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THE PHYTOCHEMICAL AND PHARMACOLOGICAL PROPERTIES OF *SARPAGANDHA*: *RAUWOLFIA SERPENTINA*

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ABSTRACT

Sarpagandha, Rauwolfia serpentina is a medicinal plant explained in *Ayurvedic* literature and in modern science. The plant is known for curing various disorders because of the presence of alkaloids, carbohydrates, flavonoids, glycosides, phlobatannins, phenols, resins, saponins sterols, tannins and terpenes. The plant parts, root and rhizome have been used since centuries in Ayurvedic medicines for curing a large number of diseases such as high blood pressure, mental agitation, epilepsy, traumas, anxiety, excitement, schizophrenia, sedative insomnia and insanity This review represents brief information about botanical description, chemical constituents, and functional as well as medicinal uses of *Rauwolfia serpentina*. In past years it was declared as a best remedy for hypertension. The alkaloid found in its root is attributed to anti hypertensive pharmacological action. In Ayurvedic literature too Our Acharyas has defined various remarkable properties like its *Jwarhar, Varnanashak, Grahi, Nidrajanan, Svashahar, Soolprashamna prabhav* of this plant. The plant also has number of pharmaceutical applications i.e. may be used as excipient in many of formulations. There is a need for us to search alternative, naturally available remedies for curing millions of people worldwide. Due to all these properties, the present review aims to evaluate the various pharmacological, phytochemical and therapeutic properties of *R. serpentine.*

INTRODUCTION

Increase in world population poses huge challenges to satisfy the need for food, shelter and cloth. There is a rise in demand for medicine, as millions of people are suffering from various types of diseases worldwide. There are several pharmaceutical formulations available commercially for the treatments of disorders but they are costly, not effective and show numerous toxic effects. Therefore, there is an urgent need for us to use an alternate, naturally available medications or herbal remedies which do not show any side effects.[1] In India, various indigenous plants are used to cure disease, as nature has provided a perfect storehouse of remedies to cure all elements of humanity. [2] The medicinal plants show the presence of various chemical substances such as alkaloids, hydrogen, carbon, nitrogen, glycosides, volatile oils, fatty acids, resins, gums and tannins that are responsible for treating various diseases.[3] Today about 300 species of medicinal and aromatic plants are used worldwide in the pharmaceutical, food, cosmetics and fragrance industries.[4] One of the medicinally important plant used for the purposes of obtaining drugs is *Rauvolfia serpentina.*

Rauwolfia serpentina is the dried root of *Rauwolfia serpentina* (Linne) Bentham ex Kurz. (Family: Apocynaceae). The roots, leaves and juice are of medicinal importance and have attracted the attention of practitioners of indigenous system of medicine, as it contain a large number of secondary metabolites (N-containing indole alkaloids) localized mainly in the roots and rhizomes. [5] It has been used in India as a part of the Ayurvedic medical system for the treatment of various ailments.[6] In Ayurvedic medicines, the roots of *R. serpentina* is used as a remedy for curing hypertension, insomnia, mental agitation, gastrointestinal disorders, excitement, epilepsy, traumas, anxiety, excitement, schizophrenia, sedative insomnia and insanity.[7] In Siddha medicine, *R. serpentina* roots are used for curing hypertension-associated headache, dizziness, amenorrhea, oligomenorrhea and dysmenorrhea like abnormalities. [8] The present review work emphasizes on the potential of *R. serpentina* as antifungal, antiinflammatory, antioxidant, antiproliferative, anticancerous, antidiuretic, antifibrillar, antiarrhythmic, anticholinergic, antidysentry, antidiarrhoeal antihypertensive, anticontractile, antidiuretic, sympathomimetic, and tranquillizing agent. [9-14]

History

Rauwolfia serpentina is said to be appear in Sanskrit as an Ayurvedic medicine named *Sarpgandha* and *Chandra*. *Sarpgandha*, snakes smell or repellant, refers to the u se as an antidote for Snake-bite. [15].

