PLANT SCIENCE TODAY
Vol 12(4): 1-13
https://doi.org/10.14719/pst.5339

eISSN 2348-1900

RESEARCH ARTICLE

Unveiling the therapeutic potential of *Soymida febrifuga* Juss: A review of traditional knowledge and modern research to unlock its therapeutic potential

Hetalba Jhala[1], Pankajkumar Nariya[2] & Mukeshkumar Nariya[1*]

[1]Pharmacology Department, Institute of Teaching & Research in Ayurveda (Institute of National Importance), Jamnagar 361 008, India
[2]Chemistry Department, Atmiya University, Rajkot 360 001, India

*Correspondence email - mukeshnariya@gmail.com

Received: 27 September 2024; Accepted: 15 May 2025; Available online: Version 1.0: 08 October 2025; Version 2.0: 17 October 2025

Cite this article: Hetalba J, Pankajkumar N, Mukeshkumar N. Unveiling the therapeutic potential of *Soymida febrifuga* Juss: A review of traditional knowledge and modern research to unlock its therapeutic potential. Plant Science Today. 2025; 12(4): 1-13. https://doi.org/10.14719/pst.5339

Abstract

Soymida febrifuga, commonly known as *Rohini*, belongs to Meliaceae family. It is an indigenous medicinal plant, abundantly found in the forests of India and dry regions of the western Peninsula. According to the JCM Herbarium, the plant has not yet been assessed, but has been declared endangered in Madhya Pradesh. *S. febrifuga* has been revered since antiquity for its therapeutic and scientific significance. This article represents a comprehensive compilation of available data on *S. febrifuga* for the first time, drawing from classical texts, botanical floras and journal databases. It highlights the plant's diverse therapeutic applications mentioned in *Ayurveda, Siddha*, *Unani* and traditional folk medicine. Indigenous tribes have long used it to treat conditions including malaria, diarrhoea, skin disorders and as an alternative to Cinchona bark. However, significant challenge lies in accurately identifying *S. febrifuga* as "*Rohini*" in ancient texts due to regional variations in nomenclature. Despite these traditional uses, more rigorous scientific research is needed to validate these claims. This review also examines recent studies on the phytochemical, pharmacological and therapeutic properties of *S. febrifuga*, alongside classical references from ancient *Acharyas* detailing its synonyms, properties (*karmas*), *rasapanchak* and related controversies. The plant contains flavonoids with proven antibacterial, antioxidant and hepatoprotective activities. To ensure its sustainable use, effective conservation and cultivation strategies are essential. Additionally, in-depth phytochemical investigations, pharmacological and clinical evaluations are needed to substantiate its therapeutic potential. Emerging fields such as nanotechnology, network pharmacology and materials science, combined with standardized cultivation practices, present promising avenues to enhance the therapeutic and economic potential of *S. febrifuga.* This review aims to bridge traditional knowledge with modern scientific approaches to unlock the full therapeutic potential of *S. febrifuga, a* valuable medicinal plant.

Keywords: *Ayurveda*; flavonoids; Indian redwood; *Mamsarohini*; Meliaceae; *Soymida febrifuga*

Introduction

Ayurveda is a complete medical system that has been used in ancient India for millennia, which promotes the health and harmony between the body, mind and spirit via the use of natural therapy, dietary and lifestyle changes (1). Based on solid philosophical, experiential and experimental foundations, this ancient medical approach is still widely used throughout the Indian subcontinent (2). In a developing country like India most people are dependent on the natural system of medicine, due to the extensive use of our natural herbs, therefore, their demand is increasing day by day (3). Sales of medicinal plants have grown by nearly 25 % in India in the past ten years. Thus, *Ayurvedic* medicinal products market and pharmaceutical companies have increased their expenditure up to 20 % annually. The most challenging problem faced in the past years was the extinction of various traditional plants. Not only this, but also erosion of traditional knowledge regarding medicinal properties and uses of plants, which has been passed from one generation to another, has regrettably been lost with the passing time (4).

Among the well-known treasures of *Ayurveda*, *Soymida febrifuga* A Juss. is having tremendous therapeutic properties which belong to family Meliaceae. The etymology of the word *"Soymida*" is derived from the Telugu name meaning "Swami / God," referring to sacred pillars in temples. "*Febrifuga*" originates from the Latin words *'febris*,' meaning "fever," and *'fugare*,' meaning "to expel" (5). It is known as *Mamsarohini* in *Sanskrit* and Indian red wood in English, in Hindi, it is called as *Raktarohini* and *Rohini* in *Gujarati*. It is commonly available in the Western Peninsula, Mirzapur hills, Chota Nagpur and Andhra Pradesh to Merwara, Gujarat and regions of Kerala, etc. It has strong anti-malarial properties and is widely used in *Yunani* system of medicine to treat fever (6).

Following several experiments in India, *S. febrifuga* is said to be as an alternative to Cinchona/Oak bark in 1791, additionally European medicine makes use of it (7). The Edinburgh Pharmacopoeia's Materia Medica from 1803 also contains its evidence (8). The plant has sparked passionate debates among *Acharyas* in several *Nighantus*, highlighting its significance and

the variety of viewpoints that surround it in folk wisdom. The plant also includes a variety of secondary metabolites, including phenols, flavonoids, alkaloids, steroids and tannins. Many tribes of India employ its parts extensively for treating a range of diseases. It also has extensive applications in folk remedies, *Siddha*, *Unani* and *Ayurveda* (9). Along with these benefits, it also acts as a laxative, aphrodisiac, acrid, refrigerant, anthelmintic agent, anti-inflammatory, hepatoprotective and treats cough, asthma and sore throats (10).

Although several studies and reviews have addressed *S. febrifuga*, the existing literature remains largely fragmented and incomplete. Most current research has focused primarily on plant-based extracts, overlooking the plant's broader ethnobotanical significance and its extensive traditional uses across diverse regions for various health conditions. Further, the plant was analysed using advanced instrumentation and preclinical studies, which may demonstrate its pharmacological properties-including anti-hyperglycaemic, anti-inflammatory and acute toxicity profiles. No prior effort has been made to comprehensively compile and integrate this information

The plant holds a prominent place in traditional *Ayurvedic* medicine, with references in ancient scriptures and detailed descriptions in later *Nighantus*. Its wide array of traditional applications underscores its potential as a versatile medicinal plant, meriting more comprehensive scientific investigation. This review represents the first systematic attempt to consolidate available data on *S. febrifuga*, drawing from classical *Ayurvedic* texts, botanical floras and modern scientific databases. By correlating its ethnomedicinal uses with *Ayurvedic* principles and substantiating them with contemporary scientific evidence, this work not only enriches the existing body of knowledge but also reinforces the therapeutic relevance of *S. febrifuga*, while preserving valuable traditional insights for future research and generations.

Review methodology

A comprehensive literature review was undertaken using the terms "*Mamsarohini*," "*Raktarohini*," "*Rohini,*" "*Soymida febrifuga*," and "Indian redwood." The investigation included a detailed examination of classical *Ayurvedic* texts such as Bh*avprakash*, *Dhanvantari Nighantu*, *Raj Nighantu*, *Sodhala Nighantu*, *Priya Nighantu*, *Adarsha Nighantu*, *Kaideva Nighantu* and *Madanapala Nighantu*, along with core *Ayurvedic* treatises like the *Charaka Samhita* and *Sushruta Samhita*. Emphasis was also placed on *Ayurvedic* herb classifications referred to as "*Varga*" or "*Gana,*" which offered insights into the traditional uses, therapeutic actions (*Karma*), inherent properties (*Guna*), pharmacodynamics (*Rasapanchak*), botanical traits, dosage, synonyms, classification-related controversies and differing perspectives of various *Acharyas*.

In parallel, a systematic electronic search was carried out across multiple scientific databases, including PubMed, Scopus, Google Scholar, ScienceDirect, NISCAIR, TKDL and the Ayush Dhara database. The search strategy employed using (MeSH) and relevant keywords such as "*Soymida febrifuga*," "physicochemical properties," "spectroscopic analysis," "chromatographic techniques," "pharmacological evaluation," *in vitro* studies, *in vivo* studies, "protective effects," "antidiabetic activity" and "*in vitro* screening." Boolean operators "AND" "OR" and "OF" were utilized to refine the search results. Inclusion criteria were based on the relevance of literature to the phytochemical, pharmacological and ethnomedicinal aspects of the plant. Redundant content across *Nighantus*, articles lacking citations or substantial data and reviews focused solely on comparative analysis with other herbs were excluded. A flow chart of inclusion and exclusion criteria for research articles are mentioned in Fig. 1. Further selected literature was systematically compiled and structured to present a scientifically coherent and comprehensive overview of *Soymida febrifuga*.

Taxonomical classification of *S. febrifuga* (11)

Kingdom:	Plantae
Domain:	Eukaryote
Sub-Kingdom:	Viridaeplantae
Phylum:	Tracheophyta
Sub-Phylum:	Euphyllophytina
Infraphylum:	Radiatopses;
Class:	Mangnoliopsida
Sub-class:	Rosidae
Super order:	Rutanae
Order:	Rutales
Sub order:	Melineae
Family:	Meliaceae
Subfamily:	Solanoideae
Tribe:	Solaneae

S. febrifuga, a member of the Meliaceae family

In the family Meliaceae, the medicine is known as *Cortex Soymida* or *Cortex swietenia*. The Meliaceae family, which has 778 species distributed among 51 genera, is the most pantropical within the Sapindales order (12). According to several studies conducted on Sapindales using molecular phylogenetic reconstruction, there is

