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Review Article

Catharanthus Roseus: Phytochemistry, Pharmacological Activities, Traditional Uses and It's Most Potent Anticancer Activity

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ABSTRACT

Madagascar periwinkle (*Catharanthus roseus* (L.) G. Don) is a widely used and highly appreciated medicinal plant whose vast phytochemical flavour and multifaceted pharmacological potential has been significantly exploited. The plant, traditionally applied in different healing systems, has been utilized in treatment of ailments like diabetes, high blood pressure, skin diseases, infections and inset of menstrual irregularities. Scientific corroboration of its ethnomedical application has been known to have discovered an extremely high number of pharmaceutically active compounds, including more than 130 indole alkaloids, flavonoids, tannins, terpenoids, saponins, and phenolic acids. Its phytochemicals, the dimeric indole alkaloids, vinblastine and vincristine have been most important, making *C. roseus* a cornerstone of anti cancer therapy. These drugs possess the cytotoxic effect against microtubule dynamics and led to the mitotic arrest and subsequent cancer cell apoptosis in the highly adherent, proliferating cells. The fact that they have been successfully used in clinical settings in treating leukaemia, Hodgkin lymphoma, breast cancer, and other cancers among other

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drugs portray the significance of the plant in contemporary pharmacology. Besides its anticancerous effects, there is a diverse distribution of pharmacological action of *C. roseus* such as antidiabetic, antioxidant, anti-inflammatory, antimicrobial, antihypertensive, and neuroprotection potential. These properties are mainly ascribed to its polyphenol and alkaloid contents which have the synergetic effect of impacting on various biological pathways. It has low the level of naturally occurring active compounds; however due to newer developments in the field of biotechnology, plant tissue culture and drug delivery systems, it is becoming easier to cultivate and make its effect even in high frequency. The summary of this review is that *C. roseus* with its traditional uses, phytochemistry, pharmacological activities, and anticancer mechanisms shapes the significance of *C. roseus* as a model plant in discovery process of drug based on natural products. Further study of its bioactive components and the effects of the latter could produce new potential medicine and strengthen the value of plant-based medicine in the world at large.

INTRODUCTION

Catharanthus roseus (L.) G. Don, also called Madagascar periwinkle, is a genus of herbaceous plant belonging to the family Apocynaceae. Given the highly recognized ornamental beauty as well as healing powers, *C. roseus* is among the most well studied medicinal plants in the contemporary pharmacognosy Fig.1[1]. This species is indigenous to Madagascar and was naturalized to many areas in the tropics and sub-tropics all over the globe such as South Asia, Africa, and the Americas where it works well under a wide range of climatic conditions and soil types. The ethnomedicinal folklore and an outstanding phytochemical composition of *C. roseus* has due to this reason enhanced its botanical eminence as such, it has become an important choice in the context of pharmacology, phytochemistry and oncology[2]. Along with the long history of native health care its use, the importance of *Catharanthus roseus* in traditional medicine is very ancient. The several cultures have used the different components of the plant; leaves, flowers, roots, and latex treating an array of ailments starting with

diabetes, fever, sore throat, infections, and even, cancer. Such systems as Ayurveda, Traditional Chinese Medicine (TCM), and African folk medicine have recorded the uses of this plant in therapeutics, owing its curative effects to the occurrence of bioactive substances in its tissues. It is based on these ethnomedical uses that scientific evaluation and finally isolation of powerful indole alkaloids was made on the plant[3]. The healing revolution that *Catharanthus roseus* triggered is mainly because of its exceptional biosynthetic abilities to synthesize more than 130 structurally distinct alkaloids most of which are the dimeric indole alkaloids, vincristine and vinblastine[4]. These agents are also having wide appreciation in clinical oncology especially their cytotoxic activity on cancer cells in the treatment of hematological cancers as well as solid tumors. Vincristine and vinblastine have established themselves as central chemotherapeutic medications, to be used in combination regimens to treat cancers, and these include Hodgkin lymphoma, acute lymphocytic leukemia, breast cancers, and Wilms tumor. The role of *C. roseus* to world health is emphasized by the fact that they are on the Model List of Essential Medicines by the World Health Organization[5]. The plant is also a rich source of flavonoids, terpenoids, tannins, saponins, phenolic acid and glycosides that give it a wide pharmacology. These compounds have diverse biological effects that include antioxidant, antimicrobial, anti-inflammatory, antidiabetic, hepatoprotective among others. These bioactives could have synergistic actions, which would reinforce the therapeutic benefit of *C. roseus*, which could be behind its widespread use in traditional medicine, and promote innovative uses of *C. roseus* in integrative medicine[6-10]. The complexity of alkaloid biosynthesis drastically makes *Catharanthus roseus* a very interesting element of pharmacological research. The taxa is the only



one to produce vinblastine and vincristine by a complex enzyme mediated coupling of two simple monomeric alkaloids-catharanthine and vindoline[11]. This coupling is controlled in a highly regulated spatial compartmentalized manner and the plant cells contain complex metabolic networks, which have now attracted research attention in plant biotechnology and metabolic engineering. These and other alkaloids of naturally low abundance in the plant (generally less than 0.0005 percent dry weight) have motivated contention in increasing their production with the assistance of biotechnological systems like use of cell suspension cultures, hairy root cultures and even synthetic biological strategies[12]. In addition, the pharmacological potential of *C. roseus* is supported by scientific evidence, which has confirmed most of its applications. As an example, the aqueous and ethanolic leaf extracts have reportedly possessed remarkable hypoglycemic and anti-diabetic properties in diabetic models as dictated by the Indian and Chinese traditional usage of the leaf to treat cases of diabetes. Its use in treatment of infections has been backed by a study of its antimicrobial activity against a variety of pathogenic bacteria and fungi. Also, *C. roseus* has been found to have antioxidant activity implying to its ability to scavenge the reactive oxygen species (ROS), thereby, protecting against oxidative stress and diseases caused by inflammation. These pharmacodynamic characteristics do not only reflect the therapeutic flexibility of this agent but also give an argument in favor of conducting additional pharmacokinetic and clinical studies[13-15]. Even in spite of the medicinal significance attached to *Catharanthus roseus*, scientific application of the plant species in therapy is not without difficulty. Although purified alkaloids preferably vincristine and vinblastine are useful cancer agents, they also have serious side effects, which include neurotoxicity and

