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Catharanthus roseus L. (Periwinkle): An herb with impressive health benefits & pharmacological therapeutic effects

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Abstract

Medicinal plants, which contain a variety of phytochemicals, have proven to be effective and safe alternatives to synthetic drugs for the treatment of infectious and chronic diseases. *Catharanthus roseus* L. It increases amounts of interest due to the discovery that it contains a variety of phytochemicals with a range of biological functions, including as an anti-inflammatory, anti-cancer, anti-bacterial, anti-fungal, and antidiabetic quality. Vinblastine and vincristin isolated in particular the first plants from this plant that were used as clinically effective anticancer medicines were developed from it. Furthermore, the isolated vindoline, vindolidine, vindolicine, and vindolinine from *C. roseus* leaves were shown to have anti-diabetic properties. These findings imply that the plant still has the potential to be a valuable source of bioactive substances. This article provides a summary of the current health benefits as well as information on the historical and present-day uses of *C. roseus* in medicine. The bioactive compounds and extracts from this plant have also been investigated for their potential as pharmaceuticals.

Keywords: Phytochemicals, *Catharanthus roseus*, vincristine, nayantara, apocynaceae

1. Introduction

Catharanthus roseus in India commonly known as “Nayantara” or “sadabahr”. *Catharanthus* word originated from Greek which means “pure blossom” and roseus means red [1]. *Catharanthus roseus* Linn is the best herbal medicinal plant which highly contains various important phytochemical substances like flavonoids, steroids, tannins, phenolic compounds, alkaloids, carbohydrates, quinones, terpenoids, saponins and etc. [2] It belongs to the family Apocynaceae. This plant mostly found in tropical and sub-tropical southern Asian countries and spread over the hills, plains and mountains of northern and southern India. It contains more than 70 indole alkaloids which plays beneficial medicinal role in ayurveda. The national cancer council of Malaysia has a logo of periwinkle [3,4]. While using *Catharanthus roseus* drugs there are several side effects are also been seen like hair loss, peripheral neuropathy, constipation, hyponatremia, etc. [5] The plant contains vincristine (Vinca alkaloid) which has very important role in chemotherapy of cancer. The leaf juice of *Catharanthus roseus* reduced the level of blood glucose which is positive point for diabetic treatment [6]. The phytochemicals of *Catharanthus roseus* are classified into two groups which are primary metabolites & secondary metabolites. The primary metabolites are obtained during growth phase and secondary metabolites are obtained from primary metabolites but they not directly involved in the life process of plant. Primary metabolites present in *Catharanthus roseus* are purines, pyrimidines, amino acids and carbohydrates. Secondary metabolites are alkaloids, flavonoids, saponins, steroids, phenols, glycosides and etc. [7] In the clinical trials and experimental animals *Catharanthus roseus* has various potential pharmacological uses in modern medicines for anticancer, antidiabetic, antimicrobial, antioxidant, anti-diarrheal, anthelmintic, hypotensive, wound healing, hypolipidemic, Alzheimer disease, antiallergic jand cardioprotective effects [8]. The goal of this composition evaluation is to highlight the important chemical constituents, health advantages, and various pharmacological effects of fenugreek on mortal health.

Table 1: Scientific classification ^[9]

Kingdom	Plantae
Division	Magnoliophyta (flowering plant)
Class	Magnoliopsida (dicotyledons)
Order	Gentianales
Family	Apocynaceae
Genus	<i>Catharanthus</i>
Species	roseus

Table 2: Vernacular Names of *Catharanthus roseus* ^[10]

Language	Vernacular name
English	Cayenne jasmine, old maid, periwinkle
Hindi	Sadabahar, Sada bahar
Kannada	Batlahoo, bilikaasikanigalu, ganeshanahoo, Kempukaasikanigalu
Malayalam	Banappuvu, nityakalyani, savanari, usamalari
Marathi	Sadaphool, sadaphul, sadaphuli
Sanskrit	Nityakalyani, rasna, sadampuspa, sadapushpi
Tamil	Cutkattumalli, cutukattumalli, cutukattuppu
Telugu	Billaganneru
Gujarati	Barmasi
Bengali	Noyontara