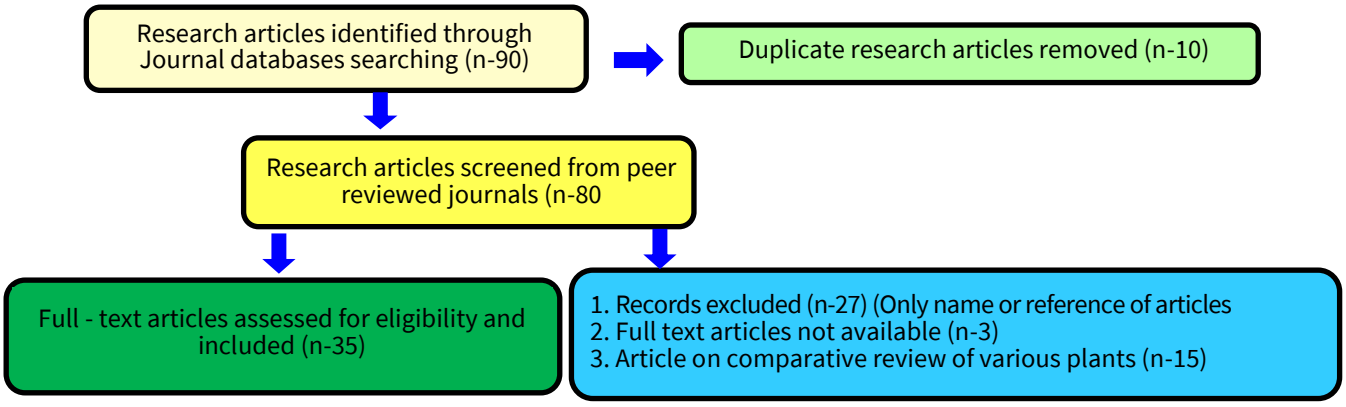

Fig. 1. Flow chart of inclusion and exclusion criteria for research articles.

a close relationship among Rutaceae, Simaroubaceae and Meliaceae (13-16). A new study sheds light on the wood anatomy of the Meliaceae subfamily Swietenioideae and confirms the close relationship between the Meliaceae and Simaroubaceae families. Meliaceae plants are characterised by their pinnately compound, alternating, or opposite leaves, a wide variety of floral arrangements and either baccate, drupaceous, or capsular fruit. Variegated in weight, hardness and its colour, it is reddish brown to dark red and wood is a distinctive material. While some of plants have nice aromas, the majority either don't have any perfume at all or lose it very soon when exposed to air (17).

Distribution and availability

S. febrifuga is found in the Manu Devi region of the Satpuda ranges in Northern Maharashtra. It is also found in Kerala, Uttar Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu and Sri Lanka, in laterite hills, highlands of Chingleput and arid hills of the Deccan region from Kurnool to Mysore (18). Due to its genus is monotypic nature, it is exclusive to India (19). It is also found in districts of Danga, Vyara and Rajpipla and in the Saurashtra region of Gujarat (20).

Botanical description

It is a tall tree having a thick stem. **Bark** is 8 mm thick blackish to brownish in colour and bitter in taste and possesses scale like in appearance. **Leaves** ranging from 22 to 44 cm in length, densely clustered towards the ends of branches, the leaflets occur in 3-6 pairs, are opposite, elliptic or oblong and have obtuse tips. They are smooth (glabrous), with prominent pennate veins that are conspicuous on the underside. The leaf base is rounded and equilaterals, extending further down the petiole on the lower side, new leaves appear are glandular and red. Petioles are red in colour. **Flowers** appear in large, spreading panicles at the ends of branches, often equalling the leaves in size. They are greenish-white and bloom from February to May. **Sepals** are circular with membranous, slightly jagged edges. **Petals** are obovate, clawed, about 6 mm long and often notched at the tips. Fruits are hard, brownish red in colour but on ripening they turn black and open at the front, it matures in the month of *Ashadh* and *Shravan*, with capsules measuring 2.5-6 cm in length (5). Seeds contains capsules which are numerous, flat and seeds are winged with a soft covering Top of FormBottom of Form (21). The important parts of *S. febrifuga* are illustrated in Fig. 2.

Description of *S. febrifuga* in *Ayurvedic* texts

In *Samhitas,* the identification of plant is given by *Acharya Dalhan* as he mentioned different meanings of *Rohini* such as *Kutki, Kayphal*, *Kaduvi*, *Tumbi* and *Haritaki* etc. but instead of word *Mamsarohini, Brihatrayi* called it as *Rohini*, while other *Nighantukars* have mentioned it as *Grahi* in properties. *Acharya Charak* and *Shushruta* mentioned it as *Shaka* (5). The identification of the plant *Rohini* in ancient texts poses a challenge due to its vague descriptions.

In *Nighantus,* description of *S. febrifuga* is given by different *Acharyas* throughout history such as *Sodhala Nighantu*, *Kaideva Nighantu*, *Bhavprakash Nighantu*, *Adarsh Nighantu*, *Priya Nighantu* (22-26). *Raj Nighantu*, *Dhanvantri Nighantu*, *Madanpal Nighantu* and *Siddhamantra* describes regarding *rasapanchak*, synonyms and its classification in various *Ganas* (27-30). The author of *Raj Nighantu*, *Pandith Narahari*, classifies two varieties of *Mamsarohini*, that is *Rohini dwaya*, i.e. *Mamsarohini* (*Soymida febrifuga* A Juss) and *Mamsi (Nordostachys jatamamsi* D.C.). Both drugs possess *sheeta virya* (cold potency), *kashaya rasa* and *krimihara* properties.

Acharya Bhavprakash quoted that, bark of *S. febrifuga* is extensively used by number of physicians in various treatment of diseases (5). This diversity in descriptions across *Nighantus* not only underscores the plant's multidimensional importance but also reflects the continuous evolution and refinement of botanical knowledge and medicinal practices over the centuries. Studying these diverse accounts offers a profound glimpse into the rich tapestry of traditional wisdom and the dynamic nature of botanical understanding in ancient and classical text.

In different *Ganas*

The grouped herbs are called *Vargas* or *Ganas* in old *Ayurvedic* texts. Their etymology is based on dietary uses and classification according to pharmacological practices. The interpretations of

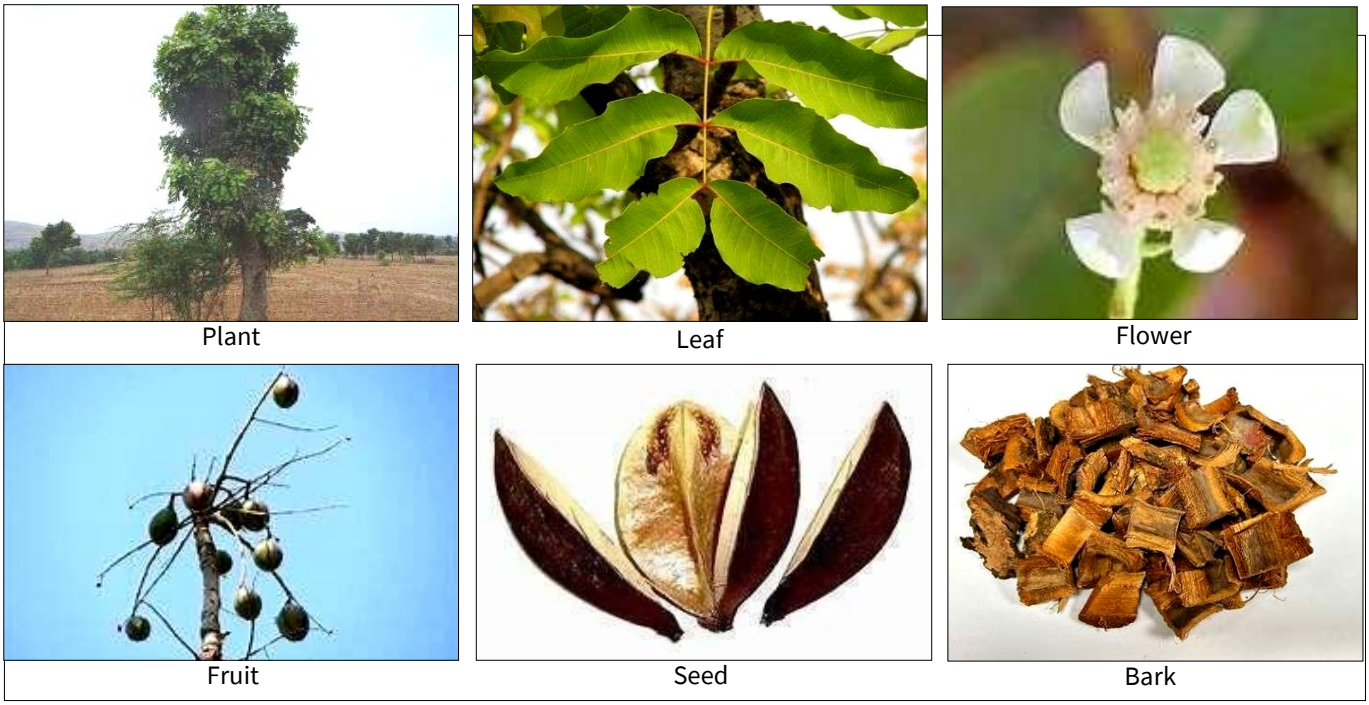

Fig. 2. Photographic identification of various parts of *S. febrifuga.*

different *Acharyas* over time regarding its places in the specific *Varga* or *Gana* are described here. *Acharya Shushruta* mentioned 37 *Ganas* (31). Among these, *S. febrifuga* is mentioned in *Nyagrodhadi Gana*, while *Acharya Charak* mentioned it in *Balya Varga,* however, *Acharya Vagbhata* also gave similar opinion (32). *Dhanvantari Nighantu* and *Shodhala Nighantu* mentioned the plant in *Karaveeradi Varga*. Meanwhile, *Acharya Bhavprakash* mentioned it in *Guduchiyadi Varga*, *Kaidev Nighantu* mentioned it in *Oshadhi Varga* and *Raj Nighantu* mentioned it in *Chandanadi Varga*. *Madanapala Nighantu* has placed the plant in *Abhayaadi Varga*, whereas *Siddhamantra* mentions it in *Pittaghna Varga*. However, the information provided varies among different texts and *Acharyas*. The opinions of *Priya Nighantu* and *Adarsha Nighantu* match with each other, both have mentioned the *S. febrifuga* in *Nimbadi* and *Sharaadi varga*.