myelosuppression[16]. Standardized, quality-controlled and clinically tested should be done especially because unregulated or indiscriminate use of crude plant extracts is potentially dangerous. Moreover, concerns surrounding environmental impact and sustainability with regard to large-scale harvesting of *C. roseus* material, as a medicine source, has attracted attention into alternative production systems such as semi-synthetic and microbial pathways of biosynthesis[17-20]. The importance of *C. roseus* in the sphere of cancer treatment cannot be underestimated. The capacity of the plant to synthesize cytotoxic substances that specifically kill proliferation of cancer cells has transformed chemotherapy. Vincristine and vinblastine work by combining with tubulin and hence prevent the formation of microtubules needed to build a mitotic spindle. This effect causes the arrest of mitosis and eventual the apoptosis of fast-proliferating cancer cells. Their applicability in combination chemotherapies has increased the functioning of treatment in various cancer types. Subsequent research is still investigating new derivatives and analogues of these alkaloids, to pursue increased efficacy and lesser adverse effects[21-25]. This review will provide a critical analysis of *Catharanthus roseus* including description of the traditional medicine that derives its use, phytochemical compounds, with a detailed report on the pharmacological effects and anticancer properties. Special attention is given to the dimeric indole alkaloids vincristine and vinblastine and their history, scientific elaborations, clinical effects and possible future considerations in the field of oncology. Also discussed in the article is the occurrence of new biotechnological methods of yielding alkaloid more and potential of the derivatives of *C. roseus* in developing new therapeutic agents[26]. *Catharanthus roseus* is an excellent example of the tremendous medical possibility of natural



products of plant origin. Being the foundation of the traditional medicine and an important agent of modern chemotherapy, this plant will always have people explore it in their studies. With an increasing level of scientific knowledge, *C. roseus*

could indicate the dawn of new pharmacology with sustainable and effective cancer treatments once again proving the necessity of nature in the development of human well-being[27].



Fig.1: *Catharanthus Roseus*

2. Phytochemistry

Catharanthus roseus (L.) G. Don is a widely known medicinal plant which exists as a very diverse and complicated chemical mixture of phytochemicals and which forms the foundation of its broad range of therapeutic activities. Of specific note is the plant being able to produce an exorbitant array of secondary metabolites and at the time of writing 130 indole alkaloids have been identified[28]. The distribution of these bioactive constituents in the various parts of the plant such as the leaves, stems, roots, flowers and seeds is dependent on the genetic as well as the environmental factors. Out of such phytochemicals, the monoterpenoid indole alkaloids (MIAs) are the most pharmacologically relevant and have attracted international attention owing to their high anticancer potential[29]. The most significant two dimeric alkaloids, vincristine and vinblastine, are natural products fabricated by the joining of the two individual precursors, catharanthine and vindoline. These have been

dimeric alkaloids which have changed modern day cancer chemotherapy by serving an inhibitory role against tubulin polymerization, disruption of the formation of mitotic spindle which induces metaphase arrest and apoptosis of heavily proliferating cells. Vincristine is particularly useful in treatment of pediatric leukaemia and lymphomas, viinblastine used in breast cancer, Hodgkin lymphoma and Kaposi sarcoma. These medicines remain essential to most chemotherapies and found in the WHO list of essential medicines[30]. *C. roseus* also synthesizes several monomeric alkaloids in addition to these characteristic alkaloids, which have the properties of anti-hypertensive, anti-diabetic, hypnotic and vasodilatory effects, including ajmalicine, serpentine, lochnericine, tabersonine, and others. These monomeric alkaloids, though not as cytotoxic as the dimeric alkaloids, has a role to play in the overall pharmacological representation of the plant. The compartmentation of these alkaloids synthesis in the plant cells and tissues is very high and requires specific enzymes systems

like tryptophan decarboxylase, strictosidine synthase and acetyltransferases. This elaborate metabolic pathway has received immense studies, especially in the algorithm of metabolic engineering and synthetic biology, that focuses on improving the yield of alkaloid using microbial expression system or tissue cultures[31-34]. In addition to alkaloids, *Catharanthus roseus* is an excellent source of flavonoids that contain quercetin, kaempferol, rutin and luteolin, apigenin. The polyphenolic compounds are those popular because of their antimicrobial, anti-inflammatory, and antioxidant properties. These flavonoids eliminate free radicals and block the mechanisms of oxidative stress which is associated with long-term diseases like cancer, heart diseases and disorders of the central nervous system[35]. They are also becoming of interest as possible anti-cancer adjuvants, potentially potentiating the effects of alkaloid based chemotherapies with reduced cytotoxic side effects. *C. roseus* also contains phenolic acids, gallic acid, ferulic acid, caffeic acid, and chlorogenic acid, which augment the antioxidant ability of the plant. These substances assist in protecting cell constituents against oxidative harm, prevent representatives of inflammatory processes and enhance the conventional uses of the plant in antibody of fever, infections and wound recuperating[36]. In addition, the plant also possesses several terpenoids and steroids like lupeol, beta-sitosterol, and stigmasterol which also makes the plant anti-inflammatory, hepatoprotective, and antimicrobial. Specifically, lupeol has already been studied in its impact on anti-proliferation and pro-apoptosis in cancer models. Another use of terpenoids is their role of modulating immune responses and could have synergistic effects when combined with other bioactive compounds. Another aspect of *C. roseus* that expands its pharmacological applications is the presence of tannins and saponins. Tannins are astringent and