2. Traditional uses

In various different countries *Catharanthus roseus* has been used as traditional medicine. The homed remedy of dried leaf of plant boiled with water then that extract administered orally to treat the diabetes in northern India. This plant also been used in many therapies for cancer treatment patients in Kenya. ^[11] people of Kancheepuram in Tamil Nādu India,

prepare powder of whole plant and combined with cow's milk and administered orally to cure diabetes. ^[12] The dried root of *Catharanthus roseus* helps to prevent urogenital infections in Venda region of southern Africa. In some region of Africa roots of this plant used for treatment of gonorrhoea. People of Zimbabwe used *Catharanthus roseus* for stomach ache infection ^{[13][14]}.

Part Used	Disease	Preparation	Mode of Administration	Country	References
Whole plant, leaf	Diabetes	The whole plant is powdered and mixed with cow's milk.	Oral intake	Kancheepuram district of Tamil Nadu, India	[12]
Leaf	Diabetes mellitus	The dried leaf is decocted	Oral intake	Northern Europe	[15]
Leaf of purple or white flowered varieties	Diabetes, hypertension and cancer	Eighteen leaves are boiled in a kettle of water. The cool solution is drunk daily	Oral intake	Cook Island	[11]
Whole plant	Throat, stomach, oesophageal cancer	The whole plant is boiled with water Pound	Oral intake. Usually taken together with <i>Sesbania sesban</i> whole plant Applied topically	Kenya	[11]
Root	Gonorrhoea	The root is boiled for 20 min.	Oral intake	Limpopo Province, South Africa	[13]
Root	Stomach	Crushed roots are mixed with a cup of water	Oral intake	Mutirikwi area of Zimbabwe	[14]
Root	Urogenital infections	The root is air dried, ground and decocted.	Oral intake	Venda region, South Africa	[13]
Whole plant	Diabetes, hypertension, dysentery, cancer	The whole plant is boiled with water.	Oral intake	Vietnam	[16]

3. Botanical description

Catharanthus roseus is an evergreen plant which grows about 32 to 80cm in height. The flowers are appear naturally in pale pink colour. Stems are usually green often permeate with red or purple.

Leaves: leaves are oval in shaped to oblong, 3 to 10 cm long and 1 to 4 cm in width. They are arranged in opposite pair.

Flower – length of flower approx. 4 to 5 cm, white or pink with red, purple or pale yellow centre follicle 1.3-3.5x0.2-0.4cm opens to the axial side.

4. Microscopic and powder characteristics

Leaves is dorsiventral. The walls of the top and lower epidermal cells are sinuous, sinous, or somewhat curled. On the lower surface, there are ranunculaceous stomata. trichomes single cell unbranched, uniseriate, nonglandular, and septate ^[17]. The size and form of the lower epidermal cells are largely similar to those of the upper ones. The spongy arenchymatous cells are situated between the palisade cells and the lower epidermal cells. It displays patches of lower epidermis with sinuous anticlinal walls and the same types of stomata, as well as portions of

upper epidermis in surface view with straight anticlinal walls and anomocytic and anisocytic stomata^[18].

5. Chemical constituents

Numerous phytocompounds of pharmacological significance, including carbohydrates, flavonoids, tannins, saponins, glycosides, terpenes, proteins, phenols, and alkaloids, are present in *Catharanthus roseus*^[19]. The plant includes 400 or so alkaloids, which are the chemical compounds of the plant that have the greatest potential for activity and are utilised in pharmaceutical processes, flavour and fragrance, ingredients, food additives, insecticides, and agrochemicals. These plants synthesise more than 100 monoterpenoid indole alkaloids (TIA) in various organs. Vinesine, vindeline tabersonine, vinblastine, vincristine, and