Varieties and synonyms according to various *Nighantus*

The plants from different origins are known by different names in various regions, which are root cause of conflicts among the *Acharyas* regarding varieties of factors including regional practices, common names and medicinal properties of the drugs (1*). S. febrifuga* owns synonyms such as *Atiruha*, *Kasa*, *Charmakar*i, *Pishitarohini*, V*rtta*, *Rakta*, *Ruha*, *Vikasa*, *Rohini*, etc. *Dhanvantari*, *Madanpal*, *Raj*, *Kaidev* and *Bhavprakash Nighantu*s have mentioned *Atiruha* as a synonym of *S. febrifuga*, but *Sodhala*, *Adarsh* and *Priya Nighantus* have not mentioned this. *Agni Ruha* has no significance in any of the *Nighantus*, but *Charmakasa* is mentioned in all the *Nighantus* except *Priya Nighantu*. *Madanpal* and *Sodhala Nighantu* entitled *Kasa*, while others disagreed. Only *Sodhala Nighantu* mentioned *Lomakar*ni.

The opinion about *Mamsarohini* is similar in all *Nighantu*s, but *Dhanvantari* and *Sodhala Nighantus* classified it as *Mamsarohi*, rest others do not agree with it. Both *Nighantus* declared *Ruha* as synonym, while *Rakta* is mentioned only in *Dhanvantari Nighantu Sodhala* and *Kaidev Nighantus* mentioned as *Mamsavardhini* and *Pishitarohini*, while *Raj* and *Kaidev Nighantus* refer as *Mamsaruha Praharavalli* is classified in *Kaidev* and *Bhavprakash Nighantus*. *Rohini*, the most common synonym is mentioned by *Sodhala*, *Madanpala*, *Raj Nighantus* and *Nighantu Adarsha*. Only *Sodhala Nighantu* mentioned *Suloma*, *Supacaa* and *Sukhadaayani*. The reference regarding *Vasa* and *Viravati* are found in *Bhavprakash* and *Kaidev Nighantu* only, but *Viravalli* is mentioned only in *Kaidev Nighantu*. *Vrutta* appears only in *Adarsh* and *Priya Nighantu.*

Ayurvedic properties according to different *acharyas*

Ayurvedic properties such as, *Rasapanchak* (group of five taste) and *Karma* (therapeutic properties) of *S. febrifuga* described by various *Acharyas* in *Nighantus* are compiled over here. *S. febrifuga* undergoes pungent taste after digestion. The drug is devoid of *Sheeta virya* (cold potency) and *Prabhav* (specific effect) is *angmard-pras*hman (pain relief) along with aphrodisiac properties and improvements in vigor. Its effects on *Dosha*, is mainly *Tridoshanashak* (pacifies all three doshas), especially *Kaphapittaghna* (pacifies *kapha* and *pitta*). A higher dose of the *S. febrifuga* causes adverse effects on *Manovaha strotas* (mental channels). Its effects on various *Dhatus* (tissues) described such as *Shukra* (aphrodisiac), *Mamsa* (wound healing), *Rakta* (enhances complexion) and *Asthi* (bone strengthening). It possesses properties like *Laghu* (light to digest) and *Ruksha* (dryness). *S. febrifuga* mainly supports circulatory system and its primary waste product (mala) is *purisha* (stool), according to *Ayurvedic* principles (33).

There is again the difference in the opinion among various *Nighantukars* regarding *rasapanchak* of *S. febrifuga*. *Katu* (pungent), *Tikta* (bitter), *Kashaya* (astringent*) Rasas* are mentioned in *Dhanvantari* and *Raj Nighantus*, whereas only *Kashaya rasa* is mentioned by *Nighantu Ratnakar* and *Sodhala Nighantu* (34). Descriptions regarding *Tikta* and *Kashaya rasas* are depicted by *Bhavprakash Nighantu*, however, *Kashaya* and *Madhura rasas* and *Madhura Vipaka* together are mentioned by *Kaidev Nighantu*.

The *Guna* (qualities) of *S. febrifuga* is described as *Picchila* and *Sara* by *Sodhala* and *Madanpala Nighantu*. Considering *Veerya* (potency), both *Ushna* (hot) and *Sheeta* (cold), *Veeryas* are mentioned by *Sodhala* and *Dhanvantari Nighantu*, while *Ushna* and *Sita Guna* are reported by *Kaidev*, *Madanpala Nighantu* and *Nighantu Ratnakar*. *Madhura Veerya* (sweet potency) and *Madhura Vipaka* (sweet post-digestive effect) are cited by *Kaidev Nighantu* and *Nighantu Ratnakar*; however, none of the texts specifically mention its *Vipaka* in detail. Regarding *Doshaghnata* (effect on doshas), *Vatahara* (*vata*-pacifying) properties are noted in *Nighantu Ratnakar*, *Raj* and *Dhanvantari Nighantu*. *Tridosha Shamaka* (pacifying all three doshas) activity is indicated by *Madanpala* and *Bhavprakash Nighantu*, while *Pittaghna* (*pitta*-pacifying) property is highlighted in *Siddhamantra Manimala*.

Therapeutic methods or acts aimed at treating disorders and restoring health are referred to as "*Karma*" (therapeutic properties) in *Ayurveda*. The precise *Doshic* imbalance (*Vata*, *Pitta*, or *Kapha*) that underlies a clinical condition determines these metrics (35). *Krimighna* (antibacterial) and *Kantashuddhikara* (beneficial for throat) properties have been attributed to the plant by *Bhavprakash*, *Raj Nighantu* and *Nighantu Adarsha*. However, the details about *Varnya* (good for complexion) and *Grahi* (absorbance quality) properties are only mentioned in *Raj* and *Dhanvantri Nighantus*. *Rochak karma* (appetite stimulant) is mentioned in *Raj Nighantu*. *Rasayana karma* (rejuvenate) is attributed by *Raj*, *Dhanvantri* and *Bhavprakash Nighantus*. Description about the *Vrushya karma* (aphrodisiac) is given in *Nighantu Adarsha*, as well as *Madanpala Nighantu*, but about *Sara guna* (fluidity), no evidence was found in any of the *Nighantus*.

Kaidev and *Sodhala Nighantus* only give relevant information about *Vranaropani Karma* (wound healing). *Balya karma* (strength) is mentioned in *Bhavprakash* and *Nighantu Adarsha*. *Ruchya Karma* (appetite stimulant) is declared in *Nighantu Adarsha* and *Sodhala Nighantu*. However, *Dhanvantari* and *Raj Nighantus* mentioned regarding its *Varnya Karma* (improves complexion). It is *Sarvarogahara* (cures all the diseases) said by author of *Raj Nighantu* and *Dhanvantri Nighantu* also supported the same. *Nighantu Adarsha* mentioned its use in *kasa* and *swasa* (cough and asthma). *Kaidev Nighantu* quoted it as *Sarva Sangrahanihara* (removes all the accumulated impurities). *Raktapittahara* (useful in bleeding disorders) properties have been reported by *Raj* and *Dhanvantari Nighantu* and are further supported by *Nighantu Adarsha*. Explanation regarding *Kanta Rogahara* (elevates throat disorder) is given in *Raj* and *Dhanvantri Nighantus*. It is *Vata Rogahara* (elevates *vata*) properties have been described by *Raj Nighantu* and *Nighantu Adarsha*. The dose of decoction is 25-30 ml and internal dose of powder is 3 g, however, at higher dose, *S. febrifuga* causes vertigo, unconsciousness and syncope which should be treated with *Snigdha* and sweet drugs (33).

Traditional and folklore uses and their relevance to modern pharmacology

The therapeutic uses of *S. febrifuga* are enlisted in Table 1. The ethnomedicinal and folklore uses are systematically illustrated in Fig. 3. It summarizes the ethnobotanical knowledge and cultural practices associated with its application in various communities.

Research indicates that *S. febrifuga* contains a variety of bioactive compounds, including limonoids, tannins and triterpenoids, which have demonstrated confirmed anti plasmodial activity by disrupting *Plasmodium* species, thereby supporting its traditional use in malaria treatment. The bark and fruit, rich in antioxidants such as tannins and flavonoids, exhibit broad-spectrum antimicrobial properties effective against gram positive and negative bacteria. The presence of tannins and resinous compounds also promotes tissue regeneration, providing a rationale for its use in wound healing and possibly in managing respiratory conditions, although more targeted research is needed (43). The bark, characterized by its bitter and astringent nature, may aid in digestion and support metabolic balance, in line with *Ayurvedic* principles related to *dosha* regulation. Despite its traditional use for snake bites, there is currently insufficient scientific validation for its antivenom potential, highlighting the need for further studies, including investigations into appropriate dosage forms.

Phytochemical studies have identified flavonoids and terpenoids with known anti-inflammatory and analgesic properties (44, 45). While, dedicated hormonal studies are scarce, anecdotal evidence and preliminary findings suggest possible estrogenic and uterotonic activity, correlating with its traditional applications in reproductive health. Additionally, the alkaloid content may function as a bronchodilator and digestive tonic, supporting mucosal integrity and gastrointestinal motility (46). In Madhya Pradesh, traditional use includes promoting lactation and aiding animal digestion. Though direct clinical evidence is limited, the presence of bark saponins may contribute to prolactin release, thereby supporting lactation (47).

