



Research Article

Rudrapalash (*Spathodea campanulata*): A Comprehensive Review of Toxicological Risk, Therapeutic Potential and Forensic Relevance

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Abstract

Rudrapalash is an attractive ornamental tree that is well known for its beautiful flowers and is also considered important from medicinal and scientific perspectives. In botany, it is known as *Spathodea campanulata*. In the English language, this tree is commonly known as the African Tulip Tree. This tree is originally native to West Africa, but today it is widely cultivated as an ornamental plant in India as well as in many other tropical and subtropical countries. The flowers often contain watery nectar; therefore, in some places it is also called the 'Fountain Tree'. Because of its ornamental importance, it is widely planted not only in tropical regions but also in other suitable climatic areas. Its bright red–orange flowers and rapid growth make it highly attractive for garden landscaping, roadside plantations, and urban green spaces. However, this plant contains several bioactive compounds, mainly alkaloids, flavonoids, triterpenoids, and glycosides. These compounds provide the plant with therapeutic properties, while at the same time they may also create certain toxicological risks. Studies have shown that the nectar and flower extracts of this plant may be toxic to certain insect pollinators. In contrast, extracts from its leaves and flowers have demonstrated antimicrobial, anti-inflammatory, antioxidant, and cytotoxic activities, indicating its potential medicinal applications. This review article synthesizes the current scientific knowledge related to the phytochemistry, toxicology, pharmacological potential, and forensic significance of *S. campanulata*. It also emphasizes the need for controlled utilization and further comprehensive research to maximize its benefits while minimizing potential ecological and health risks.

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KEYWORDS: Rudrapalash, African Tulip Tree, *Spathodea campanulata*, Toxicity, Therapeutic Potential, Traditional Medicine, Forensic Relevance.

1. INTRODUCTION

Rudrapalash Tree (*Spathodea campanulata*) belongs to the Bignoniaceae family and is commonly known as the African Tulip Tree, Flame of the Forest, or Fountain Tree [1, 2]. Its native range includes West Africa, but it has been introduced to Asia, the Caribbean, the Pacific Islands, and South America. *Spathodea campanulata*, native to tropical Africa, was introduced to India in the 19th century and is now widely planted across regions such as South and Central India as an ornamental and avenue tree [3]. This tree is widely planted along roadsides, in parks, gardens, and urban landscapes in various parts of India, such as Bengaluru, Chennai, Odisha, Assam, Jaipur, and Indore in Madhya Pradesh. The tree grows rapidly, reaching up to 30 meters, with large compound leaves and vibrant trumpet-shaped flowers [4].

Traditionally, various plant parts including flowers, leaves, and bark have been used in African ethnomedicine for anti-inflammatory, antimicrobial, wound healing, and antipyretic purposes [5, 6]. Despite these benefits, studies reveal toxic effects, particularly in insects and some vertebrates, necessitating careful evaluation of its risk and benefit profile [7]. This plant has been linked to insect mortality, bees included. However, its effects on the Neotropical *Melipona* are as yet unknown [8].

This review aims to comprehensively assess the dual nature of *S. campanulata* as a medicinally useful plant with potential toxicological concerns, synthesizing data from phytochemical, pharmacological, ecological, and ethnobotanical studies.



Source: Author (field photograph), Circle Garden, Divya Vihar Colony, Aurobindo, Indore, Madhya Pradesh, India.

Fig 1: S. Campanulata Tree



Source: Author (field photograph), Circle Garden, Divya Vihar Colony, Aurobindo, Indore, Madhya Pradesh, India.

Fig 2: S. campanulata Leaf and Flower

2. Botanical Description

Botanical Name	:	<i>Spathodea campanulata</i>
Family	:	Bignoniaceae (Jacaranda family)
Native to	:	Tropical Africa
Common Name	:	Hindi: Rudrapalas, Sanskrit: Rudrapalas, Bengali: Rudhirpalash. English: African tulip tree, Fountain Tree. In many regions of India, it is also known as Nandi Flame or Pichkari Tree.