actineoplastidemic are just a few of the alkaloids found in the plant's aerial parts. In contrast, the plant's basal or root parts contain raubasin, reserpine, catharanthine, vinceine, vineamine, and ajmalicine.^[20] Alkaloids and sugars are abundant in leaves. The plant's flowers, which were high in tannins, triterpenoids, and alkaloids, are what give diabetic wounds the ability to heal.^[21] Rosinidin, an anthocyanidin pigment, is present in *C. roseus* flowers. Many pharmacological research have found that terpenes or terpenoids indole alkaloids are potent anti-cancer, anti-inflammatory, anti-bacterial, anti-protosomal, and anti-malarial medicines^[52]. Vinblastin is mainly used for treatment of Hodgkin's disease, lymphocytic lymphoma, histiocytic lymphoma, advanced testicular cancer, advanced breast cancer, Kaposi's sarcoma.

Table 3: Plant parts used for extraction of Alkaloids^[23]

Plant part	Name of alkaloid present
flower	Catharanthine, Vindoline, Leurosine, Lochnerine, Tricin
stem	Leurosine, Lochnerine, Catharanthine, Vindoline
leaf	Catharanthine, Vindoline, Vindolidine, Vindolicine, Vindolinine, ibogaine, yohimbine, raubasine, Vinblastine, Vincristine,
root	Ajmalicine, Serpentine, Catharanthine, Vindoline, Leurosine, Lochnerine, Reserpine, Alstonine, Tabersonine, Horhammericine, Lochnericine, echitovenine

6. Health and pharmacological benefits of *Catharanthus roseus*

6.1 Anti-cancer property

Catharanthus roseus' stem and leaves are the source of the anticancer alkaloids vinblastine and vincristine.^[24] In an *in vitro* study, various concentrations of *Catharanthus*' methanolic crude extracts were reported to have potent anticancer effects against a wide range of cell types.^[25] It has been discovered that a variety of additional indole alkaloids isolated from *C. roseus* has strong cytotoxic action against different cancer cell lines. Catharoseumine, a newly discovered monoterpenoid indole alkaloid, was discovered to have an inhibitory effect on the human promyelocytic leukaemia HL-60 cell line with an IC₅₀ of 6.28 µM.^[26] In addition, five previously identified compounds (vinamidine, leurosine, catharine, cycloleurosine, and leurosidine) and three newly discovered dimeric indole alkaloids, including 140,150-didehydrocyclovinblastine,^[27] 17-deacetyoxycyclovinblastine, and 17-deacetyoxyvinamidine, all exhibited *in vitro* inhibition of cell viability against the human breast cancer cell line MDA-MB -231 with an IC₅₀ range of 0.73–10.67 µM.^[27] As a treatment for acute and chronic leukaemia, vinblastine sulphate has been used to treat Hodgkin's disease, lymphosarcoma, choriocarcinoma, neuroblastoma, carcinoma of the breast and lungs, as well as other organs. Using vincristine sulphate, an oxidised version of vinblastine,^[28] treatment for acute leukaemia in children, lymphocytic leukaemia, Hodgkin's disease, Wilkins' tumour, neuroblastoma, and reticulum cell sarcoma that effectively stops mitosis in the metaphase^[29].

6.2 Anti-diabetic property

In many parts of the world, *C. roseus* has a long history of usage in the treatment of diabetes. Both healthy and diabetic rabbits' blood glucose levels were observed to decrease in a dose-dependent manner after being treated with *C. roseus* leaf juice.^[30] The dichloromethane extract of *Catharanthus* leaves included all four of the alkaloids vindoline, vindolidine, vindolicine, and vindolinine. All four alkaloids significantly increased glucose absorption in pancreatic -

