the pancreas. Hypoglycemic action can be potentiating the insulin by enhancing the pancreatic secretion of it from β-cell of Langerhans islets or emancipating insulin from the bound form. Kokila *et al*. **[5]** also reported the anti-diabetic activity of *Thunbergia Coccinea*. Bhuiyan *et al*. **[23]** researched *T. erecta*, a medicinal plant with many reported phytochemicals and significant medicinal value and revealed that the methanol leaf extract has hypoglycemic effects in an animal model.

Numerous mechanisms of actions have been proposed for plant extracts. Some hypothesis relates to their effects on the activity of pancreatic beta cells, increase in the inhibitory effect against insulinase enzyme, increase of the insulin sensitivity or the insulin-like activity of the plant extracts. Other mechanisms may also be involved such as increase of peripheral utilization of glucose, increase of synthesis of hepatic glycogen or decrease of glycogenolysis, inhibition of intestinal glucose absorption, reduction of glycaemic index of

carbohydrates and reduction of the effect of glutathione.

3.3 Antimicrobial activity of *Thunbergia* species

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 were reported by Jeeva *et al*. **[24]**. Sultana and Das **[25]** observed that the *Thunbergia coccinea* showed the highest inhibitory activity against the bacterial strain of *Escherichia coli* and *Staphylococcus aureus* due to the presence of alkaloid, flavonoid, cardiac glycoside, saponin glycoside, tannin and phenolic compounds. Moreover, it has been reported that large number of different chemical compounds such as are presented in plant extracts, and thus these chemical components can affect multiple target sites against the bacterial cells **[26-27]**. Chowdhury *et al* **[28]** have evaluated the antifungal activity of methanolic crude extract of *Thunbergia grandiflora* leaves. Junsi and Siripongvutikorn **[16]** reported that the decoction of leaves of *Thunbergia laurifolia* used in fungal infections.

3.4 Cytotoxicity activity of *Thunbergia* species

Over the last few decades several in vitro assays using mammalian cell cultures have been developed thus avoiding the excessive use of laboratory animals which is expensive, time consuming and often involves ethical problems. Cell culture systems can be more sensitive and more reproducible than tests involving intact animals **[28]**. Suwannakud *et al*. **[7]** reported the cytotoxicity effect of ethanol and hexane extract of *Thunbergia alata* and*Thunbergia erecta*. Likewise, 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 **[30]**. *T. laurifolia* leaf and stem extracts as well as its phytoconstituent, rosmarinic acid, revealed marginal potentials on *in vitro* cytotoxicity against cancer cell lines

3.5 Anti-inflammatory activity of *Thunbergia* species

Inflammation is a common risk factor in the pathogenesis of conditions such as infections, arthritis, type 2 diabetes mellitus, obesity and cancer. Anti-inflammatory drugs can interfere in the pathophysiology of

inflammation, seeking to minimize tissue damage and provide greater patient comfort. The major classes of anti-inflammatory agents are the glucocorticoids and non steroidal anti-inflammatory drugs (NSAIDs). NSAIDs are associated with side effects such as gastrointestinal bleeding and suppressed function of the immune system, attention has shifted to alternative pharmacotherapies **[31]** Boonyarikpunchai *et al* **[32]** and Wonkchalee *et al*. **[33]** reported the anti inflammatory effects of rosmarinic acid isolated from *Thunbergia laurifolia*. Likewise, anti-inflammatory activities of the leaves of *Thunbergia coccinea* were reported by Victoria *et al* **[14]**. Ethanol and hexane extract of leaves of *Thunbergia laurifolia* plant showed anti-inflammatory activity against carrageenan-induced paw edema in mice **[34]**. Plants have the ability to synthesize a wide verity of phytochemical compounds as secondary metabolites which shows anti-inflammatory activity.

3.6 Anthelmintic activity of *Thunbergia* species

Parasitic infections remain a major constraint to livestock production globally. Control is generally achieved by use of synthetic anthelmintics in combination with grazing management. Synthetic anthelmintics have several drawbacks including resistance. One practical way of developing cheaper and effective anthelmintics is to study indigenous herbal remedies. Evaluation of the activities of medicinal plants claimed for anthelmintic property is getting attention these days. Kabir *et al*. **[35]** reported the anthelmintic activity of *Thunbergia grandiflora* on *Tubifex tubifex* worm due to presence of Proanthocyanidin tannin content. Presence of these phytochemicals may be responsible for the anthelmintic activity of *Tubifex tubifex*

3.7 Sedative and Anxiolytic Activities of *Thunbergia* species

Thunbergia were used traditionally for managing anxiety and numerous behavior disorders. Wagner *et al*. **[36]** reported that the tannins from medicinal plants exert sedative activity and saponins also have potent sedative activity. Likewise, flavonoids have potent sedative and anxiolytic effects **[37]**. Begum *et al* **[38]** observed the *T. erecta* contains phytoconstituents that possess sedative and anxiolytic activity which traditionally used in insomnia, depression and anxiety management.

Thus, the present study had elucidated the review on phytochemical and bio-activity studies of traditional medicinal plants –Genus *Thunbergia p*lants were found to be the new sources of phytoconstituents

with many pharmacological activities. The biologically active components present in these medicinal plants might be useful in modern medicine. These local ethnomedical preparations and prescriptions of these plant sources had been scientifically reviewed in this study. Thus, these *Thunbergia* medicinal plants might find use in the field of pharmacology, phytochemistry, ethnobotony and other biological activity studies for drug discovery.

4. CONCLUSION

This review article reports about the medicinal importance of the species of *Thunbergia.* Pharmacological review revealed that *Thunbergia* species has good anti-diabetic activity and this may be attributed to the presence of poly phenolic and flavanoid compounds. Also it possesses anticancer, anthelmintic, anti inflammatory, Sedative and Anxiolytic, cytotoxicity and anti microbial activities due to the presence of secondary metabolites. Based on the review, *Thunbergia* possessed various secondary metabolites which exhibits different biological activities can be considered as potential alternative herbal medicine to treat different types of diseases

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