



A REVIEW OF PHARMACOLOGICAL ACTIVITY RELATED TO EXPERIMENTAL AND CLINICAL RESEARCH ON BOERHAAVIA DIFFUSA L. ROOT

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Abstract : The Nyctaginaceae family plant, Boerhaaviadiffusa L., whose name means "to rejuvenate," is a promising drug. Ayurveda uses it as a well-known medicinal herb to treat a variety of illnesses. It is well-known in Ayurvedic medicine and goes by the local name Tambadivasu. It is a creeping perennial herb that grows in wastelands in India. The roots are used to treat anasarca, ascites, and jaundice and are also reported to have diuretic and laxative properties. This species has been utilised as medicine since the time of the ancient civilizations (B.C.). According to Ayurveda, Charaka Samhita, and Sushrita Samhita, a variety of human illnesses are treated with this species. Many scientists and researchers conducted numerous phytochemical, pharmacological, experimental, and clinical experiments on B. diffusa to better understand the historical Ayurvedic, endemic, and tribal uses of this medicinal plant. Aside from its abilities as an antidote for rat poisoning, its roots are used for the treatment of jaundice, ascites, internal inflammations, asthma, and piles. Studies on the pharmacology of B. diffusa have shown that it has diuretic, antifertility, anti-inflammatory, antidiabetic, anti-viral, antibacterial, hepatoprotective, and antioxidant properties. Alkaloids, phytosterols, lignans, rotenoids, and amino acids have all been found in B. diffusa, according to phytochemical study.

INTRODUCTION

According to Ayurveda, a well-known medicinal herb called Boerhaaviadiffusa can treat a variety of diseases. Hermann Boerhaave, a well-known Dutch physician of the 18th century, inspired the name of Boerhaaviadiffusa [7]. Hermann Boerhaave (1668-1738), a Dutch botanist, researcher, and physician at the University of Leiden in the eighteenth century, being honoured by the name of the genus Boerhavia (sometimes written Boerhaavia), while the species gets the name of own typical extensive branching. The botanical name of the plant is Boerhaaviadiffusa (Hiruma-Lima et al., 2000) [48], but Linnaeus Latinized Boerhaave's name to Boerhavius and selected the spelling Boerhaviadiffusa (Spellenberg, 2004) [55], which is the correct one. Punarnava, also known as Boerhaaviadiffusa L.-Nyctaginaceae, seems to be a promising drug that can support in the body's cell regeneration. The most popular name for it in Ayurvedic medicine is Tambadivasu. Punarnava was first described mostly in Atharvaveda as a plant that almost totally faded in the summer but instead regenerated to become green again during the rainy season. The name, that composed of words punar (which means once more/regaining/restoring) and nava (which means new, renew, or young), literally translates "one who becomes new or youthful again." The above name acts as a symbol of Punarnava's rejuvenating qualities. It is an Ayurvedic herb known as Rasayan, so it promotes physical renewal and youth. Indigenous and tribal peoples traditionally used it for years, and it is also used in Ayurvedic or natural herbal therapy. [6] [7]. In addition to being a main constituent, and is used as a therapeutic option. Numerous scientific investigations on B. diffusa undertaken recently, according to recent reports from around the world, demonstrate the presence of a wide spectrum of chemical components and

