

Review article

Nutraceutical properties of *Vinca rosea*

Prabhavathi, Anuradha Mal

Department of Botany, Shivaji College, University of Delhi, Raja Garden, New Delhi-27, India

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Corresponding author: **Prabhavathi**. Email: prabha.udsc@gmail.com

ABSTRACT

Vinca rosea (*C. roseus*), a member of the Apocynaceae family, is a popular medicinal plant found in many countries. It's gaining popularity because it's been discovered to have a variety of phytochemicals having a wide range of biological actions, such as free radicle scavenging, hypoglycemic, antibacterial, antifungal, and cancer-fighting properties. The most important alkaloids isolated from vinca plant is vincristine and vinblastine. These were the first anticancer medicines obtained from plants to be tested in clinical trials. New indole alkaloids have recently been identified from this plant, including human cancer cell lines which were efficiently suppressed *in vitro* by 14', 15'-didehydrocyclovinblastine, 17-deacetoxyvinamidine, and 17-deacetoxyvinblastine. This plant is high in alkaloids and other secondary metabolites. Vindoline, vindolidine, vindolicine, and vindolinine are some of the important alkaloids found in the leaf extracts of *V. rosea* which showed anti-diabetic activity *in vitro*. These findings imply that *C. rosea* remains a potential bioactive chemical source that warrants more investigation. This study gives a summary of the plant's botanical features, its traditional and current medical uses and phytochemical profiles. In addition, the extracts and bioactive components generated from this plant's supposed health advantages were investigated in order to establish its potential as medicinal agents.

Keywords: *Vinca rosea*; metabolites; phytochemicals; therapeutic activity; alkaloids; vincristine; vinblastine; TIA.

INTRODUCTION

Herbal plants, which contain a variety of biochemicals that have shown promise as traditional medicine for the infectious and chronic ailments, are regarded safe and effective alternatives to synthesized medications that have less side effects. A crucial function has indeed been played by a therapeutic herb in the global health system since ancient times (1).

Among the surfeit of identified medicinal plants, *Vinca rosea* is globally known for its sanative value. It is mainly found in tropical areas. It is an ornamental floral species that has a long history as a medicinal plant. References as old as 2600 BC in Mesopotamia have been found. *Vinca rosea* is still an important herb and medicine in traditional treatment of ailments. Its medicinal properties were attributed to various alkaloids (2). Herbs have been vital to the traditional health care around the world. Notwithstanding its significance as a natural medicine *Vinca rosea* also holds various indole terpenoid alkaloids (TIAs) with wide pharmacological application. About 130 bioactive alkaloids (TIAs) are reported in this plant, with vinblastine and vincristine being one of the most important. Due to its sluggish early growth, *Vinca rosea* has a somewhat extended vegetative period. From the time the seed is planted till it matures, it takes 180-200 days. The plant's long growing time is seen as one of the constraints to its larger-scale cultivation (3). According to the agriculture department of America, the *Vinca* genus consists of three types and one variation. *Vinca minor* L, *Vinca*

major L and *Vinca herbacea* Walds, and *Vinca major* L. because of the high alkaloid content, these plants have been extensively explored for their medicinal effects (4). Furthermore, a link between the chemical composition of *Vinca* species' leaves and their morphological and ultrastructural characteristics has yet to be discovered. *Vinca* alkaloids are terpene indole alkaloids, with over 50 reported for *V. minor* alone. Although the structures of various alkaloids of *Vinca* are similar, their mechanisms and toxins in play vary significantly (5). Three new types of alkaloids have been discovered from *Vinca minor* and three more from *Vinca major*, indicating that *Vinca* species are currently under-studied. Vincamine is one of very few alkaloids that has been found to be advantageous to living cells, and is commercially available and utilized as a nutraceutical supplement; however, the active chemical currently in use (vinpocetine) is a sub-derivative of vincamine (6).

Vinca minor is rich in vincamine and serves as a brain booster by stimulating blood flow and local glucose metabolism, as well as a neuron protective towards ischemia and hypoxia and having antiapoptotic and antioxidant characteristics. Apart from alkaloids, *V. rosea* includes a variety of additional phytochemicals, according to scientific research. Individual phytochemicals derived from this plant may provide health benefits. Vincristine and vinblastine from *Catheranthus roseus*, as well as their synthetic counterparts, are used to treat advanced testicular cancer, breast cancer, and lung cancer in combination

with other cancer chemotherapeutic medicines. *V.rosea*, like many other plants in the dogbane family, can be poisonous. As previously indicated, it now comes in a variety of various kinds. As earlier evaluations of *V.rosea* have mostly focused on the herb's medicinal and chemical constituents, there is a distinct paucity of knowledge concerning the species' other characteristics. The purpose of this review is to provide information on the plant's biological, ecological, chemical, and therapeutic properties.

