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Phytopharmacology of *Chloroxylon swietenia:* a review

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ABSTRACT

The nature has provided a complete store house of remedies to use for all ailments for mankind. The knowledge on drugs has accumulated over thousands of years as a result of mans inquisitive nature. Phytomedicines or natural prescriptions, have assumed a basic part in World wellbeing for a large number of years. As per the World Health Organization (WHO), "natural medications incorporate herbs, home grown materials, home grown arrangements and completed home grown items, that contain as dynamic fixings parts of plants, or other plant materials, or blends. *Chloroxylon swietenia DC*. (Family: Rutaceae) is an important traditional medicinal plant used in the treatment of various ailments like fungal infection of skin, rheumatism, common cold, cough, ophthalmic infection and cataract, wounds and as an astringent. It is a tropical aromatic tree of dry deciduous forests popularly known as East Indian Satin Wood. The findings of this study will facilitate pharmacognostic standardization of the plant material and aid in the preparation of an herbal monograph for the species. Further studies on this plant must be carried out to explore some other important, necessary and unknown benefits. As the plant has multifunctional properties, this review is worthwhile and therefore it presents comprehensive analysed information on the phytochemical and pharmacological aspects of the botanical.

Keywords: *Chloroxylon swietenia*, phytomedicines, pharmacological aspects, anti-feedant, anti-bacterial activity, IUCN, vulnerable species.

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INTRODUCTION

Ayurveda is a traditional system of medicine in which herbal therapies were used systematically. Plants have been used for medicinal purposes long before prehistoric period. Ayurveda, the traditional system of medicine continue to be widely practiced on many accounts. Population rise, inadequate supply of drugs, prohibitive cost of treatments, side effects of several synthetic drugs and development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant material as a source of medicines for a wide variety of human ailments[1].

The nature has provided a complete store house of remedies to use for all ailments for mankind. The knowledge on drugs has accumulated over thousands of years as a result of mans inquisitive nature[1,2]. For centuries, plants with medicinal properties have been utilized successfully in the treatment of ailments of varying degrees of severity[2]. Therefore screening of medicinal herbs has become a potential source of biodynamic compounds of therapeutic value. The standardization of crude drugs is an integral part of establishing its correct identity. Pharmacognostical study is the preliminary step in the standardization of crude drugs. The detailed pharmacognostical evaluation gives valuable information regarding the morphology, microscopical and physical characteristics of the crude drugs that are necessary for their proper identification[3].

Chloroxylon swietenia DC, a member of Rutaceae family is a medium sized deciduous tree with height up to 9 -15 m and 1.0 - 1.2 m girth having a spreading crown. The tree is native to India and Sri Lanka and commonly known as Ceylon Satinwood or East Indian Satinwood. *C. swietenia* is considered as a folklore medicinal plant having several medicinal uses in the folklore remedies[4]. The Malasar tribes inhabiting the forest areas in Coimbatore district of Tamil Nadu, South India apply the leaf paste on wounds, cuts, burns and skin diseases for quick recovery[5]. The leaf paste is also applied to treat worm infested wound of animals, fungal infection of skin and rheumatism[6]. Various parts of the plant are traditionally used in snakebites[7]. The stem bark is credited for its effectiveness in the treatment of common cold and cough[8], ophthalmic infection and cataract[9], wounds[10,11] and as an astringent[12]. The dried stem barks alone or in combination with sesame oil (*Sesamum indicum*) in the form of a paste is applied externally to treat itches[13,14].

A paste of the leaves and roots is taken orally and also applied as a balm to treat headache [15]. In the present paper, we report the pharmacognostical and ethnopharmacological studies of the *C. swietenia* since there are no such reports available in the literature.

In India, it is found wild in dry deciduous forests up to an altitude of 1100 m, extending in the north to the Satpuras and Chota Nagpur. It grows on black cotton soils, metamorphic rocks and bare rocky ground on poor soils, if they are well drained and contain a large portion of sand or gravel. It is a folklore medicinal plant and finds immense application as a phytopharmaceutical formulation for therapeutic use particularly in southern parts of India. *C. swietenia* is a folklore medicinal plant that is commonly used for antimicrobial, anti-fertility, analgesic, insecticidal, anti-feedant activities. The whole part of this tree has long been used in the indigenous system of medicine such as the root and bark are used as an astringent. Earlier studies have shown that the extract of plant posses anti-feedant, anti-fertility, larvicidal, mosquito repellent, anti-inflammatory, anti-microbial, hepatoprotective and anti-oxidant activity. Ceylon Satinwood is used in folk medicine in Chhattisgarh. In case of a problematic wound, the dried leaves of Ceylon Satinwood are applied on wound in order to increase the healing process. Most of these conventional uses are short of scientific confirmation. Researchers have isolated many novel bioactive compounds from this tree for treating various diseases[16].

