E-ISSN: 2583-9667
Indexed Journal
Peer Reviewed Journal
https://multiresearchjournal.theviews.in

Received: 17-05-2024
Accepted: 30-06-2024

INTERNATIONAL JOURNAL OF ADVANCE RESEARCH IN MULTIDISCIPLINARY

Volume 2; Issue 3; 2024; Page No. 578-581

Pharmacognostic and therapeutic evaluation of essential oils derived from indigenous medicinal plants

[1]Reshu Jain and [2]Dr. Jagrati Gope

[1]Department of Pharmacy, Swami Vivekanand University, Sagar, NH 26, Narsinghpur Road, Sironj, Sagar, Madhya Pradesh, India
[2]Parashar Ayurvedic Medical College and Hospital, Jamunia, Zirnia, Narsingh Road, Parvalia, Bhopal, Madhya Pradesh, India

DOI: https://doi.org/10.5281/zenodo.15615382

Corresponding Author: Reshu Jain

Abstract

Essential oils derived from indigenous medicinal plants have long been recognized for their therapeutic properties in traditional medicine systems. This study aimed to scientifically validate the Pharmacognostic characteristics and therapeutic potential of essential oils extracted from *Ocimum sanctum*, *Curcuma longa*, and *Cymbopogon citratus*. The research employed a mixed-method design involving plant collection, pharmacognostic evaluation, oil extraction, GC-MS profiling, and bioactivity assays. Macroscopic and microscopic analyses confirmed the botanical authenticity of the samples, while physicochemical assessments revealed high oil yield and favorable parameters for pharmaceutical applications. GC-MS analysis identified major bioactive constituents such as eugenol, ar-turmerone, and citral. Antimicrobial testing against *E. coli*, *S. aureus*, and *P. aeruginosa* demonstrated strong inhibitory effects, particularly from *Cymbopogon citratus*. Antioxidant assays confirmed the free radical scavenging abilities of all three oils. These findings substantiate the traditional uses of these plants and highlight their potential in modern phytopharmaceutical development, especially as natural alternatives in antimicrobial and antioxidant therapies.

Keywords: Essential oils, indigenous medicinal plants, traditional, *Cymbopogon citratus*

Introduction

Essential oils, volatile aromatic compounds extracted from plants, have played a central role in traditional medicine systems across various cultures for centuries. These natural products, primarily composed of terpenoids and aromatic phenols, are obtained from different parts of plants such as leaves, flowers, bark, and roots through distillation or mechanical extraction (Bakkali *et al*., 2008) [8]. Indigenous medicinal plants, particularly those used in Ayurveda, Unani, and folk systems in India and other biodiversity-rich regions, are a valuable source of essential oils that exhibit significant pharmacological activities. However, despite their widespread traditional use, scientific validation of their pharmacognostic characteristics and therapeutic potential remains limited.

Pharmacognostic evaluation provides a systematic approach to authenticate, identify, and analyze the morphological, anatomical, and phytochemical features of medicinal plants, ensuring quality and purity of plant-derived products (Trease & Evans, 2009) [9]. For essential oils, pharmacognostic studies encompass organoleptic properties, microscopy of oil-yielding tissues, and physicochemical profiling, often accompanied by chromatographic techniques like GC-MS to identify bioactive constituents. This comprehensive evaluation is critical to standardize the therapeutic applications of essential oils, reduce adulteration, and support evidence-based integration into modern medicine (Khair-ul-Bariyah *et al*., 2012) [11].

Therapeutically, essential oils from indigenous plants have demonstrated a wide spectrum of bioactivities including antimicrobial, anti-inflammatory, antioxidant, analgesic, and neuroprotective effects. For example, the essential oil of *Ocimum sanctum* (Tulsi) exhibits strong antibacterial and immunomodulatory properties, while *Curcuma longa* (Turmeric) oil contains ar-turmerone, which has been reported for its neuroprotective potential (Sharifi-Rad *et al*., 2017) [6]. These findings suggest that essential oils may serve as complementary or alternative therapies in treating infections, inflammatory disorders, and neurodegenerative conditions. However, therapeutic effectiveness depends greatly on the oil's chemical composition, concentration, and method of administration, which necessitates detailed pharmacognostic standardization.

In the current era of rising antibiotic resistance and growing interest in natural remedies, the exploration of indigenous essential oils through pharmacognostic and therapeutic evaluation is both scientifically and clinically significant. Such studies not only validate traditional knowledge but also contribute to the global repository of safe, plant-based medicinal options. Therefore, this research aims to bridge the gap between ethnomedicinal usage and modern pharmacological evidence by examining the botanical, chemical, and therapeutic profiles of essential oils derived from selected indigenous medicinal plants.

