A Comprehensive Review on the Phytochemical, Pharmacological, and Phytopharmaceutics Properties of *Thespesia populnea* (Linn.)

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Abstract:

Thespesia populnea (Linn.) Soland., a member of the Malvaceae family, is a medium-sized evergreen tree distributed in coastal forests of India. It is known for its diverse traditional uses in folk medicine. This review article aims to provide a comprehensive overview of the phytochemical and pharmacological aspects of *T. populnea*, with a focus on recent literature. The phytochemical analysis reveals the presence of various bioactive compounds in different parts of the plant, including alkaloids, flavonoids, terpenoids, phenolic compounds, and fatty acids. These phytochemicals contribute to the diverse pharmacological activities exhibited by *T. populnea*. Numerous studies have investigated the pharmacological properties of *T. populnea*, highlighting its potential therapeutic applications. The plant has shown promising activities such as anti-inflammatory, analgesic, antipyretic, antioxidant, antiulcer, antimicrobial, immunomodulatory, antidiabetic, anti-psoriatic, and memory-enhancing properties. These activities have been attributed to the presence of specific phytoconstituents and their mechanisms of action. In addition to traditional claims, scientific evidence supports the efficacy of *T. populnea* in various therapeutic areas. Recent studies have provided valuable insights into the underlying mechanisms of action and have identified specific bioactive compounds responsible for the observed pharmacological activities. The findings discussed in this review highlight the potential of *T. populnea* as a source of natural remedies and therapeutic agents. However, further research is needed to elucidate the exact

mechanisms of action, identify additional bioactive compounds, and conduct clinical trials to validate the traditional uses and explore new therapeutic applications of *T. populnea*. In conclusion, *T. populnea* possesses a wide range of phytochemicals and exhibits diverse pharmacological properties, making it a valuable plant for drug discovery and development. The scientific evidence supports its traditional uses and suggests

potential applications in various therapeutic areas. Further research is warranted to fully explore the therapeutic potential of *T. populnea* and translate these findings into practical applications for human health.

Introduction

Thespesia populnea (Linn.) , commonly known as Indian tulip tree or Pacific rosewood, is a botanic resource rich in therapeutic potential that has captured the attention of researchers and traditional medicine practitioners alike. Found predominantly in tropical and subtropical regions such as India, Sri Lanka, and Southeast Asia, it is noted for its widespread application in traditional medicinal systems (Kirtikar & Basu, 1987). Thespesia populnea (L.) Linn., belonging to the Malvaceae family, is a robust, medium-sized evergreen tree that grows up to 10 meters tall. It's characterized by its heart-shaped, glossy green leaves and yellow flowers, reminiscent of hibiscus, with a distinctive maroon center. Found predominantly within India's coastal forests, it is also a common sight along roadways. The tree stands at an average height of 6-10 meters (20-33 feet), typically with a short and often crooked stem crowned with a wide, dense canopy. The species is now naturally established in tropical climates worldwide, demonstrating a preference for full sunlight and an impressive tolerance for drought conditions. As a highly wind-resistant species, *T. populnea* is frequently utilized as a coastal windbreak. Its easy propagation and rapid growth further contribute to its value. This study emphasizes the tree's profile and its ethno-pharmacological significance.

Traditional Uses

The bark and fruits of the plant are traditionally acclaimed for their curative properties. Known to be astringent, cooling, purifying, anti-inflammatory, haemostatic, anti-diarrhoeal, and anti-bacterial, they have been effectively utilized in managing an array of conditions. These range from dermatological issues like scabies, psoriasis, and ringworm to ailments such as leprosy, arthritis, haemorrhages, wounds, ulcers, cholera, diabetes, ascites, dyspepsia, cough, asthma, and catarrh.

In line with the Ayurvedic Pharmacopoeia of India, the plant is suggested for treating conditions including Prameha, Raktapitta, Raktavikra, Yoniroga, Daha, Trsa, Vrana, Sotha, Balavisarpa, Pama, Khandu, Dadru, and Medoroga. It offers remedial effects for dysentery, piles, diabetes, and haemorrhoids. It's also known to cure ulcers, itching, scabies, various skin diseases, and urinary disorders. The plant's bark, known for its astringency, is used as an alternative medicine, while a hot poultice made from leaves can alleviate painful joints. When applied externally, the fruits and leaves can provide a remedy for scabies, psoriasis, and other skin afflictions. The root, leaves, flowers, fruits, and bark of the plant are the primary parts used in these remedies (Joshi, 2000).

