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REVIEW ARTICLE

Ethno-pharmacological and phytochemical study of *Rauwolfia serpentina* (Asrol) - An extensive review

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ABSTRACT

Rauwolfia serpentina L. commonly known as Asrol is widely used in traditional medicine worldwide, including in India, China, and Africa for various health ailments. It is therapeutically used to treat a wide variety of maladies, including snake, insect bite, psychiatric disorders, insomnia, febrile conditions, dysentery, hypertension, and infertility. The study aims to summarize a systemic review of the ethnopharmacology and phytochemical study of Rauwolfia serpentina L. It also includes the therapeutic importance as stated in classical literature and the pharmacological aspects which have been already explored in the present-day scientific parameters. An ethnopharmacological review of R. serpentina was done through the Unani classical text as well as analyzing research articles related to its pharmacognosy, traditional uses, phytochemistry, and therapeutic activities available on Pubmed, Science Direct, Google Scholars, Scopus, and Web of Science from their dates of inception until August 2021. The following terms were applied to the literature search "Rauwolfia serpentina", "Asrol", "Reserpine", "Ajmaline", "Unani", "Ajmalicine", to find the description of the drug. R. serpentina is extensively used as antihypertensive, antiallergic, antioxidant, antibacterial, antivenom, hypoglycemic, hepatoprotective, antidiarrhoeal, and antipsychiatric. The important alkaloids of Rauwolfia serpentina include Ajmaline, Ajmalicine, Ajmalimine, Serpntine, Reserpine, Rescinnamine, Deserpidine and Yohimbine, etc. This study provides extensive thorough relevant pharmacological and phytochemical constituents of R. serpentina and its traditional uses as well as potential pharmacological properties. It will help future researchers to explore more about its active phytoconstituents and pharmacological activities.

Keywords: *Asrol, Rauwolfia serpentina, Unani Medicine, Ethnopharmacology, Quality Traditional Medicine*

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INTRODUCTION

Rauwolfia serpentina L. (Asrol) is an evergreen shrub widely used in complementary and alternative medicine in various countries viz. India, China, Africa, etc. for therapeutic purposes.[1] Its description dates back to 1000 BC in Indian manuscripts. It has been mentioned under different names in different traditional medicine viz. Asrol in Unani medicine, Sarpagandha in Ayurvedic medicine, Lu fu mu in Chinese, Rauwolfia in English, and Chota-chand in folk medicine. [2,3] It is reported to be a famous medicinal plant in Unani, Ayurveda, Siddha, and Western medicine. In folk medicine, it is a drug of repute for centuries as a panacea. It is native to the moist and deciduous forests of Southeast Asia including India, Malaysia, Bangladesh, Pakistan, Sri Lanka, Thailand, and Burma. [4] In India, it is widespread throughout the foot-hills of the Himalayan range, up to the height of 1300-1400 m, apart from this it is

found in the sub-Himalayan range from Punjab to Nepal, Sikkim, and Bhutan and in the lower hills of Gangetic plains, Eastern and the Western Ghats and Andaman region. As per the literary evidence, it is considered a drug of choice to treat several health ailments. Its root extract is reported to be used for treating a variety of physical and mental disorders. Its wide reputation imposed a curiosity in chemists to know the cause behind its therapeutic efficacy. But, the main cause of its wide efficacy was not evident until, 1931. On 2nd July 1926, Masih-ul-Mulk Hakeem Ajmal Khan formally inaugurated a research committee (MajlisTahqiqat-e-Ilmi) appointed by the managing committee of Ayurvedic and Unani Tibbi College, Karol Bagh, New Delhi, India. Then, for the first time in India, on the inspiration of Hakeem Ajmal Khan, Salimuzzaman Siddiqui and Rafat Hussain Siddiqui: A pioneering researcher of Unani Medicine analyzed its phytoconstituents through chromatographic study. It was done on the ethanolic extract of its root and they successfully discovered five alkaloidal and six nonalkaloidal components in it. [5, 6] Though, after this, a series of chemical explorations from its root and then the whole plant was done. Till now 50 alkaloids have been identified in Rauwolfia species; among which reserpine is considered to be the most vital active component.[7] Other alkaloids include ajmaline, ajmalimine, ajmalicine, deserpidine, indobine, indobinine, reserpine, reserpiline, rescinnamine, rescinnamidine, serpentina, serpentinine, and yohimbine. The alkaloids ajmaline, ajmalimine, and ajmalicine are named on behalf of the eminent scientist Hakeem Ajmal Khan, as a token of tribute for his inspiration in research work on *R.serpentina*. Rauwolfia species is widely used in therapy because of the presence of reserpine in its root, which has a potent antihypertensive activity.[8] It is also reported to be used as a uterine tonic and anti- infertility drug.[9]