Table 1: Botanical classification of *Rauwolfia serpentina*[16]

Kingdom	Plantae
Unranked	Angiosperms
Unranked	Eudicots
Unranked	Asterids
Order	Gentianales
Family	Apocynaceae
Genus	*Rauvolfia*
Species	*R.serpentina*

Table 2 : Vernacular Names[17]

Hindi	Chandrabhaga, Chota-chand, Sarpagandha
English	Rauvolfia /Indian snakeroot
Latin	Rauvolfia serpentine
Sanskrit	Sarpaghandha
Tamil	Chevanamalpodi, Sarpagandha
Kannada	Keramaddinagaddi
Telugu	Patalaguni, Patalagandha, Sarpagandha
Malayalam	Churannavilpori, Suvapavalporiyam
Marathi	Harkaya, Harki, Hadaki/Adakai
Assamese	Arachoritita
Bengali	Chandra
Kannada	Sutranabhi
Chinese	Lu fu mu

Distribution

The family includes 50 species, distributed worldwide in the region of the Himalayas, Indian peninsula, Burma, Indonesia and Sri Lanka and is indigenous to India, Bangladesh and other regions of Asia. *Sarpagandha* is an important medicinal plant distributed in the foot-hills of Himalayan range, up to the elevation of 1300-1400 m. and almost all over the country. It is used in traditional medicine in India, China, Africa and many other countries. It grows in India, Pakistan, Sri Lanka, Burma and Thailand. In India, it is widely distributed in the sub-Himalayan tract from Punjab to Nepal, Sikkim and Bhutan. It is also found in the lower hills of Gangetic plains, eastern and Western Ghats and Andaman's. It is mostly found in moist deciduous forests at altitudes ranging from sea level to an altitude of 1, 200 m high. In the Deccan, it is associated with bamboo forests. [18]

Morphological Features

Rauwolfia serpentina is an evergreen, perennial, glabrous and erect under shrub. The maximum height of the plant is up to 60 cm. Its roots are tuberous with pale brown cork. The Leaves of the plant are in whorls of three, elliptic to lanceolate or obovate, bright green above and below pale green and thin. Its flowers are in irregular corymbose cymes, white, often tinged with violet. The flowering time is from March to May in Indian conditions. Its fruits are Drupe, single or didymous, shining black, the inflorescence with red pedicels and calyx and white corolla.

Chemical Constituents

The major alkaloid present in root, stem and leaves of the plant is Reserpine varies from 1.7 to 3.0 %. The root barks has more than 90% of the total alkaloids in roots. [18]

Three types of alkaloids are present in *Rauwolfia serpentina.*

1. Weakly basic Indole Alkaloids: The principal alkaloids are Reserpine, Rescinnamine, despiridine and these are tertiary Indole Alkaloids.

2. Indoline Alkaloids of intermediate basicity: Reserpiline, Ajmaline, Iso- Ajmaline, rauwolfinine are tertiary Indoline alkaloids.

3. Strong Anhydronium Bases: Serpentine, serpentinine and alsotonine are strongly basic anhydronium alkaloids. [19]

While Ajmalinine, Ajmalicine, Chandrine, renoxidine, reserpinine, Sarpagine, Tetraphyllicine, Yohimbine, 3-epi-ayohimbine are the other alkaloids present in *Rauwolfia serpentina.* [20] Reserpine is the most important alkaloid present in root, stem and leaves of the plant. It contains not less than 0.15% of Reserpine-rescinnamine group alkaloids, calculated as Reserpine. The percentage of alkaloid depends on geographical place from where the plant is collected and also the season of collection. Generally samples from Assam have a higher percentage of alkaloid (2.57%) and December is the best month for the collection for getting more percentage of alkaloid. [21]

