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A REVIEW ON MEDICINAL PROPERTIES OF MELIA DUBIA

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ABSTRACT

Meliadubia, commonly referred to as Malabar Neem, is a highly valuable multipurpose tree with significant potential in farm and agroforestry. Its rapid growth rate and versatility make it a standout choice for short-rotation forestry, offering substantial economic benefits through its demand in pulpwood, plywood, and timber industries. Additionally, *Meliadubia* contributes to energy and livestock needs by providing fuel and fodder. The tree's value extends beyond its commercial applications; it is renowned for its extensive medicinal, pharmacological, ethnomedicinal, and traditional uses. This article explores the literature on *Meliadubia*, emphasizing its importance in the timber industry and its diverse medicinal properties. By highlighting these aspects, we aim to provide a thorough understanding of the tree's economic and health-related advantages.

KEYWORDS: *Melia dubia*, antimicrobial, anti-diabetic, Meliaceae.

INTRODUCTION

Melia dubia L, also known as Hill Neem, Malai Vembu, and Munnattikaraka, is traditionally used for its anthelmintic properties and for treating gastrointestinal and colic disorders. The extensive use of chemical pesticides, antibiotics, and fungicides presents serious risks to human health and adversely affects plant health. Rising concerns about drug-resistant microbes have intensified the search for safer, more sustainable alternatives. The growing problem of microbial resistance raises significant concerns about the future effectiveness of antimicrobial treatments. Additionally, the side effects of anti-inflammatory medications complicate the management of chronic inflammatory diseases and impact patient health. Infectious diseases remain a major cause of mortality in developing countries, accounting for over half of all deaths.[1]

India is facing a severe imbalance between wood demand and supply, driven by shrinking forest areas and low productivity. Indian forests yield only 0.5-0.7 m^3/ha annually, far below the global average of 2.1 m^3/ha. With global wood demand growing at 1.7% per year, India's timber needs are expected to rise dramatically, from 58 million cubic meters in 2005 to 153 million cubic meters by 2020. However, the country's current forest resources and capacity for expansion are insufficient to meet this increasing demand, presenting a significant challenge for both domestic and international wood supply.[2]

To mitigate this, increasing supply through high-yielding plantations is essential. Fast-growing, elite tree species enable early harvesting and improved yields. With the current shortage of suitable raw materials, industries must focus on establishing plantations of these species to maximize productivity within shorter rotation periods.

Meliadubia presents a viable alternative for various applications, including timber, plywood, pulpwood, and fuelwood. More than 80% of the global population relies on herbal medicines as a primary healthcare option. The demand for herbal drugs is rising due to the increasing recognition of natural plant-based products, which are considered non-toxic, free from side effects, and affordably priced.

Meliadubia, a large deciduous tree native to India, has gained prominence as one of the most widely planted species in the southern part of the country. Traditionally, all parts of the M. dubia plant are utilized in herbal medicine for treating various conditions, including anthelmintic issues, malaria, leprosy, asthma, eczema, fevers, acariasis, cholelithiasis, and joint pain.

The plant's extracts have demonstrated significant antibacterial, antiviral, antifungal, antineoplastic, antidiabetic, antihelmintic, and antileprosy activities, highlighting its potential pharmaceutical applications. Phytochemical analyses reveal that M. dubia contains a diverse array of compounds, such as alkaloids, saponins, glycosides, oleoresins, resins, sesquiterpene lactones, and oils, making it a valuable biochemical resource.

Recent research has increasingly focused on the therapeutic potential of phytochemicals from medicinal plants. Studies evaluating the antimicrobial and antifungal properties. However, further investigation is needed to purify, characterize, and identify the bioactive molecules in M. dubia leaves and explore their medical applications.

