

## Research Article

# A Study of Four Ethnobotanical Medicinal Plant Usage for Ailments among the Tribals of Coimbatore District, Tamil Nadu, India and its Extraction Methods

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### Abstract

This article addresses the issue of fungal spore dissemination, which can lead to allergic pulmonary diseases, particularly Aspergilli infections. These infections are frequently observed in tropical regions such as India and can result in chronic and potentially fatal consequences if not treated promptly. Given the rise of multidrug-resistant fungal infections, alternative antifungal agents have become vital. Phototherapy, which involves using natural antifungal compounds such as polyphenolics, essential oils, and proteins, is one such alternative. Traditional healers have been using this technique to treat various ailments, including fungal infections.

In the Coimbatore district, tribals such as the Malasars, Irulas, and Konars utilize herbal sources such as *Solanum trilobatum*, *Spathodea campanulata*, *Syzygium jambos*, and *Tylophora indica* to prepare decoctions that help combat fungal infections. The text also highlights the therapeutic properties of all four plants, which have been traditionally used to treat several ailments such as pyrexia, antidote, cough, diabetes, vomiting with blood, and leprosy. These herbs are rich in phytochemical constituents like alkaloids, phenolics, flavonoids, sterols, saponins, and glycosides, which possess potent medicinal properties. Additionally, the plant has been reported to have mosquitocidal and larvicidal properties against various mosquito species. It has also been found to inhibit the growth of *Plasmodium falciparum*, the parasite that causes malaria.

Overall, these findings suggest that these plants hold great potential as alternative sources of antifungal agents and should be further explored for their therapeutic benefits. The use of natural antifungal compounds and traditional remedies could provide an effective and sustainable approach to combat fungal infections, particularly in regions where access to modern medicine is limited. Therefore, it is imperative to conduct further research in this area to identify and validate the therapeutic benefits of these natural remedies.

**Keywords:** Medicinal plant; Aspergilli infections; Fungal infections

### Introduction

Dissemination of fungal spores emerges as a significant problem in the spread of spore-derived allergic pulmonary diseases. Aspergilli are well-recognized agents of allergic bronchopulmonary infections in temperate and

tropical climates. Aspergillosis has been recorded in India, frequently in tropical areas, disseminating with the development of fungus ball and pulmonary cavitation in the patients, causing severe hemoptysis secondary to tuberculosis [1]. A type of aspergillosis called Farmer's Lung infection is a housing of mold spores in pulmonary cavities among paddy field agrarians involved in farming practices. The husk, hay, and other debris are the major growth substrates of *Aspergillus* species. Frequent exposure of field workers during harvesting of crops may frequently be prone to farmer's lung Aspergillosis infection. Treatment of such fungal infections should be considered with utmost significance; untreated may be chronic, leading to morbidity and sometimes fatal consequences among infected individuals.

Fungal infections with multidrug resistance have posed a significant threat in the tropics and emerged with resistance to antifungal agents. Since the availability of antifungals is lower than that of antibacterial agents, a search for alternative antifungal agents is mandatory with nil side effects. Phototherapy is an arena practiced among the folklore traditional healers for various diseases and disorders. From time immemorial, traditionally, from generation to generation, phytotherapy information has been considered through oral communication. Among secondary metabolites from herbal sources, plant polyphenolics, essential oils, terpenoids, saponins, alkaloids, peptides, and proteins were considered natural antifungal compounds used in various ailments [2,3]. The Malasars, Irulas, and Konars are the native people near Poondi in the Western Ghats of the Coimbatore district; they traditionally treat fungal infections with herbal sources *Solanum trilobatum*, *Spathodea campanulata*, *Syzygium jambos* and *Tylophora*

*indica* either in the form of extracts or decoctions for remedy. The most probable method of usage that prevails among the community is the decoction method. With the elementary information and empirical usages of selected plants among specific communities, we have made a rationale to review the usage of these herbs in different ailments. The purpose of this review is to know its correctness in usage among tribals aligns with the existing reports.