the efficiency in treating a variety of illnesses. Punarnava (Punahpunarnavabhawatiiti, Sanskrit for "that which becomes fresh again and again..") is said to arise from the perennial characteristic of the plant of remaining dry and dormant during the summer and regenerating from the same old root stock during the rainy season. (The Sanskrit phrase "something which rejuvenates the body" is karotishariram punarnavam.) [45]. It also referred as the Punarnava in the Rasayana Prakrana and Vayahsthapana Mahakashaya of Charaka Samhita. Vidarigandhadi Gana, Vatasansamana, and Tiktavarga as in Sushruta Samhita all provide an explanation. Boerhaaviadiffusa, sometimes known as punarnava, is used to treat a number of diseases. The plant is consumed as a vegetable by tribes in Purulia, West Bengal. Assam also use and consume boerhaavia leaves in food form. Where it becomes widely accessible in marketplaces [68]. Over the wastelands of India, a perennial herb called punarnava grows up. According to legend, the roots also diuretic and laxative and are used to cure anasarca, ascites, and jaundice. In several places, Boerhaavia sp. already utilised for medical purposes going back to the B.C. The history of herbal medicine is complex. Over time, herbal therapy also changed and developed. The raw and extract forms of punarnava also used to cure a number of illnesses. [72]. According to Ayurvedic texts, punarnava comes in two varieties: Swetha/white (Boerhaviadiffusa L.) and Raktha/red (Boerhaviaverticillata Poir.). Another variation, Nela (blue) Punarnava, also available, as indicated in Rajanighantu. Astringent, bitter, and pungent in flavour, white punarnava also has a cold potency and a pungent post-digestive impact. The white variation balances all three doshas. The red and white varieties are both used to treat edoema, anaemia, heart disease, cough, intestinal colic, and renal disorders. Vatadosha is made worse by the red one while pitta dosha is balanced by it. Punarnava is a sharp and funny guy. Chronic alcoholism, wasting conditions, sleeplessness, rheumatism, eye conditions, asthma (moderate dosages), produces vomiting in large doses, jaundice, and ascites as a result of early liver and peritoneal issues; urethritis; red variety is a nervous system, heart condition, haemorrhoids, skin conditions, kidney stones, edoema, rat and snake bites; treating chronic ophthalmia by putting drops of leaf juice mixed with honey in the eyes. There controversy over "Punarnava's" actual identity. ShvetPunarnava also connected to *B. erecta* and *Trianthemaportulacastrum* L., whereas Neel Punarnava connected to *B. repanda*, and RaktaPunarnava connected to *B. diffusa* L.. Some indigenous people consume the entire plant of this herb, not just the roots, as a healing component. For this function, leaves are primarily used. This drug's names in Taste are Tikta(bitter) and Kashaya (astringent). Although the Moola (root) is frequently advised in Ayurvedic scriptures, the Panchanga (whole plant) is the most beneficial component. The variant with pink flowers seems likely to be *B. diffusa*, whilst the plants with white flowers may probably *B. repanda*. Additionally, *B. diffusa* exhibits strong antiviral activity, which makes it particularly beneficial in medicine [53] [20] [60]. Diuretic properties are particularly present in punarnava root [16].

PHARMACOGNOSY-

Scientific Name	: Boerhaaviadiffusa Linn.
Kingdom	: Plantae
Division	: Magnoliophyta
Class	: Magnoliopsida
Order	: Caryophyllales
Family	: Nyctaginace (four o'clock)
Group	: Dicotyledons
Phylum	: Angiosperms.

Other Synonyms of this drug are *B. adsendens*, *B. caribaea*, *B. coccinea*, *B. paniculata*, *B. repens* [67].

VARNACULAR NAME OF BOERHAVIA DIFFUSA-

Boerhaviadiffusa slang names in several languages. Boerhaaviarepens Linn(Latin); Punarnava (Sanskrit); LalPunarnava, Beshakapore, Santh(Hindi); Spreading Hogweed, Shothagni, Red Hogweed, Raktapunarnava (English); Thazhuthama (Malayalam); Punarnava(Bangali); Kommegida (Kanarese); Vakhakhaparo, Dholia-saturdo(Gujarati); Tambadivasu, Ghetuli(Marathi); Chattarani(Tamil); Galijeru(Telugu); Lalapuiruni, Nalipuruni (Oriya); Itcit (Ial), Khattan (Punjabi); Sanadika, Kommeberu, Komma (Kannada); VanjulaPunarnava(Kashmiri); RangaPunarnabha(Assamese)..