MATERIAL AND METHOD

A literature-based search, covering research reports that have been published online, was performed to retrieve information on Ethno-pharmacology, phytochemistry, active constituents**,** health effects, molecular pharmacology, herb-drug interaction, of *Rauwolfia serpentina* from accessible online databases, such as Pubmed, Science Direct, Google Scholars, Scopus and Web of Science from their dates of inception until August 2021 using the key search terms of "*Rauwolfia serpentina*", "Asrol", "Reserpine", "Ajmaline", "Unani", "Ajmalicine", to find the description of the drug. This review also included offline data, collected via traditional classical Unani literature and modern pharmacological books available in our institute's library and various national libraries specially Khudabakhsh khan library in Patna India.

Ethno-botany

R.serpentina is an evergreen shrub of the Apocynaceae family. Genus Rauwolfia comprises 110 species. It is native to the sub-Himalayas tract from Punjab to Nepal, Sikkim, Bhutan, Western Ghat, and Andaman.[10] The plant frequently grows to a height between 60 and 90 cm and has pale green leaves that are 7-10 x 3-5 cm long and wide. The shapes of leaves are elliptical and occur in whorls of 3 to 5 leaves. The plant has many glossy, black, or violet, round fruits that are around 0.5cm in diameter. [4] The flowers are pink and white with an oily and white nucleus. Flowering starts from April to July and fruiting occur from July to September. But sometime, both may occur together throughout the year. The plant has a well-defined soft tuberous tap root that achieves a length between 30 to 50 cm and a diameter between 1.2 and 2.5 cm. The fresh root is acrid in odor and the wood is extremely starchy. [4, 11]

As per the Unani concept of temperament it has been designated in the third degree of cold and dry temperament. [12]

Figure 1: Plant parts of *Rauwolfia serpentina*

Fig.2. Root of *Rauwolfia serpentina*

Traditional Uses

Table 1 Traditional uses of *Rauwolfia serpentina*

Traditional uses	Reference
Sedative (Musakkin), hypnotic (*Munawwim*), and narcotic (*Mukhaddir*) properties to treat various diseases such as melancholia (*Mālankhūliya*), insomnia (*Sahr*), urticaria (*Sharā*), allergy (*Hassāsiyat*)	Sen and Bose, [13]
Hypertension (*Ḍaghṭ-al-DamQawī*)	Vakil, [14]
Uterine tonic (*Muqawwī-i-Raḥam*), hysteria (*Akhtānqal-Raḥam*), abdominal pain (*Waja'almi'da*), snake and insect bite,	Qasmi IA., [15]; Vakil, [14]
Abdominal pain (*Waja'almi'da*)	Kabir DH., 16]
Snake and insect bite	Shafiuddin HS.[12]
Vasodilator, antihypertensive, bronchodilator and depressant action	Werner,[17]; Chowhan;[18]
Anxiety, schizophrenia, epilepsy, seizure, insomnia, and sleep disorders	Healy and Savage, [19]; Lowinger, [20], Singh *et al*., [21]
Migraine (Shaqiqa)	Friedman, [22]
Antipyretic (Dafi-i-humma)	Singh et al., [21], Poonam et al., [23]; Kirtikar and Basu, [24]
Asthma (Diqal-Nafas), pneumonia (Dhat al-Ria), fever (Humma), malaria, spleen disorders (Amraz-e-Tihal), eye diseases (Amraz-e-Chashm), and, skin disease (Amraz-e-Jild)	Anisuzzaman et al., [25]; Behera et al., [26]; Britto and Mahesh, [27]; Nayak et al., [28]; Rahmatullah et al.[29], Rai, [30].

