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REVIEW ARTICLE

Phytochemical Analysis and Medicinal Properties of *Soymida febrifuga (Roxb.) A. Juss:* a Review

Anish Kumar Singh, K.K. Chandra, Rajesh Kumar*, Atul Kumar Bhardwaj
Department of Forestry, Wildlife & Environmental Sciences, Guru Ghasidas Vishwavidyalaya (A Central University) Bilaspur, (C.G), India
*Correspondence author Email: rajesh.dewangan0506@gmail.com

ABSTRACT
Soymida febrifuga (Roxb) A. Juss is a member of the meliaceae family. It is mainly used in medicinal plant and they are commonly known as "Rohina" or "Rohan" and "the red Indian wood". This plant has great potential for use for timber and medicinal purposes. These plants are mostly distributed from the tropical dry forests of India to the dry forests of the western peninsula and Indo-Malaysia. These plants may be present in reputed folk medicinal properties that were used throughout ancient times. These plants may contain phytochemical properties and bioactive compounds such as glycosides, flavonoids, alkaloids, phenol, tannins, flavonoids, terpenoids, saponins, and others that are beneficial in the treatment of a variety of human and animal diseases. The evolution of phytochemicals of this plant from the bark and stem bark extracts has confirmed that the plant has tremendous potential for medicinal properties and could be used as an antibacterial, anti-cancer remedy, anti-microbial, anti-helminthic, anti-inflammatory, uterine bleeding, dental diseases, and haemorrhage and acrid, refrigerant, for blood coagulation, good for sore throats, cures tridosha fevers, aphrodisiac and laxative, etc. This review discusses the pharmaceutical properties, phytochemical constituents, traditional uses, and biological activities of the plant, which will be useful in furthering our understanding of Soymida febrifuga's medicinal importance.
Keywords: *Soymida febrifuga, Distribution, Regeneration, Phytochemical, Medicinal properties.*

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INTRODUCTION

Soymida febrifuga (Roxb) A. Juss is known as a reputed folk indigenous medicinal plant of Central India that occurs in tropical dry deciduous forests. In India, it is distributed in the hilly districts of North-Western, Central, and Southern India and extends southward to Travancore [21]. It is common in deciduous forests in Maharashtra [27]. They are distributed in other states such as Uttar Pradesh, Bihar, Odisha, Andhra Pradesh, Karnataka, Tamil Nadu, and Kerala [26]. In Gujarat state, they are occasionally seen in the districts of Dangs, Vyara, and Rajpipla (South Gujarat), Chhotaudepur, Panchmahals (Central Gujarat), and some parts of the Saurashtra region [25]. They are commonly found in the dry forests of the western peninsula and Indo-Malaysia. These are monotypic genuses that are only found in India [30]. These plants are commonly known ***as*** Mamsarhohini or Indian redwood, and they are used for medicinal purposes [3]. *Plants of S. febrifuga* belong to the lofty deciduous family and can reach heights of 22–25 m and 2.5–3.00 m of the girths [11]**.** The plant leaves are compound and crowded at the branch ends, and the flowers are greenish-white and developed in large clusters. The fruits of the plant develop in the woody capsule. They are common, flowering from February to April, whereas the fruits are harvested from May to June. The plants' wood is hard and is used for different purposes. The plant parts are used traditionally by the tribes and local community, as well as local healers, for the treatment of several diseases since ancient times. The pharmacological studies carried out with purified extract compounds reveal that the plant *S. febrifuga* possesses anti-inflammatory, antioxidant, anti-microbial, anti-bacterial, anti-fungal, anti-diabetic, and anti-cancer activities. The various compounds were isolated from the different parts of plants of *S. febrifuga***,** like phenols, flavonoids, alkaloids, steroids, tannins,

