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CASE REPORT **OPEN ACCESS**

RAUWOLFIA SERPENTINE (SARPGANDHA): AREVIEW BASED UPON ITS PHYTOCHEMISTRY AND AYURVEDIC USES

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ABSTRACT

Rauwolfia serpentina (Sarpagandha) is a significant medicinal plant, which is described in Ayurvedic literatures and in current science because of the presence of its number of remedial properties. Thismedicinal plant is used against variety of diseases due to the presence of various phytochemicals like alkaloids, starches, flavonoids, glycosides, phlobatannins, phenols, resins, saponins, sterols, tannins, and terpenes. The plant parts like root, and rhizome have been utilized for hundreds of years in Ayurvedic medications for relieving countless diseases, for example, high blood pressure, mental disturbance, epilepsy, injuries, fervor, schizophrenia and mental conditions like insanity. The major therapeutic properties associated with *Rauwolfia serpentina*are hypoglycemic, anti-diarrheal, anti-bacterial, anxiolytic. The present study is an overview of *Rauwolfia serpentina*p hytochemistry, its therapeutic properties and its utilization in Ayurveda and Folk system of medicine.

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INTRODUCTION

Plants have been one of the most primary sources of medicines which plays a major role in maintaining the health since ancient times. Plants especially the medicinal herbs acts as general health marker of the ecosystem. These plants possess several properties which are important from medicinal and clinical point of view. Without plants there is no survivalof living beings on this earth (1,2). Medicinal herbs are utilized by almost all cultures against variety of ailments. The 1st reported use of herbal medication was recorded almost 5,000 years ago (3). Traditional systems of medicine like Chinese and Ayurveda are believed to be 5,000 years old and they have been using medicinal plants as fundamental segment of their practice (4). India is a home to numerous cultures and has rich ethnobotanical history. Each culture has its own beliefs related to the plants (5). Various medication systems like, Siddha, Ayurveda, Unani and Allopathy have demonstrated us that plants have provided humanity a vast variety of patent medicines (also called as phytomedicines) to treat different ailments and give alleviation from ailments (6,7,8). Truly, medicinal herbs and spices have appreciated a rich custom of utilization for their flavor improvement qualities and for their therapeutic properties (9).*Rauwolfia serpentina Benth* (fig. 1) is generally known as "sarpagandha" is a significant therapeutic herb of India, Bangladesh and other tropical nations of Asia. Genus *Rauwolfia* got its name after the name of the German doctor and traveler Leonhard Rauwolf, who published an account of his many travels in 1582.This plantis of great economical value (10,11,12).*R. serpentina* roots, leaves, and juice have been considered of therapeutic significance from ancient times and have pulled in the consideration of the medical specialists. Alkaloids are the major phytochemical constituents present in the leaves and roots of *Rauwolfia serpentine*. It is used in conditions like hypertension and mental disorders in various systems of medicines. In India and Malay peninsula, the roots of *Rauwolfia serpentina(Benth)* have been used as an antidote for snake venom,chomps,stings of insects, and also utilized as an anthelmintic, in loose bowels, diarrhea and also as an ecbolic (13,14,15,16,17,18,19).*Rauwolfia serpentina* is associated with anti-diabetic activity (20,21,22,23).

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It is used as "tranquillizing" drug. It is used against hypertension, anxiety, worry, and irritability (24). Vernacular names and taxonomy of plant is given in table no. 1 and 2 respectively.

Figure 1. ***Rauwolfia serpentina*** **(Sarpagandha)**

Table 1: Vernacular Names of *Rauwolfia serpentine*

Sanskrit	Chandrika
Hindi	Chota-chand , Sarpagandha
English	Rauvolfia serpentine
Bengali	Chandar , Nakuli, Chotachand , Gandrasana
Bihar	Dhan-murua or Dhanbarua or pagla-kadawa
Bombay	Chota-chanid, karavi or harkai
Telegu	Harkaya (M\arathi), patalagarud or atalaganidhi
Tamil	Covannamiloori , chivanAvalpori
Malayalam	Chuxvanaavilpori, ChivanAvalpori
Oriya	Dhannerna or dhan-barua