Parts used: mainly root, stem, and flowers.
Therapeutic dose: 500mg to 1 gram.
Chemical compositions:

Table 2: Chemical constituents of *R.serpentina* were evaluated by Harisaranraj R. et al. (2009)[31]

Secondary metabolites	mg/100 g dry weight
Flavonoid	1.72±0.11
Alkaloid	1.48±0.02
Tannin	0.51±0.20
Phenol	1.86±0.11
Macro-minerals	
Calcium	0.32±0.10
Magnesium	0.10±0.20
Sodium	0.02±0.10
Potassium	0.04±0.11
Phosphorus	0.18±0.22
Micro-minerals	
Iron	1.85±0.20
Zinc	5.38±0.11

Results are taken from the triplicate determinations on a dry weight basis expressed as Mean ± Standard deviation

Alkaloids:

Quantitative estimation of the alkaloids in the root of *R.serpentina* explored the presence of 0.1% of reserpine as the active principle while other alkaloids range from 0.7–3.0 % and all are found to be indole alkaloids. Other alkaloids include ajmaline, ajmalimine, ajmalicine, deserpidine, indobine, indobinine, reserpine, reserpiline, rescinnamine, rescinnamidine, serpentine, serpentinine, and yohimbine, etc. which are also therapeutically active.[32,33] Specifically the alkaloids ajmaline, ajmalicine, deserpidine, reserpine, serpentina, and yohimbine are used to treat hypertension and breast cancer.[34]

Table 3: Classification of alkaloids

1. Classification of alkaloids based on strength	Reference
Weak basic indole alkaloids	Pandey et al. [35]
Alkaloids of intermediate basicity	
Strong anhydronium bases	
2. **Classification of alkaloids based on chemical structure**	
Tertiary indoline alkaloids	
Quaternary anhydronium bases	
Tertiary indole bases of the yohimbine type	
Tertiary indole bases of the tetrahydro-alstonine type	

Tertiary Indoline Alkaloids-Ajmaline

Ajmaline was the first indole alkaloid isolated in 1931 by Salimuzzaman Siddiqui from the root of *R. serpentina*. It was named after his mentor Hakim Ajmal Khan as 'ajmaline'; who is one of the most renowned Unani practitioners in South Asia.[36] The pharmacological activity of ajmaline is similar to serpentina on systemic and pulmonary blood pressure.[77] It was found to be therapeutically active as a class I antiarrhythmic agent, used to stimulate respiration and intestinal movements. Ajmaline has a specific blockage activity on the sodium channel when given intravenously. Its action on the sodium channel is used for the diagnosis of arrhythmia; this test is known as "Ajmaline Test".[38,39] This is extremely advantageous in diagnosing Brugada syndrome- a hereditary cardiac disorder and clinically differentiating it from its other subtypes.[40]

Other tertiary indole alkaloids found in *R.serpentina* includes isoajmaline, neoajmaline and rauwolfinine.

Quaternary anhydronium bases-Serpentine

Structurally it is a yellow quaternary indole alkaloid with anhydronium base,[5] having molecular formula as C20H20O3N2.1½ H20 which has now been revised to C21H22O3N2 by Schlittler and Schwarz (1950).[41] It is a stereoisomer of alstonine and very closely related to the alkaloid rauwolscine which occurs in *R. canescens*.[42] Peroxidase enzyme oxidizes ajmaline to serpentina by catalyzing bis-indole alkaloid localized in the vacuole.[43]

Serpentina can inhibit type II topoisomerase, due to which it has a significant role in psychosis et.[44,45]