## Materials and Methods

### Selected plants in the study

*Solanum trilobatum* Linn: *S. trilobatum* Linn, a member of the *Solanaceae* family, is a spiny, woody climber that grows as an undershrub and is widespread in India and Sri Lanka. It bears bluish-white flowers and is known for its therapeutic properties [4,5]. The plant is known as alarka in Sanskrit, alarkapatramu in Telugu, tuduvalai in Tamil and tutuvalam in Malayalam [5]. The plant is used in folk medicine for treating all kinds of cough, diabetes, vomiting with blood, and leprosy [5,6]. Besides these, it is also used to increase male fertility and antidote, antiasthmatic, anticancer, antioxidant, antiinflammatory, antidiabetes, antimicrobial, analgesic, hepatoprotective, antiulcer, and antidandruff [7-14].

The herb is also rich in phytochemical constituents like alkaloids, phenolics, flavonoids, sterols, saponins, and glycosides. Further, the plant is reported for its mosquitocidal properties with ovicidal activity against *Culex quinquefasciatus* and *Culex tritaeniorhynchus* larvicidal activity, oviposition deterrent and skin repellent activity against *Anopheles stephensi* [15]. Premalatha, et al. (2013) reported the acetone, chloroform, and methanol leaf extracts of *S. trilobatum* for its larvicidal, pupicidal, and adult emergence inhibition properties against the vector mosquitoes *Culex quinquefasciatus*, *Aedes aegypti*, and *Anopheles stephensi* [16].

The crude aerial extracts of *S. trilobatum* have been evaluated for their larvicidal activity against *Culex quinquefasciatus* using solvent extracts such as petroleum ether, acetone, and chloroform [17]. Studies have shown that *S. trilobatum* leaves and fruits can inhibit the growth of *Plasmodium falciparum*, the parasite that causes malaria. The findings suggest they could serve as a promising natural source of anti-malarial agents. The laboratory findings have shown that the *in vitro* anti-plasmodial activity against the 3D7 strain of the parasite has been exhibited by the plant's ethyl acetate and methanol extracts. However, it should be noted that the concentration of IC50 required to achieve this effect was relatively high, at over 100 µg/mL. To date, no *in vivo* tests have been conducted on this plant, meaning that further research is needed to understand its potential as a treatment for malaria fully (Figure 1).

*Spathodea campanulata* P. Beauv: *S. campanulata*, belonging to the *Bignoniaceae* family, is commonly referred to by various names like African tulip tree, fountain tree, pichkari, and nandi flame. This tree is highly valued for its medicinal properties and has been utilized in traditional

herbal medicine to cure multiple ailments, including ulcers, filaria, gonorrhoea, diarrhoea, and fever. Its therapeutic effects have been recognized through scientific research, making it an essential plant in the field of medicine [18]. Different phytochemical compounds were isolated from *S. campanulata* leaves, i.e cathodal, spathose, ajugol, sitosterol, β-sitosterol-3-O-β-D-glucopyranoside, oleanolic acid, pomolic acid, ursolic acid, tomentosolic acid, caffeic acid, p-hydroxybenzoic acid, phenylethanol esters, phenolic acids, and flavonoids [19-27]. The plant gains its importance in numerous medical applications owing to the potent pharmacological properties of the extracts obtained from its flowers and bark. These extracts have been used traditionally for the treatment of several health conditions, such as mental disorders, malaria, hemorrhoids, bacterial infections, HIV, poor blood circulation, and gastrointestinal diseases.



Figure 1: *Solanum trilobatum*

It is imperative to note that *S. campanulata* extracts showcase exceptional therapeutic potential due to the abundance of various bioactive compounds, such as alkaloids, flavonoids, and terpenoids, which have been extensively researched for their pharmacological properties. Alkaloids, for instance, have been found to have antiinflammatory and analgesic properties, while flavonoids have shown antioxidant and anticancer properties. Terpenoids, on the other hand, have been found to have antimicrobial and antifungal properties. The bioactive compounds present in the extracts have been found to act on various molecular targets in the body, including enzymes and receptors, thereby exhibiting a diverse range of pharmacological effects. The extracts have also been found to be safe and well-tolerated, making them suitable for use in the treatment of various health conditions, Respiratory ailments, genital-urinary system disorders, and an alkaloid mixture of this plant revealed anticancer activity against certain types of cancer and its effectiveness as an adjuvant in cancer chemotherapy [21,24,26,28-30] (Figure 2).

