



# "*Rauwolfia serpentina*: A Comprehensive Review of its Pharmacological, Phytochemical and Therapeutic Properties"

Subhadeep Saha<sup>1</sup>, Dr. Deeparani Urolagin<sup>2</sup>, Vijaya Kumar J<sup>3</sup>, Harish N<sup>4</sup>.

Research Scholar, Department of Pharmacology, R R College of pharmacy, Bangalore 560090

## ABSTARCT:

*Rauwolfia serpentina*, commonly known as Sarpagandha, is a medicinal plant that has been extensively described in both Ayurvedic literature and modern science. It belongs to the Apocynaceae family and is currently endangered. However, it is cultivated for its numerous medicinal properties. The plant contains various compounds such as alkaloids, carbohydrates, flavonoids, glycosides, phlobatannins, phenols, resins, saponins, sterols, tannins, and terpenes, which contribute to its therapeutic effects. The root and rhizome of *Rauwolfia serpentina* have been used in Ayurvedic medicine for centuries to treat a wide range of ailments including high blood pressure, mental agitation, epilepsy, traumas, anxiety, excitement, schizophrenia, sedative insomnia, and insanity. In the past, *Rauwolfia serpentina* was considered a highly effective remedy for hypertension. The alkaloid present in its root is believed to have antihypertensive properties. Ayurvedic literature also describes other notable properties of this plant, such as its ability to treat fever, promote wound healing, improve digestion, induce sleep, relieve pain, and alleviate respiratory disorder.

Furthermore, *Rauwolfia serpentina* has various pharmaceutical applications and can be used as an excipient in many formulations. Given the need for alternative and naturally available remedies to treat millions of people worldwide, it is important to evaluate the pharmacological, phytochemical and therapeutic properties of *Rauwolfia serpentina*.

In conclusion, *Rauwolfia serpentina* is a valuable medicinal plant with a wide range of therapeutic properties. Its use in traditional medicine and its potential pharmaceutical applications make it an important subject of study for researchers and practitioners alike.

**Keywords:** *Rauwolfia serpentina*, Apocynaceae, Phytochemicals, Pharmacological, therapeutic.

## INTRODUCTION

The increasing global population presents significant challenges in meeting the growing demand for food, shelter, and healthcare. With millions of people worldwide suffering from various diseases, there is a rising need for effective and affordable medications <sup>[1]</sup>. Traditional pharmaceutical formulations often come with high costs, limited efficacy, and numerous side effects. As a result, there is an urgent call to explore alternative, naturally available medicines or herbal remedies that offer therapeutic benefits without adverse reactions <sup>[2,3]</sup>.

Herbal medicine has gained popularity, with over 80% of the world's population relying on it for its healing properties. In India, a rich tradition of using indigenous plants for disease treatment has been practiced, as nature has provided a vast array of remedies to address human ailments. Medicinal plants contain a diverse range of chemical substances, including alkaloids, glycosides, volatile oils, fatty acids, resins, gums, and tannins, which contribute to their therapeutic effects <sup>[4]</sup>.

According to the World Health Organization (WHO), any plant or its parts containing substances that can be used for therapeutic purposes or as raw materials for pharmaceutical synthesis are classified as drugs <sup>[5]</sup>. Today, approximately 300 species of medicinal and aromatic plants are utilized globally in the pharmaceutical, food, cosmetics, and fragrance industries. One such plant of medicinal importance is *Rauwolfia serpentina*.

*Rauwolfia serpentina* L. Benth. Ex Kurz. is an evergreen, woody, perennial shrub that reaches a maximum height of 60 cm. It features tuberous roots with pale brown cork and elliptic to lanceolate or obovate leaves arranged in whorls of three. Belonging to the Apocynaceae family, this plant is found in tropical and subtropical regions, including the Himalayas, Indian peninsula, Burma, Indonesia, Sri Lanka, and other parts of Asia <sup>[6,7]</sup>. Commonly known as Sarpagandha, Chandrabagha, Snake root plant, Chotachand, Chandrika, and Harkaya, *Rauwolfia serpentina* has attracted attention in the indigenous system of medicine due to its medicinal properties.