Table 2. Taxonomony of *Rauwolfia serpentinaBenth* (Sarpagandha) (25)

Kingdom	Plantae
Phylum	Tracheophytes
Subphylum	Angiospermae
Class	Magnoliopsida
Order	Gentianales
Family	Apocynaceae
Genus	*Rauwolifia*
Species	*serpentina*
Common names	Sarpagandha

Morphology of *Rauwolfia serpentine:* It is an erect, evergreen perennial bush with a long, irregular, nodular, yellowish rootstock, developing to a length of 60-90cm. It is an erect undershrub having basic leaves. The leaves are arranged in whorls of three, and their shape is elliptic to lanceolate or ovate, splendid green above and underneath light green and thin. It is straight forward, 7.5-10cm long,3.5-5cm wide, elliptic or lanceolate, glabrous, green above and light green underneath, pointed and whorls of 3-5. The Fruits is drupe 0.5cm in measurement and sparkling dark when completely ready. The root framework comprises of noticeable, tuberous, delicate taproot arriving at a length of 30-50cm in 2-year-old plant with a breadth of 1.2- 2.5cm. Fruits are in sporadic corymbose cyme, white, regularly touched with violet (28,29,30).

Geographical Distribution of *Rauwolfia serpentine:* It is broadly cultivated in the tropical areas of the Himalayas, the Indian peninsula, Sri Lanka, Burma, and Indonesia. The plant is native to India, Bangladesh and different areas of Asia (31). It is broadly dispersed in the lower regions of Himalayan reach up to a rise of 1300-1400 m and in the sub-Himalayan plot from Punjab eastwards to Nepal, Sikkim and Bhutan, in Assam in the lower slopes of Gangetic fields, eastern and western ghats, in certain places of focal India and in Andaman (32).

Phytochemical constituents of *Rauwolfia serpentina Benth* (Sarpagandha)

R. serpentina has variety of phytochemicals like alkaloids, phenols, tannins and flavonoids.

Alkaloids: The total alkaloid content in *R. serpentina* is 0.7 – 3.0 %. *Rauwolfia serpentina* is known to have three categories of alkaloids i.e. weak basic indole alkaloids, alkaloids of intermediate basicity and strong anhydronium bases. Resperine (0.1%) is the primary alkaloid present in this plant. In the roots, an indole alkaloid is present which is named as Resperine, associated with hypotensive activity, which is due to the fact that it has depressant action on Central Nervous System and Peripheral Nervous System. It also has sedative actions especially in hypertension caused by stress and the activity of sympathetic nervous system. It is associated with activity of releasing 5-hydroxytryptamine (5- HT) from all tissues where it is stored due to which increase of urinary metabolites occurs. Other alkaloids present in *Rauwolfia serpentine* are ajmaline, ajmalimine, ajmalicine, deserpidine, indobine, indobinine, reserpine, reserpiline, rescinnamine, rescinnamidine, serpentine, serpentinine and yohimbine etc. (33,34,35,36). Siddiqui classified these alkaloids into two categories i.e. the ajmalinie group of three white crystalline weak bases and the serpentine group of two yellow, crystalline stronger bases. The former category includes ajmaline ($C_{26}H_{26}0_2N_2$), ajmalinine ($C_{20}H_{23}0_4N$), and ajmalicinie whereas the later category includes serpentine ($C_{21}H_{23}0_4N$) and serpentinine ($C_{20}H_{20}0_{33}N_2$) (37). Van Italie and Stenhauerl identified one more alkaloid which they named rauwolfin (38). Stoll and Hofmann isolated an alkaloid named as sarpagine ($C_{19}H_{22}0_2N_2$) (39).Raupine ($C_{2o}H_{26}O_3N_2$), has been identified by Bodendorf and Eder in 1953(40). In 1954, Hofmann isolated two more alkaloids named as rauhimbine ($C_{21}H_{26}0_3N_2$), and iso-rauhimbine ($C_{21}H_{26}0_3N_2$). Substance I ($C_{22}H_{26}0_4N_2$) and substance II ($C_{21}H_{25}0_3N_2$) are other alkaloids present in *Rauwolfia serpentina* (41). Reserpinine ($C_{22}H_{26}0_4N_2$) is another alkaloid which has been identified by Schlittler and associates (42).

