Symplocos laurina: an unexplored important medicinal plant of Shola forest system

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Abstract: The importance of medicinal plants in Indian traditional health system is known to be indicative in providing information on the plant sources that are important for drug research and biodiversity conservation. Symplocos laurina belonging to Symplocaceae, commonly known as Lodhra is a shrub, usually growing in shola fringes near to water bodies. The plant is known to be one of the effective medicines for eye diseases. The present article gives an account of the updated information on its physiological, pharmacological and ecological importance. The review reveals the wide number of biological activities like antioxidant activity, anti-inflammatory, antidiabetic, antilipidemic activities and various other medicinal properties along with the phytochemical constituents that have been isolated. The species is known to play an important part in shola ecosystem. The present review also highlights how it is involved in maintaining shola ecosystem and the need for its conservation.

Keywords: montane; medicinal; lodhra; antilipidemic; antidiabetic.

Introduction

The Earth’s 34 biodiversity hotspots are the richest and most threatened places; they are not only rich in endemism but are also the habitats that have lost 70 percent of their original natural habitat. Of these hotspots the biodiversity hotspots in India are most important ecosystems of the world, harboring a unique biodiversity, which on the one hand are threatened by over-exploitation, and on the other hand threaten the adjoining lowlands by increasing runoff from deforested areas (Nautiyal and Nidamanuri 2010). The biodiversity present in these is represented by many medicinal and thus can these ecosystems be aptly called as living laboratories (Nautiyal and Nidamanuri 2010). Moreover, India is considered to be the centre of origin of 30,000 – 50,000 varieties of crop plants and ranks seventh in terms of contribution to world’s agriculture. It is also the homeland of many cultivated species and wild relatives of crop plants (Tandon and Kumaria 2005). The world health organization (WHO) estimates that about 80% of the population is still depends up-on these herbal medicines for their treatment of diseases due to easy availability, economic and less side effects when compared to allopathic system of medicines. Nearly 2000 of natural drugs are mentioned in Indian Materia Medica that have reported various pharmacological activities, out of these 1600 are from plant origin (Mukherji 2008). The biodiversity hotspots harbour many plants that are still to be utilized and explored. Symplocos is one such genus which harbours species which have been found to have many medicinally attributes. The genus Symplocos is widespread all over the world, and many species of this genus have been used as traditional herbal medicines. The chemical investigation of Symplocos species has revealed many components from this genus with significant bioactivities. Nevertheless, there are only a few Symplocos species that have been studied so far; much more attention needs to be focused species of the genus which have potential medicinal properties that are yet to be unravelled.
**Genus Symplocos: overview**

*Symplocos* Jacq., of the monogeneric family Symplocaceae (Cronquist 1981 and Takhtajan 1997) is a relatively large genus consisting of 300 species of shrubs and trees mostly evergreen flowering plants distributed in moist tropical to subtropical regions of Asia, Australia and America (Nooeboom 1975 and Cronquist 1981). The genus is systematically isolated and is the only member of the family Symplocaceae. Although the family is well defined, its systematic position is still uncertain (Caris et al. 2002). Caris et al. 2000 proposed phylogenetic relationship of the monogeneric Symplocaceae on the basis of floral morphological characters. The study, on the basis of molecular as well as morphological results showed that taxa Symplocaceae is possibly related to the members of *Ericales sensu lato*. The most recent taxonomic revision of *Symplocos* genus using ITS region and two intergenic spacers between *trnL* and *trnF* and *trnH* and *psbA* of chloroplast DNA has ascertained the monophyletic origin of the *Symplocos* species in Japan and have provided insight into the classification (Soejima and Nagamasu 2004).

There are two hypotheses for the origin of the Symplocaceae. According to Krutzsch (1989) based on spatiotemporal fossil records, *Symplocos* is assumed to have originated in North America from where it further migrated to North Atlantic after late Cretaceous or Paleocene and was widespread throughout the Northern Hemisphere by Eocene and then migrated to South America in Pliocene. According to Krutzsch, fossil records for *Symplocos* have not been traced from Africa, India, Australia or southern Southeast Asia. According to the second hypothesis put forth by Wang et al. (2004) based on molecular phylogeny and intragenic classification 111 species of *Symplocos*. Wang et al.( 2004) suggested that since the first diverging lineages are all from eastern Asia, hence the Symplocos has originated in eastern Asia, which is contrary to North American origin inferred from the occurrence of earliest fossil from North America (Krutzsch 1989).

