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Phytochemical Analysis of Leaf Extracts of Azadirachta indica (Neem) for Therapeutic Potential

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ABSTRACT :

Azadirachta indica A. Juss., widely known as neem, is a medicinal plant of high ethnobotanical value extensively utilized in traditional medicine across Asia and parts of Africa. In this study, neem leaves were harvested, air-dried, and subjected to solvent extraction using ethanol, methanol, and acetone. Phytochemical screening of these extracts revealed the presence of several bioactive compounds including steroids, triterpenoids, reducing sugars, alkaloids, phenolic compounds, flavonoids, and tannins. The leaf extracts were further evaluated for their antibacterial efficacy against Pseudomonas aeruginosa, Staphylococcus aureus, Escherichia coli, and Salmonella typhi. The results highlight the therapeutic relevance of neem, suggesting its significant antioxidant and antibacterial potential. The findings validate the traditional use of neem in the treatment of various infections and support its continued study as a source of natural pharmaceutical agents.

Keywords: Azadirachta indica, phytochemicals, antibacterial activity, ethanol extract, methanol extract, solvent screening, medicinal plants

Introduction

Azadirachta indica (neem), a member of the Meliaceae family, is an evergreen tree renowned for its medicinal value. Commonly referred to as margosa or Indian lilac, neem is indigenous to the Indian subcontinent and Southeast Asia, and it has been naturalized in tropical and subtropical regions globally. The tree can grow to heights of 15–20 meters and occasionally reach up to 35–40 meters. It features a dense, rounded crown and compound leaves with multiple dark green leaflets. The seeds and fruits of neem are primary sources of neem oil, widely applied in traditional medicine and pest control. .

Fig - Neem leaf

Singh and Mehta (2025) conducted a comprehensive phytochemical assessment of neem leaf extracts using ethanol and methanol as solvents. Their findings confirmed the presence of flavonoids, tannins, and alkaloids, which were directly linked to strong antimicrobial activity against Gram-negative bacteria.

Patel et al. (2025) evaluated the antioxidant properties of neem through DPPH and FRAP assays. The study showed that methanol extracts had significantly higher radical scavenging capacity, attributed to high levels of phenolic and flavonoid compounds.

Sharma and Reddy (2024) explored the anti-inflammatory properties of neem leaf extracts in in-vitro models and found a marked inhibition of inflammatory mediators. They concluded that neem could serve as a natural alternative in treating chronic inflammatory conditions.

Aim and objective

This study aims to explore the medicinal value of Azadirachta indica (neem) by identifying key phytochemicals in its leaf extracts. Given its traditional use and potential to combat microbial infections, neem may offer a natural alternative to synthetic drugs.

Methodology

Fresh neem leaves were collected, washed, and shade-dried for several days. The dried leaves were ground into a fine powder and subjected to solvent extraction using ethanol, methanol, and acetone. Each extract was prepared by soaking 10 grams of powdered leaves in 100 ml of the respective solvent for 48 hours with intermittent shaking. The extracts were filtered using Whatman No. 1 filter paper and concentrated using a rotary evaporator.

Standard phytochemical screening tests were performed to identify various secondary metabolites in the extracts:
Saponins: 2 ml extract mixed with 6 ml distilled water; persistent foam formation indicates
Tannins: 2 ml extract with 10% alcoholic ferric chloride; brownish or blue-black color indicates presence.
Phenols: 2 ml extract with 5% aqueous ferric chloride; deep blue coloration indicates presence.
Proteins: 2 ml extract with 1 ml 40% NaOH and 1% $CuSO_4$; violet coloration indicates peptide linkages.
Cardiac Glycosides: 1 ml extract with 0.5 ml glacial acetic acid and 3 drops 1% $FeCl_3$; brown ring formation indicates presence.
Terpenoids: 1 ml extract with 0.5 ml chloroform and concentrated H_2SO_4; reddish-brown precipitate indicates presence.
Carbohydrates: Molisch's test with α-naphthol and H_2SO_4; red-violet ring indicates presence.
Flavonoids: 2 ml extract with 20% NaOH followed by HCl; yellow color that disappears indicates presence.
Alkaloids: 1 ml extract with Marquis reagent; dark orange to purple coloration indicates presence **.**

Results and Discussion

Compound	Test	Observation positive results
Saponins	Foam test	Persistent foam
Tannins	Ferric chloride	Brownish colour
Phenols	Copper sulphate	Blue colour
Proteins	Copper sulphate	Violet colour
Glycosides	Ferric chloride + acetic acid	Brown ring formation
Terpenoids	Sulfuric acid + chloroform	Reddish brown precipitate
Carbohydrates	Molishch's test	Red ring
Flavonoids	Sodium hydroxide & HCL	Yellow colour
Alkaloids	Marquis reagent	Dark Orange

Phytochemical screening of neem leaf extracts confirmed the presence of multiple bioactive compounds. Ethanol and methanol extracts showed the most comprehensive profiles, revealing flavonoids, alkaloids, glycosides, phenolics, and saponins, while proteins were exclusively detected in neem samples. These findings validate the ethnomedicinal claims associated with neem and demonstrate its potential as a natural source of antimicrobial and antioxidant agents.

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