fatty acids, etc. Several studies, including pharmacological and phytochemical analysis, hepatoprotective and antihelminic activities, antihistamine activity, anthelmintic activity, hypoglycemic and anti-hyperglycemic activity, free radical scavenging activity, and rheological properties of various parts of S. febrifuga, indicate that the plant contains excellent medicinal properties [20]. Its bark principles are resinous and bitter, and they are also used for vaginal infections, gargles, rheumatic swellings, stomach pain, and enemata. The tree bark is mostly used for blood coagulation, anti-cancer remedy, uterine bleeding, dental diseases, hemorrhage, acrid, anti-helminthic, refrigerant, laxative, and aphrodisiac, cures tridosha fevers, anti-inflammatory in action and good for sore throats. The plant's population has been declining due to nonscientific and over-extraction, keeping it threatened and close to extinction in several regions. Review paper provides an overview of the recent status of the chemical and pharmacological relevance of the extracts *of S. febrifuga (Roxb.) A. Juss.*

Classification:

Domain:	Eukaryota
Kingdom:	Plantae
Sub- Kingdom:	Viridaeplante
Phylum:	Tracheophyta
Sub- Phylum:	Euphyllophytina
Infraphylum:	Radiatopses
Class:	Magnoliopsida
Sub-class:	Rosidae
Super order:	Rutanae
Order:	Rutales
Sub order:	Meliaceae
Subfamily:	Solanoideae
Tribe:	Solaneae

Vernacular names:

Scientific name:	*Soymida febrifuga*
English :	Indian Red Wood, Bastarol cedar, Rohan tree
Hindi :	Rakat rohan, Rohunna
Sanskrit :	Chandravallabha
Telgu :	Somi, Somidha, Sumi
Bengal :	Rohan, Rohira
Marathi :	Potar

ANTIOXIDANT AND ANTICANCER ACTIVITY

The antioxidant activity of *S. Febrifuga* bark was tested in vitro using a hydro alcoholic (methanol 70% v/v) solution. They are produced dose-dependently on inhibition of the free radical generation of hydroxyl radical, superoxide anion, and DPPH radical (Priya *et al.,* 2014). These assessments are free radical scavenging activities. The hydro alcoholic extract was dissolved in dimethyl sulfoxide (DMSO). The method used for the determination of superoxide radical scavenging activity of plant extract commonly depends on light-induced superoxide generation by riboflavin and the corresponding reduction of nitroblue tetrazolium [16]. The hydro radical scavenging activity was evaluated by the Fenton reaction by studying the competition between deoxyribose and the extracts for hydro radicals that are generated from the Fe_2+/EDTA/H_2O_2. The DPPH radical scavenging activity is the reduction of a dark blue alcoholic DPPH solution to a yellow nonradical diphenyl- picrylhydrazine in the presence of a hydrogen donating antioxidant. Lower absorbance showed higher free radical scavenging activity. The leaf extract of *Soymida frbrifuga* is known to have anti-oxidant and anti-microbial properties [23]. The presence of methanol and aqueous extracts of the leaf was found to have more excess antioxidant activity and total phenolic content than the hexane extract. Furthermore, leaf extract has antimicrobial activity against *Aspergillus fumigatus* and Candida Tropicana. *Soymida febrifuga* stem bark extract may contain antioxidants and 5-lipoxygenase inhibitory compounds that are beneficial to anticancer activities [12]. In which the methanol and aqueous extracts are the most potent in terms of their antioxidant and 5- LOX inhibitory actions. The ethno medicinal use of the stem bark of *Soymida febrifuga* for the treatment of diseases, e.g., asthma, rheumatism, and cancer.

SEEDLINGS TEST

In the *Soymida febrifuga* plant**,** various factors are responsible for the in-vivo and in vitro seed germination [8]. The in-vivo seed germination test was performed by determining the seed viability