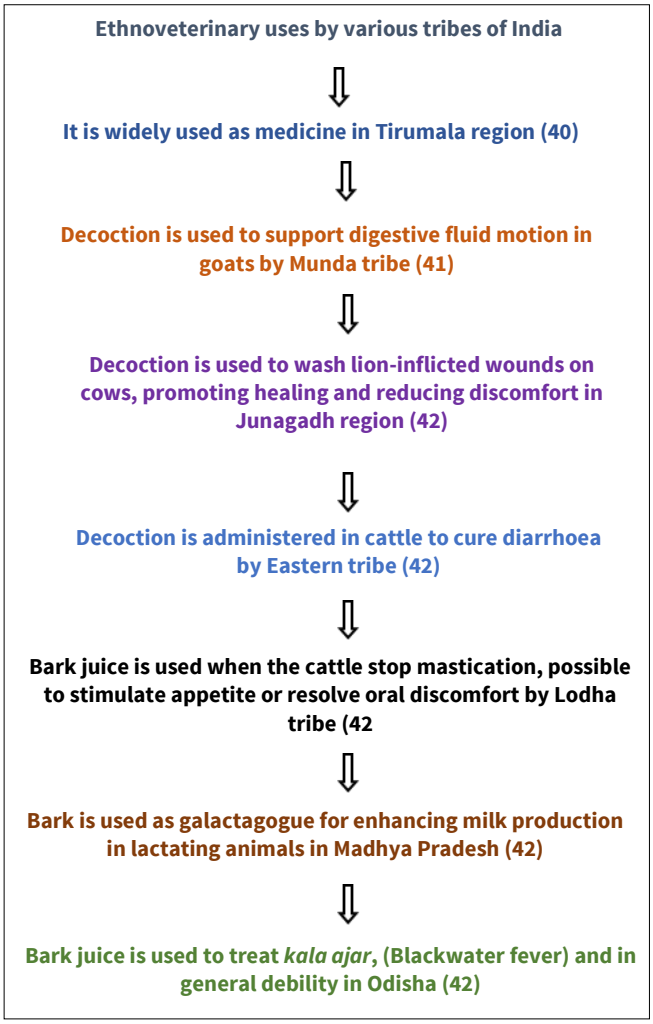

Fig. 3. Ethnomedicinal and folklore uses of *S. febrifuga.*

Non- pharmacological uses

Trade and business dealings the wood of *S. febrifuga*, commonly known as Bastard Cedar, is prized for its strength and durability. Owing to this, it is used to build bridges, rafters, beams, ploughshares, pestles, pounders, furniture and house posts (18). Because wood *S. febrifuga* is easy to work with and has a hard surface, it is utilised for flooring. Its wood is also used to prepare frames, stiles and lighter-coloured panels, such as Spanish mahogany and for upscale decorative work. In addition to office walls, it is used in railway coaches. Because it tans well, East Indian wattle bark is imported to make leather of superior quality. Bark of *S. febrifuga* is utilised in the production of ropes as well as for dying cotton (48).

Cultivation and propagation of *S. febrifuga*

The right temperature and soil are needed for *S. febrifuga* to flourish in the designated area. It requires 25-30 °C temperature, well-drained black cotton or lime soils and low to moderate rainfall. It is drought-prone It requires a temperature range from 0 °C and a maximum temperature of 40 °C to 46 °C. Direct seeding many be done on ridges at 30 cm height (7). The mature fruits of

Table 1. Therapeutic uses of *S. febrifuga*

Part used	Dosage forms	Uses
Bark	Decoction	In *Bhavprakash Nighantu* it is quoted for used in *Vrana Prakshalan* (washing or cleansing of wound) (5).
		Crushed bark with water treats cough and respiratory issues (18).
		S. febrifuga bark is bitter tonic and is used in tongue sores and in fixing loose teeth and in gum infection also (18).
		In delayed menstrual, bark juice with sugarcane is used (32).
		It is taken thrice daily cures malaria (36).
		Half cup of bark decoction is beneficial for snake bites (37).
		Boosts women's sexual vitality (38)
	Bark powder	In dysentery, *S. febrifuga* bark powder is given when there is weakness in the body and intestines (5).
		Powder of bark is applied on leucorrhoea and leukoderma in the form of poultice (39).
	Bark paste	Boiled bark paste reduces swelling in three days (11).
	Resinous content	Due to resinous bitter content present in the bark, it reduces *vata* and cures all the *Tridoshas* (18).
Fruit	Fruit paste	Fruit is immersed in goat's milk for seven days and paste is prepared by grinding it and applied locally to treat S*avarnakarana* (normalise the skin tone) (11).

the spores are collected during the rainy season and used to further propagate the *S. febrifuga*. The seeds are then sown directly into the fields or nurseries. However, the primary problem with the *S. febrifuga* is that, it is more vulnerable to insects, which ruins germination (49). Considering the aspect of planting and spacing, seeds of *S. febrifuga* are sown into the fields after 6-8 months and the distance between them is kept at 8-10 m to ensure proper growth (50). In spite of all this, the threatening fact about this is, according to the JCM Herbarium, it has not been assessed and declared endangered in Madhya Pradesh (9). Despite its medicinal significance, *S. febrifuga* faces several challenges such as overexploitation, as its bark and leaves are extensively harvested for traditional medicinal purposes, leading to a decline in natural populations. Additionally, the species suffers from a lack of formal conservation measures. The situation is further worsened by habitat loss, primarily due to agricultural expansion and land development, which continue to encroach upon its natural environment. Moreover, limited public awareness regarding the ecological and medicinal importance of *S. febrifuga* contributes to the absence of community-driven conservation efforts, further accelerating its decline. From a conservation perspective, developing propagation techniques, such as tissue culture or seed treatment methods, can support large-scale cultivation. This would reduce dependence on wild populations and support commercialization through sustainable farming. Promoting the plant's value in the herbal medicine and pharmaceutical industries can also drive economic benefits while encouraging its preservation and responsible use.

Microscopic studies

The pharmacognostical characters of *S. febrifuga* leaves, transverse section shows the presence of cuticle along with vein cells and oil globules. Trigonal petiole epidermis is a single layer in a narrow zone followed by collenchymatous hypodermis and thick cuticle. It possesses brown collenchyma and secondary growth creates a continuous xylem and phloem outside the vascular cylinder. Many fibre patches resemble the pericyclic zone. Pith includes irregular parenchymatous medullary vascular bundles. In sponge tissues, there are large intracellular spaces and the epidermis forms a thick cuticle followed by broad zones of collenchyma with few-layered brown parenchyma. Vasculature forms a shallow xylem-phloem arc circled by fibrous pericyclic zone (51). The lateral sections of bark revealed, cork in the outer layer covered by radially organized cells that varied in size and devoid of cluster crystals. Rays hitting the cork layer's inner border, generally two or four cells. Besides vertically elongated calcium oxalate crystals, phloem has tangential bands of sclerenchyma and disorganized sieve tube tissue (9).

Phytochemical composition of *S. febrifuga*

Chemical components are substances or chemicals found in plant tissues that support the biological characteristics and activity of the plants. The plants of Meliaceae have a unique chemical character, including the gedunin nucleus and occurrence of triterpenes modified into limonoids (52-55).

Flavonoids glycosides

Leaves are Quercetin 3-0-rhamnoside and quercetin 3-0-rutinoside are the chemical components are found in leaves of *S. febrifuga* (56).

Terpenoids

Bark It is bitter, colourless resinous substance that is soluble in alcohol but insoluble in water. Additionally, it has very little tannic and gallic acid. Additional components found in the bark include two tetranortriterpenoids with a modified furan ring, methyl Angolensate, lupeol and Deoxyandirobin (53-55). Fruit is also devoid of epoxyfebrinin B, 14,15dihydroepoxyfebrinin B and febrinolide together with deoxyandirobin, 17b-hydroxy-6a- aceto xyzadiradione these are tetraterpenoids which were newly found (11). Seeds also possesses lupeol and methyl angolensate and sitosterol (56).

Phenols

Heartwood consists of Fibrins A and B which is terpenoids, but these are phenols naringenin, myricetin, dihydromyrice tin and quercetin and another new tetranortriterpenoid- febrifugin (57). Methyl angolensate and Luteolin -7 Oglucoside also isolated from callus cultures of root of *S. febrifuga* (58).

Phytochemistry of *S. febrifuga*

Qualitative estimation

Investigations of various parts of *S. febrifuga* led to the isolation of various secondary metabolites in different extracts of *S. febrifuga* (Table 2).

Chromatographic evaluation

The ethanolic extract of *S. febrifuga* subjected to thin-layer chromatography using 9:4:6 solvent systems (benzene, acetone and acetate) revealed three areas with hRf values of 18 (bright green), 48.2 (greyish blue) and 64.40 (grey) (9). And another solvent system used was butanol, acetic acid and water (BAW 5:4:1) the compounds separated by TLC were further analysed using UV, NMR and IR spectroscopy to determine their structures. High-performance thin-layer chromatography (HPTLC) analysis was conducted on a chloroform extract of root bark using the solvent system of N-Butanol: Water: Acetic Acid (4:1:5). Detection at long UV (366 nm) revealed five spots with the following Rf values: 0.09, 0.18, 0.20, 0.88 and 0.95. In contrast, six spots were observed at short UV (254 nm) with Rf values of 0.07, 0.18, 0.20, 0.34, 0.80 and 0.95. After applying the vanillin sulfuric acid spray reagent, only three spots were detected with Rf values of 0.18, 0.20 and 0.95 (60).

Fluorescent study

The fluorescent study of *S. febrifuga* bark powder showed distinct colour reactions with various chemicals. Ferric chloride produced

Table 2. Presence of various secondary metabolites from different extracts of *S. febrifuga*

Secondary metabolites	Ethanolic extract	Water extract	Chloroform extract	Acetone extract	Petroleum ether extract	Reference
Phenols	+	+	-	-	-	
Flavonoids	+	+	-	+	-	
Alkaloids	+	+	-	-	-	
Steroids	+	+	-	-	-	(11, 59, 60)
Tannins	+	+	-	+	-	
Amino acids	+	+	-	+	-	
Carbohydrates	+	+	-	+	-	

intense colorations, resulting in a fern green colour, while benzene, acetic acid and water yielded brown. Ethanol showed blood red and concentrated H_2SO_4 and HCl exhibited chocolate and rust colours, respectively. The powder itself appeared maroon. Under UV light, benzene and ferric chloride displayed wine red, while acetic acid and ethanol in water produced sky blue. A fern green colour was also seen in water and concentrated H_2SO_4 and HCl revealed purple and brick red colours, respectively. The powder under UV light appeared chocolate (61).

UV analysis

The UV spectrum recorded in methanol indicated the presence of a chromophoric group with extended conjugation. A bathochromic shift was observed upon adding $AlCl_3$ to the same solvent, while no change occurred when HCl was added. Spectroscopic studies of flavonoids revealed that most flavones and flavanols exhibit two major absorption bands: Band I at 328 nm corresponds to the B ring absorption and Band II at 268 nm corresponds to the A ring absorption. The recorded wavelengths were: λ max (MeOH): 268, 328; ($AlCl_3$): 278, 302, 344, 382 (sh); ($AlCl_3$ + HCl): 278, 300, 338, 388 (sh) (9).