The *Spathodea campanulata* Tree, a fast-growing, upright tree of the Bignoniaceae family, is widely admired for its ornamental value. It can reach 10-30 meters under ideal conditions, though most cultivated specimens are smaller [9]. The tree features a stout, tapering, somewhat buttressed trunk covered with warty light-gray bark, and short, thick lateral branches. Leaves are 1-2 ft long, pinnate, and composed of 5-19 deeply veined oval leaflets, emerging bronzy before maturing too glossy dark green. Horn-shaped, velvety buds develop at branch tips in upturned whorls and sequentially open into large, crinkled, red-orange tulip-like flowers with red-streaked golden throats, frilly yellow edges, and four brown-stamened centers. Following flowering, 5-10 green-brown, fingerlike seed pods emerge per cluster, each containing approximately 500 papery seeds. Flowering occurs throughout the growing season, with peak bloom in spring [10]. Flowers are borne in terminal clusters, arising from horn-shaped, velvety olive buds that develop in upturned whorls at branch tips. Buds of the lowest tier bend outward sequentially to produce large, crinkled, tulip-like flowers, characterized by red-orange petals with red-streaked golden throats, frilly yellow margins, and four central brown-

anthered stamens. Flowering occurs in spurts throughout the growing season, peaking in spring [11].

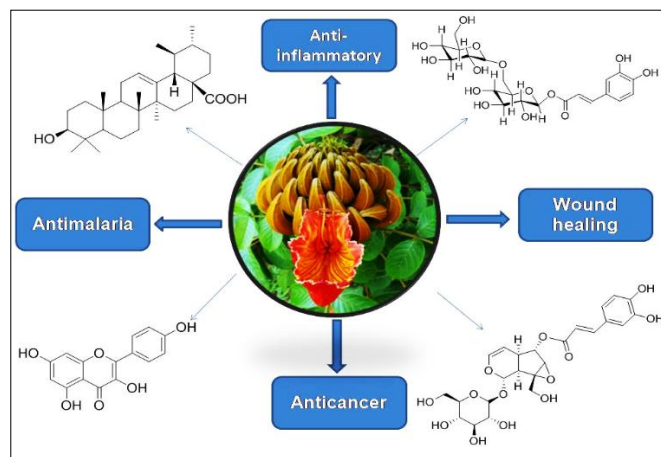
3. Phytochemistry and Bioactive Compounds

Phytochemical investigations reveal multiple classes of secondary metabolites contributing to pharmacological activities and toxicological effects.

Table 1: Major Phytochemicals in *Spathodea campanulata*

Compound Class	Plant Part	Reported Activity	References
Alkaloids	Leaves, Flowers	Antimicrobial, cytotoxic	[12]
Flavonoids	Leaves, Flowers	Antioxidant, anti-inflammatory	[13]
Triterpenoids	Leaves	Cytotoxic, anti-inflammatory	[14]
Glycosides	Flowers	Cardioprotective, anti-inflammatory	[15]
Phenolics	Leaves, Bark	Antioxidant	[16]

These compounds provide the biochemical basis for observed therapeutic effects but also contribute to insect toxicity and potential vertebrate cytotoxicity [17].



(Source: <https://japsonline.com/keyword.php?keyword=Spathodea%20campanulata>)

Fig 3: Major pharmacological activities and representative bioactive compounds of the Rudrapalash (*Spathodea campanulata*), highlighting its anti-inflammatory, antimalarial, wound healing, and anticancer potential.

4. Toxicological Risk

4.1 Insect Toxicity

The Rudrapalash Tree (*Spathodea campanulata*) is admired ornamentally, but it does pose toxicological and ecological risks, especially to insects, animals, and potentially humans. Nectar contains saponins, flavonoids, and alkaloids toxic to pollinators such as bees and ants [18]. Observations indicate insect mortality, impacting local pollinator populations and ecosystem functioning [19].

4.2 Toxic Effects on Insects

- The nectar of flowers is toxic to many insects, especially bees, butterflies, and ants.
- Studies and field observations show dead insects frequently found inside or beneath the flowers.
- Toxicity is attributed to secondary metabolites such as: Alkaloids, Saponins, Phenolic compounds

Risk

- Acts as an insect trap, reducing local pollinator populations.
- This makes it ecologically harmful, despite being attractive.