Common Names-

ErvaTostão, ErvaToustao, Pega-pinto, Hog Weed, Pig Weed, Atikamaamidi, Biskhapra, Djambo, Etiponia, Fowl's Lice, Ganda'dar, Ghetuli, Katkatud, Mahenshi, Mamauri, Ndandalida, OulouniNiabo, Paanbalibis, Patal-jarh, Pitasudu-pala, Punar-nava, Punerva, Punnarnava, Purnoi, Samdelma, San, Sant, Santh, Santi,

SatadiThikedi, Satodi, Spreading Hog Weed, Tellaaku, Thazhuthama, Thikri, Touri-touri, Tshrana, Yoegbe, Beshakapore, Raktpunarnava.

DISTRIBUTION-

The genus *Boerhaavia* contains various species that can be found in tropical, subtropical, and temperate climates [19]. It can be found in Australia, China, Egypt, Pakistan, Sudan, Sri Lanka, South Africa, the United States, and other Middle Eastern countries. It can reach 70 cm in height, especially during the rainy season. It has a substantial root system. Six species of this genus – *B. diffusa*, *B. chinensis*, *B. erecta*, *B. repens*, *B. rependa*, and *B. rubicunda* – are found in India [10] [28]. *BoerhaaviaDiffusa* is found in India's warmer regions and at altitudes up to 2,000 metres in the Himalayan region. During the rainy season, the plant blooms profusely, and mature seeds appear in October-November. The plant gets stuck on people's garments and animals' legs due to its sticky nature, which aids in its spread from one spot to another [29]. It has a long history of use among indigenous and tribal peoples, as well as in Ayurvedic and natural herbal medicine [6]. Punarnavine is the main active ingredient found in the roots, and it is an alkaloidal component.

Boerhaaviadiffusa lin. photo of naturally growing plants-



Photo of boerhaaviadiffusa L. root-

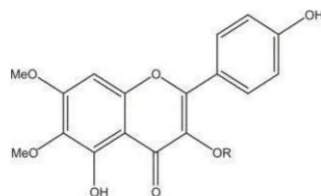


PHYTOCHEMISTRY-

Flavonoids, alkaloids, steroids, triterpenoids, lipids, lignins, carbohydrates, proteins, and glycoproteins are only a few of the bioactive substances found in the plant. Punarnavine $C_{17}H_{22}N_2O$ M.P. 236–237 °C [2][13]. Hypoxanthine 9-Larabinofuranoside [8], Ursolic acid [11], Punarnavoside [30], Lirodendrin [43], and a glycoprotein with a molecular weight of 16–20 k Da have been identified and their biological activities examined in detail [19]. Proteins and lipids abound in this herb and its roots. The herb possesses 15 amino acids, including six necessary amino acids, and the root offers 14 amino acids, including seven essential amino acids. Aside from punarnavine, the plant contains high levels of potassium nitrate [1]. Fatty acids and allantoin also found in the seeds of this plant, and alkaloids found in the roots [44]. The plant's green stalk containing boerhavin and boerhaavic acid [32]. The plant also contains a sequence of boeravinones, namely boeravinones A-F. described a new antifibrinolytic chemical called 'punarnavoside' from the roots of *Boerhaaviadiffusa*. The maximal alkaloid content (2%) accumulated in the roots of 3-year-old mature *B. diffusa* plants, according to phytochemical screening of roots collected garden-grown in vivo plants of various ages. [27] [30].

CHEMICAL CONSTITUENTS[49]

Punarnavoside, rotenoids such as boeravinones A, B, C, D, and E, lignins such as liriodendrin and syringaresinol mono-β-D glucoside, flavones and sterols, isofuroxanthone, boervine, and hypoxanthine-9-L-arabinofuranoside, Vitamin C, sodium, and calcium seem to be just a lot of small nutrients in the leaves. [68]. Chemical components include triacontano, b-Ecdysonepalmitic acid ester, b-Sitosterol, and a-2-sitosterol. Rotenoids, for example, being obtained from the roots and seem to be chemical components. It also contains boeravinones, such like boeravinone A, B, C, D, E, and F. Punarnava roots contain a phenolic glycoside & C-methyl flavone.