Analysis using infrared absorption

Infrared absorption of compound was carried out using the ethanolic extract of root bark of *S. febrifuga* by the KBr disc method, which gave bands at 1675 and 3000 cm^{-1} confirming the presence of carboxyl and hydroxyl groups (-OH). The compound showed a peak at 3000 cm^{-1} for the -OH group. The ^1H NMR analysis of the drug showed a spectrum with a distinct proton singlet at 12.25 δ, indicating the existence of the -OH group, corroborated by IR. Two peaks at 8.06 δ and 7.82 δ indicate two sets of comparable protons in the molecule (9). The chloroform extract of leaves of *S. febrifuga* used to carry out the infrared spectrum of three compounds. A broad band was obtained at 3335 cm^{-1}, with moderately intense bands at 1193 cm^{-1} and 667 cm^{-1} for the O-H bond vibrations of the hydroxyl group. C-H vibrations of the unsaturated part were observed at 879 cm^{-1} out of plane and C=C at 1667 cm^{-1} as a weakly intense band. Methyl groups were noticeable for their stretching and bending vibrations at 2934 cm^{-1}, with a vibration band at 2866 cm^{-1} and a medium band at 1459 cm^{-1}. Additionally, rocking movements were seen at 777 cm^{-1}. The faint intense band at 1036 cm^{-1} was indicative of corresponding C-C vibrations (62).

Analysis using NMR

The H^1 NMR spectrum revealed a sharp singlet at 12.25 δ, indicating the presence of an -OH group, which is further supported by IR analysis. Two peaks at 8.06 δ and 7.82 δ, each integrating for two protons, suggest the presence of two sets of equivalent protons in the molecule. Additionally, three singlets at 6.88 δ, 6.45 δ and 6.26 δ, each corresponding to a single proton, are likely attributed to aromatic CH protons. A singlet at 3.86 δ accounted for three protons, typically indicating the presence of OCH_3 protons (9).

GC-MS Analysis

S. febrifuga stem bark was extracted by using Soxhlet apparatus with n-hexane and ethyl acetate, then analysed via GC-MS on a Perkin Elmer Clarus 600C with a GsBP-5 MS column. The injector temperature was 250 °C, with helium as the carrier gas at 1.2 mL/min. The oven temperature was programmed to decreased from 450 °C to 290 °C at 10 °C/min, held for 5 min. A 1.0 µL sample was injected in spitless mode, with transfer and source temperatures at 280 °C and 230 °C, respectively and a mass range of 40 to 450 m/z and the result revealed that analysis of n-hexane extract identified 28 medicinally active compounds, with tetradecane showing the highest concentration at a retention time of 10.52 min and a peak area of 8.75 %. This was succeeded by octatriacontane. In comparison, 1,38-dibromo had a retention time of 29.27 min and a peak area of 8.57 %. Methane dichloro-nitro displayed the lowest concentration, with a retention time of 5.84 min and a peak area of 0.46 %, followed by heptacosane, which had a retention time of 17.16 min and a peak area of 0.84 %. However, the results regarding ethyl acetate extract, 15 compounds were identified, with 1-decanethiol exhibiting the highest concentration at a retention time of 12.24 min and a peak area of 1.0697 %. Following this, 3,7,11-trimethyl-3-docdecanol was noted, with a retention time of 21.33 min and a peak area of 9.163 %. Purolan showed the lowest concentration, with a retention time of 5.37 min and a peak area of 1.468 %, while tetrahydrofurfuryl propionate had a retention time of 9.68 min and a peak area of 1.872 % (63).

Pharmacological actions of *S. febrifuga*

***In-vitro* studies**

α-amylase inhibition study: The activity was performed by using chloroform, distilled water, 70 % ethanol and petroleum ether extracts of *S. febrifuga* leaf. The α-amylase inhibition percentage in extracts varied from 84.8 to 78.09 %. At a concentration of 6 mg/ml, the ethanol extract produced 84.8 % inhibition, while aqueous extract exhibited a maximal inhibition of 87.3 % (61, 64). The findings suggest that polar solvents such as water and ethanol are more effective in extracting α-amylase inhibitory compounds, likely due to their enhanced ability to dissolve polar phytochemicals. This has significant biological relevance, as α-amylase inhibitors help regulate blood glucose levels by slowing the enzymatic breakdown of starch, thereby delaying glucose absorption into the bloodstream (65). This mechanism is particularly beneficial for individuals with type 2 diabetes, where managing postprandial blood sugar spikes is essential (66). Looking ahead, future research could explore the synergistic potential of *S. febrifuga* extracts in combination with established antidiabetic agents, evaluating possible additive or synergistic effects. Additionally, *in vivo* studies are warranted to investigate the pharmacokinetics and physiological efficacy of these extracts in diabetic animal models, contributing to a deeper understanding of their therapeutic potential.

Anti-oxidant activity: Antioxidants play a crucial role in protecting the body's cells from oxidative stress induced by free radicals, which can lead to damage of DNA, proteins and cellular membranes. By neutralizing these reactive species, antioxidants help minimize tissue injury, reduce the risk of chronic diseases, support immune system function and contribute to slowing the aging process (67). The hexanes, methanol, water extracts of *S. febrifuga* leaves was used for anti-oxidant parameter. Total phenolic content was assessed with gallic acid. The water and methanol extracts showed phenolic content as 278.8±8.79 and 264.52±7.41 GAE/g, respectively, but hexane showed decreased total phenolic content (68). DPPH content showed lesser IC50 value in methanol, aqueous and hexane extracts (10 µg/mL) (IC50 values µg/mL: 59.33±1.36, 56.22±2.11 and 363.5± 3.2, respectively) when compared with ascorbic acid (69).

In another study, the various extracts leaf, bark, root and root bark of *S. febrifuga* were used for the *in-vitro* activities. The reducing power assay showed best results in bark methanolic extract in comparison to other extracts. Bark and leaf extracts *S.*

febrifuga showed higher activity in DDPH assay than that of others results regarding superoxide scavenging activity, among which bark aqueous extract showed higher results in comparison to ascorbic acid. All the extracts showed nitric oxide scavenging activity in the dose dependent manner. Hydroxyl radicals scavenging assay were subjected to concentration-dependent scavenging activity and it showed scavenging activity of various extracts. Hydrogen peroxide scavenging activity in the dose dependent manner showed more potent activity in bark and leaf methanolic extracts in comparison to other extracts. All other extracts showed potent protein oxidation effects. Data regarding lipid peroxidation activity was significant in all the extracts but highly significant in bark methanolic extract (70). Lipid peroxidation inhibition by bark extract implies it may protect cell membranes from oxidative damage. Here in this study high phenolic content in methanol and aqueous extracts of *S. febrifuga* indicates the presence of natural antioxidants. Low IC_{50} values in DPPH assay mean that these extracts are very effective at scavenging free radicals comparable to ascorbic acid (vitamin C). Both studies demonstrated dose-dependent antioxidant activity; however, only the second study investigated multiple antioxidant pathways, thereby enhancing its pharmacological significance. Despite these findings, neither study identified the specific bioactive compounds responsible for the observed effects nor provided mechanistic insights, such as involvement in cellular signalling pathways. Additionally, *in vivo* validations were absent. Future research may focus on isolating and characterizing the active constituents using advanced analytical techniques such as HPLC or LC-MS. Moreover, *in vivo* studies and mechanistic investigations are essential to confirm the efficacy of the extracts and elucidate their biological mode of action.

Anthelmintic activity: Anthelmintic activity was performed by using petroleum, chloroform, methanol extracts of *S. febrifuga* bark and albendazole was used as standard. Indian earthworm (*Pheretima posthuman*) was used (71, 72). The assay was performed in the petri plate; 10 ml of suspension were taken against the standard time duration at which there is no movement or are paralysed was noted. Albendazole (20 mg/ml) as the active standard and the methanol extracts exhibited comparable anthelmintic activity (73, 74). However, the findings are limited, as only one plant part and a single helminth species was tested. The evaluation relied solely on basic measurements of paralysis and death times, lacking dose-response analysis and chemical profiling. Future studies should investigate various plant parts across multiple helminth species, conduct detailed phytochemical analyses to identify and characterize active compounds and include in vivo experiments with standardized dose-response protocols to confirm efficacy, ensure dosage safety and understand pharmacodynamic properties.

Activity against HepG2 cells: HepG2 cell line was performed in 96 well microplate and its density were 20,000 cells per well. The result showed that ethanol extract of *S. febrifuga* at different dose levels shows that the cell viability has decreased in dose-dependent at the concentration of 10-100 mM in 24 hours and the value of IC-50 was 46.27±3.11 mM against HepG2 cells. The metal cheating activity was conducted using EDTA as positive control, the *S. febrifuga* extracts revealed dose dependent metal cheating activity among which methanolic extract of bark was more potential but which was lesser far than that of positive control (70). However, the current analysis is restricted to a single cell line and extract type, lacking comparisons across various plant parts, extraction techniques, or cancer models. Despite these limitations, the results indicate that *S. febrifuga* extracts may contain bioactive compounds with potential anticancer and metal-chelating properties. Further research is needed to explore additional cancer cell lines, conduct mechanistic studies and isolate the specific constituents responsible for these therapeutic effects.

Antimicrobial and antifungal activity: Hexanes, methanol, water extracts of *S. febrifuga* leaf was prepared and assessed for anti-microbial and anti-fungal activities on *Bacillus cereus, Bacillus cerculences, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Klebsiella aeruginosa, Candida albicans, Saccharomyces cerevisiae, Aspergillus fumigatus, Candida tropicana* and *Candida krusei*. The standards used for bacteria and fungus were chloramphenicol and amphotericin B at the concertation of 30 µg/bore, using nutrient agar culture media plate. Greater inhibitory diameter zones were observed in the methanol and aqueous extracts of leaves that that of hexane, indicating that they were more susceptible to the methanol extract (75).

In another study, effect of different extracts of root callus of *S. febrifuga* such as hexane, ethyl acetate and methanol and the compounds isolated from *i.e.*, Angolensate and Luteolin-7-0 Glucoside evaluated against *Bacillus subtilis* and *Salmonella typhimurium* using ciprofloxacin (10 mg/ml) and nystatin (500 mg/ml) as standard. The result showed that at the concentration of 200 and 400 µg/disc, methyl angolensate showed considerable antibacterial activity and antifungal activity (76). The second study highlighted significant antibacterial and antifungal activity, particularly at higher concentrations (200-400 µg/disc), with methyl angolensate showing notable potency. These results suggest that the extracts have strong antimicrobial and antifungal properties, making them a promising candidate for further development. Standardized assays (e.g., MIC, MBC) across various plant parts, along with phytochemical profiling and mechanism-of-action studies, are necessary to identify active compounds. Broader testing against resistant strains would further assess their therapeutic potential as natural antibiotics.