**Botany and taxonomy of Symplocos laurina**

*Symplocos laurina* Wall. (Symplocaceae) is distributed in tropical and subtropical Asia and has a disjunct distribution in India. It is a small evergreen tree reaching a height up to ~7 m in height with thin, smooth, light grey bark and white wood. The bark is grayish green to slight gray with patches of crustose lichens. The outer bark is thin and the inner greenish or light brown, the cut surface of the thick bark of a mature tree is reddish brown on drying, and when broken short thin fibre tips are seen. The leaves are simple alternate, very thick, lanceolate, elliptic or oblong, shortly acuminate at the apex, irregularly crenate or serrate. The flowers are yellow white fragrant that appear in close cluster, in axillary spikes. The fruits are globose, purple ribbed drupes and 1-3 seeded with a thin test as seen in Figure 1. Flowering takes during September to December followed by fruiting (Almeida 1990). *Symplocos laurina* is a perennial cross pollinating plant with dissemination occurring primarily through seeds. It is generally assumed that dispersal occurs through self-fertilized seeds. Seed dispersal is endozaic by birds and bats (Meher-Homji 1975). However, it may also be mediated by wind, which could be important for long-distance gene flow (Banu et al. 2010b). The chromosomal number is reported to be $n = 11$ for plants from Kodaishola in Tamil Nadu (Singh and Gill 1984). The species is among those referred to as a ‘Pleistocene relic’ (Meher-Homji 1975). It is reported to be a species of shola fringes and not a true shola species (Meher-Homji 1967). Regeneration of these species is reported to be very difficult in open areas as is subjected to winter frost, occasional droughts and fires. However, its distribution shows its ability to withstand cold and is often among the first species to invade the shrubby formation in shola forest (Meher-Homji 1967). But even then in its beginning stages, it thrives as long as the shrubby layer protects it against frost (Agarwal et al. 1961).

*Symplocos cochinchinensis* var. *laurina* (Symplococaceae) is distributed typically above an altitude of 800 m in Western Ghats, Eastern Ghats and North Eastern Himalayas, sparsely in Western Himalayas extending up to Burma, China, Japan and Korea. *S. laurina* is among the...
tropical stock that forms the montane forest proper. The plant grows in evergreen, mixed evergreen and wet deciduous forests, particularly near water courses and margins of jungles on hills. The plants typically occur near a water source and are always associated with *Syzygium* species (Banu et al. 2010b and Deshpande et al. 2001).

**Figure 1:** Representation of *S. laurina* in different forms in its natural habitat.

Classification of *Symplocos laurina* Wall.

*S. laurina* is often treated within the circumscription of *S. cochinchinensis*. has *S. laurina* has been recognized as one of four subspecies under a broadly circumscribed species *S. cochinchinensis* (i.e., as subsp. *laurina* (Retzius), (Nooteboom 1975 and 2004). However, *Symplocos cochinchinensis* (Lour.) S. Moore has been divided into two subspecies (Hore 1990). The inflorescences of both *S. laurina* and *S. cochinchinensis* display a distinctive combination of characters. *S. laurina* have been placed (with only East Asian distribution) under the subgenus Hopea, section Bobu after phylogenetic revision using ITS, *matK*, *rpl16* and *trnL-trnF* sequences (Wang et al. 2004).

**Kingdom:** Plantae  
**Subkingdom:** Tracheobionta  
**Superdivision:** Spermatophyta  
**Division:** Magnoliophyta  
**Class:** Magnoliopsida  
**Subclass:** Dilleniidae  
**Order:** Ericales  
**Family:** Symplocaceae  
**Genus:** Symplocos  
**Species:** *laurina*

**Vernacular names of *S. laurina* in India**

**English:** Chunga  
**Hindi:** Bholiya  
**Assamese:** Bhomroti  
**Bengali:** Buri, Bhongri  
**Oriya:** Bhaunni  
**Kannada:** Lodha / Chunga, Boothganni  
**Khasi:** Diengpi  
**Lepcha:** Gyaong, palyokkung  
**Malayalam:** Poccotti  
**Marathi:** Lodhra  
**Sanskrit:** Lodhra  
**Tamil:** Kambli–vetti

**Synonyms**

*Myrtus laurinus* Retz., *Symplocos spicata* Roxb., *Drupatris cochinchinesis* Lour. and *Symplocos attenuate* Wall.