Phenols: The secondary metabolites present in herbs, shrubs, vegetables and trees are phenols. The phenolic content of *Rauwolfia serpentina* has anti-diabetic and hypolipidemic properties. Due to the presence of phenols in it, it can be used as an anti-microbial agent (43).

Tannins: All the extracts of *Rauwolfia serpentina* contains tannins except methanolic and chloroformic extracts. *R. serpentine* is used in traditional system of medicine for mucous membrane wounds and inflammation due to the presence of tannins in it (44,45).

Table 3. Various species of Genus *Rauwolfia* (26,27)

1. *Rauwolfia amsoniifolia*	Philippines, Sulawesi, Maluku, Lesser Sunda Islands
2. *Rauwolfia andina*	Peru
3.*Rauwolfia anomala*	Mato Grosso
4. *Rauwolfia aphlebia*	Costa Rica, Panama, Colombia
5. *Rauwolfia bahiensis*	E Brazil
6. *Rauwolfia balansae*	New Caledonia
7. *Rauwolfia biauriculata*	Cuba, Haiti, Lesser Antilles, Trinidad & Tobago
8. *Rauwolfia caffra*	Africa from Togo east to Tanzania, south to Cape Province
9. *Rauwolfia capixabae*	Bahia + Espírito Santo in Brazil
10. *Rauwolfia capuronii*	Madagascar
11. *Rauwolfia chaudocensis*	S Vietnam
12. *Rauwolfia cubana*	Cuba; naturalized in Yunnan
13. *Rauwolfia decurva*	India
14. *Rauwolfia dichotoma*	São Tomé
15. *Rauwolfia gracilis*	Rondônia, Mato Grosso
16. *Rauwolfia grandiflora*	E Brazil
17. *Rauwolfia hookeri*	S India
18. *Rauwolfia indosinensis*	Cambodia, S Vietnam
19. *Rauwolfia insularis*	Palau
20. *Rauwolfia* × *ivanovii*	Cuba *(R. ligustrina* × *R. viridis)*
21. *Rauwolfia javanica*	Java, Sumatra, Lesser Sunda Islands
22. *Rauwolfia kamarora*	Sulawesi
23. *Rauwolfia leptophylla*	Colombia, Venezuela
24. *Rauwolfia letouzeyi*	Gabon, Republic of Congo
25. *Rauwolfia ligustrina*	from Mexico + Cuba south to Paraguay + NE Argentina
26. *Rauwolfia linearifolia*	E Cuba
27. *Rauwolfia littoralis*	Costa Rica, Panama, Colombia, Ecuador
28. *Rauwolfia macrantha*	Panama, Colombia, Ecuador, N Brazil, Peru
29. *Rauwolfia mannii*	Tropical Africa from Ivory Coast to Tanzania, south to Malawi
30. *Rauwolfia mattfeldiana*	Brazil
31. *Rauwolfia maxima*	Venezuela
32. *Rauwolfia media*	Comoros, Madagascar
33. *Rauwolfia micrantha*	SW India, S Thailand, Vietnam
34. *Rauwolfia microcarpa*	Myanmar
35. *Rauwolfia moluccana*	Maluku, New Guinea, Bismarck Archipelago