before in-vitro seed culture, in which the seeds are stored at 7°C at room temperature and germination occurs in-vivo. The seeds are picked randomly, and they are dipped into 100 lots of each. The tests are conducted at a normal room temperature, and the pots are filled with soil and compost manure. The percentage of germination was tested at a regular interval of 15 days for 5 months. The seedlings raised in pots are unhealthy and suffer from root rot, and the percentage of germination also decreases gradually from 50% to 0% within periods of 15 days to 5 months, respectively, due to dormancy or non-viability of the seeds. The viability of the seed is evident in biochemical tests of seeds, such as the tetrazolium chloride test (TTC test), by the development of red coloration that appears 20 days after harvest all around the cotyledonary surface. The seed viability percentage has gradually decreased and is shown by the negative reaction with tetrazolium chloride test solution after storage for 5 months. In-vitro seed germination tests of this study were performed using different sterilizing agents e.g. $HgCl_2$, NaOCl, C_2H_2OH, H_2O_2, and plant growth regulator mediums e.g. water agar, MS full strength + 1.5% sucrose, MS full strength + 1% sucrose, MS half strength, MS quarter strength, WPM full strength, WPM half strength, WPM quarter strength, B5 full strength, B5 half strength, B5 quarter strength. The mature seeds were collected from the fruits of 15-20 year old trees and the seeds were deep-soaked in 5% teepol for 15 min and washed out with tap running water. The seeds are sterilized with 70% alcohol for 30 seconds, and then rinsed 5–6 times in sterile distilled water followed by treating with the various sterilizing agents, e.g., NaOCl, $HgCl_2$, H_2O_2, and C_2H_2OH. After sterilizing the seeds, rinse them 3 times in sterile distilled water. The seeds are then inoculated in test tubes. This is used to separate MS solid and liquid medium in 10-15 ml containers. The germination of seeds is observed within 12–15 days on MS solid and liquid medium. All culture medium were incubated in a culture room at 20-25°C with a relative humidity of 50–60% and a photon flux density of 15-20 uE m^2/s-1 from white cool fluorescent tubes for 16 hours. The compression for the in-vivo and in-vitro seed germination indicates that germination percentage is poor in in-vivo conditions and it is better in in-vitro conditions. It might be due to the in-vivo condition loss of the moisture content in the seeds.

REGENERATION AND SEEDLINGS

The macro propagation of *S. febrifuga* through stem cuttings is difficult and restricted by the propagation due to rooting difficulties. The seeds have low germination capacity, and seedlings are prone to insect attack. The micropropagation by shoot organogenesis from callus culture of *S. febrifuga* has been implemented using callus culture from juvenile seedlings (Chiruvella *et al.,* 2007). They used the dissected segments of shoot tip and root of 15-day old aseptic seedlings and inoculated them on MS medium supplemented with auxins [indole3acetic acid (IAA), 2,4-dichlorophenoxyacetic acid (2,4-D) and naphthalene acetic acid (NAA)] and cytokinins (benzyl adenine (BA), coconut milk (CM), 2-isopentenyl adenine (2-iP) and kinetin alone or in combination, and the nature and morphology of callus were observed. In *S. febrifuga*, ***a*** high frequency of shoot regeneration from the callus was shown with BA along with lower levels of auxins, that is, NAA. The orientation of leaf explants in the culture medium can play an important role in the response of callus induction, morphology, and organogenesis (Ambaye *et al.,* 1971).

PHYTOCHEMICAL SCREENING

The phytochemical screening of the root bark of *S. febrifuga* evaluates the plant phytochemically by carrying out different physicochemical parameters like LOD, extractive value, ash value, and phytochemical screening, including HPTLC fingerprint (Palei *et al.,* 2013). They checked the genuinity of the bark sample by organoleptic character testing, i.e., colour, taste, odour, and nature of the sample, and found the sample was brownish-red in color, astringent in taste, and astringent in sweet odour, and smooth in nature. The physic-chemical parameters of the bark power were estimated through qualitative and quantitative tests. The qualitative test showed the presence of different chemical constituents such as alkaloids, phenols, flavonoids, carbohydrate saponin, tannin, and cyanogenic glycosides, including a quantitative analysis for tannins of about 9.44%. The chromatographic analysis of the bark power sample was conducted through thin layer chromatography (TL) and high-performance thin layer chromatography (HPTCL) using a 366 nm to 254 nm UV detection range. The TCL solvent system, i.e., N-Butanol: Water: Acitic acid (4:1:5) and Vaniline Sulphuric acid spray reagent were used and spots were investigated, which showed that all the spots have the same Rf values (between 0.07 and 0.95) at both wavelengths, 245nm (short UV) and 366nm (long UV) (Palei *et al.,* 2012). The collected exudates from the *Soymida febrifuga* were shown to have the same high viscosity as acacia gum. The charecteristrics of purified *Soymida febrifuga* gum (SFG) are its physicochemical, rheological, functional, and thermal properties. The FTIR spectra of SFG revealed a typical trend of polysaccharides [7]. In pharmacognostic