4.3 Toxicity to Animals

- Leaves, bark, and flowers contain bioactive compounds.
- Ingestion by livestock or pets may cause: Gastrointestinal irritation, Reduced appetite, Mild poisoning symptoms (based on ethnobotanical and veterinary observations)

4.4 Human Toxicological Risk

- No strong evidence of acute lethal toxicity in humans.
- However, sap, bark extracts, and flower nectar may cause: Skin irritation, Allergic reactions and Nausea if ingested in crude form.

4.5 Vertebrate Toxicity

Consumption of leaves, bark, or flowers by livestock may result in gastrointestinal irritation, reduced appetite, or mild toxicity [20]. No severe human toxicity is widely reported, but sap contact can cause skin irritation or allergic reactions [21].

4.6 Environmental Toxicity

The tree exhibits allelopathic properties, releasing compounds that inhibit the growth of neighbouring plants, contributing to invasive behaviour [22].

Table 2: Summary of Toxicological Observations

Organism	Plant Part	Observed Effect	Reference
Bees	Flowers	Lethal nectar toxicity	[23]
Ants	Flowers	Mortality upon feeding	[24]
Livestock	Leaves/Bark	Gastrointestinal irritation	[25]
Humans	Sap	Skin irritation, allergic reaction	[26]

5. Therapeutic Potential

5.1 Traditional Medicine

In West African traditional medicine, *S. campanulata* is used to treat malaria, fever, wounds, gastrointestinal disorders, and inflammation [27]. Different plant parts are prepared as decoctions, poultices, or extracts.

5.2 Pharmacological Evidence

- **Antioxidant:** Leaf flavonoids scavenge free radicals [28].
- **Antimicrobial:** Flower extracts inhibit *Staphylococcus aureus* and *Pseudomonas aeruginosa* [29].
- **Anti-inflammatory:** Reduced edema in rat models [30].
- **Cytotoxicity:** Selective activity in HL-60 cell lines [31].

6. Forensic Relevance of *Spathodea campanulata*

The Rudrapalash Tree (*Spathodea campanulata*) is of forensic relevance mainly in forensic botany and environmental forensics. Plant materials such as flowers, pollen grains, winged seeds, and leaf fragments may function as trace botanical evidence, which can be transferred to clothing, footwear, vehicles, or other objects during criminal activity [32]. Such botanical traces help in linking suspects or objects to specific

crime scenes, particularly in urban parks, institutional campuses, and roadside landscapes where this ornamental species is commonly planted^[33]. Seasonal flowering and fruiting characteristics of *Spathodea campanulata* can assist in the approximate estimation of post-mortem interval (PMI) when human remains are discovered in its vicinity^[34]. Palynological analysis of its pollen grains supports crime scene reconstruction and movement analysis, as pollen morphology is often species-specific^[35]. Additionally, as an introduced ornamental species, its presence contributes to site characterization, indicating landscaped or semi-urban environments^[36]. Thus, *Spathodea campanulata* provides supporting circumstantial evidence in forensic investigations^[37].

7. DISCUSSION

Spathodea campanulata represents a dual-faceted plant species: its rich phytochemistry offers medicinal potential, while its nectar and allelopathic properties present ecological and toxicological concerns. The plant's invasive tendencies require careful management, particularly in non-native ecosystems. Future research should focus on:

- Standardizing phytochemical extraction for medicinal use.
- Conducting controlled toxicological assessments in humans and animals.
- Investigating environmental management strategies to mitigate ecological risk.

8. CONCLUSION

The Rudrapalash Tree (*Spathodea campanulata*) is a visually striking and pharmacologically promising species, yet its toxicological profile cannot be ignored. Balancing therapeutic utility with environmental safety is essential for sustainable use. Controlled cultivation, further pharmacological validation, and ecological monitoring are recommended to maximize benefits and minimize risks. In this way, This Tree is not highly dangerous to humans, but it poses significant toxicological and ecological risks, especially to pollinators and biodiversity. Its large-scale plantation should be discouraged in ecologically sensitive areas.

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