The roots, leaves, and juice of *Rauwolfia serpentina* hold medicinal significance and contain a large number of secondary metabolites, particularly N-containing indole alkaloids, primarily found in the roots and rhizomes. In the Ayurvedic medical system, the roots of *R. serpentina* have been used to treat hypertension, insomnia, mental agitation, gastrointestinal disorders, epilepsy, traumas, anxiety, schizophrenia, sedative insomnia, and insanity. Similarly, in Siddha medicine, *R. serpentina* roots are employed to address hypertension-associated symptoms such as headaches, dizziness, amenorrhea, oligomenorrhea, and dysmenorrhea <sup>[8]</sup>.

In light of the plant's extensive traditional use and therapeutic potential, this review aims to explore the botanical description, chemical constituents, and various medicinal applications of *Rauwolfia serpentina*. By evaluating its pharmacological, phytochemical, and therapeutic properties, we can further understand the potential of *R. serpentina* as a valuable natural remedy for a wide range of ailments <sup>[9]</sup>.

## PHYTOCHEMICAL CONSTITUENTS

*Rauwolfia serpentina*, a plant that has been extensively studied, contains various phytochemical compounds or secondary metabolites. These include **alkaloids, phenols, tannins, flavonoids, and saponins**.

**Alkaloids** are organic molecules that contain a heterocyclic nitrogen ring. They are produced by plants and have diverse functions, including defense against herbivores and pathogens. Alkaloids from *R. serpentina*, such as reserpine, ajmaline, ajmalicine, deserpidine, serpentine, and yohimbine, have medicinal properties. They are used as analgesics, antispasmodics, bactericidal agents, and for the treatment of hypertension and breast cancer [10,11].

**Reserpine**, the most prominent alkaloid in *R. serpentina*, is used as a natural tranquillizer and has antihypertensive properties. It acts on the central and peripheral nervous systems by depleting the storage of catecholamines and serotonin, resulting in sedation and lowering of blood pressure.

**Ajmaline**, derived from *R. serpentina*, is a sodium channel blocker used for diagnosing Brugada Syndrome, a hereditary cardiac disorder. It stimulates respiration and intestinal movements and affects systemic and pulmonary blood pressure [12].



Figure 1: Chemical structures of some alkaloids present in *Rauwolfia serpentina*.

**Ajmalicine** is used in the treatment of circulatory diseases and helps in lowering blood pressure by affecting smooth muscle function and preventing strokes.

**Serpentine**, a topoisomerase inhibitor, exhibits antipsychotic properties. It is derived from ajmalicine through oxidation [13].

**Rescinnamine**, similar to reserpine, is used for the treatment of hypertension. It inhibits angiotensin converting enzyme and blocks the conversion of angiotensin I to angiotensin II.

**Yohimbine**, a well-characterized alkaloid, is used as an alpha-adrenergic antagonist in the treatment of erectile dysfunction. It dilates blood vessels and increases blood flow <sup>[14]</sup>.

**Phenols, tannins, and flavonoids** are secondary plant metabolites found in *R. serpentina*. They have various medicinal properties, including antidiabetic, hypolipidemic, and antimicrobial effects. Phenols are toxic to pests and pathogens, tannins have astringent properties and aid in wound healing, and flavonoids act as antioxidants and have anticancer activity <sup>[15,16]</sup>.

**Saponins**, found in *R. serpentina*, have foaming properties and are known for their hemolytic activity and bitterness. They have been used to stop bleeding and treat wounds.

*R. serpentina* also contains minerals such as calcium, zinc, and ascorbic acid (vitamin C). Calcium aids in blood coagulation, zinc is beneficial for diabetes management, and ascorbic acid is important for wound healing and overall body function <sup>[17]</sup>.

Overall, *R. serpentina* is a rich source of phytochemicals, minerals, and vitamins, making it a potential source of useful drugs for the treatment of various diseases <sup>[18]</sup>.

### Pharmacological action

*Rauwolfia serpentina*, or *R. serpentina*, is highly valued in pharmacology due to the presence of various alkaloids in its root's oleoresin fraction. These alkaloids have medicinal importance in treating cardiovascular diseases, high blood pressure, hypertension, arrhythmia, psychiatric diseases, mental disorders, breast cancer, and diseases similar to human promyelocytic leukemia.