and preliminary phytochemical studies on *Soymida febrifuga*, they performed the phytochemical tests and determined the phenols, flavonoids, steroids, terpenes, diterpenes, lactones, tannins, lignins, and saponins, alkaloids through the methods [11, 15, 19]. They also performed physicochemical and fluorescence studies as well as histological studies of the sample. The physic chemical studies are based on the investigation of organo-troleptic characteristics and include studies on both physical and sensory properties of the species, such as color, sensation, testing, oily stain, and mucilage. The fluorescence studies of the bark powder of *S. febrifuga* were treated with chemicals, i.e., benzene, chloroform, acetic acid, ethanol, water, concentration H_2SO_4, and concentration. HCL and the fluorescent colour of the solution were observed under visible and UV light [11]. Through the analysis, they indicated the physical constants of *Soymida febrifuga*, which are total ash (17.0%), acid soluble ash (5.12%), alcohol soluble extractive (22.0%), and water-soluble (28.7%). The result of the study reveals that *S. febrifuga* has secondary metabolites such as phenols, flavonoids, alkaloids, steroids, and tannins. But, diterpenes are absent in *S. febrifuga*.

FREE RADICALS SCAVENGING ACTIVITY

The methods used for the free radical scavenging activity of *Soymida febrifuga* leaves are DPPH, nitric oxide, and reducing power. The DPPH radical scavenging activity was measured through a 3ml reaction mixture containing 200 ul of DPPH (100 um in methanol) and 2.8 ml of different extracts of *Soymida febrifuga* (at various concentrations, 10–100 ug/ml) in methanol. The mixture was incubated at 37 for 30 min and the absorbance of the mixture was read at 517 nm using a spectrophotometer. They used the following formula for the calculation of the percentage inhibition of the DPPH radical [5].

$$\text{Percentage Inhibition} = \frac{\text{absorbance of control} - \text{absorbance of test}}{\text{Absorbance of control}} \text{ X } 100$$

The nitric oxide scavenging method was applied by sodium nitroprusside with the help of Griess reagent. In which sodium nitroprusside (5 mM) in phosphate-buffered saline was mixed with various concentrations of alcoholic and aqueous extracts of dried *Soymida febrifuga* leaves dissolved in methanol and incubated at room temperature for 180 minutes. The griess reagent (1% sulphanilamide, 2% H_3PO_4, and 0.1% N-(naphthyl) ethylenediamine hydrochloride NEDA) was then added to an equivalent amount of sample. The absorbance of the chromophore formed during the diazotization of nitrite with sulphanilamide and subsequent coupling with NEDA was measured at 546 nm for the determination. In this study, the determination of reducing power was also performed by mixing *Soymida febrifuga* leaf extracts (100–100 ug) in 1 ml of distilled water with 2.5 ml of phosphate buffer (0.2 m, pH 6.6) and 2.5 ml of potassium ferricyanide (1%) and then incubating at 50 °C for 30 min. The trichloroacetic acid (10%) was centrifuged (at 3000 rpm for 10 minutes). The 2.5 ml of upper layer centrifuged trichloroacetic acid was mixed with 2.5ml of distilled water and 0.5 ml of ferric chloride (0.1%) and the absorbance was measured at 700 nm. The increased absorbance of the reaction mixture indicated reducing power.