Owing to its heavy demand, the tree now has become endangered. The tree has been cited under Red List category under IUCN Red List of Threatened Species, as per the assessment of Asian Regional Workshop (Conservation and Sustainable Management of Trees, Viet Nam, August 1996) 1998 [17,18].

IUCN

Species are classified by the IUCN Red List into nine groups, set through criteria such as rate of decline, population size, area of geographic distribution and degree of population and distribution fragmentation.

1. Extinct (EX) – No known individuals remaining.

2. Extinct in the wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.

3. Critically endangered (CR) – Extremely high risk of extinction in the wild.

4. Endangered (EN) – High risk of extinction in the wild.

5. Vulnerable (VU) – High risk of endangerment in the wild.

6. Near threatened (NT) – Likely to become endangered in the near future.

7. Least concern (LC) – Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.

8. Data deficient (DD) – Not enough data to make an assessment of its risk of extinction.

9. Not evaluated (NE) – Has not yet been evaluated against the criteria.

Present position of *Chloroxylon swietenia*

IUCN updated version of 2014 have included *Chloroxylon swietenia* as Vulnerable species. It is a slow-growing species which has become very scarce in most areas because of timber exploitation. A vulnerable species is one which has been categorized by the International Union for Conservation of Nature as likely to become endangered unless the circumstances threatening its survival and reproduction improve. Vulnerability is mainly caused by habitat loss or destruction. Vulnerable species are monitored and are becoming threatened [19,20].

However, no scientific data are available regarding pharmacognostic, phytochemical and anatomical studies on stem bark of *Chloroxylon swietenia* DC. Hence, the present investigation is undertaken to establish pharmacognostic profile and ethnomedicinal values, which will help in identification of crude drug and to establish standards.

Table 1: Vernacular Names

Common name (English)	Ceylon satinwood, East Indian Satinwood, Buruta
Telugu	Billu, Bilydu, Billudu, Bella
Hindi	Bhirra, Bhivia, Dhoura, Girya
Tamil	Vaaimaram, Porasu, Mammarai, Porinja maram
Malayalam	Varimaram
Kannada	Bittula, Huragalu, Hurihuli, Masula
Sanskrit	Bhillotaka, Bimbilota
Oriya	Bheru gatcho
Marathi	Behru, Halda, Bheria, Hulda

Figure 1: *Chloroxylon swietenia*

Figure 2: *Chloroxylon swietenia* plant

Table 1: Taxonomical Classification

Kingdom	Plantae, Plant
Division	Angiosperma
Class	Eudicots
Sub-class	Rosids
Order	Sapindales
Family	Rutaceae
Genus	*Chloroxylon*
Species	*C. swietenia*

Habitat and distribution

C. swietenia is a small to medium-sized tree, distributed in India, Sri Lanka and Malaysia. In India it is distributed in Andhra Pradesh, Orissa, Madhya Pradesh, Karnataka, Tamilnadu and Kerala. It is commonly grown in poor literate soils and also occurs in tropical dry evergreen forests.

Macroscopic Characteristics

Chloroxylon swietenia or commonly known as East Indian Satinwood is a tropical, medium-sized deciduous tree native to southern India, Madagascar, and Sri Lanka. Most plant parts are used in traditional medicine in India. Essential oil obtained from the leaves and stems have anti-bacterial and anti-fungal properties. Dried leaves can be used for pains while crushed leaves for the treatment of wounds, snake bites, and rheumatism. Leaves and roots can be made into paste then taken internally or applied externally as relieve from headache. The seed yields oil. The wood is heavy, hard, durable, and used as decorative timber and in heavy construction, agricultural equipment, boat building, and railway sleepers. It is, in addition, used as fuel wood [19,21].

Deciduous small to medium-sized tree up to 18(–25) m tall; bole straight, cylindrical, branchless for up to 4.5 m, up to 45(–90) cm in diameter; bark surface yellowish or pale greyish brown, rough and corky; crown spreading; branchlets greyish hairy.