36. *Rauwolfia mombasiana*	Kenya, Tanzania, Mozambique
37. *Rauwolfia moricandii*	E Brazil
38. *Rauwolfia nana*	E Angola, Zambia, S Zaïre
39. *Rauwolfia nitida*	West Indies, Panama, S Mexico
40. *Rauwolfia nukuhivensis*	French Polynesiabut extinct
41. *Rauwolfia obtusiflora*	Madagascar
42. *Rauwolfia oligantha*	C Java
43. *Rauwolfia pachyphylla*	Venezuela, Guyana
44. *Rauwolfia paraensis*	N Brazil, Peru, Suriname, French Guiana
45. *Rauwolfia paucifolia*	E Brazil
46. *Rauwolfia peguana*	Myanmar
47. *Rauwolfia pentaphylla*	N Brazil, Peru
48. *Rauwolfia polyphylla*	S Venezuela, N Brazil
49. *Rauwolfia praecox*	W Brazil, Peru, Bolivia
50. *Rauwolfia pruinosifolia*	Minas Gerais
51. *Rauwolfia purpurascens*	Costa Rica, Panama, Colombia, Ecuador
52. *Rauwolfia rhonhofiae*	Ecuador
53. *Rauwolfia rivularis*	Myanmar
54. *Rauwolfia rostrata*	Maluku, New Guinea, Bismarck Archipelago
55. *Rauwolfia sachetiae*	Marquesas in French Polynesia
56. *Rauwolfia salicifolia*	Cuba
57. *Rauwolfia sanctorum*	Colombia, Peru
58. *Rauwolfia sandwicensis*	Hawaiian Islands (Hawai‘i)
59. *Rauwolfia* schuelii	Bolivia, NW Argentina
60. *Rauwolfia* sellowii	Brazil, Paraguay, Misiones Province of Argentina
61. *Rauwolfia* semperflorens	New Caledonia
62. *Rauwolfia* serpentina	Indian Subcontinent, China, Southeast Asia
63. *Rauwolfia* sevenetii	New Caledonia
64. *Rauwolfia* spathulata	New Caledonia
65. *Rauwolfia* sprucei	S Venezuela, Peru, N Brazil
66. *Rauwolfia* steyermarkii	Táchira in Venezuela
67. *Rauwolfia* sumatrana	Guangdong, Thailand, Myanmar, Andaman & NicobarIslands, Malaysia,Indonesia, Philippines
68. *Rauwolfia* tetraphylla	Also called Rauwolfia carescens; from Mexico and West Indies to Peru; naturalized in China, Indian Subcontinent, Andaman Islands, Vietnam, Queensland
69. *Rauwolfia* tiaolushanensis	Hainan in S China
70. *Rauwolfia* verticillata	China, IndianSubcontinent,Indochina, Malaysia, Indonesia, Philippines
71. *Rauwolfia* vietnamensis	Vietnam
72. *Rauwolfia* viridis	West Indies, Costa Rica, Colombia, Venezuela
73. *Rauwolfia* volkensii	Tanzania
74. *Rauwolfia* vomitoria	Tropical Africa from Senegal east to Sudan + Tanzania, South to Angola; naturalized in China, Bangladesh, Puerto Rico
75. *Rauwolfia* weddeliana	Brazil, Paraguay
76. *Rauwolfia*woodsoniana	Costa Rica