Mineral composition

Rauvolfia is also known to contain a large number of macro and micro-nutrients and the most abundant macro nutrient is calcium. [22] The potential of *R. serpentina to* stop bleeding and its use in treating wounds can be due to its high calcium content, as it helps in blood coagulation. *R. serpentina* contains low sodium content that can be an added advantage due to the direct relationship of sodium intake with hypertension in human. [23] The presence of zinc shows that plant can play valuable roles in the management of diabetes, which result from insulin malfunction. The plant *R. serpentina* is also an excellent source of ascorbic acids, riboflavin, thiamine and niacin. Ascorbic acid is vital for body performance as it plays an important role in normal wound healing, [24] and lack of it impairs the normal formation of intercellular substances throughout the body (including collagen, bone matrix and tooth

dentine). The *R. serpentina* is used in herbal medicine as a potential source of useful drugs for the treatment of many diseases as it is a rich source of phytochemicals, minerals and vitamins. [25]

***Ayurvedic* pharmacodynamic properties:** [26]

***Rasa* :** *Tikta*

***Guna* :** *Ruksha*

***Veerya* :** *Ushna*

***Vipaka* :** *Katu*

Table 3: Physical Properties of *Sarpagandha* as per Various *Nighantu*

S. No.	*Nighantu*	*Gana*	*Rasa*	*Guna*	*Veerya*	*Vipaka*
1.	*BhavPrakash Nighantu*[27]	*Haritakiadivarga*	*Katu, Tikta, Kashya*	*Ushna*	*Ushna*	-
2.	*Madanpal Nighantu*[28]	*Abhayadi Varga*	*Tikta*	*Ruksha*	*Ushna*	*Katu*
3.	*Raj Nighantu*[29]	*Mulakadi Varga*	*Katu, Tikta*	*Ushna*	*Ushna*	*Katu*
4.	*Kaiyadeva Nighantu*[30]	*Aushadhi Varga*	*Katu, Tikta, Kashya*	-	-	-
5.	*Dhanvantari Nighantu*[31]	*Karveeradi varga*	*Katu, Tikta*	-	*Ushna*	-
6.	*Priya Nighantu*[32]	*Shatpushpadi varga*	*Tikta*	-	*Ushna*	-

***Doshaghnata* :** *Kaphavata shamak*

Table 4: Effect of *Sarpagandha* on *Dosh* According to Different *Nighantu* [23-28]

Dosha	B.P.N.	M. P.	Raj.N.	Kaiy.N.	Dha.N.	Pri.N.
Vatahar	✓	✓	✓	-	-	-
Pitta har	-		✓	-	-	-
Kaphahar	✓	✓	✓	-	-	-

Rogaghnata: *Anidra, Bhrama, Unmada, Apasmara, Shoola, Jwara, Agnimandya, Krimi, Raktvata, Sirogatavata.*

Karma: *Kaphavatashamak, nidrajanaka.*[33]

Table 6: Therapeutic Effect of *Sarpghandha* as per *Nighantu* [23-28]

S.No.	Property	M.N	R.N	D.N	B.N	K.N	P.N
1.	*Krimihar*	-	-	✓	✓	✓	✓
2	*Jwarhar*	✓	✓	-	✓	-	✓
3	*Varnanashak*	✓	-	-	✓	✓	-
4	*Grahi*	✓	-	-	-	-	-
5	*Nidrajanan*	✓	-	-	-	-	✓
6	*Svashahar*	✓	-	-	-	-	
7	*Soolprashamna*	✓	-	-	-	-	✓
8.	*Vishnashak*	✓	✓	✓	✓	✓	
9	*Grabhashayautejka*	✓	-	-	-	-	-

M. P. = Madanpal Nighantu; Raj.N. = Raj Nighantu; K.N. = Kaiyadeva Nighantuh;
D.N. =Dhanvantari Nighantu; Pri.N. = Priya Nighantu, B.N. = Bhavprakash Nighantu

