

“Therapeutic Potential of *Catharanthus Roseus*: A Review of its Bioactive Constituents and Pharmacological Activities”

Dr. Sangeeta Yadav¹, Isha Singh², Chanchal Kumari²

1. Assistant professor in Ram Chameli Chadha Vishvas Girls College, Department of chemistry from C.C.S University, Meerut, U.P
2. M.sc students of Ram Chameli Chadha Vishvas Girls College, Department of chemistry from C.C.S University, Meerut, U.P

Corresponding author:

Dr. Sangeeta Yadav, Assistant professor in Ram Chameli Chadha Vishvas Girls College,
Department of Chemistry from C.C.S University, Meerut, U.P
Ph. No. 6392366995

Abstract

Catharanthus roseus (L.) G. Don, commonly known as **Madagascar periwinkle**, is a medicinal plant belonging to the family Apocynaceae and is widely recognized for its significant therapeutic potential. The plant has been extensively utilized in traditional medicine and has gained considerable importance in modern pharmaceutical research due to its rich phytochemical composition. It contains a diverse range of bioactive constituents, including indole alkaloids, flavonoids, phenolic compounds, tannins, terpenoids, and saponins, which contribute to its wide spectrum of biological activities.

Among its phytoconstituents, the alkaloids vincristine and vinblastine are of particular importance because of their established role in cancer chemotherapy. In addition to its anticancer properties, *C. roseus* exhibits antidiabetic, antioxidant, antimicrobial, anti-inflammatory, antihypertensive, and wound-healing activities. These pharmacological effects have attracted significant scientific interest and support the plant's potential as a valuable source of therapeutic agents. Despite its medicinal benefits, the plant may exhibit toxic effects at high doses, highlighting the importance of dose standardization and safety evaluation.

This review provides a comprehensive overview of the botanical characteristics, phytochemical constituents, pharmacological activities, toxicity profile, and therapeutic applications of *Catharanthus roseus*. Furthermore, it highlights recent research developments and future prospects related to the utilization of this plant in drug discovery and development. The available evidence demonstrates that *C. roseus* remains an important medicinal resource with considerable potential for the development of novel pharmaceutical products.

Introduction

Taxonomic Rank	Classification
Kingdom	Plantae
Division	Magnoliophyta (Angiosperms)
Class	Magnoliopsida (Dicotyledons)
Order	Gentianales
Family	Apocynaceae
Genus	<i>Catharanthus</i>
Species	<i>Catharanthus roseus</i> (L.) G. Don
Common Name	Madagascar Periwinkle
Synonym	<i>Vinca rosea</i> L.



Fig. 1 *Catharanthus roseus* or Madagascar periwinkle

1. *Catharanthus roseus* in Medicine

- *Catharanthus roseus* (L.) G. Don, commonly known as Madagascar periwinkle, is a perennial herb belonging to the family Apocynaceae. Native to Madagascar, the plant is now widely cultivated in tropical and subtropical regions across the world. It has long been used in traditional medicine for the treatment of various ailments, including diabetes, hypertension, infections, and inflammatory conditions.
- The medicinal significance of *C. roseus* is mainly attributed to its rich content of terpenoid indole alkaloids. More than 130 alkaloids have been identified from different parts of the plant, among which vincristine and vinblastine are of particular pharmaceutical importance.
- These compounds are widely used as chemotherapeutic agents in the treatment of leukemia, lymphoma, breast cancer, and other malignancies. Apart from its anticancer properties, the plant exhibits antioxidant, antimicrobial, antidiabetic, anti-inflammatory, and wound-healing activities. Owing to its diverse pharmacological effects and therapeutic applications, *Catharanthus roseus* has become one of the most extensively studied medicinal plants and continues to be a valuable source of bioactive compounds for modern drug development.
(Mahamoodally et al., 2022; Trivedi et al., 2023; Khan et al., 2024)

2. Medicinal Plants in Modern Drug Discovery

- Medicinal plants have been used for the prevention and treatment of diseases since ancient times. They represent an important source of biologically active compounds that continue to contribute significantly to modern medicine. Natural products obtained from plants possess diverse chemical structures and pharmacological properties, making them valuable resources for drug discovery.
- Several clinically important drugs, including anticancer, antimicrobial, antimalarial, and cardiovascular agents, have originated from plant-derived compounds.
- The growing interest in natural products is driven by their therapeutic potential, structural diversity, and relatively lower incidence of adverse effects compared to synthetic drugs.