As documented by Kirtikar and Basu, and Dymock, Warden, and Hooper, leaves have proven beneficial when applied to inflamed and swollen joints. They've also highlighted the use of flowers in treating itchiness in the Konkan region (Kirtikar and Basu, 1998). Furthermore, the plant's bark, fruits, leaves, and flowers are reported as helpful in addressing skin infections such as scabies, psoriasis, and ringworm. The juice of fruits is employed to treat certain herpetic diseases, and it contains an active compound that is effective against both gram-positive and Gram-negative bacteria. This property assists in curing intestinal diseases. The seeds yield a deep red, thick fatty oil, also employed for treating skin
conditions. In combination with the capsule, bark oil aids in treating urethritis and gonorrhoea. The plant's astringent bark, root, and fruits have been used to treat dysentery, cholera, and haemorrhoids, with the mashed bark serving as a poultice or hot fomentation for wounds.

Figure 1: *Thespesia populnea* plant showing leaf, stem and flowers.

The pharmacological properties

The pharmacological properties of *T. populnea* have been extensively investigated, as the existing literature shows. Among these, the plant's impact on dermatitis is notable.

Previously, the allergenic nature of *T. populnea* was unrecognized. An incident where a patient developed allergic contact dermatitis spurred further investigation into the plant's constituents. Wood shavings from the plant were methodically extracted, the isolated constituents were purified and identified, and their effects were evaluated using guinea pig models.

The principal chemical compound found was a novel mansion: 7-hydroxy-2, 3, 5, 6-tetrahydro-3, 6, 9-trimethylnaphtho [I, 8 BC] pyran-4, 8-dione. Upon experimental induction, this compound demonstrated moderate sensitizing properties (Hausen 1997).

T. populnea's various pharmacological activities have been studied extensively. For example, researchers have found that its ethanol extract, when orally administered to rats, significantly improves liver injury when evaluated using a CCl4 model (Shirwaiikar et.al, 1995).

Further studies have also revealed its antisteroidogenic activity. Experiments using albino mice showed that various extracts of *T. populnea* significantly reduced the weight of the uterus and ovaries. It also led to an increase in the levels of cholesterol and ascorbic acid in the ovaries, and inhibited 3-beta hydroxyl steroidal dehydrogenase and glucose 6 phosphate dehydrogenase (Kavimani et.al., 1999).

Notably, the plant's cytotoxic properties have been explored as well. Quinones such as mansonone-D, mansonone-H, thespone and thespesone, isolated from *T. populnea*'s heartwood, demonstrated cytotoxic action against human breast adenocarcinoma cells through aerobic incubation. These quinones generate superoxide anion radicals and H2O2 during aerobic incubation with NADH: cytochrome c reductase, confirmed by EPR spin trapping experiments (Inbaraj et.al., 1999).

Its potential in wound healing is another aspect under exploration. An aqueous extract from the plant's fruit demonstrated significant activity in excision and incision wound models in rats after both topical and oral administration (Nagappa and Binu 2001). Furthermore, *T. populnea*'s antioxidant activity has been examined. Both aqueous and methanol extracts of the plant's bark displayed notable antioxidant activity in rats, especially in inducing liver injury with carbon tetrachloridev: olive oil. This resulted in increased levels of various antioxidant enzymes and a decreased level of lipid peroxidation (Ilavarasan et.al., 2003). The plant also showed anti-implantation activity when tested on female albino rats. The isolated principle from PE extract showed significant anti-implantation activity, whereas the final alcoholic extract showed no such significant action (Ghosh and Bhattacharya 2004). The effects of *T. populnea* on Alzheimer's disease have also been investigated. Notably, plant extracts improved memory in mice, reversed amnesia induced by certain drugs, reduced central cholinesterase activity, and demonstrated a cholesterol-lowering property

similar to simvastatin (Vasudevan and Parle 2006). Lastly, researchers explored the plant's antinociceptive and anti-inflammatory properties. Ethanolic extract of *T. populnea* bark reduced inflammation and pain in various animal models, confirming the presence of numerous beneficial compounds in the bark. Moreover, the extract was safe, with no mortality observed in acute oral toxicity studies (Vasudevan et.al., 2007).

