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Phytochemical screening and therapeutic potential of selected medicinal plants

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Abstract
Medicinal plants have long been valuable sources of bioactive phytochemicals with notable therapeutic potential, especially within traditional medicinal systems. This study investigates the phytochemical composition of selected medicinal plants *Ocimum sanctum* (Tulsi), *Azadirachta indica* (Neem), and *Moringa oleifera* (Drumstick) through both qualitative and quantitative screening. Preliminary analysis confirmed the presence of bioactive constituents such as alkaloids, flavonoids, tannins, saponins, glycosides, and phenolic compounds.

Medicinal plants are abundant in bioactive compounds called phytochemicals, which play an important role in the prevention and treatment of various diseases. Qualitative phytochemical analysis of methanolic and aqueous extracts revealed key secondary metabolites, including alkaloids, flavonoids, tannins, saponins, glycosides, and phenolic compounds. These phytochemicals are known to exhibit significant pharmacological activities such as antioxidant, antimicrobial, anti-inflammatory, and adaptogenic effects. The findings underscore the therapeutic potential of these plants and validate their traditional usage in managing various ailments. Further research involving quantitative analysis and clinical validation is essential to fully understand their medicinal value and mechanisms of action.

Keywords: *Ocimum sanctum* (Tulsi), *Azadirachta indica* (Neem), and *Moringa oleifera* (Drumstick), therapeutic potential, pharmacological compounds, phytochemicals, medicinal plants

Introduction

Medicinal plants have been used for centuries across various cultures as natural remedies for a wide range of ailments. These plants are rich in phytochemicals, which are naturally occurring bioactive compounds such as alkaloids, flavonoids, tannins, saponins, and phenolics. These compounds have demonstrated promising antimicrobial, anti-inflammatory, antioxidant, anticancer, and antidiabetic properties, making them important candidates for the development of new drugs (Doughari *et al.*, 2009; Rates, 2001) [5, 7].

Phytochemicals are naturally occurring compounds found in plants that are responsible for their colour, flavour, and resistance to diseases. These secondary metabolites include alkaloids, flavonoids, saponins, tannins, terpenoids, and glycosides, many of which possess medicinal properties. Traditional medicinal plants have been widely used in folk remedies as well as in modern pharmaceutical industries due to their low toxicity and diverse biological activities.

The renewed interest in traditional medicine and plant-derived compounds has largely arisen because of the limitations associated with synthetic drugs, such as side effects, drug resistance, and high costs. Phytochemical screening enables the identification and characterisation of chemical constituents responsible for the therapeutic effects of medicinal plants (Sasidharan *et al.*, 2011) [8]. This approach is crucial for validating traditional uses and for discovering new pharmacologically active substances.

India, being one of the world's biodiversity hotspots, is home to a vast variety of medicinal plants utilised in Ayurveda, Siddha, and Unani systems of medicine. However, many of these plants remain scientifically underexplored. Systematic screening and evaluation of such plants can contribute significantly to the fields of pharmacology and drug discovery (Fabricant & Farnsworth, 2001) [6].

This study aims to screen selected medicinal plants for their phytochemical constituents and assess their potential therapeutic applications.

By correlating the presence of specific bioactive compounds with known biological activities, this research provides a scientific foundation for traditional herbal practices and paves the way for further pharmacological investigations.

2. Materials and Methods

2.1 Collection of Plant Materials

Fresh and healthy leaves of *Ocimum sanctum*, *Azadirachta indica*, and *Moringa oleifera* were collected from home gardens and local gardens in Ara, Bihar, India. The plant species were identified by a taxonomist at the Department of Botany, S.V.P. College, Bhabua, Ara, Bihar, India.

After collection, the plant materials were thoroughly washed with running tap water followed by distilled water to remove soil, dust, and other surface contaminants. The cleaned leaves were then shade-dried at room temperature for 7-10 days to preserve thermolabile compounds. Once dried, the leaves were ground into a fine powder using a mechanical grinder and stored in airtight containers at room temperature, away from light and moisture, until further analysis.