Flavonoids: Kaempherol is isolated from the methanolic extract from the leaves *of Rauwolfia serpentina* is identified as flavonoid, which is associated with the anti-oxidant activity. Rutin is another flavonoid isolated from the leaves of *Rauwolfia serpentina* (46).

Saponins: Saponin are associated with coagulation of red blood cells. The high saponin content of *Rauwolfia serpentina* helps to stop bleeding and make it use in treating wounds (47).

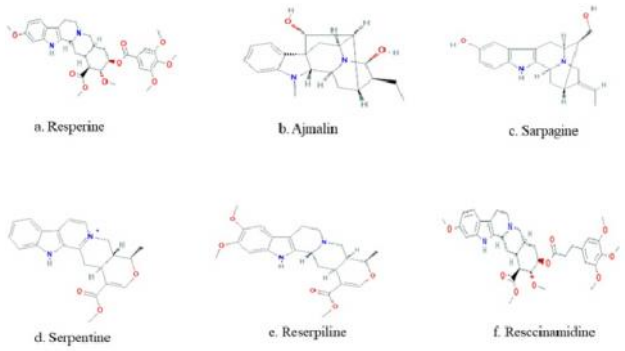

Figure 2. Chemical structures of phytochemicals of *Rauwolfia serpentine*

Folk View of Rauwolfia serpentina Sarpagandha

Rauwolfia serpentina was utilized in India as a folk medication for quite a long time to treat a wide numberof ailments, e.g. snake and insect bites, febrile conditions, malaria, stomach pain, and diarrhea. It is additionally utilized as a uterine energizer, febrifuge, and remedy for nervous system disorders (48). The conventional use of this plant are loose bowels, fever, cut, injuries, stomach-ache, periods related problems (49). The plant is utilized in gastrointestinal issues by the "kavirajes" of Puthiaupazilla of Rajshahi area of Bangladesh (50). The paste is made up of sarpgandharoots, buds with milk and applied on the snake bit affected area in Karnataka (51). Its roots are administered in snake bite in Orissa, (52). In Tamil Nadu this plant is utilized in regular intervals of three days for this purpose (50 grams /day) (53). The decoction of leaf and rhizome are taken orally in snake bite in Kanyakumari (54). The roots are squeezed first and then tied over the snake bitten area in some areas of Karnataka (55). Some tribes of Madhya Pradesh also use this plants in the treatment of snake bite (56). In some areas of Western Ghats of Kerala, the mixture of sarpgandha root and duck flower along with water is used twice a day at regular interval of three days in the treatment of snake bite (57). In Uttar-Pradesh, it is used as antidote. (58) In Madhupur Bangladesh, the root decoction is used against liver pain (59). It is also used in the treatment of dysentery and to kill internal parasites in children in some areas of Orissa (60). Also it is used in mental disorders (61). In Nepal it is used to treat pneumonia (62). It is also utilized in the treatment of scabies (63). In some parts of Bangladesh, tribal people used it in the spleen treatment (64) and root powder is also consumed for treatment of high blood pressure (65). This plant is popular as 'Pagalpankijadi' in folk medication system which is used as a medicine for insanity and there is also reported incident that Mahatma Gandhi administered this plant inhis daily routine. (66). In Andhra Pradesh the sarpgandha root paste is used against headache (67). In Orissa, the leaf of this plant are utilized against stomach pain (68).

In Telangana, Orissa, Kerala and Tamil Nadu the paste of whole plant and root powder is used for skin disease (69,70,71,72,73). In West Bengal the root extract is used for the treatment of loose motion (74). The root juice is administered against diabetes in west Bengal (75,76). Chronic wounds are treated with root powder and root paste in Jharkhand (77).

Ayurvedic View of Rauwolfia sepentina (Sarpagandha)

The primary focus of ayurvedic treatment is to reestablish the harmony between the three significant body frame works i.e vatta (air and space), pitta (fire) and kapha (earth and water) (78,79,80,81).

Rauwolfia sepentina (Sarpagandha)is a very popular Ayurvedic herb which has been utilized in India as Ayurvedic system practices for various diseases (82). Rauwolfia *sepentina* is kapha and Vatta sedative. Traditional Ayurvedic herbal formulations of *R. serpentina* are utilized as a solution for restoring hypertension, sleep deprivation, CNS disorders, gastrointestinalissues, fervor, epilepsy, injuries, nervousness, energy, schizophrenia, narcotic sleep deprivation, insanity, antidote, anti-pretic, manages regular menstural flow, improve appetite and helps in digestion (83,84,85). The root mixture of *R serpentina* with ginger and black pepper regularizes the menstrual cycle (86). Rasapanchak of *Rauwolfia serpentina* is given in table 4.

Table 4. Rasapanchak/Properties of *Rauwolfia serpentine* as per Ayurveda (87)

Sanskrit/English	Sanskrit/English
Veerya/ Potency	Ushana/Hot
Vipak/ Metabolic property	Katu/ Pungent
Guna/ Physical property	Ruksha/Dry
Rasa/ Taste	Tikta/ Bitter

Properties of Sarpagandha (88)

Paachansansthan: It enhances the digestion.

Rakatvehsansthan: It is administered in hypertension. It significantly lowers down the high blood pressure.

Prajannansansthan: It maintains the overall reproductive health of males and females both.

Taapkram: It is effective against fever.