Therapeutic uses

The drug *Sarpagandha* is cardiodepressant, hypnotic and sedative. It is used in hypertension, insomnia, sexual aggression and vertigo. The drug is much used in schizophrenia and conditions involving influence of evil spirits (*Bhutawadha*). The classical text of Indian medicine mention about drug, *Sarpagandha* is included in *Aparajit Gana* which is indicated in mental disorder (*Susruta uttartantra* 60/47). *Sarpandha* is also included in *Ekasar Gana* (*susruta kalpa* 5/84) useful against *Visha* and for treatment of *Musaka visha* (*Susrtuta kalpa* 7/29). Also use in treatment of *Visuchika* (*Vrindamadhava* 6/26). In modern era *Sarpagandha* is used as an effective Antihypertensive and it is WORLD'S FIRST ANTIHYPERTENSIVE DRUG. [34]

***R. serpentina* in pharmacology**

R. Serpentina holds an important position in the pharmaceutical world due to the presence of various alkaloids in the oleoresin fraction of the roots. Alkaloids of this plant have a great medicinal importance to treat cardiovascular diseases,[35] high blood pressure, hypertension,[36] arrhythmia, various psychiatric diseases,[37] mental disorders, breast cancer, human promyelocytic leukemia[38] like diseases.

Reserpine is the main alkaloid that shows highly complex pattern of activity mainly variation of amine concentration in brain. It is responsible for influencing the concentration of glycogen, acetyl choline, g-amino butyric acid, nucleic acids and anti-diuretic hormone.

The effects of reserpine include respiratory inhibition, stimulation of peristalsis, myosis, relaxation of nictitating membranes and also influences temperature regulating centre. It increases the volume and free acidity of gastric secretion.

Its various pharmacological activities include anticholinergic, hypotensive, anticontractile, sedative, relaxant, hyperthermic, antidiuretic, sympathomimetic, hypnotic, vasodialater, antiemetic, anti-fibrillar activity tranquilizing agent, anti-arrhythmic, antifungal and nematocidal. [139]

R.serpentina is believed to have following pharmacological attributes:

(1). By the action on vasomotor centre, as it leads to generalized vasodilatation by lowering blood pressure.

(2). By depressant action on the cerebral centres as it soothes the general nervous system.

(3). It exerts a sedative action on the gastric mucosa and shows stimulating action on the plain musculature of theintestinal tract.

(4). It also stimulates the bronchial musculature. [40]

***Rauwolfia's* main uses are** [41]

High blood pressure: The *Rauwolfia* herb is the best remedy for high blood pressure and it has been adapted by medical fraternity in most countries. Those alkaloids which have a direct effect on hypertension have been isolated in it and are widely used by the practitioners of modern medicine. But they have certain unpleasant side effects which the drug taken in its raw form, does not have. Half a teaspoon of its powder taken thrice a day is effective in relieving hypertension.

In insanity: The *Rauwolfia* plant is highly beneficial in treating insanity. One gram of powdered root can be taken twice a day with 250 ml of goat's milk, sweetened with sugar candy. It is unsuitable for those with a low blood pressure, depressed and hypotensive patients.

In insomnia: *Rauwolfia* is a wee-known remedy in treating insomnia because of its sedative properties. The very first dose of *Rauwolfia* enables the patient of a phlegmatic and gouty nature to go to sleep. About 0.6 to 1.25 grams of the powder of its root is mixed with some scented vehicle and taken. It is non-stimulating and should be given in doses of 0.25 grams to the patient at bedtime for sound sleep.

In Hysteria: *Rauwolfia* is useful in treating hysteria. One gram of powdered root can be administered thrice with milk. Treatment should be continued till a complete cure is obtained.

In itching skin: It relieves itching in urticaria. One gram of powdered root can be taken with water.