Cytotoxicity: The bark extract of *S. febrifuga*, compounds isolated from the extraction was subjected to chromatographic technique for further separation of 27 new compounds, further they were tested for cytotoxic activity against PANC-1 cell line. The result depicted that 4′-hydroxy-3,5-dimethoxystilbene showed stronger activity (PC50, 44.4 µM). Similarly other compounds were not much active or having very slow activity. The drug used as positive control was Arctigenin, depicted cytotoxic activity at 1 µM. The test drug was found to be effective in killing PANC-1 pancreatic cells at the concentration of 10 µg/ml. The cytotoxic activity in other cell line such as colon 26-L5 carcinoma (colon 26-L5), B16-BL6 melanoma (B16-BL6), lung A549 adenocarcinoma (A549), cervix HeLa adenocarcinoma (HeLa) and HT-1080 fibrosarcoma (HT-1080) cell lines and their structure-activity relationship were evaluated. The cytotoxic of one of the compounds against colon26-L5 was found to be much stronger that the doxorubicin which was positive at IC50 3.12 µM (77).

Bark extracts of *S. febrifuga* prepared in chloroform and methanol were used again various cell lines such as MCF-7 (human breast tumor, adenocarcinoma, mammary gland (negative)), MDA-MB-231 (human breast tumor, adenocarcinoma, mammary gland

(positive)), A-431 (human epidermoid carcinoma) and HT-1080 (human fibrosarcoma). The chloroform extracts inhibited cell growth in MCF-7, A-431 and HT-1080 cell lines, while the methanol extract did not show cytotoxic effect at 100 mg/ml. However, the aqueous extract showed limited action on MDA-MB-231, MCF-7 and A-431 cell lines, with an IC50 value of 7.2 g/ml for MCF-7, but no activity on HT-1080 cell line at 100 g/ml (78). The key differences between the two studies lie in their use of purified compounds with detailed potency data in one, versus crude extracts in the other, making direct comparison challenging. However, the first study included a broader range of cancer cell lines, enabling a more extensive evaluation of anticancer potential. None of the studies investigated the mechanism of cytotoxicity (e.g., apoptosis, cell cycle arrest), limiting insights into how these compounds function. These findings suggest that specific compounds and chloroform extracts from *S. febrifuga* exhibit selective and potent anticancer properties, positioning them as promising candidates for future research.

In-vivo studies

Anti-hyperglycaemic activity

Assessment of activity was conducted on Wistar albino rats using methanolic extract of bark of *S. febrifuga* and glibenclamide (10 mg/kg) as a standard. Three dose levels i.e. 100, 200 and 400mg/ kg were assessed through measurement of fasting blood glucose (FBS) levels at fixed intervals, by using glucose oxidase-peroxidase method. *S. febrifuga* extract at 200 mg/kg, resulted in a 54.1 % reduction in FBS level (79, 80).

In another study, anti-hyperglycaemic activity was performed on Wistar albino rats by using methanolic extract of S. *febrifuga* bark obtained from column fractions, at the different dose levels (100, 200, 400 mg/kg). In this protocol diabetes was induced by injection of alloxan monohydrate (125 mg/kg, ip) dissolved in normal saline. After 72 hr of injection, blood glucose level was assessed and those with >250 were selected. The highest effect in the reduction of blood glucose level was observed at 200 mg/kg as well as 400 mg/kg of test drug (81, 82). In both studies, the 200 mg/kg dose resulted in the most consistent and significant reduction in blood glucose, with one study reporting a 54.1 % decrease. However, key differences and gaps were noted, such as one study using crude methanol extract, while the other utilized column fractions, which could affect potency due to varying compound concentrations. Additionally, mechanistic data is lacking on how the extract lowers glucose (e.g., through insulin secretion, glucose uptake, or enzyme inhibition). Future research should focus on standardizing extract preparation, identifying active compounds, conducting mechanistic studies of *S. febrifuga* as an anti-diabetic agent.

Anti-inflammatory activity

Assessment of the activity by using hydroalcoholic, alcoholic and aqueous extracts of *S. febrifuga*, against carrageenin induced inflammation in albino rats and Indomethacin with a dose of 10 mg/kg, p.o. served as standard. Alcoholic extract at the dose of 100 mg/kg, showed 33.4 % and 55.2 % inhibition and aqueous extract showed 45.2 % and 56.6 % inhibition at the same dose level and the hydroalcoholic extract resulted in 53.3 % and 66.2 % inhibition. All the three extracts showed satisfactory results against inflammation but most potent results were found in hydroalcoholic extracts of *S. febrifuga* (83). The key differences and gaps observed include the greater effectiveness of the hydroalcoholic extract, suggesting a synergistic effect of both polar and non-polar compounds. However, individual active components were not identified and only a single dose (100 mg/kg) was tested, with no investigation into dose-response relationships or the mechanism of action (e.g., COX inhibition, cytokine modulation). While the results are promising, they are limited to acute inflammation in animal models, with no data on chronic models or human relevance. Future research should focus on isolating active compounds, exploring mechanisms of action and conducting dose-response studies.

Acute toxicity study

The hydroalcoholic and aqueous extracts of *S. febrifuga* bark was used for the assessment of acute toxicity in the albino rats at the different dose levels of 100, 500, 1000 and 2000 mg/ kg of body weight. The observation was done continuously for 2 hr for the changes in behavioural, neurological and autonomic changes and after the completion of 24 or 72 hr, the same observations was done and death, if any. The test drug did not show any behavioural, neurological and autonomic changes, nor any deaths observed in the animals, which indicated the extracts are safe (78). Key gaps and limitations identified include the short observation period of only 72 hr, with no data on long-term or repeated dose effects. Additionally, no biochemical or histopathological analysis was performed to detect potential subclinical organ toxicity. Future research should focus on evaluating chronic and sub-chronic toxicity, conducting organ-specific toxicity and biochemical analyses.

Controversy related to *S. febrifuga*

Different *Nighantus* may vary in descriptions and classification of *S. febrifuga*. This can lead to confusion or disagreements among practitioners regarding the correct identification and usage of this drug (84). The unclear description of *S. febrifuga* (*Rohini*) in ancient writings makes its identification difficult. In ancient literature like *Charaka Samhita*, the term *Mamsarohini* is mentioned as "*Rohini shaka*" (type of vegetable) and described in the context of *Virudha Ahara* (incompatible food), which causes *Raktapitta* (bleeding ailment) and the same views are shared by *Acharya Sushruta* also. This clarifies *Charak Samhita* and *Sushruta*'s claim that *Rohini* of that time was likely a *shaka* (vegetable) plant. The identification of *Rohini shaka* as *Katukarohini* concerned *Acharya Chakrapani*. Interestingly, *Chakrapani* does not include *Rohini* in the *Charaka Samhita*. Opinion of *Brihatrayi* was that *Rohini* is *Sheeta* in *Veerya*, *Balya Guna*, *Kasaya* and *Tikta* in *Rasa Pradhana* and possesses *Stanya shodhana* (cleansing of breast milk), *Jwaraghna* (elevates fever), *Rakta*, *Vishagna* (elevates poison), *Vrana shodhana* (cleansing of wound), etc.

Gulma Chikitsa describes *Rohini* and *Katuka* differently, but both are having similar features. *Acharya Chakrapani* considered *Katu Rohini* as best. *Rohini* and *Katu Rohini* are the chief ingredients of *ghrita* formulations named *Rohiniyadi* and *Traayamanadi ghrita*. *Acharya Privyavat Sharma's* commentary implies that, whether *Rohini* is referred as *Katuka rohini* or not, in that case, the medicated *ghrita* prepared from *Rohini* would have been referred to as *Katukarohinyadya gritha* or *Katukadya gritha*, yet *Rohini* is mentioned in historical references in situations where it is connected to *tikta* (bitter compounds) in one instance and *Katuka* in another. This suggests that *Rohini* has to be regarded as separate from *Katuka* and *tikta*. Thus, it may be inferred from these allusions that *Rohini* is not the same as *Katukarohini*, but rather a distinct entity. Based on the description in *Nyagrodhadi Gana*, the useful parts of the plant are *twak* (bark) and *phala* (fruit), suggesting that it may be a tree (24). Based on available information, *S. febrifuga* and *Viburnum coriaceum* show similar

characteristics to *Tilwaka Bheda*, which has led to some disagreement in identification. However, *S febrifuga* is more widely recognized as *Rohini* or *Mamsarohini* due to its medicinal properties such as antipyretic action, astringent nature, bitter taste and use of bark. Its dark red bark, resembling muscle tissue, gives it the name *Raktarohan* (85).

Future prospective

Taxonomical clarification

The historical confusion between plants like *Rohini*, *Katukarohini* and others underscores the need for botanical, morphological and genetic studies to clearly establish their identity and classification. Resolving these identities will facilitate legal standardization and support the development of pharmacopeial monographs and regulatory acceptance.

Toxicology and safety profiling

Traditional warnings about high doses (e.g., syncope, unconsciousness) highlight the necessity for controlled toxicological studies. Further research on adverse effects is needed. The ancient practice of using *Snigdha* and sweet drugs in overdose situations can be scientifically validated and incorporated into detoxification protocols.

Conservation and sustainable cultivation

As a valuable timber tree with medicinal bark, *S. febrifuga* should be promoted in agroforestry. Due to over-exploitation, conservation efforts must be prioritized both *in-situ* and *ex-situ*. Sustainable harvesting practices should be adopted to ensure that bark and wood collection does not threaten natural populations. Additionally, developing tissue culture techniques can help overcome challenges such as poor seed germination, insect damage and long growth periods. Awareness programs for farmers on seed priming, pest control and irrigation will aid in adopting better cultivation practices for sustainable propagation.

Pharmacological research and drug development

Modern pharmacology can help validate traditional *Ayurvedic* claims and explore bioactive compounds such as lupeol, methyl angolensate, quercetin derivatives and flavonoids, which have a range of therapeutic properties. Isolating these compounds from the bark, leaves and fruit could position *S. febrifuga* as a strong candidate for drug development. Targeted formulations based on its efficacy in wound healing, menstrual disorders and respiratory issues could lead to the creation of new plant-based therapeutics with promising potential. Molecular pathways underlying its pharmacological effects can be explored using omics technologies.