*Syzygium jambos* Alston: *Syzygium jambos* Alston is an evergreen tree of the family Myrtaceae commonly known as rose apple [31]. It is native to Southeast Asia, widespread in sub-Saharan Africa, and naturalized in India in Kerala and Tamil Nadu, where it is grown both for its

fruits and medicinal properties [32]. The species has a long history of use in Indian traditional medicine for the treatment of numerous ailments [33]. This fruit has been traditionally used as a tonic for the brain and liver, as well as a diuretic. The flowers have been used to reduce fever, while the seeds have been used to treat diarrhea, dysentery, and catarrh. Additionally, the fruit has been utilized as an anesthetic and analgesic. Leaf extracts have also been used in the treatment of diabetes, rheumatism, sore eyes, and as a febrifuge. Moreover, studies have suggested that the fruit extract may have antiviral properties against herpes simplex type 1,2 and vesicular stomatitis virus [34].



**Figure 2:** *Spathodea campanulata*

Bark extract is used to treat asthma, bronchitis, and hoarseness; oil and leaf extracts have been reported for their antibacterial activity against gram-positive and gram-negative strains and antifungal activities [35-39]. In Cuba, the root extract is used to treat epilepsy [40]. In a study by Kuate, et al. (2007), the ethanol bark extract of *S. jambos* and its isolated triterpenoids friedelin,  $\beta$ -amyrin acetate, betulinic acid, and lupeol exhibited antidermatophytic activity against *Microsporum audouinii*, *Trichophyton mentagrophytes* and *Trichophyton soudanense* [41] (Figure 3).



**Figure 3:** *Syzygium jambos*

*Tylophora indica* (Burm f.) Merill: *Tylophora indica*, also known as Antmul, is a plant species belonging to the family Asclepidaceae. It is a twining perennial plant that is widely distributed throughout the southern and eastern regions of India. This plant is commonly found in plains, forests, and hilly areas. The plant is found growing normally in Uttar Pradesh, Bengal, Assam, Orissa, Himalayas, and sub-Himalayas in India [42]. It is a branching climber or shrub that grows up to 1.5 meters; leaves are obovate-oblong to elliptic-oblong, 3 cm-10 cm long, and 1.5 cm-7 cm wide [43]. Roots Long fleshy with longitudinally fissured light brown, corky bark. Flowers minute, 1 cm-1.5 cm across, in 2-3 flowered fascicles in axillary umbellate cymes. Calyx is divided nearly to the base, densely hairy outside; the segments are lanceolate and acute. Corolla greenish yellow or greenish purple; lobes oblong, acute. Fruit a follicle, up to 7 cm  $\times$  1 cm, ovoid lanceolate, tapering at apex forming fine mucro, finely striate, glabrous, Seeds 0.6 cm-0.8 cm  $\times$  0.3 cm-0.4 cm long [44]. The plant has been reported to contain 0.2%-0.46% alkaloids viz. Tylophorine, tylophorinine, tylophorinidine, (+) septic, isotylocrebrine, tylophorinicine, sterols, flavonoids, wax, resins, and tannins [45].

The plant has been traditionally used for the treatment of bronchial asthma, jaundice, and inflammation [46]. Scientific research has proven that this plant has antitumor, immunomodulatory, antioxidant, anti-asthmatic, smooth muscle relaxant, antihistaminic, hypotensive, and anti-rheumatic properties. This plant has also been used in Ayurvedic medicine to treat asthma, dermatitis, and rheumatism [46]. Although the utilization of the leaf and root of this plant for the management of jaundice in Northern Karnataka is widespread, the scientific literature concerning its efficacy in the treatment of liver disorders is limited. It has been reported that this particular substance exhibits various activities, such as immunomodulatory activity, antiinflammatory activity, anticancer activity, and anti-amoebic activity. These properties suggest that the substance may have potential therapeutic benefits in treating certain diseases or conditions [47-49] (Figure 4).



**Figure 4:** *Tylophora indica*

## Common methods of plant extract preparation

Pharmaceutically extraction involves the separation of medicinally active portions of plants with the aid of selective solvents by diffusion into the solid plant material and solubilizing compounds with similar polarity [50]. The substances obtained from plants are liquids, semisolids, or powders that are relatively impure and known as menstrum. The herbal products are designed to be used both orally and externally and consist of intricate combinations of medicinal components, including alkaloids, glycosides, terpenoids, flavonoids, and lignans [51]. Therefore, the extraction methods used to standardize the herbal drug significantly impact its final quality. Various methods are employed to extract medicinal plants, including maceration, infusion, percolation, digestion, decoction, hot continuous extraction (Soxhlet), fermentation-based aqueous-alcoholic extraction, counter current extraction, supercritical fluid extraction, microwave-assisted extraction, ultrasound extraction (sonication), and phytonic extraction (using hydrofluorocarbon solvents). On the other hand, for extracting aromatic plants, hydro-distillation techniques (such as water distillation, steam distillation, and water-steam distillation), hydrolytic maceration followed by distillation, expression, and enfleurage (cold fat extraction) are commonly used [51].

