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# An overview of *Catharanthus roseus* and medicinal properties of their metabolites against important diseases

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**Abstract:**

*Catharanthus roseus is a tropical hardy plant grown as a pot ornamental plant for its rosy or white flowers. It is popularly known as Madagascar periwinkle. It is small in size perennial herbaceous evergreen plant that was native to the Madagascar island. The plant has very good tolerance against heat, grows one or two feet high, have glossy, dark green leaves (1-2 inches long) and flowers even in the hot weather. The blooms of the natural wild plants are pale pink with a purple "eye" in their centers, but horticulturists have developed varieties with colors ranging from white to pink to purple. The plant has immense medicinal importance for its alkaloids. All parts of the plant including leaf, root, shoot and stem contains more than 200 alkaloids, which are used for therapeutic purposes against several diseases. The most important alkaloids vinblastine and vincristine are derived from leaves and they exhibits anti-cancer and anti-diabetic property. Another alkaloid rubacine derived from roots is used as hypotensive and anti-arrhythmic agent. In the present review more information on this magical plant will be provided.*

**Key words:** Vincristine, Vinblastine, Anticancer, Secondary metabolites

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## INTRODUCTION

*Catharanthus roseus* is an evergreen ever blooming herb which has its origin in central Madagascar island. Periwinkle is recorded for as back as 50 B.C. in folk medicine literature of Europe as diuretic, hemorrhagic and wound healing. It was introduced to many parts of the world in 18$^{th}$ century. It is believed to be brought in India by the Portuguese mercenaries in the middle of 18 century in Goa. Presently it is cultivated in Europe, India, China, and America. In several parts of world it was used, to treat several kinds of diseases like coughs and sore throats to eye and lung infections. Most interesting property is its folk use in treating diabetes. Because of these properties, globally scientist and researchers identify dozens of alkaloids: some of them lower blood sugar levels (providing folk remedies with scientific provenance) and blood pressure. However, when two very important alkaloids namely vinblastin and vincristrine were isolated from *C. roseus*, both are the source of anticancer drugs, from then onwards *C. roseus* becomes choice of breeders, pharmacists and genetic/genomic researchers.

*Cathranthus roseus* is one of the best-studied medicinal plants (van der Heijden *et al.* 2004; Verpoorte *et al.* 2007). It is an erect, bushy, evergreen and ever blooming herb. The plant is largely a self pollinating species and carries 2n = 16 chromosomes in the somatic cells. Knowledge about its terpenoid indole alkaloids pathways is growing (Ma *et al.* 1984). Since, *Cathranthus roseus* has somewhat small genome size, low chromosome number and self-compatibility, it has become a good model plant for transcriptomic/proteomic/metabolomic investigations on plant secondary metabolism (Rischer *et al.* 2006; Verpoorte *et al.* 2007; Murata *et al.* 2008).

## NOMENCLATURE AND TAXONOMY

The name *Catharanthus L.G. Don* is derived from the latin words Katharos (pure) and anthos (flower), referring to the neatness and beauty of the flower. Reichenbach, in 1935, first recognized and generically separated the existing genus *Catharanthus* from *Vinca* and designated it as *Lochnera*. George Don, in 1935 assigned it the name *Catharanthus L.G.Don*.

**Figure 1: *Catharanthus roseus* with different eye color**

### Taxonomic Hierarchy

| | | |
|---|---|---|
| Kingdom | : | Plantae |
| SubKingdom | : | Tracheobionta (Vascular plants) |
| Division | : | Magnoliophyta |
| Class | : | Magnoliopsida |
| SubClass | : | Asteridae |
| Order | : | Gentianales |
| Family | : | Apocynaeean (Dog-bane family) |
| Subfamily | : | Plumeroideae |

| | | |
|---|---|---|
| Tribe | : | Plumerieae |
| Subtribe | : | Alstonrieae |
| Genus | : | *Catharanthus G.Don* |
| Species | : | *Catharanthus roseus* |