**Ethnopharmacology and other uses**

*S. laurina* has many uses in indigenous system of medicine. The bark is astringent, acrid, refrigerant, opthalmic, expectorant, anti-inflammatory, depurative, febrifuge, haemostatic, stomachic and constipating (Anonymous 1980). Pulverized bark is given with honey in biliousness (Anonymous 1986). According to the Ayurveda system of medicine it is useful in vitiated conditions of pitta and kapha, asthma, bronchitis, dropsy, arthritis, ulcers, leprosy, skin disease, ulemorrhagia, haemorrhage, haemoptysis, dyspepsia, leucorrhoea, diarrhoea, dysentery and gonorrhoea (Anonymous 1980). Its bark is described as bitter and pungent which is used as aphrodisiac and in menorrhagia, the diseases of ‘raktpitta’ and the disease of the eyes (Warrier et al. 1996). Bark is used in ophthalmia and to check threatened abortion (Anonymous 1986). The ‘‘Sarabendra vaidya muraigal’’ (a text generated by many ayurvedic, siddha and unani physicians at the period of the King Serfoji II) reports usage of *Symplocos cochinchinensis* (Lour.) S. Moore. to treat diabetes mellitus (Gangadharan 1982; Nair 2005). Ved (2007) reported use of three species of *Symplocos* viz. *Symplocos racemosa*, *Symplocos paniculata* and *Symplocos cochinchinensis* as ‘lodhra’ for treating diabetes mellitus. The decoction of leaves is valued in Indian medicines. Paste of leaves, boiled in oil is used for application in the scalp diseases (Anonymous 1976). The leaves impart a yellow dye used as a mordant. The fruits and seeds are strung into rosaries (Anonymous 1976). The wood is white, soft and even grained. It is used for building temporary rafts (Anonymous 1976) and as fuel (Hore 1990) and is used for match-splints (Anonymous 1976).

**Physiological studies in *symplocos laurina***

*Fitness analysis of Symplocos laurina*

Banu and Kashyap
**Symplcos laurina** is a small evergreen tree, which is mainly distributed in the understory of forests at lower elevations and is an important part of shola system. Plant has two propagation methods: clonal reproduction and sexual reproduction (Yunchun et al. 2006). The fitness of the two reproduction methods varies with different habitats. The clonal reproduction predominated in habitats with enough water and fertility and with high canopy cover, while sexual reproduction predominated in environments with less water and fertility and stronger sunlight (Yunchun et al. 2006). Similar observation has noted made by the author also. The bottleneck of the two reproduction methods has been reported to be different; it is from seed to seedling for sexual reproduction, while from seedling to mature plant for clonal reproduction. *S. laurina* occupies a new environment by grown-up plantlets first by invasion and then occupies the space quickly through ramets because of the ease of clonal reproduction thus making it a one of the pioneering plants that establish shola ecosystem.

**Chemical constituents**

From the leaves of *Symplcos cochinchinensis* phlorizin (0.7%) has been isolated and 3,28-O-bis-β-D-glucopyanosides of 19α – hydroxyarjunolic acid and 19α – hydroxyasiatic acids were identified by hydrolysis of triterpenoids saponins isolated from bark (Hore 1990). Preliminary phytochemical screening of hexane extract of *Symplcos cochinchinensis* leaves shows the presence of steroids, triterpenoids and phenolic compounds (Sunil, Ignacimuthu and Agastian 2011). The high-performance liquid chromatography (HPLC) analysis of hexane extract of *Symplcos cochinchinensis* shows the presence of oleanolic acid at a concentration of 0.76 %. Compound β-sitosterol (1.61 %) has been reported from methanolic extract of bark of *Symplcos cochinchinensis* by HPLC analysis (Sunil et al. 2012).

**Biological activity**

**Antioxidant activity of Symplcos cochinchinensis S. Moore** (Sunil, Ignacimuthu and Agastian 2011) studied the antioxidant activity of aqueous methanol extract of *Symplcos cochinchinensis* S. Moore leaves. The study reported that the leaves of *S. cochinchinensis* are a good source of natural antioxidants. The study showed that the total phenolic content of the extract comprised of 230 mg of gallic acid equivalents/g extract. The methanol extract showed very good scavenging activity on 2, 2-diphenylpicrylhydrazyl (DPPH) (IC50 620.30 ± 0.14 lg/ml), hydroxyl (IC50 730.21 ± 1.05 lg/ml) and nitric oxide (IC50 870.31 ± 0.19 lg/ml) radicals. The methanol extract was reported to show strong suppressive effect on lipid peroxidation. In *in vivo* study CCl4 induced oxidative stress, Sunil and Ignacimuthu (2011) noted significant increase in the SGOT, SGPT and LDH levels along with reduction in liver SOD, CAT, GSH and GPx levels. Pre-treatment of rats with the extract for 7 days had been shown to significantly reduce the levels of SGOT, SGPT and LDH compared to CCl4 treated rats. The SOD, CAT, GSH and GPx levels were shown to increase considerably with extract treatment. The activity of the extract was found to be comparable to the standard drug, silymarin.