The quality of an extract is controlled by 3 main factors: The plant part used as the starting material, the solvent used for extraction, and the extraction procedure itself. Plant-derived products are intricate blends of metabolites obtained in liquid, semisolid, or powder form and have diverse applications in the pharmaceutical industry [50]. These botanicals can be used as medicinal agents, including tinctures and fluid extracts. They can also be further processed to be incorporated into any desired dosage form, such as tablets and capsules. The extraction of secondary plant components can be done using fresh or dried plant materials, as reported by Parekh, et al. in 2006 [52]. Traditional and tribal people have used fresh plant materials for ethnomedicinal purposes, which led to the logic behind plant extract preparation. Traditional healers often use many plants in the dry form or as an aqueous extract. In search of bioactive compounds with antimicrobial properties, underground parts such as roots, tubers, rhizomes, and bulbs have been extensively used compared to other above-ground parts, as highlighted in Das, et al.'s report in 2010 [6].

## Discussion

### Choice of solvents

Eloff, et al. (1998) described the effectiveness of extracting biologically active compounds from plant material is greatly influenced by the type of solvent used [53]. Several factors determine the choice of solvent, such as the number of phytochemicals to be extracted, the rate of extraction, the range of various compounds extracted, the mixture of inhibitory compounds extracted, the unsophistication of enduring extracts, the toxicity of the solvent in the bioassay

process, and the possible health hazards associated with the extractants. Duraipandiyar, et al. (2006) outlined factors for successive extraction using solvents with increasing polarity to extract a wide polar range of compounds [54]. The selection of a solvent is determined by the intended purpose of the extract. In order to guarantee that the end product is free from any detrimental residues, it is imperative that the solvent employed is non-toxic and does not hinder the bioassay. Furthermore, the solvent selection is dependent on the particular compounds that are being aimed for extraction.

Water is a widely used solvent for extracting plant products with anti-microbial properties. However, water-soluble flavonoids, mainly anthocyanins, do not have any antimicrobial significance, while water-soluble phenolics are only crucial as antioxidant compounds [6]. Acetone is most commonly used as a solvent for extraction due to following reasons

1. Many hydrophilic and lipophilic components from the plants can be dissolved by acetone.
2. Acetone is miscible with water and is volatile, making it a helpful extractant.
3. It impacts low toxicity in bioassays.
4. Acetone is particularly beneficial for antimicrobial studies where the extraction of more phenolic compounds is necessary [6,53].

Both acetone and methanol have been discovered to extract saponins that possess antimicrobial properties, according to Philip in 2006. The higher levels of polyphenols in ethanolic extracts, when compared to aqueous extracts, contribute to their superior activity level. This is due to the fact that ethanolic extracts are better at breaking down the cell walls and seeds that have a unipolar nature, which results in the release of polyphenols from cells. The presence of polyphenol oxidase enzyme in water extracts is responsible for the decrease in their activity level. This enzyme breaks down polyphenols in water extracts. However, it remains inactive in methanol and ethanol. Moreover, water provides a better medium for the growth of microorganisms when compared to ethanol, as stated by Lapornik, et al. (2005) [55].

The addition of water to pure ethanol up to 30% in order to prepare ethanol 70% resulted in the detection of higher concentrations of bioactive flavonoid compounds, according to Bimakar in 2010 [56]. Additionally, ethanol is more capable of penetrating the cellular membrane to extract intracellular components from plant material, as reported by Wang in 2010 [57]. Since almost all the aromatic or saturated organic compounds identified from plants that are active against microorganisms are obtained through initial ethanol or methanol extraction, they are usually acquired through this method, according to Cowan in 1999 [58]. Compared to ethanol, methanol is more polar, but due to its cytotoxic nature, it is unsuitable for extraction in certain kinds of studies as it may lead to incorrect results.