TC6 or myoblast C2C12 cells, with vindolicine having the highest activity. Furthermore, the substances vindolidine, vindolicine, and vindolinine showed effective protein tyrosine phosphatase-1B (PTP-1B) inhibitory activity, suggesting their therapeutic potential against type 2 diabetes.^[31] vindoline, vindolidine, vindolicine, and vindolinine derived from *C. roseus* (L.) G. Don leaves have been shown to have hypoglycemic and antidiabetic properties. According to these experts, these substances increased glucose absorption in pancreatic or Vindolicine, the substance that had the highest activity in myoblast cells, Aside from that Vindolidine, Vindolicine, and Vindolinine demonstrated a significant level of protein tyrosine inhibitory action. These substances have phosphatase-1B inhibiting action, suggesting they may be used to treat diabetes. Additionally, vindolicine had the strongest antioxidant properties in both the oxygen radical absorption capability and 1,1-diphenyl-2-picrylhydrazyl assays revealed that this substance also lessened the oxidative damage that H₂O₂-induced in pancreatic cells. Vindolicine may therefore be used as an antidiabetic in the future^[32].

6.3 Potential Use as Anti-Alzheimer's Disease Agents

50–60% of persons with dementia have Alzheimer's disease (AD), a neurodegenerative condition of the central nervous system. In the later stages of life, it is characterised by severe memory loss, emotional instability, and personality changes.^[33] According to theories, AD primarily affects cholinergic neurons in the neocortex and hippocampus, resulting in the cholinergic. Acetylcholinesterase (AChE), an enzyme that breaks down acetylcholine in the synaptic cleft, is inhibited as part of the current effective AD treatment to raise acetylcholine (ACh) levels.^[34] In an *in vitro* microassay, the leaf, stem, and root of *C. roseus*' aqueous extract were found to be highly effective at inhibiting AChE. The aqueous extract of the leaf, stem, and root of *C. roseus* was found to be very effective at inhibiting AChE in an *in vitro* micro assay. Vinpocetine when subjected to a well-tolerated dose up to 60 mg/d in clinical trials of dementia and stroke proved no significant adverse events^[35].

6.4 Wound healing activity

The *Catharanthus* flower extract in rats showed antibacterial and wound healing properties. Rats' wound-healing activity was assessed. Rats were used to test the ethanol extract of *C. roseus* at 100 mg/kg/day for its ability to heal wounds. In comparison to controls, a high rate of wound contraction was seen together with a notable shortening of the epithelization period, a pronounced rise in dry weight, and a considerable increase in the hydroxyproline content of the granulation tissue. Evidence for the use of *C. roseus* in the management of wound healing includes wound contraction, enhanced tensile strength, and hydroxyproline content. [36]

6.5 Microbial activity

A significant medicinal plant is *Catharanthus roseus* .plant for innovative drugs because the majority of the infections caused by bacteria are evolving opposition to many of the currently obtainable antibacterial medications. Phytes have natural resources that were useful for providing powerful chemotherapeutic drugs a wide range of activity. [37] The clinical significance of the antibacterial activity of crude extracts from various *Catharanthus roseus* sections against various bacterial species. Each plant part is extracted using the proper solvent, and then its antibacterial activity is tested using an agar well diffusion assay on a total of six bacterial stains. Additionally, the minimal inhibitory concentration(s) for active crude extracts were assessed. Data showed that the microorganism examined, the extraction method, the plant part utilised for extraction, the state of the plant part (fresh or dried), and the solvent used for extraction all have a significant impact on the pattern of inhibition. [38] The antimicrobial activity of the plant's leaf extracts was tested against microorganisms like *Staphylococcus aureus* NCIM 5021, *Salmonella typhimurium* NCIM 2501, and *Pseudomonas aeruginosa* NCIM 2036, and it was discovered that the extract could be used as a prophylactic agent in the treatment of many diseases. [39]