The main alkaloid found in *R. serpentina* is reserpine, which has a complex pattern of activity in the brain. It influences the concentration of glycogen, acetylcholine, gamma-aminobutyric acid (GABA), nucleic acids, and anti-diuretic hormone. Reserpine's effects include respiratory inhibition, stimulation of peristalsis, constriction of the pupils (myosis), relaxation of the nictitating membranes, and influence on the temperature-regulating center. It also increases the volume and acidity of gastric secretion <sup>[19,20]</sup>.

In Unani medicine, *R. serpentina* is used in the form of Pitkriya capsules, which contain arsol (*R. serpentina*). These capsules have sedative and hypnotic properties, diuretic effects, nerve-soothing properties, and anesthetic properties. *R. serpentina* exhibits various pharmacological activities, including anticholinergic, hypotensive, anticontractile, sedative, relaxant, hyperthermic, antidiuretic, sympathomimetic, hypnotic, vasodilatory, antiemetic, anti-fibrillar, tranquilizing, anti-arrhythmic, antifungal, and nematocidal effects <sup>[21]</sup>.

The pharmacological attributes of *R. serpentina* are believed to include its action on the vasomotor center, leading to generalized vasodilation and lowering of blood pressure. It also has a depressant effect on the cerebral centers, soothing the general nervous system. Additionally, it exerts a sedative action on the gastric mucosa and stimulates the smooth muscles of the body <sup>[22]</sup>.

It is important to note that the information provided here is based on the available literature and research on *R. serpentina* in pharmacology. It is always recommended to consult a healthcare professional or pharmacist for specific medical advice or information [23].

*Rauwolfia serpentina*, also known as Indian snakeroot, contains a group of bioactive compounds known as alkaloids, with the primary active alkaloid being reserpine. This plant has been traditionally used in Ayurvedic medicine for its potential medicinal properties. Its pharmacological actions include:

**1. Antihypertensive Effects:** The most well-known pharmacological action of *Rauwolfia serpentina* is its antihypertensive (blood pressure-lowering) effect. Reserpine, one of the main alkaloids in the plant, acts as a peripheral vasodilator by reducing the sympathetic nervous system's activity. It decreases the release of norepinephrine (noradrenaline) from sympathetic nerve endings, leading to relaxation of blood vessels and decreased cardiac output. This effect helps to lower blood pressure and has been used in the treatment of hypertension [24].

**2. Sedative and Tranquilizing Effects:** *Rauwolfia serpentina* has been historically used as a sedative and tranquilizer. Reserpine's ability to inhibit the release of neurotransmitters like norepinephrine and serotonin in the brain contributes to its calming effects. This property has been used to manage anxiety, insomnia, and other nervous system disorder [25].

**3. Antipsychotic Effects:** Reserpine's impact on neurotransmitter levels in the brain also led to its use in the past as an antipsychotic medication. It was used to manage certain symptoms of schizophrenia, although it has largely been replaced by other medications with fewer side effects [26].

**4. Antiarrhythmic Effects:** *Rauwolfia serpentina's* alkaloids, particularly reserpine, have been reported to have antiarrhythmic properties. They can help regulate heart rhythm and reduce abnormal heartbeats, although this application is less common than its use as an antihypertensive [27].

**5. Antispasmodic Effects:** Some studies suggest that *Rauwolfia serpentina* extracts may have antispasmodic effects on smooth muscles, potentially contributing to its traditional use in relieving gastrointestinal and uterine spasms [27].

**6. Anti-inflammatory Effects:** *Rauwolfia serpentina* extracts have demonstrated anti-inflammatory properties in some studies. This could be attributed to the presence of various bioactive compounds with potential anti-inflammatory actions [28].

It's important to note that while *Rauwolfia serpentina* has these pharmacological actions, its use has declined over the years due to the development of more effective and safer medications for conditions like hypertension and mental health disorders. Additionally, reserpine and other alkaloids present in the plant can have significant side effects and interactions with other medications, which has led to its restricted use and caution in its administration. Always consult a healthcare professional before using any herbal supplements or alternative treatments [29].

## ***R. serpentina* as a medicinal herb and therapeutic agent**

*Rauwolfia serpentina* or *R. serpentina* is known for its extensive therapeutic actions and is commonly used in the treatment of hypertension and psychotic disorders such as schizophrenia, anxiety, epilepsy, insomnia, and insanity. It is also used as a sedative and hypnotic drug.