Bd-1: R=β-D-galactopyranoside
Bd-2: R=H
Fig.2. Chemical structure of Punarnava (Boerhavia Diffusa Linn.).

PHYTOCHEMICALCOMPONENTS-

Punarnavine (Alkaloids), β-sitosterol (Phytosterols), Liriodendrin (Lignans), Punarnavoside (Rotenoids), Boerhavine (Xanthenes), and Potassium nitrate are the main phytochemical components of the complete plant (Salts). In addition to the newly discovered dihydroisofuroxanthin, the roots also include the rotenoidsboeravinones AI, BI, C2, D, E, and F. Beta-Ecdysons, Alanine, Arachidic Acid, Aspartic Acid, Behenic Acid, Boerhavine Acid, Boerhavone, Campesterol, Daucosterol, Flavone, 5-7-dihydroxy-3'-4'-dimethoxy, XY-6-8-dimethyl, Galactose, Glutamic Acid, Glutamine, Glycerol, Glycine, HentriacontaneN,Heptadecyclic Acid, Histidine, Hypoxanthine-9-l-arabinofuranoside, Leucine, Liriodendrin, Methionine, Oleic Acid, Oxalic Acid, Palmitic Acid, Proline, Hydroxyl Serine, SitosterolOleate, Triacontan-1-OL, Threonine, Tyrosine, Ursolic Acid, Valine, Xylose, triacontanolhentriacontane5, 7-dihydroxy-3, 4-dimethoxy-6, 8- dimethyl flavone, and an unidentified ketone (mp 86°). SitosterolPalmitate, Stearic Acid, Stigmasterol, Syringaresinol-Mono-Beta-d-glucoside, In addition to the newly discovered dihydroisofuroxanthin and two lignans known to be antifibrinolytics, liriodendrin and syringaresinol mono-β-D-glucoside, the roots also contain the rotenoid-boeravinones AI, BI, C2, D, E, and F [72] [69].

CHEMICAL CONSTITUENTS OF ROOT-

Seven of the root's 14 amino acids are necessary ones (total 11.54 percent). These are: valine 0.75 percent; alanine 1.18 percent; arginine 0.75 percent; aspartic acid 0.95 percent; glutamic acid 1.45 percent; leucine 0.88 percent; methionine 0.45 percent; ornithine 0.96 percent; phenylalanine 0.71 percent; proline 0.5 percent; serine 0.85 percent; threonine 0.79 percent; tryptophan 0.65 percent; tyrosine 0.72 percent; 29. According to studies, the root contains boerhavone and boerhavine, two novel c-methyl flavones and dihydrofuroxanthones, respectively[40] [26]. Its roots isolate four brand-new chemicals, namely boerhavisterol, boerhadiffusene, diffusarotenoid, and boerhavianostenyl benzoate, and also a well-known rotenoid, boeravinone A[50]. Boeravinone A, B[31], C[34], D, E, F[35], G, and H [61] discovered after the ether extracts roots of B. diffusa examined. The root extracts of B. diffusa also included a phytoecdysone known as "ecdysterone," which functions as an insect moultinghormone[24]. Roots showed fewer flavonoid derivatives compared to leaves, such as quercetin-3-O-robinobioside and eupalitin-3-O-galactosyl (1-2)-glucoside, but they actually showed one phenolic acid, caffeoyltartaric acid, which the leaves lacked[64].