SYNTHESIZING OF SILVER NANOPARTICLES

The biogenic silver nanoparticles (AgNPs) were synthesized and a spectroscopic investigation was conducted on the catalytic and bacterial properties of the aqueous stem bark of *Soymida febrifuga* [28]. Mostly, the nanoparticles were characterized by using UV-Visible spectroscopy, X-Ray analysis (EDAX), Transmission Electron Microscope (TEM), and Fourier Transform Infrared Spectroscopy (FTIR). The silver nanoparticles were also tested for antimicrobial and catalytic activities, which exhibited effective antibacterial activity against two gram-positive (*Bacillus subtilis* and *Staphylococcus aureus*) and two-gram negative (Escherichia coli and Pseudomonas putrid) bacterial strains. The particles also effectively exhibited catalytic activity in the degradation of organic dyes, acting as potent environmental pollutants such as Methylene blue, Rhodamine B, and Eosin Y dyes [29].

HEPATOPROTECTIVE ACTIVITY

The leaf extract of *Soymida febrifuga* is present in the hepatoprotetive activity of ethanol that is induced in liver toxicity in Albino wister rats [29]. The hot percolation method was used to extract the most commonly used in plant dried materials with ethanol. The phytochemical test has confirmed the presence of phenolic compounds and flavonoids. The hepatoprotective activity of the extract was assessed in paracetamol-induced hepatotoxic rats. The biochemical markers of hepatic damage like serum glutamic oxaloacetic transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), alkaline phosphatise (ALP), bilirubin, and total protein levels were tested in both groups, i.e., paracetamol treated and untreated groups. Paracetamol increased the levels of SGOT, SGPT, and ALP, where it decreased the total

protein level in the liver. The characteristics are a macroscopic and microscopic powder that has a loss on drying and ash values that show the dorsiventral character of leaflets [4]. The absence of stomata in the upper lamina, the presence of more cluster-type calcium oxalate crystals, and the presence of cicatrix were observed. The acid-soluble ash value was obtained at a high level because of the abundant calcium oxalate crystals. The successive extractive values were also determined using petroleum ether (60–80%), chloroform, and methanol. Methanolic extractive value was 26.459 % w/w, which is high quietly. The preliminary chemical analysis of the extracts showed that petroleum ether extract contains sterols and triterpene-type compounds, whereas the methanolic extract contains tannins, flavonols, sugars, and glycosides.

ANTIFEEDANT ACTIVITY

The leaves of *Soymida febrifuga* are mostly isolates of the three new phragmalin-type limonoids, which together make up the thirteen that are also known as the limonoids. The structures of these compounds were established on the basis of spectroscopic data and they were evaluated for their antifeedant activities in tobacco caterpillar (*Spodoptera litura*) and coster semi looper (*Achaea janata*) by using bioassay [10]. The anti-plasmodial activity in the twig barks of *Soymida febrifuga* in vitro confirms the antimalarial activities of the plant [14].