Tertiary indole bases - Yohimbine type

Reserpine

The antihypertensive property of Rauwolfia is due to the presence of reserpine in its root. The chemical structure of reserpine is 3, 4, 5-trimethyl benzoic acid ester of reserpic acid. It is an indole derivative of 18-serpentina of the yohimbine type. Reserpine is the most active component among all the alkaloids present in *R. serpentina*. It is mainly used as a natural tranquilizer.[46,47]

It was first isolated in 1952 from the roots of *R.serpentina* as a pure crystalline alkaloid.[41] At the molecular level, it causes a depressant action on the central and peripheral nervous system by binding to catecholamine storage vesicles present in the nerve cell. This stops the regular storage of catecholamine and serotonin and thus reduces the concentration of catecholamine. It also impedes the function of the autonomic nervous system by depleting the transmitter substance from the adrenergic neurons. [48,49,50] Thus it is used as an effective antihypertensive agent. It helps in controlling heart rate, cardiac contraction, and peripheral resistance. In other cases of hypertension which get aggravated by stress and sympathetic nervous system activity, reserpine lowers the blood pressure and helps in sedation. Along with its use in the treatment of hypertension and cardiovascular diseases, it has active therapeutic intervention in neurological diseases also.[51,52]Reserpine also causes 5-hydroxytryptamine (5- HT) to be released from all tissues and results in the increase of urinary metabolites.[35,53]

Rescinnamine

Rescinnamine is an ester alkaloid found in Rauwolfia which was similar to reserpine in its chemical and therapeutic properties. It was first explored in the 1950s and was used for the treatment of hypertension but, later with the discovery of reserpine, it was found to be less potent than reserpine and does not reduce the blood pressure effectively as reserpine.[54] It lowers the blood pressure by having an inhibitory action on angiotensin-converting enzyme (ACE) and ***peptidyl-dipeptidase***, which catalyzes the conversion of angiotensin I to angiotensin II (the vasoconstrictor substance) and stimulates aldosterone secretion from the adrenal cortex. Inhibition of ACE results in decreased plasma angiotensin II concentration, which helps in reducing blood pressure.[55]

Deserpidine

Deserpidine, an ester alkaloid differs from reserpine by lacking a methoxy group at C-11, which is synthesized from reserpine. It restrains the ACE and blocks the conversion of angiotensin I to angiotensin II, [56] thus helping in reducing the blood pressure. It also regulates the nerve impulses and nerve pathways to reduce high blood pressure and also works as an antipsychotic. Thus, it is used due to its antihypertensive and antipsychotic properties.

Yohimbine

Yohimbine, another indole alkaloid is the selective alpha-2 adrenergic antagonist. Adrenergic antagonism relaxes the smooth muscle by binding on these receptors and lowers blood pressure. It helps to improve erectile function by dilating blood vessels and causes an increase in the blood flow in the penis.[57,58,59] Thus, it has an effective role in erectile dysfunction. It was also screened for its efficacy in diabetes in animal and human models carrying polymorphisms of the α2A-adrenergic receptor gene. It is also used to dilate the pupil.[60]

Tertiary indole bases - Tetrahydroalstonine type

Ajmalicine

Ajmalicine is derived from tryptophan which is converted to tryptamine via secologanin, strictosidine, and cathenamine. This conversion of cathenamine to ajmalicine is facilitated by the enzyme NADPH and tryptophan decarboxylase (TDC). Thus it is observed that decarboxylase is the key enzyme included in the synthesis of ajmalicine in Rauwolfia.[61] It has a large number of applications in the treatment of circulatory diseases, specifically in providing normal cerebral blood flow. It also has an action on smooth muscle function because of which it is used in preventing strokes and helps in lowering blood pressure. [32]