Industrial applications

The tannins in bark can be promoted as an eco-friendly alternative in leather tanning and textile dyeing. Its high-quality wood could also serve as a sustainable, regional substitute for expensive imported woods.

Veterinary applications

Traditional veterinary uses, such as treating cow diarrhoea and aiding injury healing, can be explored through modern veterinary pharmacology. In community healthcare, traditional decoctions could be promoted for common ailments in rural healthcare models.

Conclusion

S. febrifuga, holds substantial cultural, ethnobotanical and biomedical importance. It has been traditionally utilized across various systems of medicine, including *Ayurveda*, *Siddha*, *Unani* and folk practices, particularly among tribal communities. However, in some regions, it is now considered endangered, highlighting the urgent need for conservation efforts and the development of effective cultivation strategies especially through modern techniques like tissue culture to support its sustainable commercialization. This review emphasizes its significant medicinal potential due to its wide range of bioactive compounds and demonstrated pharmacological activities. Despite its therapeutic promise, several challenges remain, including difficulties in cultivation, proper taxonomic identification and historical ambiguities in classical texts. Current research underscores the plant's largely untapped pharmacological value, necessitating further scientific studies to ensure standardization, safety and broader integration into modern drug discovery and development.

Acknowledgements

We wish to extend our sincere thanks to the Director, Dean (Academic) and Dean (Research) for their constant support and providing Institute facilities.

Authors' contributions

HJ envisioned and collected the material and went through online resources and classical texts and combined all the information and wrote the draft with MN and PN. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used Quill Bolt and Grammarly in order to check the plagiarism, grammar editing and for paraphrasing. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

References

1. Sharma RK, Dash B, editors. Charaka Samhita. Vol. 1. Chaukhamba Sanskrit Pratishthan; 2013
2. Patwardhan B, Gautam M. Botanical immune drugs: Scope and opportunities. Drug Discov Today. 2005;10(7):495–502. https://doi.org/10.1016/s1359-6446(04)03357-4
3. Chopra RN, Nayar SL, Chopra IC. Glossary of Indian medicinal plants. New Delhi: Council of Scientific and Industrial Research; 1956. p. 197. https://doi.org/10.1086/402350
4. Ali M. Present status of herbal medicines in India. J Herb Med Toxicol. 2009;3(2):1–7.
5. Chunekar K, editor. Bhavprakash Nighantu of Shri Bhavmishra. 143rd ed. Varanasi: Chaukhambha Bharatiya Academy; 2010. p. 343-44
6. Murthy EN, Reddy KN, Reddy S, Raju P. Plants used in ethnoveterinary practice by Koyas of Pakhal Wildlife Sanctuary. Ethnobotanical Leaflets. 2007;11:1–5. https://ethnoleaflets.com/leaflets/reddy2.htm.

7. Chiruvella KK, Mohammed A, Thammineni C, Paritala V, Ghanta RG. *In vitro* propagation, phytochemical investigations and biological activities of an endemic medicinal plant, Indian red wood (Meliaceae): A review. Int J Med Plants. 2014;2(4):559. https://doi.org/10.1038/s41598-021-03032-1
8. Flückiger FA, Hanbury D. Pharmacographia. 2nd ed. London: Macmillan and Co; 1879. p. 827
9. Danapur V, Seetharam YN. Pharmacognostical and preliminary phytochemical studies on *Soymida febrifuga* A. Juss. Int J Pharmacogn. 2018;6(2):80–84. https://doi.org/10.13040/IJPSR.0975-8232.IJP.6(2).80-84
10. Narasimhan SY. Medicinal plants of India. Bangalore: Interline Publishing Pvt. Ltd; 1996. p. 1
11. Rajput AP, Bhagvan, Kachhava C. Phytochemical analysis and biological activities of *Soymida febrifuga* (Roxb) Juss (Meliaceae): An overview. Intern J Res and Analytical Rev. 2019;6(2):826–34. https://ijrar.com/upload_issue/ijrar_issue_20543632.pdf
12. Gama L, Muellner R, Demarco D, Pirani R. Evolution of reproductive traits in the mahagony family (Meliaceae). J Systamatics and Evolution. 2020;1–5. https://doi.org/10.1111/jse.12572
13. Gadek PA, Fernando ES, Quinn CJ, Hoot SB, Terrazas T, Sheahan MC, Chase MW. Sapindales: Molecular delimitation and infra-ordinal groups. Am J Bot. 1996;83:802–11. https://doi.org/10.2307/244585
14. Koenen EJM, Clarkson JJ, Pennington TD, Chatrou LW. Recently evolved diversity and convergent radiations of rainforest mahoganies (Meliaceae) shed new light on the origins of rainforest hyperdiversity. New Phytol. 2015;207:327–39. https://doi.org/10.1111/nph.13490
15. Muellner-Riehl AN, Weeks A, Clayton JW, Buerki S, Nauheimer L, Chiang YC, et al. Molecular phylogenetics and molecular clock dating of Sapindales based on plastid rbcL, atpB and trnL-trnF DNA sequences. Taxon. 2016;65(5):1019–36. https://doi.org/10.12705/655.5
16. Lin N, Moore MJ, Deng T, Sun H, Yang LS, Sun YX, Wang HC. Complete plastome sequencing from Toona (Meliaceae) and phylogenomic analyses within Sapindales. Appl Plant Sci. 2018;6(4):1040. https://doi.org/10.1002/aps3.1040
17. Panshin A. Comparative anatomy of the woods of the Meliaceae, sub-family Swietenioideae. Am J Bot. 1993;20(10):638–68. https://doi.org/10.2307/2436127
18. Kirtikar KR, Basu BD. Indian medicinal plants. Dehradun: Oriental Enterprises; 2003. p. 559–60, 778–80
19. Yadav AP, Suresh G, Rajendra PK, Appa SRM, Suresh BK. New phragmalin-type limonoids from *Soymida febrifuga*. Tetrahedron Lett. 2011;53:773–77. https://doi.org/10.1016/j.tetlet.2011.11.143
20. Shah GL. Flora of Gujarat State. Vol. I-II. 1st ed. Gujarat: Forest Department; 1978
21. Murthy YS, Gupta S. Morphological studies in Meliaceae: A reinvestigation of floral anatomy of members of Swietenieae and Trichilieae. J Biosci. 1976;55:872. https://doi.org/10.1007/bf03046871
22. Acharya Shodhala's. Shodhala Nighantuh: Commentary by Pandey Gyanendra. Edited by Prof. Dvivedi RR. Varanasi: Chowkambha Krishnadas Academy; 2009. p. 538
23. Kaiyadeva Acharya. Kaiyadeva Nighantu. Pathyapattyavibodhaka. Sampadde Acharya Priyavrit Sharma and Guruprasad Sharma. Varanasi: Chowkambha Orientalia; 1979. p. 696
24. Bhavamishra. Bhavaprakasha Nighantu. Hindi Commentary by K.C. Chunekar. 1st edition. Varanasi: Chaukhumbha Bharathi Academy; 2002. p. 984
25. Sri Vaidya Bapalal, Nighantu Adarsha, Varanasi, Chaukhabha Bharati Academy; Reprint-2007. p.158
26. Sharma Priyavrat. Priya Nighantu. 2nd edition. Varanasi: Choukamba Surabharati Prakashana; 1995. p. 275
27. Narahari Pandit. Raja Nighantu. Vyakhyakara: Dr. Indradev Tripati. 3rd edition. Varanasi: Chaukhamba Krishnadas Academy; 2003. p. 703
28. Bhogika Mahendra, Dhanwantari Nighantu. Commentary by Sharma Guruprasad. Edited by Sharma Priyavrat. 2nd edition. Varanasi: Chowkambha Orientalia Publication; 1998. p. 360
29. Madanapala Nrupa. Madanapala Nighantu. Published by Ganga Vishnu Sri Krishnadas. Bombay; 1867. p. 296
30. Vaidyaacharya Keshava. Siddhamantra. Commented by Prakasha. Edited by P.V. Sharma. 1st edition. Varanasi: Chaukhamba Amarabharathi Prakashan; 1977. p. 113
31. Sharma PV, editor. Dalhanakruta, Sushruta Samhita. 1st ed., reprint. Varanasi: Chaukhambha Vishvabharati; 2004. p. 355–67
32. Shastry JL. Dravyaguna Vijnana. Vol. 2. Revised ed. Varanasi: Chaukhambha Bharatiya Academy; 2010. p. 667–68
33. Gogte V. Ayurvedic pharmacology and therapeutic uses of medicinal plants: Dravyaguna Vijnana. Varanasi: Chaukhambha Sanskrit Santhan; 2017. p. 690
34. Nighantu rathnakara, edited by Bhishagvaryanavra Krishnashastri, Published by Jawaji Vasudev, Bombay; 1936. p. 808
35. Sharma RK, Dash B, (eds). Charaka Samhita of Agnivesha, Reprint ed. Varanasi: Chaukhamba Sanskrit Series Office; 2009. p.101
36. Kantamreddi VS, Wright CW. Screening Indian plant species for ant plasmodial properties: ethnopharmacological compared with random selection. Phytother Res. 2012;26(12):1793–99. https://doi.org/10.1002/ptr.4651
37. Chiranjibi P, Reddy SC, Murthy MSR. An ethnobotanical survey of medicinal plants used by the Didayi tribe of Malkangiri district of Orissa, India. Fitoterapia. 2008;79:67–71. https://doi.org/10.1016/j.fitote.2007.07.015
38. Katewa SS, Chaudhary BL, Jain A. Folk herbal medicines from the tribal area of Rajasthan, India. J Ethnopharmacol. 2004;92(1):41–46. https://doi.org/10.1016/j.jep.2004.01.011
39. Maurya R, Dongavara N. Studies on the medicinal uses of wild trees of Nagpur district. Int J Life Sci Pharma Res. 2012;2(1):23. https://www.cabidigitallibrary.org/doi/full/10.5555/20123373877
40. SreeLatha Devi RK, Sreenivasulu P, Basha SKM. Ethno medico botanical studies of high valued medicinal plants of Tirumala Hills. Indian J Fundam Appl Life Sci. 2013;3(1):198–202
41. Pal DC. Plants used in treatment of cattle and birds among tribals of Eastern India. In: Glimpses of Indian Ethnobotany. New Delhi: Oxford and IBH Publishing Co; 1981. p. 245–57
42. Jain SK. Glimpses of Indian Ethnobotany. London: Oxford and IBH Publishing Co.; 1981. p. 215–55
43. Takechi M, Tanaka Y, Takehara M, Nonaka GI, Nishioka I. Structure and antiherpetic activity among the tannins. Phytochem. 1985;24(10):2245–50. https://doi.org/10.1016/S0031-9422(00)83018-6
44. Ferraz CR, Carvalho TT, Manchope MF, Artero NA, Rasquel-Oliveira FS, Fattori V, et al. Therapeutic potential of flavonoids in pain and inflammation: Mechanisms of action, pre-clinical and clinical data and pharmaceutical development. Molecules. 2020 10;25(3):762. https://doi.org/10.3390/molecules25030762
45. De Sousa DP. Analgesic-like activity of essential oils constituents. Molecules. 2011 7;16(3):2233–52. https://doi.org/10.3390/molecules16032233
46. El-Sakka MA. Phytochemistry alkaloids. Al Azhar University, Faculty of Pharmacy, Department of Pharmacognosy: Cairo, Egypt; 2010
47. Barbosa AD. An overview on the biological and pharmacological activities of saponins. Int J Pharm Pharm Sci. 2014;6(8):4750.
48. Ashalatha M, Thejaswini C. A critical review on Mamsarohini. Int Ayurvedic Med J. 2015;3(9):2875–78.
49. Chiruvella KK, Mohammed A, Dampuri G, Ghanta RG. *In vitro* shoot regeneration and control of shoot tip necrosis in tissue cultures of