CHEMICAL CONSTITUENTS OF WHOLE PLANT-

Characterization of the whole plant extract of B. diffusa led to isolation of four new flavonoids and phenol glycosides such as eupalitin 3-O-β-Dgalactopyranosyl-(1''-2'')-O-β-Dgalactopyranoside, 3,3',5-trihydroxy-7-methoxyflavone, 4',7- dihydroxy-3'-methylflavone and 3,4-dimethoxyphenyl-1-O-β-D apiofuranosyl-(1''-3')-O-β-D-glucopyranoside[62]. Root, stem, and leaf samples used to isolate the two quinolizidine alkaloids punarnavine I and punarnavine II [48]. Both roots and the leaves found to contain a number of volatile substances[64].

Table 1: CHEMICAL CONSTITUENTS ISOLATED FROM BOERHAA VIA DIFFUSA

Class	Compounds	References
Alkaloid	Punarnavine	[2] [3] [13]
Rotenoids	Boeravinone A-F	[31] [34] [39]
Glycoside	Hypoxanthine 9-L-arabinofuranoside	[8]
	Hentriacontane, β -sitosterol and ursolic acid	[12]
	Punarnavoside	
	C-methylflavone 5,7-dihydroxy-3',4'-dimethoxy- 6,8-dimethylflavone	[30] [27]
Acids	β -ecdysone, triacontane	[26]
	β -sitosterol- β -D-glucoside	
	tetracosanoic, hexacosanoic, stearic, palmitic, arachidic acids	[24] [17]
Lignans	Boerhavin and boerhavic acid	
	Liriodendrin	
Lipids	syringaresinol mono- β - D-glucoside	[32]
	Glycoprotein	[43]
	5-methyleicos-4-ene	[35]
	Eicos-4-ene	[10]
Phenolic compounds	4-methyloctadec-3-ene	[51]
	4-methylnonadecylbenzene	
	3,4-dihydroxy-5-methoxycinnamoylrhamnoside	
	Quercetin 3-O-rhamnosyl (1 \rightarrow 6) galactoside (quercetin 3-O-robinobioside)	[56]
	Quercetin 3-O-(2"- rhamnosyl)-robinobioside	
	Kaempferol 3-O-(2"-rhamnosyl)-robinobioside	
	3,5,4'- rihydroxy-6,7-dimethoxyflavone 3-O-galactosyl(1 \rightarrow 2)glucoside [eupalitin 3-O-galactosyl(1 \rightarrow 2)glucoside]	
	Caffeoyltartaric acid	
	Kaempferol 3-O-robinobioside	
	eupalitin 3-O-galactoside	
	Quercetin	
	Kaempferol	
6, 9, 11-Trihydroxy-6a		
12a-dehydrorotenoid (coccineone B)	[57]	

USES-

Ethano medicinal uses-

In both the traditional and folk streams of indigenous medical systems, Boerhaavia Diffusa thought to possess important therapeutic characteristics. The various plant components used to treat cancer, jaundice, dyspepsia, inflammation, enlargement of the spleen, abdominal pain, and as an anti-stress agent. It seems to pungent, astringent, and bitter in taste.

Ethanobotanical uses-

The Garhwal Himalayan population treats piles through its roots (Uttaranchal). The Bhils of the Jhabua area of Madhya Pradesh use the root paste to treat bloody dysentery. In order to treat body nodules, the plant's decoction is provided. The root juice used to treat internal inflammatory diseases, scanty urine, and asthma. In the Lalitpur district of Uttar Pradesh, the Sahariya tribe uses Boerhaaviadiffusa to treat illnesses like leukorrhea, rheumatism, and stomachaches. The tribes of Madhya Pradesh's Ambikapur district also utilise this plant to treat elephantiasis. The tribal people of the Indo-Nepal Himalayan Terai region gather this plant for medical use, mostly to cleanse the kidneys and treat seminal weakness and high blood pressure [46].