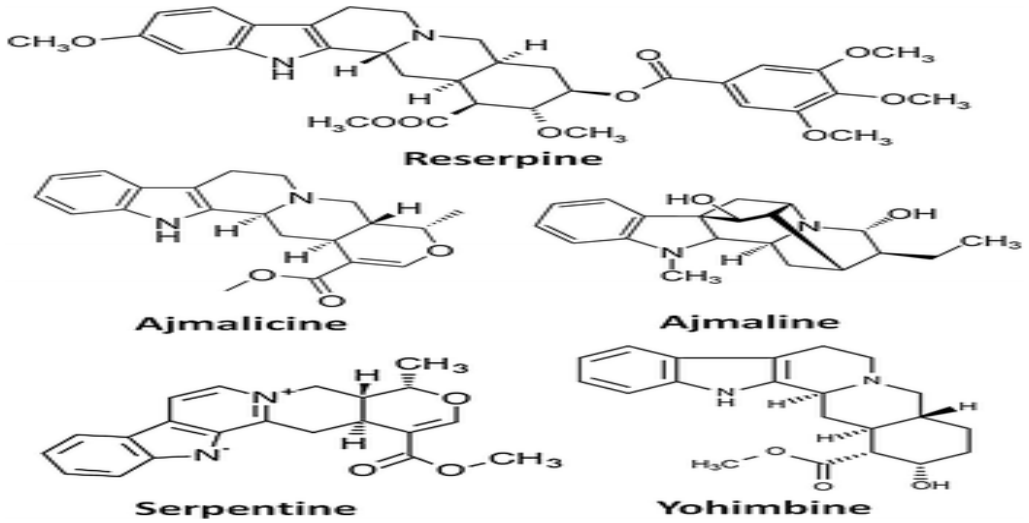

Fig 4: Chemical structure of the major alkaloids of *Rauwolfia serpentina*

Phenols

Phenols found in the *R. serpentina* helps to inhibit the growth of pests and plant pathogens, which cause an adverse effect on the growth of plant[62], present to some extent in all herbs, shrubs, vegetables, and trees.[63,64]Rich concentration of total polyphenols in *R. serpentina* also has a therapeutic intervention, being used for its significant antidiabetic and hypolipidemic properties;[65] as an expectorant and emulsifying agent and anti-microbial agent.

Tannins

Tannins are polyphenolic compounds that act by binding to organic compounds, alkaloids, amino acids, and specifically to the protein to which they bind and precipitate. The oxidizing inhibiting property of tannin owes to the presence of its component: gallic acid and diagallic acid.[66] They are used for their astringent properties, enhance wound healing, and reduce the inflammation of the mucous membrane. Other than anti-hypertensive action, *R. serpentina* is traditionally used in South-eastern India for its healing activity due to tannin present in it.[43,53]

Flavonoids

Flavonoids are also poly-phenolic compounds based on 15 C-framework (present in two phenyl rings and a heterocyclic ring). These are strong water-soluble components that act by their effect on the signaling pathway. It prevents oxidative cell damage, has free radical scavenging properties, and thus is used as a

strong anti-oxidant agent. [63, 67, 68] They reduce the risk of heart disease, and have significant anti-cancerous properties. [69, 70]

Saponin

Saponins are tri-terpenes glycosides, which are found in more than seventy plant families. These bitter components have a specific characteristic of forming foams in aqueous solutions. They coagulate red blood cells. *Rauwolfia serpentina* is rich in saponins, thus it has an effective use to stop bleeding and helps in treating wounds,[31, 71, 72] used of its hemolytic activity, and cholesterol binding properties.[73]

Pharmacological activities

Antihypertensive and anti-allergic Activity

Since Vakil [1] has done thorough review studies and clinical studies for R. serpentina effect on hypertension. Similarly, significant antihypertensive activity was found in an animal model by Shah et al.[74] They found a promising effect on serum lipid profile and serum proteins, so that it could be used for its therapeutic efficacy as a hepato-protective, reno-protective agent, used to manage hypertension and hypercholesterolemia by protecting the liver and renal architectures. A study by Ranjini et al. [75] on leaf extract of R. serpentina and cloves, *Allium sativum* cloves on sheep kidney and lung ACE have also reported significant anti-hypertensive effects.