Table 3: Morphology

Leaves	15 - 23cm long and abruptly pinnate. The leaflets (10 - 20 pairs) are sub-opposite or alternate, oblong, obtuse, glabrous and glaucous.
Stem	Straight cylindrical stem generally attaining a girth of 3-4 feet.
Flowers	Small white or cream in colour and present in terminal or axillary panicles 10-20cm long. The tree is usually leafless from February to May, flowers appear during March-April, and fruits generally ripen during May-August and produce seeds profusely almost every year. Buds are round. Inflorescence a terminal or axillary pyramid-shaped panicle up to 15 cm long, short-hairy.
Fruit	Oblong three-segmented capsule 2.5-4.5cm long, containing 1-4 seeds in each segment.
Wood	Produced by the tree is often a golden colour with a reflective sheen. It is used for small luxury items and as a veneer in wooden furniture. It is one of the best-known satinwoods.
Seeds	About 4 in each cell, imbricate, compressed, winged especially above, their margins are angular, attached to the edges of the septa. 1 cm long, with oblong wing on one side, up to 1.5 cm long.

Figure 3: *Chloroxylon swietenia* plant in flowering season

Figure 4: Fruits and seeds of *Chloroxylon swietenia*

Cultivation

Chloroxylon swietenia is a deciduous Tree growing to 18 m (59ft) by 18 m (59ft) at a fast rate. It is hardy to zone (UK). Suitable for: light (sandy), medium (loamy) and heavy (clay) soils, prefers well-drained soil and can grow in nutritionally poor soil. Suitable pH: acid, neutral and basic (alkaline) soils and can grow in very acid and very alkaline soils. It cannot grow in the shade. It prefers moist soil and can tolerate drought.

A plant of the lowland moist tropics, where it is found at elevations up to 450 metres. In its natural habitat *Chloroxylon swietenia* occurs in dry deciduous forest on poor,

well-drained sandy or rocky soils, at low to medium altitudes. It grows best in areas where annual daytime temperatures are within the range 30 – 40 ^{0}C, but can tolerate 10 – 47 ^{0}C. It prefers a mean annual rainfall in the range 1,000 - 1,500mm, but tolerates 750-1,900mm. Grows best in a sunny position, and succeeds in most soils that are well-drained. It prefers a pH in the range 6-7, tolerating 5-7.8. Established plants are drought tolerant. The tree has shown good growth rates in Nigeria. It coppices well. The plant is susceptible to fire damage. In India the tree is an alternative food-plant for the caterpillars of *Papilio demoleus*, a pest of *Citrus* spp[16].

Chemical constituents

The plant has many medicinal properties and hence has been extensively investigated. The chemical constituents are isolated from the various parts of *C. swietenia* and they are mono and sesquiterpenes, phenolics, coumarins, alkaloids, lignans, sugars and their derivatives and fatty alcohols. The total constituents have been divided into five major categories.

1. Terpenes

2. Phenols

- ✓ Coumarins
- ✓ Lignans
- ✓ Other phenols

3. Alkaloids

4. Sugars

5. Others compounds

Terpenes

Monoterpenes

These are the main components in volatile essential oils of plants and widely distributed throughout vegetation types but are found in especially high concentrations in plants such as conifers. Geraniol, geranyl acetate, α-pinene, α- terpinene, limonene, Δ3–carene, α- phellandrene, α-terpineol and linalool were isolated from the leaves of *C. swietenia*. Essential oils like myrcene, alloocimene, Cis-β-ocimenes and β-pinenes were obtained from the steam distillation and shade-dried leaves of *C. Swietenia*.

Sesquiterpenes

The essential Sesquiterpenes oils like copaene, β-caryphyellene oxide, iso-caryophyllene oxide, germacrene-D, β-bourbonene, βcaryophyllene, α-humulene, δ-cadenene, E-nerolidol and (E)-farnesol were obtained from the stems and leaves of *C. Swietenia*.

Coumarins

Xylotenin, xanthoxyletin, 7-demethyl suberosin, luvangetin; aesculetin dimethyl ether, nodakenetin, swietenol, alloxanthoxyletin, tert-butyl ketones, swietenone, and rutamarin were isolated from heart wood and bark of *C. swietenia*. Xylotenin, isopimpinellin, bergaptan, heliettin and furanocoumarin were isolated from the leaves of *C. Swietenia*.

The isolated coumarins from the bark of *C. swietenia*, swietenocoumarin A, swietenocoumarin B, swietenocoumarin C, swietenocoumarin D, swietenocoumarin E, swietenocoumarin F, nodakenetin, and demethylluvangetin, rutamarin, aesculetin dimethyl ether, chalepin and suberosin, swietenocoumarin G-I. 6-(2'3'-dihydroxy- 3-methylbutyl)- 8-prenylumblliferone or cumarindiole were isolated from the leaves of *C. Swietenia*.