This study aims to
1. Examine the antibacterial properties of M. dubia leaf extracts against human bacterial pathogens and plant pathogenic fungi.
2. Analyze the phytochemical profile of M. dubia.
3. Identify antimicrobial compounds using Thin Layer Chromatography (TLC).[2]

PARTS USED

Taxonomy

- **Kingdom:** Plantae
- **Class:** Magnoliposida
- **Order:** Sapindales
- **Family:** Meliaceae
- **Genus:** Melia
- **Species:** Meliadubia
- **General name:** meliadubia
- **Botanicals name:** meliadubiacav
- **Kannada name:** hebbevtikaribvam
- **Tamil name:** malaivembu
- **Hindi name:** kalakhajur[3]

Locational pictures of *Melia dubia*


CHEMISTRY

Valentina et al had reported that the leaf extracts of M. dubia revealed the presence of alkaloids, carbohydrates, steroids, tannins, flavonoids, saponins andglycosides.[2] Purushothaman et al found that two new tetranortriterpenoids, compositin and compositolide, have been isolated from leaves and seeds of Melia dubia.[4] Nagalakshmi et al had reported that the leaf essential oil consists chiefly of monoterpenes (35.71%) and oxygenated monoterpenes (27.98%), accompanied by a relatively much smaller amount of alkanes (11.17%), sesquiterpene hydrocarbons (9.26%) and phenylpropanoids (3.90%). The monoterpene camphene occurs as a major constituent (21.68%) of this leaf essential oil. It is accompanied by a noticeable amount of α- and β-pinene (3.12% and 5.13%, respectively) and a much smaller amount of sabinene (2.75%). The oxygenated monoterpenes are distinctly dominated by the presence of the bicyclic ketone camphor (17.85%), while iso-borneol and borneol are detected in much smaller amounts (4.15% and 1.12%, respectively.[5] De Silva et al earlier reported that the bitter principle in Melia dubia Cav. fruits is salannin, previously found in Melia azadirachta L.[6] Murugesan et al had reported that the phytochemical components of Melia dubia (Cav) are unsaturated fatty acids, terpenoids (diterpenes and sesquiterpenes) antioxidants, phenolic derivatives and lipophylic organic compounds. Phytochemical compounds such as Linolenic acid, Palmitic acid, Caryophyllene, Humulene, Aromadendrene, Probucol, Germacrene-D, Phthalic acid 6-ethyl-3-octyl, Butylated hydroxy toluene.[4]

MEDICINAL PROPERTIES OF *MELIA DUBIA:*

Meliadubia is an important medicinal plant and in recent history this plant is reported for various medicinal properties.

Antibacterial

Antibacterial activity of silver nanoparticles (AgNPs) was evaluated using the paper disk diffusion method against Gram-negative E. coli and Gram-positive S. aureus. Bacteria were grown on nutrient agar plates. AgNPs were dissolved in distilled water at concentrations of 10, 20, 40, 60, and 80µM/ml and applied to 6 mm filter paper disks. A control solution containing 10 µg of AgNPs in 1 ml of distilled water was also tested. Plant extracts were evaluated under the same conditions. After a 24-hour incubation period, the inhibition zones around the disks were measured. The antibacterial efficacy was determined by analyzing the size of these inhibition zones.[5]

Antifungal

The antifungal properties of silver nanoparticles (AgNPs) were assessed against Aspergillus niger and Candida tropicalis. The AgNPs were confirmed to be crystalline, corresponding to the (111) and (200) planes of the face-centered cubic (FCC) lattice. Table 1 summarizes the findings, showing that AgNPs synthesized from ALM produced inhibition zones of 13 mm against Aspergillus niger and 14.5 mm 8 mm, respectively. These results underscore the superior antifungal activity of AgNPs and their potential for biomedical applications.[6]

Anti-inflammatory

In this study, anti-inflammatory activity was evaluated by measuring superoxide anion production and elastase release in fMLF/CB-induced human neutrophils. Compound 2 exhibited the strongest anti-inflammatory effect, with an EC50 of 5.54 ± 0.36μM for inhibiting superoxide anion production. Additionally, compound 2 reduced elastase release by 39.38 ± 8.69% at 10μM. Other compounds showed minimal effects in these assays. LY294002 served as a positive control.[7]