Taxonomic classification

Vinca rosea, also known as *Catharanthus roseus* and widely known as Madagascar periwinkle, is an apocynaceae family plant that is indigenous to Madagascar. Other names for this plant are listed in Table 2 include *Ammocallis rosea*, *Lochnera rosea*, *rose periwinkle*, Cape periwinkle, pink periwinkle and "old maid". Due to changes in plant taxonomy classification as a result of persistent research, there has been inconsistency in nomenclature in the literature. Roseus means rose-colored in Latin, while *Catharanthus* word stands for pristine or pure bloom in Ancient Greece. Linnaeus, who published the plant's description for first time, abbreviated it as G. Don.*Catharanthus roseus* (MP) which was previously categorized as *Vinca rosea* L. (1759) *Ammocallis rosea* (L.) and Rchb. ex Endl. (1838) are homotypic variants. *Vinca guilelmi-waldemar ii* Klotzsch is a heterotypic synonym of *Vinca guilelmi-waldemar ii* Klotzsch. Phenols, alkaloids and flavonoids, are the most potent and active components found in *Vinca rosea*. These secondary metabolites have antioxidant, anti-allergic, antibiotic, hypoglycemic, and anti-carcinogenic properties in the human body. Now a days *Vinca rosea* is known as *Catharanthus roseus* and is the primary source of vinca alkaloids, which are now known as *catharanthus* alkaloids (Table1). It grows wild and flourishes in the sun, rainfall, or at the beach, in good or terrible soil. It is commonly known as 'Sadabahar,' which means 'always in bloom.'

Table1: Taxonomical classification

KINGDOM	<i>Plantae</i>
DIVISION	<i>Tracheophyta</i>
CLASS	<i>Magnoliopsida</i>
ORDER	<i>Gentianales</i>
FAMILY	<i>Apocynacea</i>
GENUS	<i>Catharanthus</i>
SPECIES	<i>roseus</i>
SUBFAMILY	<i>Rauvolfiodea</i>
TRIBE	<i>Vinceae</i>

Table 2: Vernacular names

Language	Common name
Hindi	Sadabahar, Baramassi, Ainskati, Ushamanjairi
English	old-maid-flower, Madagascar periwinkle, Bright-eyed periwinkle, rose periwinkle, rose periwinkle
German	Zimmerimmergr'un
Indonesian	Tapak dara
Bengali	Nayantara
Marathi	Sadaphuli
Tamil	Sudukattumallikai
Telugu	Billaganneru.

Morphological characteristics

These perennial herbs are decussate or almost decussate (small bushes). In the leaf axils, flowers are usually solitary.

Calyx: Each flower features a calyx with five long, narrow lobes and only a cylindrical neck with five petals, as well as a calyx with five long, thin lobes. It blooms with pink, purple and whitish colored flower and tends to be 20-80 cm tall.

Stem: Tubular (terete) stems are longitudinal wrinkled sometimes slightly winged, green or dark crimson, and glabrous especially when young.

Leaves: The opposing leaves are borne upon tiny petioles that are 2.5-9.0 cm in length and elliptical to obovate in shape, green with whiter veins, and borne on short petioles. With a little point protruding from the midrib, the leaf tip is rounded to sharp. Hairy stems and leaves are common, yet hairless stems and leaves do exist.

Flower: Flowers are borne singly or in pairs on very short stalks on the leaf axils (pedicels). Sepals are 5 to 6 mm in length, thin, and commonly hairy.

Corolla: Corolla has narrow, long lobes and tube that are practically flat and spread perpendicular to the tube. Corolla has 5 lobes, white to pink or pinkish purple in color, 1.0-2.8 cm long, obovate in shape, corolla tube is greenish in color and commonly its 2.3 cm in length, with dark pink and yellow in color from inside. Anthers 5, are hidden within the upper portion of the corolla tube.

Fruits: The fruit is a follicle with many little black seeds that is 2.0-4.7 cm long.