## Vernacular names

*Catharanthus roseus*, during the course of its spread and naturalization over the tropics and subtropics has acquired a diversity of vernacular names as shown in the table:

| **Country** | : | **Vernacular name(s)** |
|---|---|---|
| England | : | Madagascar periwinkle |
| India | : | Cape – periwinkle, Church yard blossom, Dead-man's flower, Ainskati, Rattanjor, Sadaphul, Sudukad umullai, Billagannerue (Telugu) Bara Massi and Sada Bahar (in Hindi), Gulfering(Kashmiri), Nayantara (Bengali). |
| Indonesia | : | Indische maagdepalm, Kembang saritijha, Kembang – dembaga. |
| Japan | : | Nichinchi |
| Philippines | : | Chichirica |
| West Indies | : | Oldmaid, Ramgoat rose, Jasmine, Magdalena, Vicaria |

## CHARACTERISTICS

- It is an erect branched deciduous herb woody at the base.
- The branching starts from the base.
- The leaves are short stalked leathery, petiole generally orbate, rarely oblong elliptic having oblong tips.
- The leaf blade ranges from 2 to 4 inch.
- The younger leaves are particularly very soft, light green in colour.

- Veins are prominent over the lower surface of the leaves
- The colour of the upper surface of the leaves is deep green while of lower surface is much lighter in color
- The seeds are black in colour and oblong in shape
- Stem and leaves contain white latex
- There are three variants in *Catharanthus roseus* rose purple flowered white flowered and white flowered with rose purple spots in the center.
- All the parts of the plant contains about 200 indole monoterpenoid alkaloids
- The plant is a self pollinating species, carries 2n=16 chromosome in the somatic cells.
- The plant survives and flowers even in very hot weather and needed very little water to grow.
- The way of propagation is through stem cutting or seeds
- Very commonly grown in tropical and subtropical areas.

## GENETICS

*Cathharanthus roseus* is a diploid plant with a karyotype comprising of 16 chromosomes, eight bivalents are visualized at meiosis. The floral morphology of *C. roseus* is conductive both for self and insect pollination. The natural population of *C.roseus* has been observed to have considerable genetic variability. Variation resulting from crossbreeding, induced mutagenesis and n- polyploidy has been variously employed in *C. roseus* (Ge and Li 1989).

Initial crossing studies have shown that although the plant is self pollinated, frequent out crossing has been observed resulting into different intermediate types. Artificial tetraploids have been produced by number of workers. Tetraploid plants have shorter thicker stem, larger and thicker leaves.

## Alkaloids in Catharanthus:

**Alkaloids** are large group of naturally occurring, basically produced from plants, bacteria, fungi, and animals, chemical compounds. They mostly contain basic nitrogen atoms. Alkaloids have a wide range of pharmacological activities including antimalarial, anticancer, anti-arrhythmic, analgesic, antibacterial, antihyperglycemic activities etc. Because of their potent pharmacological effects, alkaloids are the basis for many drugs.

More than 130 alkaloids have been identified from extract of different plant parts of *C. roseus* (van der Heijden *et al.* 2004, Zhu et al. 201). Because of large number of alkaloids it is very complicated and costly process to extract and purify vincristine and vinblastine. However after the development of plant tissue cell culture systems it is more reasonable to isolate these alkaloids as well as increasing their potential yields (Swanberg and Dai 2008).

Traditionally, *Catharanthus roseus* has been used in large scale to treat the diabetes and high blood pressure. *C. roseus* has some diuretic action, meaning that it may promote the loss of urine from the body. This effect may help to relieve high blood pressure, but other diuretics are both safer and more effective to use. The high risk of serious side effects from *Catharanthus roseus* makes taking it inadvisable.

**Plant parts used for extraction of Alkaloids**:

| S. No. | Plant parts | Name of Alkaloids |
|---|---|---|
| 1 | Leaf | Catharanthine,Vindoline,Vindolidine,Vindolicine,Vindolinine,ibogaine, yohimbine, raubasine, Vinblastine, Vincristine, |
| 2 | Stem | Leurosine, Lochnerine, Catharanthine,Vindoline |
| 3 | Root | Ajmalacine, Serpentine, Catharanthine,Vindoline, Leurosine, Lochnerine, Reserpine, Alstonine, Tabersonine, Horhammericine, Lochnericine,echitovenine.(Shanks et al.1998). |
| 4 | Flower | Catharanthine,Vindoline, Leurosine, Lochnerine, Tricin (Flavones). |