ANTI MICROBIAL AND ANTI-BACTERIAL ACTIVITY

S.febrifuga root callus is used to make ethyl acetate and methanol extracts for phytochemical and antimicrobial activities [12]. Among all of them, ethyl acetate extract was found most effective against *Bacillus subtilis* and *Salmonella typhimurium*, respectively. In addition, the methyl angolensate had antifungal activity against *Aspergillus niger,* while luteolin-7-O-glucoside inhibited *Alternaria alternata*. Furthermore, anti-bacterial and anti-fungal screening was performed using alcoholic, hydroalcoholic (40:60), and aqueous extracts of the bark of *Soymida febrifuga* stem [30]. This extract was studied against the gram-positive, gram-negative, and fungal strains using the agar cup method (500 mcg/cup) and compared with the standard antibacterial and antifungal drugs Kanamycin (30 mgc/cup) and Ketoconazole (100 mgc/cup), respectively. For the growth of antibacterial and antifungal strains, they used nutrient broth, saboguraud broth, and agar culture media and tested the extract against *Esherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aurens*, *Bacillus cereus*, *Aspergillus nigar*, *Aspergillus claratus*, and *Candida albicans*. It also has good antifungal activity against *Aspergillus nigar* with a 74% inhibition of fungal growth. Where the hydroalcoholic extract also showed good antibacterial activity against *Esherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Bacillus cereus* with 78%, 66%, 69%, and 61% inhibition of bacterial growth, respectively, it also showed good antifungal activity against *Aspergillus nigar* with 85% fungal growth inhibition. The aqueous extract of the stem bark of *S. febrifuga* also showed good antibacterial and antifungal activity against *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Aspergillus nigar* with 63%, 64%, and 55% inhibition of growth, respectively. The anti-inflammatory activity of alcoholic, hydro-alcoholic, and aqueous extracts of *S. febrifuga* was conducted in albino rats [31]. The extract of *S. Febrifuga* may be present in acetone and methanol, which showed antibacterial activity against the pathogenic bacteria *Pseudomonas aureginosa* (37mm) and *Klebsiella pneumonae* (38 mm). The inhibition was noticed at its maximum at higher concentrations [6]. Many antibacterial activities of the *S. febrifuga* leave extracts against selected major human pathogenic bacteria, e.g., *Escherichia coli*, *Bacillus substilis*, *Proteus vulgaris*, *Klebsiella pneumonia*, and *Staphylococcus aureus* through the agar well diffusion method. The results of the study revealed that the leaf extracts showed excellent inhibitory activity against all the tested pathogenic bacteria [24].

ANTI DIABETIC

S.febrifuga bark extract is a significant result shown in hypoglycaemic and antihyperglycaemic activities in normal healthy and alloxan-induced diabetic rats, respectively [12]. At the dose of 200 mg/kg at 20% for the chloroform in acetone, the higher activity was comparable to that of glibenclamide. From *S. febrifuga,* there is a possibility of getting an effective compound from its bark extract, which can be valuable in the fight against diabetes.

Many scientists worked on the related Pharmacogonestic and Pharmacogonestic activities of *Somida febrifuga A. Juss.*

Table 1:- The phytochemicals and pharmacological activities of Soymida febrifuga A. Juss.

Plant parts	Phytochemical Properties	Pharmacological activities	References
Leafs	Free radicals scavenging activity Hepatoprotective activity Sterols triterpene, tannins, flavonols, sugars, and glycosides. Three new phragmalin-type limonoids	Antioxidant, Antimicrobial and Hepatoprotective activities Anti-feedant activity Antibacterial activities	[20, 5, 4, 29, 6, 9]
Bark	Free Radical scavenging properties phenols, flavonoids, steroids, terpenes, diterpenes, lactones, tannins, lignins, saponins, alkaloids	Antioxidants , anti-plasmodial and anti-malarial activities Anti-diabetic activities	[12, 20, 9, 10, 14]
Stem/ Stem bark	5-Lox inhibiter New flavones -5, 7 dihydroxy 3,4 dimethoxy flavones Silver nanoparticles (AgNPs) synthesize	Antioxidant, anticancer activity , Anti-bacterial and Catalytic activities	[12, 28]
Root/ Root bark	Alkaloids, Phenols, flavonoids, carbohydrates, saponin, tannin, and cynogenic glycosides	Anti-fungal, and anti-microbial activities Anti-inflammatory activities	[8, 17, 18, 30, 31]
Fruits	Epoxy febrinin B 14,15-dihydropoxy febrinin B Febrinolide		[1]

CONCLUSION

This review detailed the medicinal information about the plant *Soymida febrifuga. A. Juss* could be of great interest to researchers for further research into phytochemical properties and their medicinal aspects. The biological activity of the leaf extracts has not been investigated, especially for the discovery of their pharmacological benefits. The seed germination is too low, which may be one of the reasons for the very low population of the plans after anthropogenic exploitation. The present study gives an idea of the phytoconstituents and their uses against different diseases. The proper research of the seed germination potential and phytochemical investigations of the plant *S. febrifuga* will make this wonder medicine and provide a perfect option for the treatment of several diseases in the future.

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