they have antimicrobial properties and hence they are useful in the treatment of diarrhea, skin infection and small wounds. Conversely, Saponins exhibit hemolytic/ Immune- stimulant effects and they can be used to enhance bioavailability of other drugs when administered together by being able to enhance membrane permeability[37-39]. These phytochemicals are qualitatively and quantitatively dispersed depending on the age, part, geographical origin and cultivating circumstances of the plant. Research surveys have also demonstrated that plant materials are aerial, leaving insensitively in leaves and stems, are more likely to contain higher amounts of alkaloids than the roots or grains. Additionally, secondary metabolite biosynthesis has also been shown to respond to environmental stresses (such as salinity, drought and pathogen attack) which in many instances may be directed towards higher levels of alkaloid biosynthesis as part of a plant defense response. Owing to the fact that natural abundance of vinblastine and vincristine is usually less than 0.0005 percent of dry weight, sustainable means of production is urgently desired. Scientific progress related with plant biotechnology has brought with it emerging mechanisms like cell suspension cultures, hairy root cultures and genetically engineered microbial hosts to commercially produce such economically important compounds[40-43].

3. Traditional uses

Madagascar periwinkle (*Catharanthus roseus* (L.) G. Don) has been used in the traditional systems of medicine of various cultures and continents, centuries before they were discovered to contain potent anticancer alkaloids. Native populations in Asia, Africa, and the Americas have been using the different parts of this plant (such as leaves, flowers, stems, roots, and latex) to treat a wide range of conditions. In Ayurvedic, *C. roseus* is



commonly referred to as Sadaphuli, or Nityakalyani and it has been traditionally used in management of type 2 diabetes mellitus, hypertension, menstrual disorders, skin diseases as well as toothaches. Leaves known to be used mainly as decoction or paste have been administered orally as a hypoglycemic agent with the endorsement of traditional healer and its modern reviews that justify the use of leaf against this condition. Besides its antidiabetic application, the plant is externally used in the preparation of boils, eczema, dermatitis and insect bites, exploiting its supposed anti inflammatory and antimicrobial characteristics[44]. *C. roseus* contains cooling, detoxifying, and blood-purifying effect in the Traditional Chinese Medicine (TCM). Traditionally it is used in treating fevers, epilepsy, tonsillitis, bleeding disorders and hypertensive attacks. Its roots are thought to be sedative and purgative and infusions made of the entire plant are frequently employed in dispelling internal heat, quieting the mind and bringing circulation into regularity. The use of *C. roseus* preparations by Chinese herbalists in conditions that can be roughly analogized to present-day understandings of malignancy dates back a far longer time than is generally assumed; the exact anticancer mechanisms involved were, however, not understood in those days. The fresh leaf juice is used in a direct manner in treating skin sores and infections in the Filipino folk medicine, whereas the whole plant is prepared as teas to treat dysmenorrhea, gastrointestinal disorders, and high blood pressure in Vietnam. In Africa and particularly in the parts of the continent like Nigeria, Kenya and South Africa, *Catharanthus roseus* is a key element of traditional healing application. Locally it is used to treat malaria, dysentery, diarrhea and urinary tract infections. Leaves and root decoctions are used to lower the fever, and to fight parasitic diseases, in parallel with the antiparasitic and antibacterial plant

compounds. In certain African tribes, the crushed leaves are used as a treatment of snake bite, scorpion sting and external wounding, which refers back to the antimicrobial and constrictive nature of the leaves. Besides, the plant is used as oral contraceptive in some traditional applications, which is associated with high safety concerns because of its cytotoxic constituents and should be avoided in evidence-based medicine[45]. *C. roseus* is traditionally used as a component of cancer-like symptoms and hemorrhoids as well as dyspepsia and rheumatism treatments in the Caribbean and Latin America. The use of the extract suggests analgesic and anti-inflammatory action as traditional healers usually make infusions or decoctions of this plant to get relieved of headache, body pains, and tooth pains. In its folk medicine actions, the plant is usually applied to purify blood and clean kidneys. Likewise the Suriname and Guyana native healers administer periwinkle based herbal preparations to treat diabetes, high cholesterol levels, and tuberculosis; they are usually coupled with other medicinal herbs. In the early years of this century *C. roseus* was also used in South America (especially Brazil and Peru) to treat snake bite and the latex is still applied locally to arrest haemorrhage or promote wound healing. This plant will be familiar to the Mediterranean and European among other users, although it is not native, but has been integrated into popular herbal practice to treat constipation, inflammation diseases and cardiac complaints, typically drunk as a tea or contained in a tincture. Periwinkle Italian and Greek traditional medicine Use periwinkle is used to treat memory loss within traditional Italian or Greek medicine, and also as a mild sedative. *C. roseus* preparations used in homeopathy have been reported to be useful in the treatment of abnormal vaginal bleeding, leucorrhea and diabetic neuropathy but well-established science is lacking[46]. The broad range of folk applications associated with



Catharanthus roseus can be linked to the large number of phytochemical constituents which are reported to be present in this plant, especially the alkaloids, flavonoids, phenolics and tannins, many of which are now reported to be biologically active. Notably, the modern pharmacological study of the plant occurred on the basis of the traditional uses. This is seen when traditional practice is based on the use of periwinkle, as a diabetes management agent, in India and the Caribbean, which in turn led to scientific research which ultimately ascertained its hypoglycemic and insulin-sensitizing effects. Traditional healer reports, in anecdotal form, that the plant caused swelling and tumor reduce and information was used to isolate vincristine and vinblastine (two of the strongest known anticancer agents of natural origin). But it is worth mentioning that even though traditional medicine is a significant contributor of ethnopharmacological wisdom behind *C. roseus*, it is pertinent to consider that, there are inhibitory concentrations associated with crude plant components which can be toxic when not standardized given that alkaloid components contained in the plant exhibit narrow therapeutic window. Greater than respected dose of raw extract, chronic utilization can generate bad outcomes including neurotoxicity, intestinal upset, or hematological difficulties. Hence, although conventional applications are stimulating, they give good information and treatment hypotheses, the move to effective notions of plant experts

through scientific scrutiny, controlled extraction, and clinical tests is necessary[47]. To summarize, *Catharanthus roseus* has found deep roots in the traditional healing where it has long been used to treat various ill conditions in most parts of the world including diabetes, infections, and skin diseases as well as symptoms that indicate the presence of cancer. The rich traditional medicine connected with the plant acted as a stimulus towards scientific research and the invention of modern medicine. The *C. roseus* historical application is one of the many examples of how ancient knowledge and scientific drug innovation work alongside each other, and the potential longevity of ethnobotany knowledge base in the disease-treating mechanism, and providing healthcare systems with a synergetic approach to managing pharmacological products[48].