**Activity of Symplcos cochinchinensis (Lour.) Moore**

The anti-inflammatory activities of *Symplcos cochinchinensis* (Lour) Moore ssp *laurina* has been reported from n-hexane, chloroform, ethyl acetate and methanol extracts of leaves *Symplcos cochinchinensis* Lour. ssp *laurina* (Symplcocaceae) (Vadivu and Lakshmi 2008). The study investigated *in-vitro* anti-inflammatory activity using human red blood cell membrane stabilization method. The methanol extract was reported to show effective *in-vitro* anti-inflammatory activity. The *in vivo* anti-inflammatory activity was also screened using carrageenan-induced paw edema in rat model. In the study the potency of the extracts were compared with standard diclofenac. The methanol extract showed significant membrane stabilizing action on human red blood cell membrane and reduction of edema in carrageenan induced rat paw edema model.
Antidiabetic effect of *Symplocos cochinchinensis* (Lour.) S.

Sunil, Ignacimuthu and Agastian (2011) and Sunil et al. (2012) have reported the potential of *Symplocos cochinchinensis* as an antidiabetic agent. The antidiabetic efficacy of the hexane extract of *Symplocos cochinchinensis* leaves in high fat diet–low streptozotocin (STZ) induced type 2 diabetic rats showed results that justifies its traditional usage in type 2 diabetes mellitus (Sunil, Ignacimuthu and Agastian 2011). The antihyperglycemic effect of the hexane extract at 250 and 500 mg/kg was studied in high fat diet–low STZ induced type 2 diabetic rats for 28 days. The extracts showed no adverse effects up to a concentration of 5 g/kg. In hypoglycemic study, the blood glucose was observed to reduce mildly after treatment with hexane extract at 250 and 500 mg/kg. The oral glucose tolerance test showed significant reduction in the plasma glucose levels when treated with the hexane extract at 250 and 500 mg/kg concentration for 30 min after glucose load. In high fat diet–low STZ induced type 2 diabetic rats, after 28 days treatment with the hexane extract at 250 and 500 mg/kg reduced the plasma glucose level by 17.04 % and 42.10 %, respectively. A significant reduction in plasma insulin, plasma and hepatic total cholesterol (TC), triglycerides (TG) and free fatty acids (FFA) and a significant increase in liver glycogen were observed in treated diabetic by the investigators. Sunil et al. (2012) also reported antidiabetic activities of *Symplocos cochinchinensis* bark methanolic extract in streptozotocin (STZ) induced diabetic rats.

Phylogeographical analysis of *Symplocos laurina*

The South Asian biogeography is characterized by marked discontinuity in distribution of a number of wet zone species (areas of over 250 cm rainfall per year) from India and Sri Lanka (Karanth 2003). The Indo-Burma region, which includes the Northeastern region (NEI) and the Western Ghats (WG) from South India (SI) have been identified as two biodiversity hotspots from India. Many plant species of temperate shrub savanna type such as *Gaultheria fragrantissima*, *Rhododendron arboreum*, *Mahonia leshenaultii*, *Symplocos laurina* and others are found in the wet evergreen montane (shola) forests of SI and Sri Lanka and are also found about 2200 km away in the wet evergreen forests of NEI and throughout Southeast Asia, although absent from the intervening dry zone (central India). These disjunct distributions among wet-zone taxa of the Indian subcontinent have intrigued biologists for decades (Karanth 2003). Additionally, Meher-Homji (1975) has suggested that the present distribution of the montane forest genera like *Pittosporum*, *Symplocos*, *Elaeocarpus*, etc. on lower altitudes can provide a key to the past distribution of the present day disjunct taxa of the montane shrub-savanna like *Rhododendron*, *Gaultheria*, *Mahonia* etc. In order to look into the past distribution of the montane species of India common to SI and NE. Banu et al. (2010a, 2010b) have used *Symplocos laurina* Wall. (Symplocaceae) as model plant species to study this disjunction distribution and have reported the analysis of genetic diversity from populations collected from these two regions. Banu et al. (2010a) used polymerase chain reaction–restriction fragment length polymorphism technique to determine the chloroplast (cp) and mitochondrial (mt) DNA haplotypes of 218 individuals from 12 populations, collected from Northeast India (NEI), and South India (Western Ghats, WG and Eastern Ghats, EG). Their study identified WG region as the most diverse for chlorotypes and the NEI region for creatinine levels to near normal. The action of SCBe was found to be comparable to that of glibenclamide (Sunil et al. 2012).