Anti-microbial

The antimicrobial activity of M. dubia leaf extracts (MDL1 and MDL2) was assessed using the well diffusion method. Petri dishes (90 mm diameter) with 20 mL Mueller-Hinton agar were prepared and inoculated with 24-hour cultures of Escherichia coli and Streptococcus mutans using a cotton swab. Each leaf extract (10 mg) was dissolved in 100 µL methanol to achieve a concentration of 100 mg/mL. For the assay, soybean casein digest agar (4g) was dissolved in 100 mL distilled water and autoclaved. Test cultures (100 µL) were spread evenly on the agar plates.

Wells (5 mm in diameter) were created in the agar plates, and 25 µL of each leaf extract and ciprofloxacin (25 µL of a 0.1 mg/mL solution) were added to the wells. The plates were incubated at 35°C for 24-48 hours. The antimicrobial activity was determined by measuring the zones of inhibition around the well saved. Test cultures (100 µL) were spread evenly on the agar plates.[8]

Anti-oxidant

MDL1 and MDL2 demonstrated significant antioxidant activity in the H_2O_2 free radical assay, surpassing the effects of the standard quercetin (Table 5). Hydroxyl radicals, highly reactive and damaging, can attack DNA, causing strand breaks that may lead to carcinogenesis, mutations, and cytotoxicity. Additionally, these radicals initiate lipid peroxidation by abstracting hydrogen atoms from unsaturated fatty acids, further contributing to cellular damage (Gordon, 1990).[9]

Anti-breast cancer activity

The in vitro anti-breast cancer efficacy of silver nanoparticles was assessed using the MCF-7 cell line at various concentrations. As shown in Table 2, increasing the concentration of silver nanoparticles led to a higher rate of cancer cell death. Cytotoxicity data, illustrated in Fig. 7, demonstrate that the nanoparticles exhibit significant potency, with an IC50 value of 31.2µg/mL. This indicates that 50% of the cancer cells were killed at concentrations below 31.2 µg/mL, underscoring the effective anti-cancer potential of the silver nanoparticles.[9]

Anti-urolithiatic activity

Chronic administration of ethylene glycol (0.75%) in aqueous solution to rats induced hyperoxaluria, resulting in increased urine oxalate and calcium levels of 3.68 ± 0.01 mg/24h and 4.50 ± 0.01 mg/24h, respectively, compared to the normal control group (Table 1, Group II). Treatment with ethanol and aqueous extracts significantly reduced these elevated levels ($p < 0.01$), bringing oxalate and calcium excretion down to 0.79 ± 0.01 mg/24h and 1.09 ± 0.04 mg/24h, respectively.[10]

Bio-pesticidal activity

Melia dubia contains several compounds with potent pesticidal effects found throughout its various parts. Notably, the refined bark is rich in toosandanin (60-70%), a compound effective against Helicoverpaarmigera (Koul et al., 2002) and a strong antifeedant and growth inhibitor for Pieris rapae larvae (Shin-Foon, 1989). Additionally, limonoids from M. dubia and other Meliaceae members offer an environmentally friendly approach to pest management (Carpinella et al., 2002).

Different extracts from M. dubia exhibit diverse pesticidal activities, including ovicidal (Malarvannan et al., 2009), larvicidal (Karthikeyan et al., 2014), and growth-inhibitory effects. These extracts also function as antifeedants, stomach poisons, and disrupt moulting and development in pests (Bhuiyan et al., 2001).