4. Pharmacological activities

The pharmacological actions of *Catharanthus roseus* are manifold and most of these activities can be ascribed to the abundance of secondary metabolites, mainly indole alkaloids, flavonoids and phenolics as well as terpenoids in this plant. Vast pharmacological studies have confirmed most of its traditional uses and identified other therapeutic possibilities especially in cancer, hormonal and infectious disease treatment. Major pharmacological actions listed in *C. roseus* include the following Fig.2:

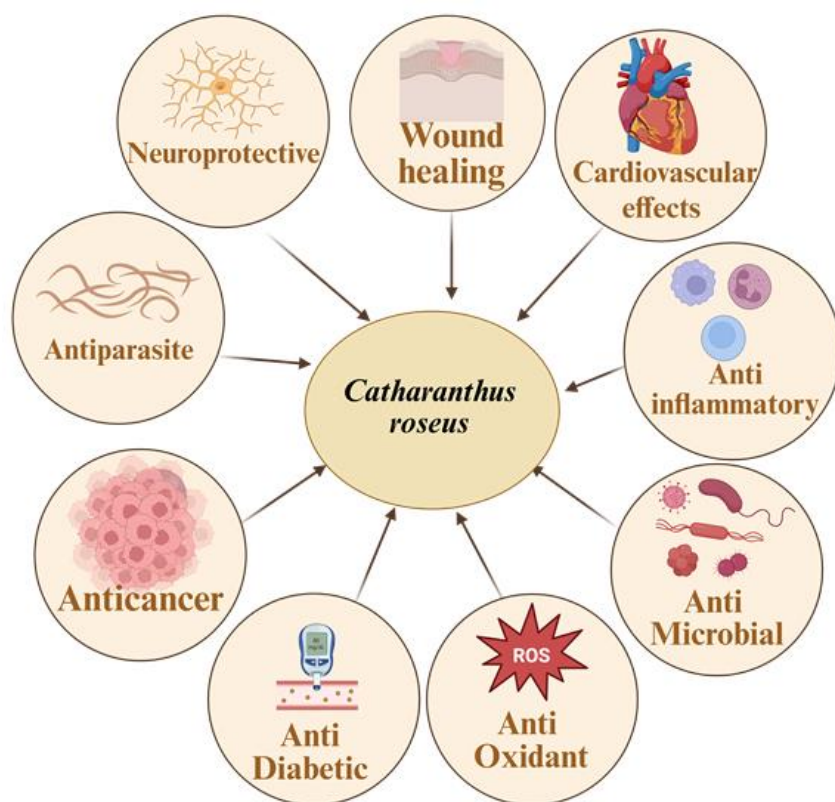


Fig.2: *Catharanthus roseus* pharmacological activities

4.1 Anticancer activity

The *Catharanthus roseus* (L.) G. Don because of its productions of powerful anticancer alkaloids has become one of the most important medicinal plants in oncology. The plant has worldwide fame regarding the discovery of two indispensable dimeric indole alkaloids, namely vinblastine and vincristine, which have changed the face of cancer chemotherapy most profoundly. The alkaloids are biosynthesized by the enzymatic condensation of two monomeric precursors that are naturally present natural plant materials (catharanthine and vindoline). Though occurring in small amount (< 0.0005 per cent of dry weight), vincristine and vinblastine have very selective cytotoxic effect on dividing cancer cells hence they are one of the most potent agents of natural chemotherapy to have ever been discovered. Vinblastine and vincristine act on cancer cells, mainly by disrupting microtubules. These are the compounds

specific to tubulin proteins and prevent them to be assembled into the microtubules. The end result of all this is the arrest of cell division at the metaphase level during mitosis leading to death of the cell by apoptosis (programmed cell death). This interference with the mitotic spindle formation inhibits normal segregation of the chromosomes and is especially deadly to the fast growing dividing cells like the ones that are present in a tumor. Also, the two alkaloids can disrupt the process of signal transduction, repress angiogenesis as well as hinder the invasion and migration of cancer cells. Vincristine is widely employed in the therapy of malignancies in the blood such as acute lymphoblastic leukemia (ALL), non-Hodgkin lymphoma, Hodgkin lymphoma, other myeloma, Wilms tumor, as well as neuroblastomas. It is commonly used in combination programs, e.g. CHOP or MOPP regimens. Instead, vinblastine has proved effective against solid malignancies such as breast

cancer, testicular cancer, Kaposi sarcoma and lung cancer. A relatively clear profile of toxicity and predictable pharmacokinetics also contributes to the level of its therapeutic efficacy[49]. Along with vinblastine and vincristine, other related alkaloids vindesine, vinorelbine, and vinflunine (derivatives of the original substances, but semi-synthesized) were invented to maximize the clinical responses and minimize their toxicity. These analogs have increased the therapeutic scope of the vinca alkaloids particularly in the resistant or refractory cancers. Current studies also examine the possible chemotherapeutic synergy between vinca alkaloids and other chemotherapeutics or investigational drugs to improve response rates and reduce toxicity. The anticancer effect of *C. roseus* is the best-documented, pharmacological activity of the plant mainly because of the dimeric alkaloids such as vincristine and vinblastine that are present. These consist of compounds which bind to tubulin and prevent the formation of microtubules causing the cells to stagnate at metaphase and result in apoptosis of rapidly dividing cancer cells. Vincristine is applied in the treatment of leukemia, lymphoma, neuroblastoma and Wilms tumor and vinblastine used in the treatment of Hodgkin Disease, testicular cancer and Kaposi sarcoma. In vitro and in vivo experiments have depicted strong cytotoxicity of plant extracts and isolated compounds towards MCF-7 (breast), A549 (lung) and HeLa (cervical) cell lines. *C. roseus* has been selected in most frontline chemotherapy protocol due to anticancer efficacy[50].