Prostate cancer

Prostate cancer is considered to be major causes of cancer-related deaths among men. Modern techniques such as chemotherapy and radiotherapy have not provided significant survival benefits to patients with prostate cancer. [42] Natural products have proven to be a major resource for identification of bioactive compounds used in the treatment of a variety of ailments and diseases, including cancer as compared to chemotherapy and radiotherapy. Various parts of this plant have been used as a traditional medicine for centuries to treat a variety of ailments including fever, general weakness, intestinal diseases, liver problems and mental disorders.

Extracts from the root bark of this plant are enriched with compounds of ß-carboline alkaloid family of which the main constituent is alstonine. This compound has been previously reported to reduce tumour cell growth in mice inoculated with YC8 lymphoma cells or Ehrlich ascetic cells.[43] The plant extract has anti-prostate cancer activity in both in vitro and in vivo model systems which, based upon analyses of gene expression patterns of treated prostate cancer cells, may be modulated by its effects on DNA damage and cell cycle control signalling pathways. [44]

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

R. serpentina has an extensive spectrum of valuable therapeutic actions, mainly effective in the treatment of hypertension and psychotic disorders like schizophrenia, anxiety, epilepsy, insomnia, insanity, and also used as a sedative, a hypnotic drug. The plant is reported to contain a large number of therapeutically useful indole alkaloids and these alkaloids are largely located in the roots. Fabricant and Fransworth (2001) has emphasized the various ethnobotanical uses to cure various circulatory disorders. Extracts of the roots are valued for the treatment of intestinal disorders, particularly diarrhoea and dysentery and also as anathematic. Mixed with other plant extracts, they have been used in the treatment of cholera, colic and fever. The root was believed to stimulate uterine contraction and recommended for the use in childbirth. A study by Azmiand Qureshi (2012) showed therapeutic effects of *Rauvolfia* with incomplete hypoglycemic action in diabetic hypertensive patients. The juice of the leaves has been used as a remedy for the opacity of the cornea.93 *Rauvolfia's* juice and extract obtained from the root can be used for treating gastrointestinal and circulatory diseases. The Juice of tender leaves and root extract is used to treat liver pain, stomach pain, dysentery and to expel intestinal worms. The extract is also utilized to treat cancer which is one of the leading cause of death and other diseases mentioned below.

Other uses: It is used as an antidote to the bites of poisonous reptile like snakes. It is also used to treat dysentery and other painful affections of the intestinal canal. The root of Serpentina also possess anti bacterial properties.

Infusion, decoction and extract of the roots are employed to increase uterine contractions for expulsion of foetus, to treat painful affections of bowels, diarrhoea, dysentery, cholera, colic and fever. The root was believed to stimulate uterine contraction and recommended for use in child-birth in difficult cases. The juice of the leaves has been used as a remedy for capacity of the cornea (Wealth of India) .[45]

DISCUSSION

As we seen above that *Sarpgandha* have many properties like antifungal, antiinflammatory, antioxidant, antiproliferative, anticancerous, antidiuretic, antifibrillar, antiarrhythmic, anticholinergic, antidysentry, antidiarrhoeal antihypertensive, anti-contractile, antidiuretic, sympathomimetic, and tranquillizing agent. These all properties have close resemblance with therapeutic properties explained in old texts and *Nighantus*. All this discussion shows that, the old sages have very good knowledge about its pharmacological properties.

CONCLUSION

The use of natural substances, particularly plants, to control diseases is a centuries old practice that has led to the discovery of more than half of all modern pharmaceuticals. Various texts in literature and researches, studies in modern science describes *Rauwolfia serpentina* used as a remedy for curing hypertension, insomnia, mental agitation, gastro-intestinal disorders, excitement, epilepsy, traumas, anxiety, excitement, schizophrenia, sedative insomnia etc which shows usefulness and importance of this plant. However, only a few works has been done on this plant and there is a large scope of investigation for researchers to explore its potential in the field of medicinal research and pharmaceutical sciences.

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