In vitro antilipidemic activities of *Symplocos cochinchinensis* (Lour.) S. Moore bark

Recently, the antilipidemic activities of *Symplocos cochinchinensis* bark methanolic extract (SCBe) in streptozotocin (STZ) induced diabetic rats has been reported. SCBe was reported to show antilipidemic activity as evidenced by significant decrease in serum TC, TG, LDL-C levels and significant increase in HDL-C level in treated diabetic rats. SCBe also restored the altered plasma enzymes (SGOT, SGPT and ALP), total protein, urea and
mitotypes for *Symplocos laurina*. Based on their analysis they identified two main lineages for *Symplocos laurina* in India, the NEI WG lineage and the EG lineage. The population structure of *S. laurina* observed in the study by Banu et al. (2010a) points towards the persistence of the species in putative refugial areas pre glaciation. The study reports the further establishment of other populations of *S. laurina* from these refugial populations indicating involvement of many historical processes and events like altitudinal shifts etc.

In an effort to understand the population structure and evolutionary history of *Symplocos laurina* in India, using markers from nuclear gene region Banu et al. (2010b) reported the first set of polymorphic nuclear markers for Glyceraldehyde-3-phosphate dehydrogenase gene for *S. laurina*. The marker generated was used to study its utility in deciphering the genetic structure of *Symplocos laurina*. Banu et al. (2010b) reported presence of two dominant haplotypes, low genetic diversity within population, high differentiation and number of population specific haplotypes for *Symplocos laurina* populations in India. The study further concludes that the populations are presumably ancient and might have spread across its extant distribution range in India through a recent range expansion.

**Conclusion**

Owing to the various disturbances there has been loss of a great number of plant species including endemic and irreplaceable varieties and many more are awaiting a similar fate. In India alone, about 15-20% plant species are considered to be threatened. A great number of plant species in the northeast India are becoming extinct and many more are awaiting a similar fate because of the alarming rate of deforestation and degradation which is causing threat to the world’s well known hot spot (Tandon and Kumaria 2005). *S. laurina* is a part of montane ecosystem complex also known as sholas, and is a principal tree species or even the climax species in subtropical evergreen broad-leaved forests (Guo et al. 1997). The species is important both in the tree and shrub layers (Ma et al. 2002) and therefore, very important for the regeneration of evergreen broad-leaved medicinal forests. The plant is known to reproduce by either clonal or sexual reproduction and the fitness of the two reproductive methods varies with different habitats. Clonal reproduction predominates in habitats with enough water and fertility and high canopy cover, while sexual reproduction predominates in environments with less water, fertility and stronger sunlight. The bottlenecks of the two reproductive methods are different; the bottleneck is from seed to seedling for sexual reproduction, while it is seedling to mature plant for clonal reproduction. *S. laurina* occupies a new habitat first by invasion of grown-up plantlets and then occupies the space quickly through ramets because of the ease of clonal reproduction. The plant being among the pioneering stock is subjected to a wide range of factors namely frost, fire, wind, precipitation, differences in day and night temperatures etc. Moreover, the species is known to grow in the fringes (border) of the shola forests, making it susceptible to anthropogenic destruction (by exploitation for firewood as well as for medicinal properties). All these factors severely affect establishment of the plant in its natural habitat. Primary forests of Asia, particularly those of the Western Ghats and the Eastern Ghats of peninsular India, are disappearing at an alarming rate (e.g. 25.6% of the total forest area, 19.5% of the dense forest cover and 33.2% of open forests of WG have undergone deforestation during the last 22 years) due to anthropogenic activities and are replaced by forests comprising inferior species or to changed land use pattern of these forests (Jha et al. 2000). The disappearance of tropical forests is occurring when our understanding of their structure and dynamics is yet to be complete and is hence inadequate (Hubbell and Foster 1992). The importance of conservation could be ascribed to a region/areas on the basis of past evolutionary history or future evolutionary potential (Jha et al. 2000). The elevated genetic variation obtained in *S. laurina* population by Banu et al. (2010a and b) in Northeast India and Western Ghats populations highlights the importance of these populations as reservoir of genetic diversity. As refugial areas, these are valuable populations under a global climate-change scenario. As the knowledge of population structure is important for ex-situ and
in-situ conservation of natural populations (Williams and Hamrick 1996). As *S. laurina* is a good colonizer: local genetic stock of *S. laurina* can be used for the restoration of degraded habitats in shola system. Planning of conservation strategies for degraded forest ecosystems in shola should be initiated for *S. laurina*.

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