4.2 Antidiabetic activity

C. roseus is highly tested in the traditional medicine, where it is used in the treatment of diabetes, a fact that has strong scientific evidence. The ethanolic and aqueous extracts of leaves showed hypoglycemic action in streptozotocin and

alloxan induced diabetic rats. The popularity is thought to include boost in insulin secretion, generation of insulin soreness and minimization of oxidative stress. The antihyperglycemic effect is due to active phytochemicals present in it such as vindoline and flavonoids. Continuous treatment with herbal extracts too have demonstrated the ability to lower serum glucose and triglycerides as well as enhance the activity of the pancreatic β cell[51].

4.3 Antioxidant activity

C. roseus owes its antioxidant activity mainly to the flavonoids (quercetin, kaempferol) and phenolics (gallic acid and chlorogenic acid) and vitamin C. The compounds modify these free radicals and help increase the level of oxidative stress thereby preventing the damage of the cells. The radical scavenging activity of the plant has been affirmed through several assays, viz., DPPH, FRAP, and ABTS. This activity is ionic in relation to the anti-cancerous, anti-diabetic and anti-inflammatory effect of avoiding the oxidative damage of DNA, proteins, and lipids [52].

4.4 Antimicrobial activity

C. roseus antimicrobial properties against wide range of microbes have been extensively reported. Both polar and non polar extracts have exhibited bacteriostatic and bactericidal activity against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Bacillus subtilis*. There is even antifungal activity where it has been shown by *Candida albicans* and *Aspergillus* species. Alkaloids, terpenoids, tannins and saponins are credited with the antimicrobial effect; they permeate microbial cell walls and prevent enzyme systems [53].

4.5 Anti-inflammatory activity



C. roseus strains a powerful anti-inflammatory effect, with a pattern proven both in an acute and chronic inflammation in vivo model. Extracts have been found to have a considerable paw edema inhibition effect as a result of carrageenan and formalin-induced arthritis in the rodents. The anti-inflammatory activity works by preventing the pro-inflammatory cytokines (TNF-alpha, IL-6) production, blocking COX-2 expression and figuring out the NF-kappa B signal. Terpenoids and flavonoids are assumed to be important in regulating such inflammatory pathways [54].

4.6 Antihypertensive and cardiovascular effects

The vasodilator and anti-hypertensive alkaloids like ajmalicine and serpentine act on the alpha-adrenergic receptors and calcium channel modulation. The compounds enhance cerebral blood flow and they are applied in treatment of hypertension and peripheral vascular diseases. The plant has also exhibited anti-atherogenic, hypolipidemic and protective properties on the cardiovascular system in experimental models, and this has probably occurred through using antioxidant properties and lowering effects on lipid levels.

4.7 Wound healing and dermatological uses

C. roseus has been traditionally applied in the treatment of skins like wounds, ulcers, boils, and rashes. The leaf extracts administered topically enhance wound contraction, collagen production and epithelialization. It possesses an antibacterial and anti-inflammatory postpones infection and expedites healing. Wound models have indicated better tensile strength and lesser scar production when subjected to wound formulations containing plants.

4.8 Neuroprotective activity

Some preliminary experiments indicate a neuroprotective activity of *C. roseus* neuroprotectivity, particularly, related to antioxidant, anti-inflammatory mechanisms. Some of these alkaloids have been demonstrated to have the potential to cause neuronal damage by oxidative stress and enhance the memorizing functions. These results may suggest potential uses in neurodegenerative disorders like Alzheimer and Parkinson disease but further studies are needed.

4.9 Antiparasitic activity

C. roseus extracts have demonstrated activities on multiple protozoan parasites. Traditional medicine uses it to treat malaria and its effect against Plasmodium species has been demonstrated in experimental studies. It is believed that the mechanism of the antiparasitic actions is the disturbance of the parasitic metabolism and reproduction [55].

5. CONCLUSION

Catharanthus roseus (L.) G. Don is an exceptional case of medicinal plant, which connects knowledge of traditional herbal medicine with the developments of the modern pharmacological sciences. Its wide spectrum of phytochemical components, especially the abundance of more than 130 indole alkaloids, has made it the vital source of bioactive compounds with wide-spectrum therapeutical activity. Within its compounds, the dimeric alkaloids vinblastine and vincristine are remarkable discoveries that have been developed in the field of oncology and that can be considered the most significant contribution of the plant to today modern medicine. These drugs have found themselves an important part of chemotherapeutic applications of several malignant and have made a huge difference in the patient outcomes worldwide. On top of its anticancer us effect, *C. roseus* has a broad