6.6 Anti-oxidant property

The antioxidant capacity of the two types of *Catharanthus roseus* L., 'rosea' (pink flowers) and 'alba' (white flowers), roots was discovered by utilising several test methods, such as hydroxyl radical scavenging activity, the capacity to scavenge superoxide radicals, Nitric oxide radical scavenging activity and DPPH radical inhibition strategy. [40] In ORAC and DPPH experiments, the plant's vindolicine had the strongest antioxidant capacity. At concentrations of 12.5 µg/mL and 25.0 µg/mL, it also reduced H₂O₂-induced oxidative damage in -TC6 cells. [41] Additionally, it was shown that isolated alkaloids from *C. roseus*, such as vindoline, vindolidine, vindolicine, and vindolinine, have antioxidant characteristics. [42]

6.7 Hypotensive activity

Significant changes were made to the hypotensive properties of an extract produced from *C. roseus* plant leaves. The leaf extracts (hydroalcoholic or dichloromethane-methanol) have been shown to have extraordinary antihyperglycemic and hypotensive effects in lab animals. [43] In a crossover approach, the hypotensive effects of *Catharanthus roseus* leaf extract were examined in rats with adrenaline-induced hypertension (AIHR) and compared to those of atenolol. Animals treated with a leaf extract from *Catharanthus*

roseus had hypotensive effects. Atenolol also demonstrated hypotensive effects. [44]

6.8 Anti-diarrheal activity

The extracts considerably decreased the amount and weight of wet faecal pellets, and Wistar rats in the extract-treated groups had diarrhoea that was less severe than that in the control rats. Additional extract doses of 200 and 500 mg/kg prevented diarrhoea brought on by castor oil as well as prevented the gastrointestinal passage of charcoal powder. This information supports the conventional use of *C. roseus* for the management and treatment of diarrhoea. [45] Castor oil was used as an experimental diarrhoea-inducing agent along with the pre-treatment of the extract in order to assess the plant's ethanolic leaf extracts' anti-diarrheal properties in wistar rats. ethanolic extracts' ability to prevent diarrhoea Castor oil-induced diarrhoea was inhibited by *C. roseus* in a dose-dependent manner. [46]

6.9 Antiulcer property

The plant's vincamine and vindoline alkaloids demonstrated anti-ulcer properties. Test animals with ulcers have shown the *C. roseus* plant's leaves to have anti-ulcer properties. Vincamine is well known for its neuroprotective and cerebro-vasodilatory effects [47].

6.10 Anthelmintic activity

Chronic diseases are brought on by helminths infections in both humans and livestock. Pherithema posthuma was used as an experimental model and piperazine citrate as the standard reference in the evaluation of *C. roseus*'s anthelmintic properties. The conventional medication at 50 mg/ml was shown to have a death time of 40.67 min, but significant anthelmintic activity was seen in the ethanolic extract at a concentration of 250 mg/ml. This study supports ethnomedical assertions that *C. roseus* is an anthelmintic herb. [48] It has been determined that the *Catharanthus roseus* extract in water, methanol, ethyl acetate, and ethanol exhibited anthelmintic action. [49]

6.11 Bio pesticidal property

The biological efficacy of solvent extracts of *Catharanthus roseus* against gramme pod borer *Helicoverpa armigera* larvae was assessed. *C. roseus* leaf extract fractions in ethyl acetate were discovered to be an effective biopesticide. Deshmukhe *et al.* (2010) have reported that *Catharanthus roseus* has insecticidal effects. [50]

7. Conclusions

Today, there is a rising global demand for natural goods and plant-based medications. *Catharanthus roseus* is a wonderful herb because of the variety of uses it has. It ranks highly as a popular ornamental plant in the horticultural sector and as a model plant for studies in phytopathology and biotechnology, in addition to its natural supply of anticancer chemicals for medication on the global market. Alkaloids and phenolic compounds found in *C. roseus* have a variety of biological effects, including anticancer, antidiabetic, antioxidant, antibacterial, and antihypertensive actions. Although many unknown chemicals have been found in this substance, many alkaloids and phenolics have been recognised. As a result, efforts should be made to continue finding and isolating novel phytochemicals within *C. roseus*' various structural elements. Further research is

required to determine the possible applications of bioactive chemicals obtained from this material for usage in the pharmaceutical and nutraceutical sectors.

8. Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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