Consequently, medicinal plants remain an essential focus of pharmaceutical and biomedical research aimed at developing novel therapeutic agents. (Koehn & Carter, 2005; Atanasov et al., 2021)

Phytochemical analysis of *Catharanthus roseus*

Table: Phytochemical Constituents of *Catharanthus roseus* and their Pharmacological Activities

Category	Phytochemical Constituent	Plant Part	Pharmacological Activity
Major Alkaloids	Vincristine	Leaves, stems	Potent anticancer agent used in the treatment of leukemia, lymphoma, and breast cancer
	Vinblastine	Leaves, stems	Antineoplastic compound that inhibits cell division and suppresses tumor growth
	Ajmalicine (Raubasine)	Roots, leaves	Exhibits antihypertensive and vasodilatory properties
	Serpentine	Roots	Demonstrates antihypertensive and mild sedative effects
	Catharanthine	Leaves	Antioxidant activity; serves as a precursor in vinblastine biosynthesis
	Vindoline	Leaves	Antioxidant activity; serves as a precursor in vincristine and vinblastine biosynthesis
	Primary Metabolites	Carbohydrates	Leaves, stems, roots
Proteins and Amino Acids		Whole plant	Contribute to growth, tissue repair, and enzyme synthesis
Lipids		Seeds, leaves	Involved in membrane structure and energy storage
Organic Acids		Leaves and roots	Participate in metabolic regulation and antioxidant defense mechanisms
Secondary Metabolites	Flavonoids	Leaves, flowers	Possess antioxidant, anti-inflammatory, and antimicrobial activities
	Phenolic Compounds	Leaves, flowers	Exhibit free-radical scavenging and antioxidant properties
	Tannins	Leaves, roots	Demonstrate antimicrobial, astringent, and wound-healing activities
	Terpenoids	Leaves, stems	Associated with anti-inflammatory and antimicrobial effects
	Saponins	Leaves, roots	Exhibit antioxidant, antimicrobial, and immunomodulatory properties
	Steroids	Leaves, stems	Possess anti-inflammatory activity and potential therapeutic applications