Literature Review

Singh and Kumar (2020) [8] reviewed the pharmacognostic characteristics of essential oils extracted from Indian medicinal plants, emphasizing their organoleptic, macroscopic, and microscopic parameters. The review detailed the essential oil profiles of plants like *Cymbopogon citratus* (lemongrass) and *Eucalyptus globulus*, revealing their dominant bioactive compounds such as citral and eucalyptol. The study concluded that standardized pharmacognostic evaluation not only authenticates plant materials but also ensures consistency in therapeutic efficacy across batches, which is especially critical in the case of volatile essential oil constituents.

Sharma and colleagues (2021) [7] investigated the antimicrobial efficacy of essential oils obtained from Himalayan medicinal plants like *Valeriana jatamansi* and *Artemisia maritima*. Their review analyzed recent in vitro and in vivo studies, highlighting the potential of these oils against multidrug-resistant strains of *Staphylococcus aureus* and *Escherichia coli*. They emphasized that the pharmacological actions of these oils are often linked to their complex mixture of terpenoids and flavonoids, which disrupt microbial membranes and enzyme systems. The review concluded that further pharmacognostic standardization and toxicity assessments are essential for clinical application.

Alotaibi and Badr (2022) [1] conducted a comprehensive review on the neuropharmacological properties of essential oils used in traditional Arabian and South Asian medicine. The paper focused on oils derived from plants like *Lavandula angustifolia*, *Boswellia sacra*, and *Nardostachys jatamansi*. It reported anxiolytic, antidepressant, and cognitive-enhancing effects supported by animal model studies. The authors attributed these effects to monoterpenes like linalool and α-pinene, and called for greater integration of pharmacognostic screening with clinical trials to validate therapeutic claims.

In their 2023 study, Patel and Joshi explored the antioxidant potential of essential oils derived from indigenous Indian spices, including *Cinnamomum verum* and *Syzygium aromaticum*. Their analysis of pharmacognostic parameters (yield, solubility, refractive index) along with GC-MS profiling revealed a rich composition of eugenol, cinnamaldehyde, and carvacrol, compounds known for their free-radical scavenging activity. The review highlighted the relevance of these oils in preventing oxidative stress-related diseases, urging researchers to prioritize bioavailability studies and formulation development.

Nair and colleagues (2024) [4] provided an ethnopharmacological and pharmacognostic review of essential oils used by tribal communities in Kerala and Tamil Nadu. Focusing on plants such as *Ocimum tenuiflorum* (Tulsi) and *Zingiber zerumbet*, they documented traditional uses along with recent scientific validations. The study emphasized the importance of preserving indigenous knowledge and integrating it with modern analytical methods, including chromatographic fingerprinting and toxicity profiling. Their work underscored the therapeutic promise of these oils in respiratory, inflammatory, and dermatological conditions.

Research Methodology

1. **Research Design:** The present study employs an experimental and descriptive pharmacognostic research design to evaluate the physicochemical, microscopic, and therapeutic properties of essential oils obtained from selected indigenous medicinal plants. This mixed-method design allows both qualitative and quantitative analysis-starting from plant identification and authentication to extraction, characterization, and biological testing of the essential oils.
2. **Selection and Authentication of Plant Material:** Medicinal plants known for their ethnomedicinal use and essential oil content were selected based on ethnobotanical surveys and literature review. Samples such as *Ocimum sanctum*, *Curcuma longa*, and *Cymbopogon citratus* were collected from authenticated sources or local forests with guidance from botanists and tribal knowledge holders. Botanical authentication were performed by a qualified taxonomist, and herbarium specimens were preserved for reference.
3. **Extraction of Essential Oils:** Essential oils were extracted using hydro-distillation or steam distillation methods depending on the nature of the plant part used (leaf, root, rhizome). The process was carried out in a Clevenger apparatus, and the oils obtained will be dried over anhydrous sodium sulfate and stored in amber vials at 4 °C to preserve their integrity. Yield percentage were calculated based on fresh weight.
4. **Pharmacognostic Evaluation:** Pharmacognostic evaluation were included macroscopic and microscopic analysis of the plant material such as color, texture, trichomes, stomata, and oil glands, using compound and dissecting microscopes. Physicochemical parameters like ash value, moisture content, extractive values, and volatile oil content were determined following standard protocols as per Ayurvedic Pharmacopoeia of India. These assessments help in ensuring quality control and standardization.
5. **Phytochemical and GC-MS Analysis:** Preliminary phytochemical screening were conducted to detect the presence of compounds such as terpenoids, flavonoids, phenols, and alkaloids. Subsequently, the chemical composition of the essential oils was analyzed using Gas Chromatography-Mass Spectrometry (GC-MS). These were identified and quantified bioactive components such as eugenol, thymol, linalool, and α-

pinene, which are often responsible for the therapeutic activity of essential oils.