***T. populnea* seeds' Properties: Anti-Inflammatory, Analgesic, and Antipyretic**

The seeds of *T. populnea* were methodically processed with petroleum ether and ethanol, yielding unsaponifiable matter and fatty acids, which were segregated from the seed oil. The ethanolic extract was further subdivided using various solvents. A model of acute arthritis was stimulated in rats via a sub-plantar injection of carrageenan, and subsequent swelling was monitored using a plethysmometer. Analgesic efficacy was tested through heat-induced pain models, and antipyretic activity was gauged using a model induced by brewer's yeast. The oral administration of TPO and plant extracts, along with the tested fractions, notably reduced the carrageenan-induced swelling and brewer's yeast-induced fever. The ethyl acetate (EtOAc) fraction was particularly effective, and unsaponifiable matter showed noteworthy anti-inflammatory and analgesic properties. The GC-MS analysis revealed the presence of fourteen fatty acids, the most abundant of which were palmitic and stearic acid. Standard ascorbic acid has demonstrated strong antioxidant capabilities when tested alongside the ethanolic extract of *T. populnea* using the nitric oxide method. Such antioxidants are crucial in neutralizing free radicals, volatile molecules implicated in a range of degenerative conditions including cancer, cardiovascular diseases, and cognitive impairment. An evaluation of the ethanolic extract from *T. populnea* bark and leaves for their effect on blood sugar levels was conducted in streptozotocin-induced diabetic rats. This was then compared with the standard anti-diabetic drug glibenclamide. The extract exhibited an anti-diabetic effect in these models, suggesting a mechanism involving the inhibition of free radical generation (Shah Amol and Alagawadi 2011).

In a quest to understand the anti-psoriatic properties of *T. populnea*, three compounds – TpF-1, TpF-2, and TpS-2 – were singled out from the bark powder. The compounds' physical, chemical, and spectral profiles were analyzed (Shrivastav et.al., 2009). Various extracts and the isolated compounds were applied topically in a screening for anti-psoriatic effectiveness (Parthasarathy et.al., 2009). Among these, the pet-ether extract showed the highest anti-psoriatic performance, enlarging the orthokeratotic region by 25%. Notably, compound TpF-2 caused a 38% increase in the same region. These results paint *T. populnea* as a valuable candidate for more in-depth study into its anti-psoriatic effects (Sarma et.al., 2011). Flavonoids, known for their diverse pharmacological actions, including antimicrobial, antioxidant, cytotoxic, chemoprevention activities, and strong anti-proliferative effects, are abundant in *T. populnea*. The methanolic extract from the plant's flowers revealed the

presence of alkaloids, tannins, flavonoids, and anthroquinone glycosides through phytochemical testing. Thin-layer chromatography was utilized to identify individual components, comparing the Rf value with the standard flavonoid quercetin. Research into total phenolic and flavonoid content was also conducted. The antibacterial properties of the extract were put to the test against a host of bacteria strains. The results showed that the extract exhibited significant antibacterial activity at varying concentrations, proving its effectiveness in a dose-dependent manner (Gaind KN, Bapna et.at. 1967; Saravana Kumar et.al. 2009).

Other activities of *T. populnea*

The methanolic extract of *T. populnea* (Malvaceae) demonstrated synergistic activity when combined with oxytetracycline against 12 different Gram-positive and Gram-negative bacteria, with minimum inhibitory concentrations ranging from 62.5 µg/mL to 1000 µg/mL. The synergistic effects were confirmed using Kirby and Bauer techniques, revealing an 83.3% synergism rate against all 12 bacteria strains, including both Gram-positive and Gram-negative species. Notably, the highest synergistic activity was observed against Shigella boydii (ATCC8700) (Saravana Kumar et.al. 2009). *T. populnea* (L.) has been traditionally used in folk medicine for ulcer treatment. To evaluate the anti-ulcer potential of the terpenoid fraction derived from *T. populnea* leaves, experiments were conducted orally administering the terpenoid fraction at doses of 50, 100, and 200 mg/kg. Gastric ulcerations were induced through pylorus ligation, aspirin administration, and aspirin-induced ulcerogenesis in pylorus-ligated rats. Various parameters including ulcer index, gastric volume, pH, free and total acidity, sodium and potassium ion output, as well as biochemical estimations such as total proteins, total hexodes, hexosamine, fucose, and sialic acid were analyzed. The terpenoid fraction exhibited a dose-dependent decrease in the ulcer index. It also reduced aggressive factors such as gastric volume, free and total acidity, while increasing pH and K+
ion output. Moreover, the terpenoid fraction significantly decreased protein levels and increased total carbohydrates (TC). Notably, mucin activity (TC: P) showed a significant increase at the tested dose level of 200 mg/kg. Overall, the terpenoid fraction derived from *T. populnea* leaves demonstrated significant antiulcer activity in experimentally induced ulcer in a rat model by decreasing gastric secretions and enhancing glycoprotein levels (Patil et.al. 2010).