Lignans

Lignans are a class of secondary plant metabolites produced by oxidative dimerization of two phenyl propanoid units. They are widely distributed in the plant kingdom and have been found in species belonging to more than seventy families. Lignans are found in roots, rhizomes, stems, leaves, seeds and fruits. The isolated lignans like hinokinin, savinin, collinusin and syringaresinol from the bark of *C. Swietenia*.

Other Phenols

Cinnamic acid is used in flavours, synthetic indigo and certain pharmaceuticals, though its primary use is in the manufacturing of the methyl, ethyl, and benzyl esters for the perfume industry. p-Hydroxy methyl cinnamate was isolated from leaves; 2,4-Dihydroxy 5-prenyl cinnamic acid was isolated from heart wood of *C. Swietenia*.

Flavonoids

Flavonoids are polyphenolic molecules containing 15 carbon atoms. Flavonoids are plant nutrients, that when consumed in the form of fruits and vegetables are non-toxic as well as potentially beneficial to the human body. Isoquercetrin were isolated from the leaves of *C. swietenia*. Gossypetin-8-O-β-D glucopyronoside 3-Sulphate were isolated from the flower of *C. swietenia*.

Alkaloids

Alkaloids have been used hundreds of years in medicine and some are still prominent drugs today. Skimmianine, γ-fagarine and furanoquinoline were isolated from the bark of *C. Swietenia.* Swietenidin A and swietenidin B were isolated from the bark of *C. Swietenia*.

Other compounds

In addition to terpenes, alkaloids, phenolics and lignans, the plant also contains various other compounds like aromatic/aliphatic compounds, sugars and fatty acids. 4-O-methylglucouronic acid, glucouronic acid, galactose and arabinose are isolated from the gum exudates of *C. swietenia*. *C. swietenia* gum after hydrolysis contains a mixture of D-galactose, L-Aribinose, D-galacturonic acid, 4-methyluronic acid, aldobiouronic acid, 6-O-methyl D-glucouronic acid, rhamnose and Dglalactouronic acid. The seeds of *C. swietenia* yields non-drying oil and the oil contains the glycerides of stearic, plamitic, myristic, oleic and linoleic acids.

Traditional Usage

Chloroxylon swietenia has been used in the folkloric medicine. Malasar tribes from Coimbatore (Tamil Nadu, South India) apply the leaf paste on wounds, cuts, burns and skin diseases for quick relief. Chenchus of Nallamalais (Andhra Pradesh, South India) apply the leaf paste to treat worm infested wound of animals, fungal infection of skin and rheumatism. Various parts are also used in the treatment of snakebites, common cold and cough, ophthalmic infection and cataract, astringent, itches, headache, impotence etc. Most of these conventional uses are short of scientific confirmation. Researchers have isolated many novel bioactive compounds from this tree for treating various diseases. In friction it is used to treat bruises and painful joints. A paste of the leaves and roots is taken internally to treat headache and is applied to the forehead as a balm for the same purpose. In Sri Lanka the root bark in milk is drunk to treat impotence.

Pharmacological value

The plant is known to possess various biological and pharmacological activities and the various active compounds responsible for the activities are presented in Table 4.

Table 4: Ethnomedicinal importance

Sl. No.	Pharmacological activity	Reference
1	Anti-oxidant activity	22
2	Anti-microbial activity	23
3	Anti-fungal activity	24
4	Mosquitocidal activity	13
5	Anthelmintic activity	25
6	Analgesic activity	26
7	Anti-inflammatory activity	27
8	Hepatoprotective activity	28
9	Anti-diabetic activity	29,37
10	Wound healing activity	30,37
11	Mosquito repellent activity	31
12	Larvicidal activity	32
13	Insecticidal, anti-feedant and oviposition deterrent activity	33
14	Larvicidal and ovicidal activity	34
15	*In-vitro* fungitoxic and cytotoxic efficacy	35
16	Mushroom tyrosinase inhibition activity	36

CONCLUSION

The present findings support the usage of the plant extracts for the traditional treatment of diseases. *Chloroxylon swietenia* have been used in the folkloric medicine, its medicinal usage was high in the history. Some of its traditional usage was scientifically proven but still some usages are yet to be proven. Conservation of this medicinally valuable tree is much important. This article would have provided an idea on the medicinal value of *Chloroxylon swietenia* and the importance of conserving this tree before it become extinct from the world. Further research on the molecular mechanism and the isolation of the compound responsible for this effect may lead to new therapeutic agents. Such herbal medicines may provide potential effect as compared to the conventional available synthetic drugs, with less or no side effects. Further, this investigation will be helpful to identify the plant and also provide valuable information to the researchers to establish the pharmacological activities supported with possible mode of action.

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