A study by Kulawardhana et al. (2018) evaluated the effectiveness of two leaf extracts from M. dubia: an aqueous extract (T1) and a methanol-based formulation (T2). The methanol extract proved more effective in managing pests such as thrips, mealy bugs, and caterpillars. The methanol-based formulation significantly mitigated caterpillar damage in crops, enhancing leaf area preservation and improving yields. Application to cabbage plants resulted in a notable increase in yield compared to untreated controls.[2]

Antifeedant activity

Koul et al. (2002) investigated the antifeedant and growth-inhibitory effects of Melia dubia extracts on Spodoptera litura and Helicoverpaarmigera. Their studies showed that dichloroethane (DCE) and methanol (Me) extracts inhibited larval growth in a dose-dependent manner. In leaf disc-choicetests, DCE and Me-5II fractions achieved 50% deterrency at concentrations of 22.5 and 16.8µg cm^-2, respectively. The DCE-5 fraction was more toxic to larvae (LC50 of 0.65%) compared to Me-5II (LC50 of 0.8%) 72 hours after application. While neither fraction exhibited contact toxicity, their deterrent effects lasted for at least 60 hours in laboratory conditions. Chanthuru et al. (2014) assessed the larvicidal activity of ethyl acetate extracts from M. dubia leaves and roots. They found that a 12-hour exposure to these extracts resulted in 98% mortality in mosquito larvae from leaves and 96% mortality from roots. These findings demonstrate the significant larvicidal potential of Melia dubia, suggesting it could serve as an effective natural larvicidal agent.[2]

Anti-diabetic activity

Ethanol extracts of Melia dubia fruits have shown significant hypoglycemic effects. Susheela et al. (2008) reported that intraperitoneal administration to mice reduced blood glucose levels by up to 52.14% at a dose of 300 mg kg^-1 body weight after six hours. With a therapeutic index of 2.5, the extract is both safe and effective as a natural hypoglycemic agent. Further studies by Mamun-or-Rashid et al. (2014), Nojima et al. (1998), Makheswari et al. (2012), and Schwab et al. (2006) reinforce the potential of Melia dubia for diabetes management.[2]

Anti-helimenthic

The present study found that Melia dubia had limited anthelmintic activity against Haemonchuscontortus in sheep. This contrasts with Das et al. (2016), who reported significant anthelmintic effects of M. dubia methanolic extract on earthworms, with notable paralysis at 6.47 and 10.3 minutes and death at 9.42 and 16.27 minutes, respectively, at a concentration of 150 mg/ml. Variations in results may be due to differences in solvent types and their efficiency in extracting active metabolites. The anthelmintic activity is likely related to the high levels of phenolics, tannins, and alkaloids in M. dubia, which can disrupt parasite energy metabolism (Athnasiadou et al., 2001) and bind to proteins on the parasite's cuticle. Despite these findings, research on M. dubia's anthelmintic properties is sparse, with more focus given to its antiurolithiatic effects (Vennila and Mariyal, 2015).

CONCLUSION

Meliadubia (Melia dubia), also known as Malabar Neem, emerges as a promising multi-purpose tree with significant potential in both commercial and medicinal domains. Its rapid growth and versatile applications in timber, plywood, pulpwood, and fuelwood address critical needs in forestry and energy. The tree's role extends into traditional medicine, where its various parts are utilized for their therapeutic benefits. The extensive pharmacological properties of M. dubia, including antimicrobial, antidiabetic, antihelmintic, and antileprosy activities, underscore its potential as a valuable source of natural remedies.

Phytochemical analyses have identified a range of bioactive compounds within M. dubia, including alkaloids, saponins, glycosides, and essential oils, which contribute to its medicinal efficacy. Despite these promising findings, further research is necessary to isolate and characterize specific bioactive molecules, especially through techniques such as Thin Layer Chromatography (TLC). This continued research will enhance the understanding of M. dubia’s therapeutic potential and facilitate its integration into modern medicine and sustainable agroforestry practices. In summary, Meliadubia's combination of economic value and medicinal properties makes it a noteworthy candidate for both commercial cultivation and medicinal exploration, offering a dual advantage of addressing global wood demand and providing valuable natural remedies.

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