Terpenoid lactones have been obtained by extraction and concentration in chloroform fraction. It is possible to find tannins and terpenoids in the aqueous phase, but typically, they are extracted using less polar solvents [58]. Ether is commonly used selectively for the extraction of coumarins and fatty acids [58]. Dichloromethane is another solvent used to carry out the extraction procedures. It is specially used for the selective extraction of only terpenoids [58].

### Extraction methods

Plant tissue homogenization in solvent has been widely used by researchers [6]. Serial exhaustive extraction is a widely used extraction method in which compounds are extracted successively with solvents of increasing polarity, beginning with a non-polar solvent such as hexane and ending with a more polar solvent such as methanol. This technique ensures that a broad range of compounds with different polarities can be extracted effectively. Some researchers employ soxhlet extraction of dried plant material using organic solvent. This method is unsuitable for thermolabile compounds due to the risk of compound degradation resulting from prolonged heating [6]. Soxhlet extraction is a technique that is used when the desired compound has poor solubility in a particular solvent and the impurity is insoluble in that solvent. This method involves the continuous extraction of the sample using a small amount of solvent, which is evaporated and then condensed to produce a concentrated extract. Soxhlet extraction is beneficial for extracting compounds that are sensitive to heat or have a high boiling point. This approach cannot be used for substances that are sensitive to heat, as prolonged heating can cause these substances to break down [59].

Decoction method is used for the extraction of the water soluble and heat stable constituents from crude drug by boiling it in water [50]. Infusion is a way to make a drink using natural plant-based ingredients by soaking the plant materials in hot or cold water for a short time. Digestion is another way to make this type of drink, where the plant materials are gently heated during the soaking process [50].

Percolation is a commonly employed extraction technique that effectively isolates active constituents during the preparation of fluid extracts and tinctures. It involves the passage of a solvent through a bed of the source material, thereby promoting the gradual release of the desired compounds. This technique is preferred over other methods due to its ability to extract a comprehensive profile of constituents and ensure high yield and purity [51]. Sonication is a scientific technique that uses ultrasound waves to enhance the permeability of cell walls by producing cavitation. The technique employs ultrasound waves with frequencies ranging from 20 kHz to 2000 kHz. This technique has diverse applications in various fields, including medicine, biology, chemistry, and nanotechnology. The primary objective of sonication is to disrupt cell membranes, release cellular contents, and facilitate the extraction of molecules. Sonication has proven to be a valuable tool for researchers and scientists in studying the structure and function of cells, synthesizing

nanoparticles, and developing new drugs [51].

Fluid extracts of plant drugs are often used in medicines and supplements. One way to prepare them is by using a process called cold maceration. This involves mixing the plant material with a liquid and letting it soak for a while until the good stuff dissolves. The mixture is stirred regularly to help everything dissolve evenly. After a set amount of time, the liquid is strained, and the extract is ready to use. This method is beneficial for preparing extracts of thermolabile drugs that are sensitive to heat and could be damaged by the high temperatures used in other extraction methods [60]. The method of cold maceration was supported by a report from phytochemical analysis of Gaza Strip Palestine medicinal plants. Chloroform, ethanol, and distilled water were frequently used in the cold maceration method for the extraction of a wide range of polar compounds [61].

### Conclusion

Fungal infections can seriously threaten humans, animals, and plants if left untreated, causing significant health complications. It is a common occurrence among individuals seasonally or annually. However, many tribal communities have developed home remedy practices to treat such infections. These practices include the preparation of decoctions for drinking, creating pastes, using leaves as overlays on the site of infection, and incorporating certain food items into their diet to combat the infection. In the Western Ghats of Coimbatore district, the tribal communities rely on locally available herbs to treat various ailments, especially skin and eye infections. Out of these herbs, 4 plant species-*Solanum trilobatum*, *Spathodea campanulata*, *Syzygium jambos*, and *Tylophora indica* are predominantly used to overcome infections. Among these, *Tylophora indica* is used less frequently due to its scarcity in the summer season. It is crucial to note that these remedies have been passed down through generations and are still used today by these communities to address their healthcare needs, emphasizing the importance of traditional knowledge and practices. The study also examined the methods used for the extraction of these plants and analyzed their pharmacological properties. The results of this review strongly suggest that these plants are effective in treating various ailments and can be developed into potent natural remedies. Further research and development in this area is crucial to fully understand the medicinal properties of these plants and to harness their full potential for effective treatments.

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### Conflict of Interest

We declare that, we all authors have no conflict of interest.

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