Punarnava also help to revitalise the body's failing organs and renew dying cells. Punarnava is utilised in a number of kidney illnesses, including CKD. Only a small percentage of patients to meet the increasing expenditures and rigorous procedures required by the modern treatment strategy, that also includes dialysis and kidney transplantation, to provide adequate renal care. Hence, it's important to study reliable and cheap treatments.

For best advantages, each component must be prepared according to its unique medicinal value. This plant is aphrodisiac, regenerates the liver, male reproductive system, and other organ systems; detoxifies the liver and skin; raises libido and erection quality and quantity; and lowers cough and asthma symptoms. It must be utilised in the making of Vajikarana. This herb helps to clear renal calculi and cleanses the kidneys (kidney

stones). Punarnava is mostly used for therapeutic purposes, both internally and externally to reduce pain and swelling. If applied to the eyes, the fresh juice of its roots helps treat eye conditions like conjunctivitis and night blindness. The wounds' seeping stops if paste is placed to them. Punarnava also useful for treating many different illnesses inside. Punarnava, strong diuretic effect, most frequently used and the most effective herb for reducing swelling. Increased urinary flow improves filtration, revitalises renal processes, and removes extra fluids and kleda. Punarnava purgative effect in high doses. particular after treating malaria, punarnava successfully decreases fever. The greatest treatment for rheumatic swollen joints seems to be a decoction of rasna, sunthi, and punarnava because rasna relieves pain and vata, sunthi eliminates ama, and punarnava reduces swelling.

Healing power and curative properties-

For the treatment of the following conditions, including adrenal depletion and excessive cortisol production, as well as for conditions affecting the liver, gallbladder, kidneys, urinary tract, and menstrual cycles.

Dropsy (edema)-

Urine production and output both increased with punarnava. It works well for the treatment of dropsy, a condition in which the body's tissues and cavities or natural hollows store an excessive amount of a watery fluid. In order to treat this illness, the fresh, boiled herb must be given. Furthermore, 4 to 6 gm of a liquid extract of the fresh or dried plant given.

Stomach disorders-

The herb helps to support and strengthen the stomach's function. Treatment for numerous digestive problems, especially intestinal colic, is aided by it. The root powder is consumed in quantities of 5 gms (1 tsp) three times each day. Additionally, it helps to remove or destroy intestinal worms.

Asthma-

The herb goes to support the stomach's function and strengthen it. Several stomach conditions, especially intestinal colic, helped by it. Three times a day, 5 gm (1 tsp) of the root powder is taken. Intestinal worms also removed or killed with this method.

Fevers and hot flashes

In the management of fevers, punarnava generally helpful. It lowers temperature by causing a great deal of perspiration.

Skin diseases

For a number of chronic diseases, the plant's root works well as a treatment. Ulcers, abscesses, and other skin conditions can benefit from the use of a hot poultice made from the root.

Other discomforts-

The plant's root is effective in treating a number of illnesses, including gonorrhoea, kidney, and heart ailments. It's also helpful for paralysis, anaemia, cough, pleurisy, nervous weakness, and constipation.

Other uses[16][4][41][32][36]

Abdomen, Abdominal Pain, Anemia, Anthelmintic, Anti-inflammatory, Ascites, Asthma, Blood Purifier, Calculi, Cancer(abdominal), Cataract, Childbirth, Cholera, Cough, Debility, Diuretic, Dropsy, Dyspepsia, Edema, Emetic, Expectorant, Eye, Fever, Food, Gonorrhea, Guinea Worms, Heart Disease, Heart Ailments, Hemorrhages(childbirth) Hemorrhages(thoracic) Hemorrhoids, Hepatoprotective, Inflammation(internal), Jaundice, Kidney Disorders, Lactagogue, Laxative, Liver, Menstrual, Ophthalmic, Renal, Rheumatism, Snakebite, Spleen(enlarged), Stomachic, Urinary, Urinary, Urinary Disorders, Weakness, Albuminuria, BeriBeri, Blenorrhagia, Chologogue, Cystitis, Gallbladder, Hepatitis, Hepatotonic, Hepatoprotective, Hydropsy, Liver, Nephritis, Sclerosis(Liver), Spleen(enlarged), Urinary Disorders, Childbirth, Sterility, Yaws, Erysipelas, Anti-flatulent, Appetite Stimulant, Joint Pain, Lumbago, Nephritis, Tonic, Urticaria, Abscess, Anti-convulsant, Boil, Convulsions, Epilepsy, Emetic, Expectorant, Febrifuge, Laxative, Abortifacient, Aphrodisiac, Dysmenorrhagia.