The plant contains a variety of therapeutically useful indole alkaloids, with the majority of these alkaloids found in the roots [29]. *R. serpentina* has been traditionally used to treat circulatory disorders, and extracts of the roots are valued for their effectiveness in treating intestinal disorders like diarrhea and dysentery. They have also been used in combination with other plant extracts to treat cholera, colic, and fever. The root has been believed to stimulate uterine contractions and has been recommended for use during childbirth [30].

Furthermore, *R. serpentina* extract has been utilized in the treatment of cancer and other diseases. However, it is important to note that further research is needed to fully understand and validate the therapeutic potential of *R. serpentina* in these conditions.

It is always recommended to consult a healthcare professional or herbalist for specific medical advice or information regarding the use of *R. serpentina* as a medicinal herb or therapeutic agent [31].

### **Prostate cancer**

Prostate cancer is a significant cause of cancer-related deaths in men. While modern techniques such as chemotherapy and radiotherapy have not provided significant survival benefits for prostate cancer patients, natural products have shown promise in the identification of bioactive compounds for the treatment of various ailments, including cancer [32].

*Rauwolfia serpentina*, or *R. serpentina*, has been used in traditional medicine for centuries to treat a range of ailments, including fever, general weakness, intestinal diseases, liver problems, and mental disorders. The root bark of this plant contains compounds from the  $\beta$ -carboline alkaloid family, with alstonine being the main constituent. Alstonine has been found to reduce tumor cell growth in mice inoculated with YC8 lymphoma cells or Ehrlich ascitic cells [33,34].

Studies have shown that *R. serpentina* extract exhibits anti-prostate cancer activity in both *in vitro* and *in vivo* model systems. The effects of the extract on prostate cancer cells may be modulated by its impact on DNA damage and cell cycle control signaling pathways, as indicated by analyses of gene expression patterns [35].

It is important to note that while these findings are promising, further research is needed to fully understand the potential of *R. serpentina* in the treatment of prostate cancer. Consultation with healthcare professionals and oncologists is crucial for appropriate diagnosis, treatment, and management of prostate cancer [36,37].

## Mental illness

*Rauwolfia serpentina*, also known as Indian snakeroot or Sarpagandha, is a plant that has been traditionally used in Ayurvedic medicine for various purposes, including the treatment of mental health disorders. The plant contains a group of active compounds called reserpine alkaloids, with reserpine being the most well-known compound. Reserpine has been used in the past as an antipsychotic and antihypertensive medication due to its ability to affect neurotransmitter levels in the brain, particularly dopamine.

In the context of mental illnesses, reserpine was historically used to treat conditions like schizophrenia and bipolar disorder. It was one of the first antipsychotic medications discovered and used. However, its use has declined over the years due to the development of more effective and better-tolerated medications with fewer side effects. Modern antipsychotic and mood-stabilizing medications have largely replaced reserpine for the treatment of mental illnesses [38].

It's important to note that while *Rauwolfia serpentina* and its compounds were used in traditional medicine, they are not commonly used in mainstream psychiatric treatment today. The field of psychiatry has advanced significantly, and more targeted and evidence-based treatments are available for various mental illnesses. If you or someone you know is dealing with a mental health condition, it's recommended to seek guidance and treatment from a qualified medical professional.

## Schizophrenia

*Rauwolfia serpentina* and its primary compound, reserpine, have been historically explored as a potential treatment for schizophrenia, which is a complex mental disorder characterized by abnormal thinking, perceptions, emotions, and behavior. Reserpine, derived from *Rauwolfia serpentina*, was believed to be effective in managing some of the symptoms of schizophrenia by modulating neurotransmitter levels in the brain, particularly dopamine.

In the mid-20th century, reserpine was one of the few medications available for treating schizophrenia. It was thought to have antipsychotic effects due to its ability to deplete the brain's stores of dopamine and other neurotransmitters. However, the use of reserpine for schizophrenia treatment was associated with significant side effects, including sedation, depression, and a risk of exacerbating certain symptoms.

As medical research and understanding of schizophrenia advanced, newer and more targeted antipsychotic medications were developed, such as the typical antipsychotics like chlorpromazine and later the atypical antipsychotics like risperidone and olanzapine. These medications are designed to address the specific neurochemical imbalances associated with schizophrenia while generally causing fewer side effects than older treatments like reserpine [39,40].