Pharmacological Activities of *Catharanthus roseus*

- **Anticancer Activity:** The anticancer potential of *Catharanthus roseus* is primarily attributed to the presence of the indole alkaloids vincristine and vinblastine. These compounds interfere with microtubule formation during mitosis, thereby inhibiting cell division and inducing apoptosis in rapidly proliferating cancer cells. Vincristine is widely used in the treatment of acute lymphoblastic leukemia, Hodgkin's lymphoma, and neuroblastoma, whereas vinblastine is employed in the management of Hodgkin's disease, breast cancer, and testicular cancer. The discovery of these alkaloids established *C. roseus* as one of the most significant medicinal plants in modern chemotherapy. (Noble, 1990; van Der Heijden et al., 2004; Mahamoodally et al., 2022; Khan et al., 2024)
- **Antidiabetic Activity:** Traditionally, *C. roseus* has been used for the management of diabetes mellitus. Various studies have reported that extracts of the leaves and roots can reduce blood glucose levels by enhancing insulin secretion, improving glucose utilization, and reducing oxidative stress. The hypoglycemic activity is mainly associated with alkaloids, flavonoids, and phenolic compounds present in the plant. (Mahamoodally et al., 2022; Trivedi et al., 2023; Sharma et al., 2024)
- **Antioxidant Activity:** The plant exhibits considerable antioxidant activity due to its rich content of flavonoids, phenolic compounds, and terpenoids. These phytochemicals neutralize reactive oxygen species (ROS) and prevent oxidative damage to cellular components. Antioxidant activity contributes to the prevention of various chronic diseases, including cancer, cardiovascular disorders, and neurodegenerative conditions. (Mustafa & Verpoorte, 2007; Nejat & Valdiani, 2014; Hira et al., 2024)
- **Antimicrobial Activity:** Extracts of *Catharanthus roseus* have demonstrated antimicrobial activity against a wide range of bacterial and fungal pathogens. The antimicrobial effects are attributed to alkaloids, tannins, flavonoids, and saponins, which inhibit microbial growth by disrupting cell membranes and interfering with essential metabolic processes. (Mahamoodally et al., 2022; Trivedi et al., 2023; Sharma et al., 2024)
- **Anti-inflammatory Activity:** The plant possesses significant anti-inflammatory properties that help reduce inflammation and associated tissue damage. Secondary metabolites such as flavonoids and terpenoids inhibit the production of inflammatory mediators, thereby alleviating symptoms of inflammatory disorders. (Mahamoodally et al., 2022; Chaturvedi et al., 2022; Sharma et al., 2024)
- **Antihypertensive Activity:** Certain alkaloids, particularly ajmalicine and serpentine, exhibit antihypertensive effects by promoting vasodilation and improving blood circulation. These compounds contribute to the traditional use of *C. roseus* in the management of high blood pressure and cardiovascular disorders. (van Der Heijden et al., 2004; Mahamoodally et al., 2022; Trivedi et al., 2023)
- **Other Biological Activities:** In addition to the activities mentioned above, *Catharanthus roseus* has shown potential antidiarrheal, hepatoprotective, immunomodulatory, and neuroprotective

effects. These pharmacological properties further highlight the therapeutic importance of this medicinal plant and support ongoing research into its clinical applications. (Nejat & Valdiani, 2014; Chaturvedi et al., 2022; Khan et al., 2024)

Future Prospects for *Catharanthus roseus*

- The growing interest in plant-derived therapeutics has highlighted *Catharanthus roseus* as a promising source of novel bioactive compounds. Future research should focus on the identification and characterization of new phytochemicals with enhanced therapeutic potential and reduced toxicity.
- Advances in biotechnology, metabolic engineering, and synthetic biology may improve the production of valuable alkaloids such as vincristine and vinblastine, overcoming limitations associated with their low natural yield.
- Furthermore, the development of nanotechnology-based drug delivery systems could enhance the efficacy and targeted delivery of *C. roseus*-derived compounds. Comprehensive clinical studies and safety evaluations are also required to validate traditional medicinal uses and facilitate the development of standardized herbal formulations.
- Continued investigation into the pharmacological properties of this plant may contribute significantly to future drug discovery and the treatment of various chronic diseases.

(Nejat & Valdiani, 2014; Atanasov et al., 2021; Mahamoodally et al., 2022; Khan et al., 2024)

Conclusion

Catharanthus roseus (Madagascar periwinkle) is one of the most valuable medicinal plants owing to its rich phytochemical composition and diverse therapeutic properties. The plant contains numerous bioactive constituents, particularly the indole alkaloids vincristine and vinblastine, which have gained global recognition for their role in cancer chemotherapy.

In addition to its anticancer potential, *C. roseus* exhibits antidiabetic, antioxidant, antimicrobial, anti-inflammatory, antihypertensive, and wound-healing activities. These pharmacological properties highlight its significance in both traditional and modern medicine.

Although the plant possesses considerable therapeutic value, appropriate safety evaluation and dose standardization remain essential to minimize potential toxic effects.

Continued research on its phytochemistry, biological activities, and advanced drug delivery approaches may further expand its pharmaceutical applications.

Overall, *Catharanthus roseus* remains a promising medicinal resource with substantial potential for future drug discovery and development.

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