Hypolipidemic activity

Root powder of *R. serpentina* was explored for its effect in lowering the raised lipid biomarkers in animal model-rabbit.[65] Biomarkers included level of serum triglyceride (TG), total cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), alanine aminotransferase (ALT), and lactate dehydrogenase (LDH), respectively. The test revealed significant hypolipidemic activity.

Antioxidant Activity

R. serpentina contains a good concentration of tocopherols, phenoles, flavonoids, carotenoids, ascorbic acid, and pigment composition, which contribute to the free radical scavenging property. Nair et al. studied this in the methanolic extract of its leaves by DPPH (1,1-diphenyl-2-picryl hydrazyl) superoxide anion scavenging activity and its reducing power.[76] In the same experiment by Nair et al., it was compared among the five species of Rauwolfia in which *R. serpentina* was reported to contain the highest total phenolic content, thereby exhibiting DPPH radical scavenging activity, and the highest pigment composition of Vitamin E. [76] Patyal et al. used ethanolic root extract of *R. serpentina* for combating the oxidation stress, free radicals using ferric reducing ability in which they found a significant anti-oxidant effect.[77]

Antidiabetic Activity

Azmi *et al*. studied atherogenic dyslipidemia, arteriosclerosis, and glycosylation index of *R.serpentina* in alloxan-induced type-1 diabetic mice for 14 days.[78] Biomarkers evaluated included fasting blood glucose, insulin, glycosylated HbA1c, hemoglobin (Hb), cardiac biomarkers- TG, TC, LDL-C, very LDL-C, and HDL-C levels. At the end of the study, it was found to significantly reduce glycosylation, atherogenic, and arteriosclerosis. Thus, the study concluded a therapeutic potential of *R. serpentina* in lowering the risk of atherogenic dyslipidemia, arteriosclerosis, and glycosylation.

Hyperglycemic Activity

Azmi and Qureshi studied the effect of *R.serpentina* on hyperglycemic, hematinic, and antioxidative dysfunctioning with an alloxan-induced diabetic mice model for 14 days.[79] A considerable reduction in the blood glucose level was found due to its recovering action on the protein concentration and normalizing the level of ALT, alkaline phosphatase, and aspartate aminotransferase thus restoring liver functions.

Hepatoprotective Activity

Chitme *et al*. [80], investigated the hepatoprotective activity of aqueous ethanolic extract (AET 50:50 v/v) of the root of *R. serpentina* against paracetamol-induced hepatic damage in rats.[80] The AET has a reverse effect on the level of liver glutathione, Na+ K+-ATPase activity, serum marker enzyme, serum bilirubin and thiobarbituric acid, liver glutathione peroxide, glutathione-S-transferase, glutathione reductase, superoxide dismutase, catalase, and glycogen. It was observed that it has a significant anti-oxidant effect and normalizes impaired membrane functions and can be used as a hepatoprotective agent. Chitme *et al.* [81] further investigated the free radical scavenging activity of *R. serpentina* in an animal model by CCl4 -induced hepatotoxicity.[81] The extract significantly exhibits free radical scavenging activity by showing an increased level of glutathione peroxide, glutathione-S-transferase, glutathione reductase, superoxide dismutase, catalase, and glutathione and decreased level of lipid peroxidation. They showed a prominent antioxidant activity and CCl4 -intoxicated liver recovery.

Antidiarrheal activity

A study by Ezeigbo *et al*. was done on methanolic extract of leaves of *R. serpentina* in castor oil-induced diarrhea in mice.[82] Graded dose from 100, 200, and 400 mg kg of the extract was used to assess the function. The dose-dependent reduction in intestinal weight and fluid volume showed a significant antidiarrheal effect.