Fig. 1: Wild type flower *Vinca rosea*

Geographical distribution and its ecology

It is a tropical plant found around the world. It is a perennial and native to Madagascar that can be found across Southern Asia and the tropics. In many tropical and subtropical regions, it is a popular ornamental plant including Spain, China, Australia, and India. It is used medicinally in both Northern and Southern Europe. The major markets for medicinal products generated from this plant are in the United States, UK, Netherlands and some European countries (7). *Vinca rosea* is a drought and salinity tolerant plant that can thrive in a wide range of habitats, including sandy soils, shrub lands, and due to its hardiness, it can be found in grasslands, inland river banks, savanna dunes, arid wastelands, structures, sides of roads, and even shores and limestone rocks. It can reach heights of up to 900 meters above sea level. *V. rosea* grows best in a pH range of 5.3–6.7, can tolerate high salinity (up to 2000 ppm) and is resistant to high temperature and drought. This plant preferably grows in dry, frost-free, humid climates and plenty of rainfall, full sun or light shade, and well-drained soils. In warm areas, it blooms and gives fruit all year around. *V. rosea* is unable to survive in excessive amounts of water, damp soils, or a cool spring.

Genetics

All *vinca* species have $2n = 16$ chromosomes and a genomic size of 1500 megabytes. Colchicine treatment caused tetraploidy, or the multiplication of chromosome number, which resulted in increased levels of Indole terpenoid alkaloids (TIAs), enlarged stomata, branches, and leaflets, but lower pollen fertility and seed set compared to diploid plants (4). Unlike most of the other species in the family, *vinca* is unique in that it is self-compatible. Intra flower self-pollination is rare in periwinkles due to the physical

separation of the stigma and anthers (7). Amidst this, few periwinkles have large ovaries or patterns that allow self-pollination within the flower. *Vinca* is a cross-pollinating species and the level of pollen dispersal is highly affected by climatic circumstances and the presence of seasonal pollinators, particularly butterflies and moths, with the floral structure suited to pollination by these protracted tongued insects. Self-incompatible *Catharanthus* varieties have been shown to engage in natural cross pollination in Madagascar. both types of pollination take place in *V.rosea*.

Genetic diversity

Despite the fact that many aspects of alkaloid production have been explored, little is known about the genetic variability of alkaloid content across accessions, and the effect of breeding towards flower colour or growing environment on vincristine (VCR) and vinblastine (VBL) levels. As a result, efforts must be made to find chemotherapeutic-potential accessions among the vast resources of naturally existent germplasm, identify the sorts of plant tissues that store these bioactive molecules, and use genetic modifications to boost alkaloids supply.

Major bioactive compounds derived from *V. rosea*

Due of their high phytochemical content, these plants have been extensively investigated for their medicinal qualities. In addition to alkaloids and phenols, polyphenols, steroids, alkaloids, flavonoids, glycosides, iridoid glycosides, and anthocyanins have also been detected in various portions of the plant. Furthermore, certain research shows that the plant's leaves and stems contain identical components, but this is not the case with the composition of seedlings and petals (8).

Table 3: Phenolic components found in *Vinca rosea*

Plant Parts	Identified phenolic compound	Reference
Seed	Kaempferol-3-O-(2,6-O-rhamnosyl-galactoside)-7-O-hexoxide	(11,13)
	Quercetin--3-O-(2,6-di-O-rhamnosyl-galactoside)	(12,13)
	Kaempferol-3-O-(2,6-di-O-rhamnosyl-galactoside)	(11)
	Isorhamnetin-3-O-(2,6-di-O-rhamnosyl-glucoside)	(12,13)
Petal	4-O-caffeoylquinic acid	((11,13)
	Kaempferol-3-O-(2,6-di-O-rhamnosyl-glucoside)	(12,13)
	Isorhamnetin-3-O-(6-O-rhamnosyl-glucoside)	(12,13)
	Isorhamnetin-3-O-(6-O-rhamnosyl-galactoside)	(12,)
Leaf	3-O-caffeoylquinic acid	(12,13)
	4-O-caffeoylquinic acid	(13)
	5-O-caffeoylquinic acid	(12,13)
Stem	3-O-caffeoylquinic acid	(12)
	5-O-caffeoylquinic acid	(12,13)
	4-O-caffeoylquinic acid	(11,12)

Phenol compounds

Phenolic chemicals are a class of metabolites found in plants of all kinds. The above molecules range in scale from simple compounds with single phenolic hydroxyl or even in complex molecules such as polyphenols like flavonoids. VR has different type of compounds with phenolic nature which has antioxidant capacity, such as C6C1 compounds like 2,3-dihydroxybenzoic acid, phenylpropanoids including cinnamic acid derivatives, anthocyanins, and flavonoids, in addition to the most important compound alkaloids. Some of important isolated phenols are quercetin, SAG, 2,5-DHBA SA benzoic acid, glucovanillin, and gallic acid, vanillyl alcohol, kaempferol, glucovanillic acid (Table 3).