spectrum of pharmacological uses such as antidiabetic, antioxidant, anti-inflammatory, antimicrobial, neuroprotective, and cardiovascular activities. These attributes are made possible by presence of flavonoids, phenolics, tannins, saponins, and terpenoids which either singly or synergistically generate therapeutic effects. A combination of other traditional medicines like the Ayurvedic system, Traditional Chinese Medicine, African, and Caribbean folk medicine has long used the plant to treat all kinds of illnesses, including diabetes, infections, high blood pressure, and skin diseases, among others. Such traditional practices have not only been instrumental in scientific research, but they have also justified the historical importance of the plant in ethno medicine. Despite the massive medicinal potential, clinical usefulness of *C. roseus* is limited especially given the poor natural production of the most prolific alkaloids. This has triggered large scale research activity in the spheres of plant tissue culture, biotechnological synthesis and nanotechnology drug delivery in the hopes that the efficiency of production and bioavailability, as well as improved specific therapeutic actions, will be increased. In addition, further research activities are ongoing in search of innovative analogs and combinations with which it is possible to optimize anticancer activity and reduce toxicity. To conclude, *Catharanthus roseus* is an extraordinary plant in the context of pharmacology having become both the mainstay of folk medicine and an effective tool of the modern pharmaceutical industry. Its exceptional phytochemical compositions and established medicinal benefits qualify its research by necessitating continued research, sustainable utilization and biotechnological innovation. Due to the increasing attention on plant-based therapeutics, the *C. roseus* is a testimony to what medicinal plants have to offer in resolving multifaceted health issues and provide value to the healthcare system worldwide.

REFERENCES

1. Jain MN, Kumar MA, Singh MN, Kumar MD, Singh MS. Catharanthus Roseus: Traditional Uses, Phytochemistry, And Modern Pharmacology: Article History-Date of Submission: Mar 09, 2025, Revision: April 05, 2025, Acceptance: April 24, 2025. International Journal of Medical Science. 2025 May 5:41-70.
2. Sarkar BK, Polash MJ, Islam MJ, Hanif MA, Jannat N, Kundu SK, Sarkar BK, Hossain MS. Unlocking the therapeutic potential of Catharanthus roseus leaves via in-vitro, in-vivo, and in-silico study. Scientific Reports. 2025 Jul 17;15(1):25909.
3. Chakraborty D, Jha L. Unlocking the Therapeutic Potential of Catharanthus Roseus: A Modern Pharmacological Perspective an A Historic Medicinal Plant.
4. Adel Shalaby N, Elhassaneen YA, M Kawila A. Phytochemicals and Bioactivities of Vinca (Catharanthus roseus) Leaf Extracts: Potential Roles in Lipid Oxidation Inhibition and Atherosclerosis Prevention InVitro. Alexandria Science Exchange Journal. 2025 Jun 30;46(2):415-32.
5. Yadav RK. Phytochemical Screening, Gc-MS Analysis, Antioxidant Activity, And Ftir Analysis of Catharanthus roseus (L.) G. Don (Doctoral dissertation).
6. Hira FA, Islam A, Uddin MN. Immunomodulatory and Pharmacological Properties of Catharanthus Roseus: A Comprehensive Review.
7. Jershia Hadrin J, Rosy BA. Geographical Variation in Morphological Traits of Catharanthus Roseus [L.]: A Comparative Study Across Five Distinct Ecological Niches from Southern Tamil Nadu, India.
8. Pham HN. Investigation of the biological and anticancer properties of bioactive compounds



- derived from *Helicteres hirsuta* Lour. and *Catharanthus roseus* (L.) G. Don (Doctoral dissertation, Open Research Newcastle).
9. Banik D, Mandal S, Kundu BB, Chakra BK, Adhikari N, Bhunia A. A Comparative Evaluation of Cold Maceration, Soxhlation and Ultra Sound Assisted Extraction for Phytochemical Screening of Whole Plant of *Blumea Lacera* (Burm. f.) Dc. Along With Its Antibacterial Effect With Respect to *Catharanthus Roseus* (L.) G. Don.
10. Sharma P, Kaur R, Kaur A. Deep Eutectic Solvents as Eco-Friendly Agents for Unlocking Antioxidants from *Catharanthus roseus*.
11. Bhardwaj V. Eco-Friendly Antibacterial Potential of *Catharanthus roseus* Leaf Extracts: A Green Approach to Natural Drug Discovery. *Journal of Microbes in Health and Disease*. 2025 Jun 3;1(1):100004.
12. Abirami P, Sampath S, Al-Ansari MM, Al-Dahmash ND, Lopes BS, Vincent S, Saravanan M. One-pot synthesis of Ag-Cr bimetallic nanoparticles from *Catharanthus roseus* for anti-bacterial, anticancer, anti-diabetic, and anti-inflammatory activity and toxicity study in zebrafish. *Biomass Conversion and Biorefinery*. 2025 Feb;15(4):4999-5013.
13. de Andrade CM, Rohlf IA, Caetano TT, Ronzani LD, Stein VC. The redesigned *Psychotria* genus: medicinal potential of alkaloids and biotechnological strategies for metabolite improvement. *Phytochemistry Reviews*. 2025 Jul 5:1-7.
14. Gonçalves BM, Duarte N, Ramalheite C, Barbosa F, Madureira AM, Ferreira MJ. Monoterpene indole alkaloids with anticancer activity from *Tabernaemontana* species. *Phytochemistry Reviews*. 2025 Jun;24(3):2271-307.
15. Parvez S, Parvin MN. Phytochemical, Pharmacological, and Toxicological Studies of *Solanum americanum*: A Systematic Review. *Journal of Herbal Science*. 2025;14(2):52-62p.
16. Kaur A, Kaur R, Bhardwaj U, Sharma P. Optimisation and utilization of deep eutectic solvents for the green extraction of anticancer alkaloids from *Catharanthus roseus*. *Natural Product Research*. 2025 Mar 5:1-9.
17. Shahi S, Singh SK. Phytochemical Analysis and Characterization of Cancer-Cure Medicinal Plants: A Comprehensive Review. *International Journal of Environmental Sciences*. 2025 Jun 15;11(10s):592-606.
18. Luikham S, Bhattacharyya J. On the traditional medicinal plants and plant-derived natural drugs used by indigenous people of Nagaland, India. *Natural Product Research*. 2025 Feb 16;39(4):848-63.
19. Nayila I, Sharif S, Ullah R, Alotaibi A, Shah SA, Bibi M, Hameed S, Iqbal A. Molecular docking and dynamics simulations of bioactive terpenes from *Catharanthus roseus* essential oil targeting breast cancer. *Open Chemistry*. 2025 Jun 20;23(1):20250169.
20. Jafarpour E, Kheiry A, SaniKhani M, Razavi F. Enhancing Morpho-phytochemical Properties of *Catharanthus roseus* L. var. 'Ocellatus' via Plant Growth Regulators. *International Journal of Horticultural Science and Technology*. 2025 Jul 1;12(3):693-706.
21. Kumar S, Khati PS, Bhardwaj N. Exploring the Antibacterial Potential and Phytochemical Composition of Methanolic Leaf Extracts from *Catharanthus Roseus*, *Saraca Indica*, *Psidium Guajava* and *Bryophyllum Pinnat*. *Journal of Experimental Zoology India*. 2025 Jan 1;28(1).
22. Shah S, Singh SK. Phytochemical Analysis and Characterization of Cancer-Cure Medicinal Plants: A Comprehensive Review. *International Journal of Humanities Education*. 2025 Jun 18;13(1):942-62.