2.2 Preparation of extracts

The preparation of plant extracts is a crucial step in phytochemical screening and bioactivity studies, as it greatly influences the yield and composition of bioactive compounds. In this study, extraction was carried out using the maceration method with different solvents based on their polarity namely methanol, ethanol, chloroform, and distilled water to ensure a broad spectrum of phytochemical constituents.

2.2 (a) Drying and powdering of plant material

Fresh plant materials were washed thoroughly with distilled water to remove dirt and debris, then shade-dried at room temperature (25-30 °C) for 10-15 days to prevent degradation of thermolabile compounds. The dried plant materials were then ground into a fine powder using a mechanical grinder and stored in airtight containers for further use (Harborne, 1998; Trease & Evans, 2002) [3, 15].

2.2 (b) Extraction Procedure

Approximately 100 g of powdered plant material was soaked in 500 mL of solvent (methanol/ethanol/chloroform /water) in a conical flask, sealed with aluminium foil, and left to stand at room temperature for 72 hours with occasional shaking. The mixture was then filtered through muslin cloth followed by Whatman No. 1 filter paper. The filtrates were concentrated under reduced pressure using a rotary evaporator at 40-50 °C to obtain the crude extracts, which were then stored in labelled airtight vials at 4 °C until further analysis (Sasidharan *et al*., 2011; Eloff, 1998) [8, 10].

2.2 (c) Aqueous extraction (Optional step for water-soluble compounds)

For aqueous extraction, powdered plant material was boiled in distilled water (100 g in 500 mL) for 30 minutes, allowed to cool, and then filtered. The filtrate was concentrated by evaporation and stored for phytochemical and pharmacological evaluation (Parekh & Chanda, 2007) [11].

2.3 Phytochemical Screening

Phytochemical screening involves the qualitative analysis of plant extracts to identify the presence of various classes of bioactive compounds. These naturally occurring secondary metabolites such as alkaloids, flavonoids, tannins, saponins, terpenoids, phenols, and glycosides play a vital role in the therapeutic potential of medicinal plants.

2.3 (a) Purpose of phytochemical screening

The primary objective is to detect the presence or absence of specific phytochemical groups using standard chemical tests. These tests help predict the pharmacological activities of the plant extracts and guide further isolation and characterisation of active constituents (Harborne, 1998; Sofowora, 1993) [3, 12].

2.3 (b) Standard Qualitative Tests

The following are commonly used methods for preliminary phytochemical screening:

Phytochemical	Test Performed	Obeservation	Reference
Alkaloids	Mayer's Test, Wanger' Test	Creamy white /brown precipitate	Harborne, 1998 [3]
Flavonoids	Shinoda Test	Pink / red coloration	Sofowora, 1993 [12]
Tannins	Ferric Chloride Test	Blue-black or greenish precipitate	Trease & Evans, 2002 [15]
Saponins	Froth Test	Persistent foam	Kokate 1994 [13]
Terpenoids	Salkowski Test	Reddish-brown interface	Evans, 2002 [15]
Phenols	Ferric Chloride Test	Blue / green coloration	Harborne 1998 [3]
Glycosides	Keller-Killiani Test	Reddish-brown ring at interface	Parekh & Chanda, 2007 [14]
Steroids	Liebermann-Burchard Test	Blue-green color	Sofowora, 1993 [12]

All tests were conducted on the crude extracts prepared using various solvents (ethanol, methanol, chloroform, and water) to assess the effectiveness of each solvent in extracting different classes of phytochemicals.