6. **Evaluation of Therapeutic Activities:** To assess the therapeutic potential, the essential oils were subjected to in vitro antimicrobial assays using the agar well diffusion or broth microdilution method against standard bacterial strains (*E. coli*, *S. aureus*, *P. aeruginosa*). In addition, antioxidant activity was measured through DPPH and ABTS radical scavenging assays. If required, anti-inflammatory or neuroprotective activity were tested on relevant cell lines using ELISA or spectrophotometric techniques.
7. **Data Analysis:** All experimental data were recorded in triplicate and expressed as mean ± standard deviation. Statistical analysis will be performed using GraphPad Prism or SPSS software, and results were compared using one-way ANOVA or t-test as applicable. A significance level of $p<0.05$ were used to determine statistical relevance.

Data Analysis: The data analysis is divided into three sections: pharmacognostic evaluation, phytochemical/chemical composition analysis, and therapeutic (bioactivity) evaluation.

Table 1: Macroscopic and Microscopic Characteristics of Selected Indigenous Plants

Plant Name	Plant Part Used	Macroscopic Features	Microscopic Features
Ocimum sanctum	Leaf	Green, aromatic, ovate-shaped	Diacytic stomata, glandular trichomes
Curcuma longa	Rhizome	Yellow-orange, aromatic, cylindrical	Starch grains, parenchymatous cells with oil
Cymbopogon citratus	Leaf	Long, linear, lemon-scented	Parallel venation, silica bodies, oil ducts

The pharmacognostic characteristics confirm the identity and authenticity of the selected plant materials. Microscopy revealed oil-bearing structures such as trichomes and ducts, indicating suitability for essential oil extraction.

Table 2: Physicochemical Parameters of Essential Oils

Plant Name	Oil Yield (%)	Refractive Index	Specific Gravity	Solubility in Alcohol (1:1)
Ocimum sanctum	0.6	1.476	0.92	Completely soluble
Curcuma longa	0.9	1.503	0.93	Soluble
Cymbopogon citratus	1.2	1.485	0.89	Completely soluble

Table 2 presents the physicochemical characteristics of essential oils derived from *Ocimum sanctum*, *Curcuma longa*, and *Cymbopogon citratus*. The oil yield was highest in *Cymbopogon citratus* (1.2%), followed by *Curcuma longa* (0.9%), and *Ocimum sanctum* (0.6%), indicating that lemongrass is the most efficient source among the three for essential oil extraction. Refractive index and specific gravity values for all oils were within the standard ranges reported for pure, unadulterated essential oils, reflecting their good quality and purity. Notably, all three oils exhibited good solubility in alcohol (1:1), which is an important parameter for their formulation in pharmaceutical or cosmetic preparations. These physicochemical properties not only confirm the identity and integrity of the oils but also suggest their suitability for therapeutic applications, particularly in formulations where alcohol solubility and consistency are critical. The results support the use of these oils as standardized herbal products in pharmacognostic and industrial applications.

Table 3: Major Chemical Constituents (GC-MS Profiling)

Plant Name	Major Constituents Identified	Percentage (%)
Ocimum sanctum	Eugenol, methyl eugenol, caryophyllene	65%, 20%, 10%
Curcuma longa	Ar-turmerone, curcumene, zingiberene	40%, 25%, 18%
Cymbopogon citratus	Citral, geraniol, limonene	70%, 15%, 10%

The physicochemical evaluation confirmed purity and consistency across batches. GC-MS analysis identified biologically active compounds such as eugenol and citral, which are known for antimicrobial, antioxidant, and anti-inflammatory properties. The highest oil yield was observed in *Cymbopogon citratus*, making it a promising candidate for commercial applications.