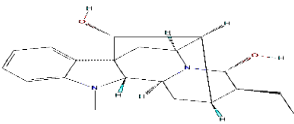
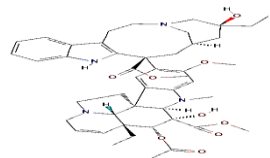
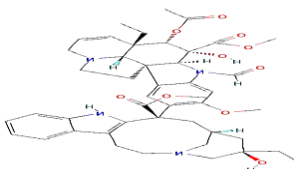

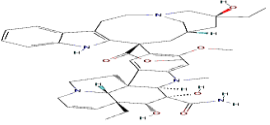
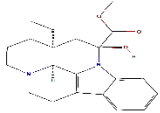
Major alkaloids

Vinca rosea contains various types of indole alkaloids, many of which have high therapeutic value.

Vincristine and vinblastine are dimers formed when monoindole alkaloids like catharanthine and vindoline, which are usually found in the aerial portion of plants and are coupled together and used in treating cancer. Both the aerial and root parts of a plant produce vincristine and vinblastine. *Rauwolfia serpentina* has lower levels of ajmalicine (vasodilator) and serpentine (hypertensive) in comparison to *C. rosea*. Reserpine is also present in their bodies. Hypotensive, sedative, and tranquilizing effects are all present in the alkaloids. The alkaloid alstonine is found in the root bark, and it has long been utilized for its relaxing and blood pressure-lowering properties.

Yohimbine (Procomil) is a stimulant and aphrodisiac alkaloid first discovered in the *Pausinystalia yohimbine* plant. This chemical is also found in *V. rosea*, along with another flavonoid called hirsutidin (10).

Table 4: Major alkaloids found in *V. rosea*

Alkaloid	Plant part	Chemical structure	Chemical formula	Reference
Ajmalicine	Leaf Stem Root		$C_{21}H_{24}N_2O_3$	(17,20, 26)
Ajmaline	Leaf Stem Root		$C_{20}H_{26}N_2O_2$	(17,20)
Vinblastine	Leaf Stem Root		$C_{46}H_{58}N_4O_9$	(17,20)
Vincristine	Leaf Stem Root		$C_{46}H_{56}N_4O_{10}$	(17,20)
Vindesine	Leaf Stem Root		$C_{43}H_{55}N_5O_7$	(17,20)
Catharanthine	Leaf		$C_{21}H_{24}N_2O_2$	(18,20)
Vincamine	Leaf Stem Root		$C_{21}H_{26}N_2O_3$	(20)

The production of secondary metabolites in plants is regulated by both biotic and abiotic influences. Due to the protective function of plants, environmental stress encourages the development of secondary metabolites, including the most important phytochemicals found in *Vinca* (alkaloids). As a result, more in vitro and in vivo research is required. According to, Misra and Gupta (14) the salinity (100 mM NaCl) increased the deposition of indole alkaloids in *V.rosea* roots and leaves. According to several investigations, Ultra violet-B light stimulates alkaloid formation in *Vinca roseus* hair roots via stimulating protein kinase. Furthermore, at an acceptable pH of the culture medium of test, biomass, and alkaloid production in *C. roseus* cell suspension cultures increased in tandem with improvement in the overall nitrogen and phosphate, because nitrogen is an essential element of alkaloids as well as phosphorus affects alkaloids synthesis. Other therapeutic herbs have shown a similar phenomenon. According to Oueslati *et al.*, (15) the polyphenol content of the *Mentha pulegium* leaf was more than three times higher than that of the regulate terpenes enhanced by green leaves of thyme plants in drought tolerance after being watered for 14 days a nutritional solution containing 100 mM sodium chloride (Table 4).

Phyto bioactivity

Traditional use

Vinca rosea has been used to relieve an array of illnesses in traditional medicine in world and especially in developing countries where the plant has been naturalized. From ancient times VR is used for treatment of various ailments such as dysentery, dengue fever, diarrhea, skin infection, leukemia, indigestion, eye irritation and insect bites, In some parts of African countries plant root is used as a tonic, and is said to have antihypertensive and sedative

effects (16). In Ayurveda, it is used to treat diabetes. Blood glucose levels that reduce due to activity of aqueous extracts from VR have also been demonstrated in a latest study (19).