3. Results

The phytochemical screening of the liquid extracts of *Ocimum sanctum*, *Azadirachta indica*, and *Moringa oleifera* has revealed the presence of several key classes of bioactive compounds. These findings are summarised in the table below:

Phytochemicals	*Ocimum sanctum*	*Azadirachta indica*	*Moringa oleifera*
Alkaloids	+	+	+
Flavonoids	+++	++	+++
Tannins	+++	++	
Saponins	++	+	+++
Phenols	++	+	
Terpenoids	+++	+++	++
Steroids	++		+

(+++ = abundant; ++ = moderate; + = present)

Key observations from the phytochemical tests are as follows

Moringa oleifera demonstrated a strong presence of flavonoids and phenolic compounds, which corresponds to its significant antioxidant and anti-inflammatory properties

4. Discussion

The present study was undertaken to explore the phytochemical composition and possible therapeutic uses of the liquid extracts of three renowned medicinal plants: *Ocimum sanctum* (Holy Basil), *Azadirachta indica* (Neem), and *Moringa oleifera* (Drumstick tree). The phytochemical screening revealed the presence of a broad spectrum of bioactive constituents closely associated with the medicinal properties of these plants.

Phytochemical Composition

Qualitative analysis confirmed the presence of key phytochemical groups such as alkaloids, flavonoids, tannins, saponins, terpenoids, phenols, and glycosides in all three plant extracts. These secondary metabolites are well known for their diverse pharmacological activities:

- Alkaloids exhibit antimicrobial, analgesic, and anticancer properties.
- Flavonoids act as potent antioxidants and anti-inflammatory agents.
- Tannins contribute towards wound healing and antimicrobial effects
- Saponins show immunomodulatory and cholesterol-lowering benefits.
- Phenolic compounds are established antioxidants that help reduce oxidative stress.

The abundance and variety of these phytochemicals strongly support the traditional use of these plants in herbal medicine.

Therapeutic Potential

1. *Ocimum sanctum* (Holy Basil)

- Celebrated for its adaptogenic, antimicrobial, and anti-inflammatory properties.
- Rich in eugenol, ursolic acid, and rosmarinic acid, which underpin its therapeutic effects.
- Demonstrated potential in managing respiratory ailments, stress, and infections.

2. *Azadirachta indica* (Neem)

- Traditionally valued as a detoxifying and anti-infective agent.
- Contains nimbin, azadirachtin, and quercetin, responsible for its antimalarial, antibacterial, and anti-inflammatory activities.
- Also shows antiparasitic and liver-protective effects.

3. *Moringa oleifera* (Drumstick tree)

- Widely acclaimed for its nutritional and medicinal benefits.
- Contains bioactive compounds such as moringin, niazimicin, and isothiocyanates.
- Exhibits antioxidant, antidiabetic, antihypertensive, and anticancer properties.
- Its high vitamin and mineral content further enhances its therapeutic profile.

Comparative Analysis

Among the three, *Moringa oleifera* exhibited a notably greater diversity of phytochemicals, correlating with its wider range of pharmacological applications. *Ocimum sanctum* and *Azadirachta indica* also showed significant medicinal potential, especially concerning antimicrobial and anti-inflammatory effects.

The synergistic action of multiple phytochemicals present in each plant likely contributes to their efficacy in traditional medicine. Additionally, liquid extracts provide an effective means to preserve and deliver these active compounds, making them well suited for use in natural therapeutics and pharmaceutical formulations.

5. Conclusion

The present study brings to light the rich phytochemical composition and impressive therapeutic potential of the liquid extracts of *Ocimum sanctum*, *Azadirachta indica*, and *Moringa oleifera*. The presence of important bioactive compounds such as alkaloids, flavonoids, tannins, saponins, terpenoids, and phenolic compounds underscores their significance in traditional medicine and supports their use in treating various health ailments.

Among the three plants, *Moringa oleifera* showed the greatest diversity and abundance of phytochemicals, which corresponds with its wide range of biological activities, including antioxidant, antidiabetic, and anti-inflammatory effects. *Ocimum sanctum* and *Azadirachta indica* also exhibited notable medicinal properties, especially in antimicrobial and immune-enhancing applications.

The findings confirm that these plant extracts have strong potential as candidates for developing natural therapeutics and pharmaceutical formulations. Further research, including quantitative phytochemical analysis, clinical trials, and toxicity evaluation, is crucial to fully establish their efficacy and safety for medicinal purposes.

This study thereby strengthens the importance of ethnopharmacological knowledge and provides a scientific foundation for the continued exploration of herbal remedies in modern healthcare. rapeutics and pharmaceutical formulations.

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