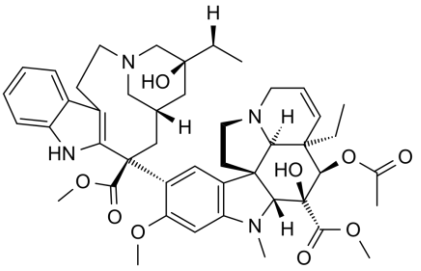
## Alkaloid Content:

| Plant part | % alkaloid content on dry weight basis |
|---|---|
| Root | 0.12 – 9.00 |
| Stem | 0.07 – 0.46 |
| Leaf | 0.10 – 1.16 |
| Flower | ~ 0.005 |
| Fruit | ~ 0.40 |
| Seed | ~ 0.18 |
| Pericarp | ~ 0.14 |

## TYPES OF ALKALOIDS

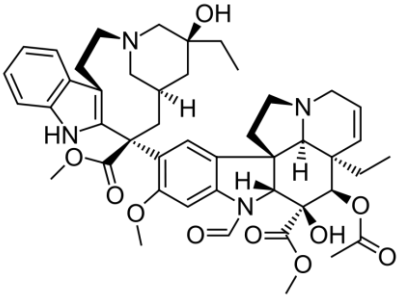
A wide range of alkaloids has been discovered from *C. roseus*. More than 130 alkaloids of the indole and the dihydro-indole groups have been isolated and characterized from different plant organs (van der Heijden *et al.* 2004). A few important ones are described as follows:

**VINBLASTINE**: Vinblastin is very important alkaloid extracted from leaf part of *C. roseus*. Previously the cost of exraction and purification of vinblastin was very high but now after the advancement of various biotechnological approaches, new protocols for rapid production have been developed. Vinblastin inhibits the cell cycle of cancer cells. It binds with tubulin, and inhibits the formation of microtubules. Due to the inhibition of formation of microtubules, cell cycle arrest in M phase because of none separation of chromosomes during anaphase of mitosis (Jordan et al 1992; Himes 1991). Vinblastin is mainly used for treatment of Hodgkin's disease, lymphocytic lymphoma, histiocytic lymphoma, advanced testicular cancer, advanced breast cancer, Kaposi's sarcoma.



**Chemical Structure of Vinblastin**

**VINCRISTINE**: Vincristine formally known as leurocristine, sometimes abbreviated "VCR", is a alkaloid extracted from *Catharanthus roseus* (Madagascar periwinkle). It is normally used in cancer chemotherapy. The chemical structure of vinblastine and vincristine are very similar, but their effects are not the same. Vinblastine is used to treat specific types of cancer, such as Hodgkin's disease, and Vincristine is used in the treatment of acute lymphoblastic leukemia (ALL). When vincristine is added to the treatment regimen for children suffering from ALL, the survival rate reaches eighty percent (Jordan et al 1992; Himes 1991).



**Chemical Structure of Vincristine**

## OTHER IMPORTANT USES

- **Anti-diabetic activity**: The "periwinkle tea" prepared from leaf decoction of *C. roseus* is used for curing diabetes. Hypoglycemic defects of a number of indole-

alkaloids such as Lochnerine, tetrahydroalstonine and Vindolidine have also been revealed (Singh et al.2001).

- **As a cardio-vascular drug**: Ajmalicine (Raubasine) present in root is reported to improve cerebral circulation when given intra-muscularly to humans suffering from cerebral sclerosis (Jayanthi et al. 2010).
- **Anti-helminthic activity**: The plant has been reported to possess vermifungal properties. Dried leaves, incorporated into the soil produce nematicidal and ovistatic effects.
- **Anti-bacterial and pesticidal activities**: Antibacterial action against *Vibrio cholera*, *Mycobacterium pyrogenes* var. aureus, *Salmonella typhi* and Spinach mosaic virus have been revealed by *in-vitro* studies. Insect growth inhibition and insect sterilant properties have also been reported in *Heliothus armigera, Spodolptera litura, Achoea janata* and *Gryllodes sigillatus* (Balaabirami and Patharajan 2012).

## CONCLUSION:

*Catharanthus roseus* L. (Apocyanaceae) is used for the treatment of various diseases like diabetes, and tumors in all over the world from the last several decades. Every part of Catharanthus like root, stem, bark and flower are rich sources of several bioactive compounds. Several studies already published on the alkaloids and their pharmaceutical properties however still more works are require to increases the production of theses alkaloids at large scale. The synergistic effect with natural compounds may also increase the efficiency of these alkaloids need to study more in future.

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