Various parts of the *Vinca* plant enjoy wide usage in many countries: Bee stings are treated with leaf juice in India, and extracts from boiling plant leaves are used to halt bleeding in Hawaii. Floral extracts are used to cleanse the eyes of babies in Cuba and Jamaica (21). Leaves of *Vinca* plant are used for treatment in menorrhagia and rheumatism in African countries. In the Philippines, leaf decoctions are used for hyperglycemia, tender leaf decoctions were used for stomach pain, and root decoctions are used for treatment of intestinal parasites. Leaf infusions are used to treat menorrhagia. Raw leaf extracts and roots have anti-cancer properties. Bitter and astringent leaves are used to induce vomiting in the event of poisoning, while roots are utilized for laxatives, warming treatments, purifiers, hemostasis, and toothache in Madagascar (22). Leaf juice is used to treat indigestion and dyspepsia in Mauritius. This plant is used to treat diabetes in the West Indies and Nigeria. Flower decoctions are used in the Bahamas to treat asthma, TB, and flatulence. This plant is used to treat diabetes, high blood pressure, sleeplessness, and cancer in Malaysia. Plant gargling is used to treat sore throats, chest discomfort, and laryngitis in the United States (23).

Use in modern medicine

Scientists looking into the plant's anti-diabetic properties discovered the existence of many highly deadly alkaloids in its tissues in the 1950s (24). These alkaloids are currently being utilized to treat a variety of cancers, with a derivative known as vincristine reportedly being proven to improve children leukemia survival rates little less than 10%.

Table 5: Modern medicinal use of *V. rosea*

Application	Modern research		Reference
	<i>In vitro</i>	<i>In vivo</i>	
Antibacterial (antiseptic) activity	Bacteria		(25)
Antifertility effect	Male rat		(26)
Antifungal activity	<i>Trichophyton rubrum</i> <i>Hendersonula toruloidea</i>		(27,28)
Antihypercholesterolemic activity (antihyperlipidemic)	Rabbit, rat		(29)
Antimutagenic activity	Micronucleated erythrocytes		(30)
Antioxidant activity	Rat		(29)
Antineoplastic activity	Mice, rat	Clinical use	(32)
Antiproliferative activity	Human cells		(33)
Blood cleanser		Clinical use	(34)
Cytotoxic activity	Human cell line		(27)
Hypotensive activity	Rat		(34)
Regression of accessory reproductive organs	Male Wistar rats		(28)
Enhances kidney and liver functions	Wistar rat		(31)

Antibacterial activity has been discovered in individual compounds isolated from *V. rosea*. Yohimbine, an alkaloid extracted from the plant's leaves, stems, and roots, has antifungal and antiviral activities against the herpes simplex virus (type 1) (35). Catharoseumine, found throughout the entire plant of *V. rosea*, was found to inhibit *Plasmodium falciparum* which causes malaria, with an IC₅₀ value of 4.06 M (36). In addition to looking into the anticancer properties of specific alkaloids from *V. rosea*, the full crude extract was tested on a variety of cancer cell lines. According to this research, *V. rosea* root and stem extract have strong in vitro cytotoxic effects against an array of cancer cell lines. In some of similar other studies it found that the considerable anticancer activity of the indole alkaloid-enriched extract obtained from *V. rosea* cell cultures was attributable to the combined action of bioactive components rather than a single ingredient. These findings showed that the bioactive components identified in *C. roseus* had a synergistic impact and a beneficial interaction with cancer cells, which has been seen in the other plant matter and is being investigated as a cancer therapy technique. Antioxidant properties have been discovered in *V. rosea* extracts and isolated alkaloids such as vindoline, vindolidine, vindolicine, and vindolinine (36), which may help to prevent and minimize oxidation process. Although oxidation reactions are important for life, they generate free radicals, which set off a cascade of metabolic events that harm or kill cells, contributing to cell ageing, cardiovascular disease, brain disease (including Alzheimer's disease), mutagenic alterations, and tumor growth (37).

CONCLUSION

Vinca rosea is high in alkaloids and phenolics, which have a variety of medicinal effects, including cancer and diabetes prevention, as well as antihypertensive, antioxidant, and antibacterial properties. Many alkaloids and phenolics have also been discovered in this plant, but there are many more that have yet to be discovered. As a result, work on identifying and isolating novel phytochemicals from *V. rosea* various structural components should continue. In addition, prospective applications of bioactive chemicals produced from this material in the nutraceutical and pharmaceutical industries must be studied further.

CONFLICT OF INTEREST

There are no conflicts of interest declared by the authors.

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