Antibacterial Activity

Patyal et al. [77] explored the antibacterial activity of *R.serpentina* against two Gram-positive (*Bacillus subtilus* and Staphylococcus) and three Gram-negative bacteria (*Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Salmonella typhimurium*), among which it was found to be effective against *Klebsiella pneumonia, Staphylococcus*, and *B. subtilis*.[77] The activity was also assessed by Murthy and Narayanappa against *S. aureus, Escherichia coli, P. aeruginosa, B. subtilis, and K. pneumonia.*[83] Negi et al. also studied the antibacterial activity in the methanolic extract of roots of *R. serpentina* against gram-positive and gram-negative bacteria.[84] The study found that extract was effective against *S. aureus* with highest Zone of Inhibition (ZoI) (13 mm) with lowest Minimum Inhibitory Concentration (MIC) (625 μg) and *E.coli* possess the highest MIC (10 mg), whereas *Proteus vulgaris* was observed to be resistant to the tested extract concentration of up to 10 mg. Methanolic and chloroform extracts of leaf and root *R.serpentina* also exhibited strong antibacterial activity.[83, 84]

Antivenome activity

Ethanolic extract of *R. serpentina* was evaluated by Rajashree *et al.* for its antivenom activity as per the methodology adopted by Akston and Reid (1983) to determine the lethal dose (LD50) of *N. naja* venom.[85] It was found that the plant extract significantly reduced the lethal effect of the *N. naja* venom. About 0.14 mg of its extract was sufficient to neutralize the lethal effect of 2LD50 of *N. naja* venom.

James et al. (2013) also explored the venom-neutralizing potential of the aqueous *R. serpentina* extract in mice in *D. russelli* venom.[67] In this study, the venom lethality dose of LD of *D. russelli* venom was found to be 0.628 μg/g which was effectively neutralized by 10.99 mg/3LD of plant extract. The LD of the tested drug extract was found to be more than 2000 mg/kg. These findings suggest that *R. serpentina* extract possesses active phytoconstituents which restrain the toxins present in *D. russelli* venom.[86]

CONCLUSION

The present study provides a brief insight into the ethnopharmacological, phytochemical and pharmacological activities of *Rauwolfia serpentina*, which is therapeutically used to treat various health ailments for centuries in ancient and modern India. It has been successfully used in traditional medicine for its wide spectrum of therapeutic potential as a sedative, hypnotic, narcotic, and anti-allergic, used in treating melancholia, insomnia, sleep disorders, hypertension, urticaria, depression, uterine tonic, hysteria, abdominal pain, snake and insect bite, infertility, anxiety, schizophrenia, epilepsy, seizures, fever, malaria, eye diseases, pneumonia, asthma, skin disease, and spleen disorder. The therapeutic potential of *R.serpentina* is attributed to the presence of active phytoconstituents viz. presence of more than 50 alkaloids, out of which reserpine is counted as the most vital principle active constituent. Its main action as a natural tranquilizer is used as an antihypertensive, and sedative, and increases urinary metabolites. Another pharmacologically active alkaloid present in it includes Yohimbine (selective alpha-adrenergic antagonist) used for the treatment of erectile dysfunction. Ajmalicine, for the treatment of circulatory diseases, especially in providing relief to normal cerebral blood flow, affects smooth muscle movement; prevents strokes, and helps in lowering blood pressure. The presence of phenolic compounds provides an anti-microbial agent, while saponins and tannins are used for their astringent, haemostyptic, and wound healing properties, they reduce the inflammation of mucous membranes. Flavonoids are potent water-soluble antioxidants and free radical scavengers that prevent oxidative cell damage and have strong anticancerous activity. Several literary pieces of evidence have been already researched through animal and clinical screening. Further, those effects which are already studied as per the present-day parameters are needed to be used in a clinical study for overcoming ailments. While those which are already used should be watched for any adverse effects, and if found should be noted for pharmacovigilance. But several effects are still unexplored in scientific parameters. Many of the action potentials are still waiting for their clinical use. The present study provides a base and a thorough review of its phytochemistry and its traditional uses for future researchers to work upon.

AUTHOR'S CONTRIBUTIONS

Alam: Principal investigator of the study, first drafts of the manuscript up to its final version.
Bano: Participated in literature analysis and manuscript editing.
Sumbul Rehman: Pparticipated in literature analysis and manuscript editing.

Imam: Collected relevant literature information.
All the authors have read and approved the final manuscript.

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CONFLICT OF INTEREST
The authors have no conflict of interest.

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