23. Sharma A, Kaur A. Catharanthus roseus leaf-based green synthesis of silver oxide nanoparticles: Characterization, phytochemicals screening and antimicrobial activity. *The Microbe*. 2025 Jul 17:100469.
24. Asiri A, Al Al Ali A, Abu-Alghayth MH. Structure-based multitargeted screening of bioactive compounds of Catharanthus roseus against breast cancer. *Advancements in Life Sciences*. 2025 Jan 29;12(1):191-6.
25. Hemmati N, Azizi M, Spina R, Dupire F, Saeedi M, Arouei H, Laurain-Mattar D. Endophytic fungi isolated from various organs of Catharanthus roseus: Phytochemical screening and investigation of indole alkaloids. *South African Journal of Botany*. 2025 Feb 1;177:674-83.
26. Mendonce KC, Palani N, Rajadesingu S, Radhakrishnan K, Ayyar M, Priya LS. Pharmacological potential of bioactive compounds in Catharanthus roseus extract: A comprehensive review. *Toxicology Reports*. 2025 Mar 17:101998.
27. Sarkar BK, Polash MJ, Islam MJ, Hanif MA, Jannat N, Kundu SK, Sarkar BK, Hossain MS. Unlocking the therapeutic potential of Catharanthus roseus leaves via in-vitro, in-vivo, and in-silico study. *Scientific Reports*. 2025 Jul 17;15(1):25909.
28. Yadav S, Badajena S, Khare P, Sundaresan V, Shanker K, Mani DN, Shukla AK. Transcriptomic insight into zinc dependency of vindoline accumulation in Catharanthus roseus leaves: relevance and potential role of a CrZIP. *Plant Cell Reports*. 2025 Feb;44(2):43.
29. Zhang M, Liao J, Zhang Z, Shi H, Wu J, Huang W, Li C, Song L, Yu R, Zhu J. Structural characterization of two novel heteropolysaccharides from Catharanthus roseus and the evaluation of their immunological activities. *Carbohydrate Polymers*. 2025 Jan 15;348:122896.
30. Sarkar S, Sharma S. Therapeutic insights into Catharanthus roseus: Advances in vinca alkaloid production and cancer treatment. *South African Journal of Botany*. 2025 Sep 1;184:780-93.
31. Li C, Colinas M, Wood JC, Vaillancourt B, Hamilton JP, Jones SL, Caputi L, O'Connor SE, Buell CR. Cell - type - aware regulatory landscapes governing monoterpene indole alkaloid biosynthesis in the medicinal plant Catharanthus roseus. *New Phytologist*. 2025 Jan;245(1):347-62.
32. Ahsan M, Radicetti E, Mancinelli R, Ali HM, Younis A, Sajid M, Manan A, Ali S, Valipour M, Zulfiqar H. Alleviation of cadmium stress and improved growth performance of periwinkle (Catharanthus roseus L.) by foliar application of zinc oxide nanoparticles. *South African Journal of Botany*. 2025 Jan 1;176:129-40.
33. Chang C, Guo X, Wang B, Wang Y, Zhang M, Yu F, Tang Z. CrGRF1/4 mediating light signal to regulate monoterpenoid Indole alkaloid biosynthesis in Catharanthus roseus. *Plant, Cell & Environment*. 2025 Jul;48(7):4886-901.
34. Kaur A, Kaur R, Bhardwaj U, Sharma P. Optimisation and utilization of deep eutectic solvents for the green extraction of anticancer alkaloids from Catharanthus roseus. *Natural Product Research*. 2025 Mar 5:1-9.
35. Yahyazadeh M, Selmar D, Jerz G. Electrospray–Mass Spectrometry-Guided Targeted Isolation of Indole Alkaloids from Leaves of Catharanthus roseus by Using High-Performance Countercurrent Chromatography. *Molecules*. 2025 May 9;30(10):2115.
36. Devi NA, Ravikumar P, Devendran P, Mohan R, Ravichandran K, Veeralakshmi M, Yuvaloshini J, Sundari MM. Efficacy of Catharanthus roseus leaf and flower extracts mediated Ag incorporated ZnO nanoparticles