Today, the treatment of schizophrenia typically involves a combination of antipsychotic medications, psychotherapy, and psychosocial interventions. These approaches aim to manage symptoms, improve functioning, and enhance the overall quality of life for individuals with schizophrenia. If you or someone you know is dealing with schizophrenia or any other mental health condition, it's crucial to consult a qualified healthcare professional to determine the most appropriate and effective treatment plan.

### High blood pressure

*Rauwolfia serpentina* has been historically used for its potential effects on managing high blood pressure (hypertension).

The main active compounds in *Rauwolfia serpentina* are a group of alkaloids, particularly reserpine. Reserpine has been found to have antihypertensive (blood pressure lowering) properties by affecting the sympathetic nervous system. It works by reducing the release of norepinephrine and dopamine, which are neurotransmitters that play a role in regulating blood pressure and heart rate.

However, the use of *Rauwolfia serpentina* and its compounds like reserpine has declined over the years due to several factors:

1. Side Effects: Reserpine can cause a range of side effects including depression, sedation, and gastrointestinal disturbances. It can also cause a drop in blood pressure that may lead to dizziness or fainting.
2. Interaction with Other Medications: *Rauwolfia serpentina* and its compounds can interact with other medications and potentially cause adverse effects or reduce the effectiveness of other drugs.
3. Availability of Safer Alternatives: Modern medicine has developed a variety of more targeted and safer medications for managing hypertension. These newer medications have fewer side effects and are better understood in terms of their interactions and effects on the body.
4. Regulation and Standardization: Herbal remedies can vary significantly in terms of potency and quality due to factors such as plant sourcing, growing conditions, and preparation methods. This variability makes it difficult to ensure consistent dosages and effects <sup>[41,42]</sup>.

Due to these concerns, the use of *Rauwolfia serpentina* and its compounds is not as common in modern medical practice for hypertension management. If you are seeking treatment for high blood pressure, it's important to consult a qualified healthcare professional who can guide you towards appropriate and safe treatment options based on your individual health needs and medical history.

In addition to high blood pressure, extracts of *R. serpentina* have been found to be helpful in treating other diseases. These include fever, malaria, eye diseases, pneumonia, asthma, AIDS, headache, skin diseases, and spleen disorders.



## CONCLUSION

*Rauwolfia serpentina*, or *R. serpentina*, has been studied for its potential as an antioxidant, anticancerous, antidiuretic, antiarrhythmic, antidysentery, antidiarrheal, antihypotensive, anticontractile, and tranquillizing agent.

As an antioxidant, *R. serpentina* has been found to possess compounds that can help neutralize harmful free radicals in the body, potentially reducing oxidative stress and protecting against cellular damage.

In terms of anticancerous properties, studies have shown that *R. serpentina* extracts and its alkaloids exhibit cytotoxic effects on cancer cells, inhibiting their growth and inducing apoptosis (programmed cell death). These findings suggest that *R. serpentina* may have potential as an adjunct therapy in cancer treatment.

*R. serpentina* has also been investigated for its antidiuretic effects, which means it can reduce urine production. This property may be beneficial in conditions where excessive urine production is a concern, such as diabetes insipidus.

The plant has shown antiarrhythmic activity, meaning it can help regulate abnormal heart rhythms. This property may be attributed to its influence on the cardiovascular system, including its effects on blood pressure and heart rate.

Additionally, *R. serpentina* has been traditionally used as an antidysentery and antidiarrheal agent, suggesting its potential in the treatment of gastrointestinal disorders characterized by diarrhea and dysentery.

The plant has been found to have antihypotensive effects, meaning it can help raise low blood pressure. This property may be beneficial in certain cases of hypotension.

*R. serpentina* has also been studied for its anticontractile properties, which means it can relax smooth muscles. This effect may be useful in conditions where muscle spasms or contractions need to be alleviated.

Lastly, *R. serpentina* has been recognized for its tranquillizing or calming effects on the nervous system. This property may contribute to its traditional use as a sedative and hypnotic agent.

It is important to note that while these potential benefits have been observed in studies, further research is needed to fully understand the mechanisms of action and clinical applications of *R. serpentina* in these areas. Consulting with healthcare professionals is advised for specific medical advice or information.

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