In the investigation of immunomodulatory effects, the methanolic extract of *T. populnea* (METP) was administered orally at doses of 100, 200, and 400 mg/kg b.w. Levamisole, a standard immunomodulatory drug, was used as a positive control (50 mg/kg b.w, p.o), while Cyclophosphamide served as the standard immunosuppressant drug (30 mg/kg b.w, p.o). The assessment of immunomodulatory properties encompassed Delayed Type Hypersensitivity (DTH), Humoral Antibody (HA) response to Sheep Red Blood Cells (SRBC), and Cyclophosphamide-induced myelosuppression. The results clearly indicate that the

methanolic extract exhibited a significant enhancement of the DTH response at a dose of 400 mg/kg b.w, p.o ($P<0.01$). Increasing doses of the extract displayed an augmentation of antibody titers. Moreover, METP counteracted Cyclophosphamide-induced immunosuppression, as evidenced by the restoration of white blood cell counts to normal levels at a dose of 200 mg/kg b.w, p.o ($P<0.001$). Phytochemical screening revealed the presence of flavonoids, triterpenoids, proteins, amino acids, phenolic compounds, and steroidal compounds. The observed immunomodulatory activity of the plant can be attributed to these phytoconstituents (Gaikwad et.al., 2011). Postprandial hyperglycemia, a key characteristic of diabetes mellitus, has been a target in diabetes therapy. Inhibition of the enzyme α-amylase is a therapeutic approach to reduce hyperglycemia. The leaves of *T. populnea* were investigated for their potential as α-amylase inhibitors. The fractions obtained through successive fractionation using solvents of different polarity were examined for the

presence of primary and secondary metabolites. The total phenolic content of the fractions was determined using HPLC and its correlation with the α-amylase inhibitory activity was assessed. Furthermore, the protein content of the extracts was estimated to gain insights into the nature of the inhibitor present. The study demonstrated that the leaves of *T. populnea* exhibited significant inhibitory activity against α-amylase, suggesting their potential as agents for managing hyperglycemia (Sangeetha and Vedasree, 2012). To evaluate the memory-enhancing activity of *T. populnea*, two behavioral models, namely the Elevated Plus-Maze and Hebb-Williams maze, were employed as exteroceptive measures of memory. Additionally, interceptive behavioral models of amnesia induced by diazepam, scopolamine, and aging were utilized. The ethanol extract of *T. populnea* was orally administered at three different doses (100, 200, and 400 mg/kg) for seven consecutive days to distinct groups of young and aged rats. Notably, the plant extract (200 and 400 mg/kg, p.o.) significantly improved the memory of both young and aged rats. Moreover, the extract demonstrated the ability to reverse the amnesia induced by scopolamine (0.4 mg/kg, i.p.) and diazepam (1 mg/kg, i.p.). The cholesterol-lowering, anticholinesterase, anti-inflammatory, and antioxidant properties of *T. populnea* may contribute favorably to its memory-enhancing effects. Therefore, the bark of *T. populnea* shows promise as a potential candidate for improving memory, warranting further investigation into its potential application in the management of Alzheimer's disease (Vasudevan and Parle 2007).

Conclusion:

Thespesia populnea (Linn.) Soland. is a valuable plant with significant phytochemical and pharmacological properties. The plant has been extensively studied for its bioactive compounds and their potential therapeutic applications. The phytochemical analysis has revealed the presence of alkaloids, flavonoids, terpenoids,

phenolic compounds, and fatty acids, which contribute to the diverse pharmacological activities exhibited by *T. populnea*.

The pharmacological studies have demonstrated the plant's potential in various areas of medicine. It exhibits anti-inflammatory, analgesic, antipyretic, antioxidant, antiulcer, antimicrobial, immunomodulatory, antidiabetic, anti-psoriatic, and memory-enhancing properties. These activities have been attributed to specific phytoconstituents and their underlying mechanisms of action. The recent literature provides valuable insights into the therapeutic potential of *T. populnea*. However, further research is necessary to fully understand the mechanisms of action, identify additional bioactive compounds, and conduct clinical trials to validate its traditional uses and explore new therapeutic applications. In conclusion, *T. populnea* holds promise as a source of natural remedies and therapeutic agents. Its phytochemical composition and pharmacological activities make it a valuable candidate for drug discovery and development. Continued research and exploration of *T. populnea*'s potential will contribute to its utilization in various healthcare sectors and pave the way for the development of novel treatments based on this plant.

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