- for enhanced antimicrobial and antioxidant abilities: a comparative analysis. *Applied Physics A*. 2025 Feb;131(2):97.
37. Thakur R, Yadav S. Exopolysaccharides and biofilm forming microbial inoculant AB-13 acting in a consortium promotes growth of economically important medicinal plant *Catharanthus roseus*. *International Journal of Biological Macromolecules*. 2025 Jun 9;145:122.
 38. Li X, Yu H, Guo Y, Liu J, Yu W, Guo X. Comparative role of oxidative balance, alkaloid production, and metabolites in exposure to red-to-blue light in *Catharanthus roseus*. *Plant Physiology and Biochemistry*. 2025 Jun 17;110:170.
 39. Cole-Osborn LF, Soens N, Bernal-Franco D, Prifti O, Cram EJ, Lee-Parsons CW. Identification of DELLA and GID1 genes in *Catharanthus roseus* and their potential role in regulating vindoline biosynthesis. *Plant Molecular Biology*. 2025 Jun;115(3):72.
 40. Zhang Y, Ni X, Fu X, Taheri A, Zhang W, Liu P, Liu H, Li L, Wang Y, Tang K. Comprehensive analysis of SPL gene family and miR156a/SPLs in the regulation of terpenoid indole alkaloid biosynthesis in *Catharanthus roseus* L. *BMC Plant Biology*. 2025 Jul 2;25:817.
 41. Quadri A, Sambuco B, Trenta M, Tassinari P, Torreggiani D, Mercolini L, Protti M, Zambonelli A, Puliga F, Barbaresi A. Bioengineered Indoor Farming Approaches: LED Light Spectra and Biostimulants for Enhancing Vindoline and Catharanthine Production in *Catharanthus roseus*. *Horticulturae*. 2025 Jul 12;11(7):828.
 42. Mendonce KC, Palani N, Rajadesingu S, Radhakrishnan K, Ayyar M, Priya LS. Corrigendum to “Pharmacological potential of bioactive compounds in *Catharanthus roseus* extract: A comprehensive review”[*Toxicol. Rep.* 14 (2025) 101998]. *Toxicology Reports*. 2025 Jul 24;102094.
 43. Gao X, Zhu X, Wang Z, Liu X, Guo R, Luan J, Liu Z, Yu F. Modulation of Terpenoid Indole Alkaloid Biosynthesis in *Catharanthus roseus* by *Sphingomonas* Sp Y503 via the CrMAPKKK1 - CrMAPKK1/CrMAPKK2 - CrMPK3 Signaling Cascade. *Plant, Cell & Environment*. 2025 Feb;48(2):1692-704.
 44. Al-Huqail AA, Goala M, Arya AK, Kumar P, Gupta D, Gaur SK, Širić I. Mechanistic and kinetic modeling of cadmium and lead phytoextraction by Madagascar Periwinkle [*Catharanthus roseus* (L.) G. Don] in battery waste contaminated soil. *Scientific reports*. 2025 May 26;15(1):18291.
 45. Yassin MA, Mohsen EH, George NM, Marawan MA, El-Sayed AS, El-Demerdash MM. Bioprocessing and characterization of thermostable phytase from *Aspergillus terreus*, an endophyte of *Catharanthus roseus*, with a potential activity to hydrolyze phytic acid in wheat bran. *BMC biotechnology*. 2025 Jul 8;25(1):68.
 46. Nourozi E, Hedayati A, Madani H, Hosseini B, Hemmaty S. In vitro synthetic polyploidization and enhancement of anticancer compounds in *Catharanthus Roseus* (L.) G. Don important cultivars. *Scientific Reports*. 2025 Feb 24;15(1):6563.
 47. Banyal A, Thakur R, Thakur P, Thakur V, Chand D, Kumar P. Sustainable vinblastine production by *Alternaria alternata*, an endophytic fungus isolated from *Catharanthus roseus* in the Northern Himalayan Region. *3 Biotech*. 2025 Jun;15(6):187.
 48. Szymańska G, Urbaniak K, Rosicka-Kaczmarek J, Miśkiewicz K, Lipert A, Kochan E. Dynamics of growth and production of indole anti-cancer alkaloids in *Catharanthus roseus* shoot cultures cultivated in flasks and

- nutrient sprinkle bioreactor. Industrial Crops and Products. 2025 Aug 1;230:121048.
49. Talukder P, Dasgupta M, Hazra A, Mohanta S. Polyphenols as Mitigators of Metal - Induced Stress in Madagascar Periwinkle (*Catharanthus roseus* L.). Biotechnology and Applied Biochemistry. 2025 Jun 30.
 50. Sharma A, Kaur A. *Catharanthus roseus* leaf-based green synthesis of silver oxide nanoparticles: Characterization, phytochemicals screening and antimicrobial activity. The Microbe. 2025 Jul 17:100469.
 51. Huzafa M, Hassan A, Bashir B, Mehmood A, Ahmed J. Expression Profiling of Genome-Wide Identified and Characterized Trans-Isoprenyl Diphosphate Synthase Family in *Catharanthus roseus* (L.) G. Don Under Stress Conditions. Plant Molecular Biology Reporter. 2025 May 21:1-3.
 52. Pan A, Gao H, Lin Y, Yang B, Chang C, Liu Z, Wang Y, Jin Z, Yu F. Isolation and functional identification of Jasmonate resistant 1, a Jasmonic acid isoleucine-conjugating enzyme in *Catharanthus roseus*. Journal of Plant Research. 2025 Jun 6:1-3.
 53. Liu Y, Shi J, Patra B, Singh SK, Wu X, Lyu R, Liu X, Li Y, Wang Y, Zhou X, Pattanaik S. Transcriptional Reprogramming Deploys a Compartmentalized 'Timebomb' in *Catharanthus roseus* to Fend Off Chewing Herbivores. Plant, Cell & Environment. 2025 May;48(5):3236-56.
 54. Sales JR, Camara WA, Lacerda CF, Neves AL, da Silva Junior FB, Lima AF, Pinho LL, Sousa NI, Silva BA, Coelho AF. Mineral nutrition and toxicity indicators in *Celosia argentea* and *Catharanthus roseus* cultivated under saline stress and biostimulant addition. Journal of Plant Nutrition. 2025 May 7:1-3.
 55. Abirami P, Sampath S, Al-Ansari MM, Al-Dahmash ND, Lopes BS, Vincent S, Saravanan M. One-pot synthesis of Ag-Cr bimetallic nanoparticles from *Catharanthus roseus* for anti-bacterial, anticancer, anti-diabetic, and anti-inflammatory activity and toxicity study in zebrafish. Biomass Conversion and Biorefinery. 2025 Feb;15(4):4999-5013.

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