Saatmikaran: It is used as an anti-venom in snake biting

Naadisansthan: It is mainly used inepilepsyandinsomnia. It is administered with gheeduring night in insomnia. Also used in treating anxiety andinsanity. Sarpagandha Ghanvati, Sarpagandha Yoga, Sarpagandha Churna and Mahesvari Vati are the primary Ayurvedic formulations of Rauwolfia serpentine (Sarpagandha) (89,90).

Modern View of *Rauwolfia serpentina* (Sarpagandha): In today's scenario Global herbal drug industry is facing issue of adulteration. Herbal drugs are getting adulterated either unintentionally or intentionally. Due to the continuous practice of adulteration, people are losing interest from herbal drugs (91,92,93,94,95,96). Intentional adulteration is becoming a very common method of degrading herbal drugs. There are many ways of adulteration like by substituting standard

commercial variety, by substituting superficially similar but inferior drug, by substituting artificially manufactured drug, substitution of exhausted drugs, by substituting toxic materials etc. Vendors of herbal drugs apply these techniques of adulteration so smartly that adulteration remains undetectable only microscopic and chemical analysis can detect these changes (97,98,99). There are several disadvantages associated with adulteration like degradation of the drug quality, high cost, side effectsandslow action mechanism (100). While traditional herbal drugs are free from adulteration and have negligible side effects associated with them. *Rauwolfia serpentina* has several traditional herbal formulations which are used against variety of diseases. *Rauwolfia serpentina* is a well-known traditional anti-diabetic drug which significantly lowers down the blood glucose level without any side effects. Similarly, many other therapeutic properties of this medicinal herb has been demonstrated by many reported studies.

Therapeutic Properties of *Rauwolfia serpentina* (Sarpagandha)

Anti-bacterial: The findings of one of the *in-vitro* studies demonstrated that reserpine content is effective against many of the human pathogens like *Salmonella typhimurium, Escherichia coli, Citrobacterfreundii, Proteus vulgaris, Enterococcus faecalis*and *Staphylococcus aureus* (101).

Hypoglycemic: The methanolic extract of *Rauwolfia serpentina* was checked for its hypoglycemic activity in alloxan-induced diabetic rats. Result showed that methanolic extract exhibited hypoglycemic, hypolipidemic and hepato-protective activities in alloxan-induced diabetic rats (102). The methanol root extract of *Rauwolfia serpentina* was evaluated for the same in another *in-vivo* study which showed that methanolic extract showed glycemic, antiatherogenic, coronary risk, and cardio protective indices in alloxan-induced diabetic mice (103).

Anti-diarrheal: An *in-vivo* study conducted on mice models in which diarrheawas artificially induced by administering castor oil to check the anti-diarrheal activity showed that methanolic extract of *Rauwolfia serpentina*is associated with anti-diarrhoeal activity andhelped inreducing intestinal weight and fluid volume (104).

Antiarrhythmic: An *in-vivo* study on rats and cats demonstrated that ajmaline derived from biomass grown in tissue culture, exhibit antiarrhythmic properties exactly in the same way as ajmaline derived from the natural root of *Rauwolfia serpentine* (105). Ajmaline asa class Iantiarrhythmic agent derived from the roots of the plant is very helpful in diagnosing Brugada Syndrome (hereditary cardiac disorder) (106).

Anxiolytic: The findings of the reported clinical study suggested that reserpine, alseroxylon and the whole crude rootexhibited anxiolytic action in ambulatory patients showed *Rauwolfia serpentina* use as an anxiolytic agent (107).

CONCLUSION

Medicinal herbs have a very significant place in all the systems of medicines. They are serving for humanity since ancient times. *Rauwolfia serpentina Benth (Sarpagandha*), is an important Ayurvedic herb. Alkaloids are the major phytochemical constituents of *Rauwolfia serpentina*. Each of its phytochemical is used against many ailments. In Ayurveda, it is used in many formulations for the treatment of several diseases. Whereas it is used as a folk remedy for variety of diseases like malaria, diarrhea, fever, nervous system disorders etc. The reported clinical data on its phytochemistry and therapeutic properties demonstrated its significance.

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