Table 4: Antimicrobial Activity (Zone of Inhibition in mm)

Plant Name	*E. coli*	*S. aureus*	*P. aeruginosa*
Ocimum sanctum	18 mm	21 mm	16 mm
Curcuma longa	15 mm	19 mm	14 mm
Cymbopogon citratus	20 mm	22 mm	18 mm
Standard (Ampicillin)	23 mm	25 mm	21 mm

Table 4 illustrates the antimicrobial potential of essential oils from *Ocimum sanctum*, *Curcuma longa*, and *Cymbopogon citratus* against three pathogenic bacterial strains: *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. Among the tested oils, *Cymbopogon citratus* exhibited the highest antimicrobial activity, producing zones of inhibition of 20 mm, 22 mm, and 18 mm respectively, which were only slightly lower than the standard antibiotic Ampicillin. *Ocimum sanctum* also showed strong inhibition, particularly against *S. aureus* (21 mm), which supports its traditional use in treating skin infections and respiratory ailments. *Curcuma longa* demonstrated moderate antimicrobial effects, with the lowest zone of inhibition among the three oils but still within effective ranges. Overall, all three essential oils displayed broad-spectrum antimicrobial activity, suggesting their potential as natural alternatives or adjuncts to conventional antibiotics, especially in combating resistant bacterial strains. These findings validate the traditional medicinal use of these plants and highlight their relevance in developing herbal antimicrobial agents.

Table 5: Antioxidant Activity (DPPH Assay – % Inhibition)

Plant Name	50 µg/mL	100 µg/mL	200 µg/mL
Ocimum sanctum	45.2%	61.3%	78.4%
Curcuma longa	40.6%	55.0%	71.2%
Cymbopogon citratus	48.5%	63.7%	81.6%
Standard (Ascorbic acid)	50.1%	65.9%	85.0%

All three essential oils showed significant antimicrobial activity, with *Cymbopogon citratus* showing the largest zones of inhibition across all tested bacterial strains. In antioxidant assays, the oils demonstrated dose-dependent free radical scavenging effects comparable to the standard antioxidant (ascorbic acid). This validates the traditional use of these oils in treating infections and inflammation-related ailments.

The integrated pharmacognostic and therapeutic evaluation confirms that essential oils from *Ocimum sanctum*, *Curcuma longa*, and *Cymbopogon citratus* possess potent bioactive compounds and significant biological activity. These findings support their ethnomedicinal use and present strong potential for development as phytopharmaceutical agents.

Conclusion

The comprehensive pharmacognostic and therapeutic evaluation conducted in this study confirms that essential oils from *Ocimum sanctum*, *Curcuma longa*, and *Cymbopogon citratus* possess significant bioactive compounds and exhibit promising biological activity. Microscopic and physicochemical assessments validated the identity and purity of the plant materials, while GC-MS profiling revealed potent therapeutic constituents. The oils demonstrated substantial antimicrobial effects against common pathogenic bacteria and potent antioxidant properties in vitro. Among the three, *Cymbopogon citratus* showed the highest oil yield and bioactivity, making it a particularly strong candidate for further pharmacological exploration. Overall, the study supports the ethnomedicinal relevance of these plants and advocates their integration into standardized, evidence-based herbal formulations for health and wellness.

References

1. Alotaibi A, Badr G. Neuropharmacological properties of traditional essential oils: A review of experimental evidence. Arabian Journal of Chemistry. 2022;15(3):103–112.
2. Bakkali F, Averbeck S, Averbeck D, Idaomar M. Biological effects of essential oils-A review. Food and Chemical Toxicology. 2008;46(2):446–475. doi:10.1016/j.fct.2007.09.106
3. Khair-ul-Bariyah S, Ahmed D, Ikram M. Pharmacognostic evaluation and phytochemical analysis of *Pistacia integerrima* leaf. Asian Pacific Journal of Tropical Biomedicine. 2012;2(3 Suppl):S1043–1046. doi:10.1016/S2221-1691(12)60357-3
4. Nair R, Rani R, Kumar S. Ethnopharmacological uses and pharmacognostic analysis of essential oils in tribal communities. Indian Journal of Traditional Knowledge. 2024;23(1):45–52.
5. Patel V, Joshi D. Antioxidant evaluation of essential oils from indigenous Indian spices using GC-MS profiling. Pharmacognosy Research. 2023;15(2):98–106.
6. Sharifi-Rad M, Varoni EM, Salehi B, *et al*. Plants of the genus Curcuma: From traditional uses to modern medicine. Medicinal Chemistry. 2017;13(2):1–19. doi:10.2174/1573406413666170119091537
7. Sharma M, Gupta R, Verma S. Antimicrobial properties of essential oils from Himalayan medicinal plants: A review. Journal of Ethnopharmacology. 2021;267:113517.
8. Singh R, Kumar A. Pharmacognostic profiling and essential oil analysis of Indian aromatic herbs. International Journal of Herbal Medicine. 2020;8(4):12–18.
9. Trease GE, Evans WC. Pharmacognosy. 16th ed. London: Saunders Elsevier; c2009.