Soymida febrifuga (Roxb.) A. Juss. Plant Tissue Cult Biotechnol. 2011;21(1):11–25. https://doi.org/10.3329/ptcb.v21i1.9559

50. Singh A, Baghel RK. Traditional knowledge of medicinal plants used by the tribals of Chitrakoot, Madhya Pradesh, India. J Med Plant Stud. 2017;5(2):24–29.
51. Kshirsagar S, Sahu K, Dube U, Moris S. Microscopical study and quantitative estimation of steroids in *Soymida febrifuga* leaves. Indian J Pharm Res. 2017;6(13):445–47.
52. Ambaye RY, Indap MA, Panse TB. Identification of methyl angolensate in the bark of *Soymida febrifuga* (Roxb.) A. Juss. Curr Sci. 1971;7:158. https://www.cabidigitallibrary.org/doi/full/10.5555/19710601805
53. Adesida GA, Taylor DAH. Extractives from *Soymida febrifuga*. Phytochem. 1972;11:1520–24. https://doi.org/10.1016/s0031-9422(00)90133-x
54. Purushothaman KK, Chandrasekharan S. Occurrence of methyl angolensate and deoxyandirobin in *Soymida febrifuga* A. Juss. Indian J Chem. 1974;12:207–08.
55. Purushothaman KK, Chandrasekharan S, Conolly JD, Rycroft DS. Tetranortriterpenoids and related substances: New tetranortriterpenoids with a modified ring from bark of *Soymida febrifuga* A. Juss (Meliaceae). J Chem Soc Perkin Trans. 1977;1:1873–82. https://doi.org/10.1002/chin.197749349
56. Lakshmi V. Chemical composition of fatty acids from the fixed oil of *Soymida febrifuga*. Natl Acad Sci Lett. 1987;10(6):195–96.
57. Rao MM, Gupta PS, Krishna ME, Singh PP. Constituents of heartwood of *Soymida febrifuga*. Indian J Chem. 1979;17B:178. https://ijrar.com/upload_issue/ijrar_issue_20543632.pdf
58. Adesida GA, Adesogan EK, Okorie DA, Taylor DAH, Styles BT. Isolation of methyl angolensate from stem bark of *Soymida febrifuga*. Phytochem. 1971;10:845. https://ijrar.com/upload_issue/ijrar_issue_20543632.pdf
59. Velraj M, Srikanth J. Pharmacognostical and preliminary phytochemical studies on the stem bark of *Soymida febrifuga* (Roxb). Res J Pharmacogn. 2009;6(2):94–97.
60. Palei KA, Nishteswar K, Shukla VJ. Phytochemical screening of *Soymida febrifuga* Roxb. (Meliaceae) root bark. Int J Pharm Life Sci. 2013;4(2):2371–74.
61. Chase CR, Pratt R. Fluorescence of powdered vegetable drugs with particular reference to the development of a system of identification. J Am Pharm Assoc. 1949;38:324–31. https://doi.org/10.1002/jps.3030380612
62. Kachhava BC. Isolation and characterization of phyto constituents from chloroform extract of *Soymida febrifuga* A. Juss leaves. J Res Chem. 2023;4(2):108–10. https://doi.org/10.22271/reschem.2023.v4.i2b.104
63. Sinalkar S, Kokitkar S. Phytochemical study, antioxidant activity and GC-MS analysis of *Soymida febrifuga* A. Juss. Indian J Sci Technol. 2024;17(26):2691–97. https://doi.org/10.17485/IJST/v17i26.1280
64. Tamil IG, Dineshkumar B, Nandhakumar M, Senthilkumar M, Mitra A. *In vitro* study on α-amylase inhibitory activity of an Indian medicinal plant, *Phyllanthus amarus*. Indian J Pharmacol. 2010;42(5):280–82. https://doi.org/10.4103/0253-7613.70107
65. West IC. Diabet Med. 2000;17:171–80. https://doi.org/10.1046/j.1464-5491.2000.00259.x
66. Bischcoff H. Eur J Clin Invest.1994;24(3):3–10.
67. Kasote DM, Hegde MV, Katyare SS. Mitochondrial dysfunction in psychiatric and neurological diseases: Cause(s), consequence(s) and implications of antioxidant therapy. Biofactors. 2013;39:392–06. https://doi.org/10.1002/biof.1093
68. Niki E. Antioxidants in relation to lipid peroxidation. Chem Phys Lipids. 1987;44:227–53. https://doi.org/10.1016/0009-3084(87)90052-1
69. Blois MS. Antioxidant determinations by the use of a stable free radical. Nat. 1958;1199–200. https://doi.org/10.1038/1811199a0
70. Reddy BS, Reddy RK, Reddy BP, Ramakrishna S, Diwan PV. Potential *in vitro* antioxidant and protective effects of *Soymida febrifuga* on ethanol-induced oxidative damage in HepG2 cells. Food Chem Toxicol. 2008;46:3429–42. https://doi.org/10.1016/j.fct.2008.08.034
71. Vidyarthi RD. A textbook of zoology. New Delhi: S. Chand and Co.; 1967. p. 329–70
72. Chatterjee KD. Parasitology, protozoology and helminthology. Calcutta: Guha Ray Sree Saraswaty Press Ltd.; 1967. p. 168–69
73. Mali RG, Hundiwale JC, Sonawane RS, Patil RN. Evaluation of *Capparis decidua* for anthelmintic and antimicrobial activities. Ind J Nat Prod. 2004;20(4):10–13.
74. Mali RG, Mahajan S, Patil K. Anthelmintic activity of root bark of *Capparis spinosa*. Indian J Nat Prod. 2005;21(4):50–51. https://www.cabidigitallibrary.org/doi/full/10.5555/20063220828
75. Berghe VA, Vlietinck AJ. Screening methods for antibacterial and antiviral agents from higher plants. Method Plant Biochem. 1991;6:47–68. https://www.scirp.org/reference/referencespapers?referenceid=2335338
76. Chiruvella KK, Mohammed A, Dampuri G, Ghanta RG, Raghavan SC. Phytochemical and antimicrobial studies of methyl angolensate and luteolin-7-O-glucoside isolated from callus cultures of *Soymida febrifuga*. Int J Biomed Sci. 2007;3(4):269–78. https://doi.org/10.59566/ijbs.2007.3269
77. Awale S, Miyamoto T, Linn TZ, Li F, Win NN, Tezuka Y, et al. Cytotoxic constituents of *Soymida febrifuga* from Myanmar. J Nat Prod. 2009;72(9):1631–35. https://doi.org/10.1021/np9003323
78. Karunasree V, Veeresham C, Sambasiva Rao KRS, Asres K. Antioxidant, 5-Lipoxygenase inhibitory and anticancer activities of *Soymida febrifuga* A. Juss. Mol Clin Pharmacol. 2012;3(2):134–42.
79. Turner MA. Screening methods in pharmacology. New York: Academic Press; 1965. p. 18–22. https://doi.org/10.1016/B978-1-4832-3266-9.50007-4
80. Turner RC, Holman RR. Lessons from the UK perspective diabetes study. Diabetes Res Clin Pract. 1995;28. https://doi.org/10.1016/0168-8227(95)01105-m
81. Angel I, Burcelin R, Girard J, Salomon Z. Normalization of insulin secretion by selective alpha-2 adrenoceptor antagonist and GLUT-4 glucose transporter expression in adipose tissue of type-II diabetic rats. Endocrinology. 1996;137:2022–27. https://doi.org/10.1210/endo.137.5.8612543
82. Okokon JE, Bassey AL, Nwidu LL. Antidiabetic and hypo lipidemic effects of ethanolic root extract of *Setaria megaphylla*. Int J Pharmacol. 2007;3:91–95. https://doi.org/10.3923/ijp.2007.91.95
83. Yadav R, Kashaw V. Evaluation of anti-inflammatory activity of alcoholic, hydroalcoholic and aqueous extract of *Amoora rohituka* and *Soymida febrifuga* in albino rats. Asian J Pharm Pharmacol. 2018;4(6):908–13. https://doi.org/10.31024/ajpp.2018.4.6.28
84. Sharma PV. Dravyaguna Vijnana: Materia medica-vegetable drugs. Varanasi: Chaukhambha Orientalia; 2005
85. Sharma P. Dravyaguna Vijnana, Volume V. Varanasi: Chaukhambha Bharati Academy; 2011

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://

horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc
See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

Publisher information: Plant Science Today is published by HORIZON e-Publishing Group with support from Empirion Publishers Private Limited, Thiruvananthapuram, India.