In arthritic animals, aqueous extract and the alkaloid component of the root dramatically reduced serum aminotransferase levels in a manner similar to that of hydrocortisone.

As medicine in the Ayurvedic system-

Old Indian medical texts like the CharakaSamhita and SushritaSamhita mention the usage of punarnavastakavath, punarnavakshar, and punarnavataila, three Ayurvedic medicines prepared from punarnava, for curing a variety of diseases. Punarnava, a diuretic listed in the Indian Pharmacopoeia, may be found throughout the entire plant of *B. diffusa* (Chopra, 1969). [10]. According to Anand (1995), it became utilised as a diuretic to treat renal conditions as well as blood pressure and seminal edoema (Gaitonde et al., 1974) [16].

Punarnava in Eye Diseases-

To treat various eye conditions like conjunctivitis and night blindness, fresh root juice of Punarnava gets applied to the eyes. Due to its multifaceted activity, it fitted to both topical and oral applications. In Ayurveda, herbs used in combination with other herbs to reduce the strength of one herb or to boost a specific effect of one herb with the assistance of another. Hence, in certain circumstances used in compound preparations and in some diseases it must be administered as a single medicine. There are some compound medicines that treat eye problems or contain punarnava as a component.

Formulations from Gupta vaidyaprakasika [70]

SwethaPunarnava root is pasted with various things and serves flavorful purposes. Below is a summary of it. (Table-2)

Table 2: Root used as Collyrium

Punarnava root grounded with	Gupta vaidyaprakasika	SarangadharaSamhita
Ghee	Corneal opacity	Corneal opacity
Honey	Watering from eye	Watering from eye
Tilataila	Itching in eye	Cataract
Water or rice flour water	Night blindness	--
Kanjika	--	Night blindness
Milk	Itching in eye	Itching in eye

PHARMACOLOGICAL AND BIOLOGICAL ACTIVITY -

According to pharmacological studies, *B. diffusa* roots have a variety of beneficial effects, including anti-inflammatory [9], diuretic [16], laxative [5], anti-urethritis [18], anticonvulsant [21], antinematodal [22], antifibrinolytic [29], antibacterial [42], antihepatotoxic [23], anthelmintic, anti-leprotic, anti-asthmatic, anti-scabby and antistress activities.

Experimental and Clinical Investigations

Antiviral activity

Large plant materials first converted into aqueous extracts, were synthesised and examined both in vivo and in vitro for their ability to inhibit the growth of phyto-pathogenic viruses on systemic and hypersensitive hosts. BoerhaaviaDiffusa root extracts were discovered to have a wide range and extremely high antiviral activity out of the numerous plants evaluated [58].

Antioxidant activity

According to Premkumar et al. (2010) [67], Boerhaviadiffusa plays a preventive and beneficial effect in maintaining cell survival, cellular contact, and maintenance of cell membrane architecture. Boerhaviadiffusa's various parts exhibit varying levels of antioxidant activity, and it has been noted that leaves exhibit higher antioxidant activity than roots. According to Pereira et al. (2009) [64], aqueous extract of *B. diffusa* leaves exhibits higher antioxidant activity than roots. However, ethanol extract of Boerhaviadiffusa has been discovered to have greater antioxidant activity than methanol extract (Rachh et al., 2009) [65].

Hepatoprotective activity

Additionally, the hepatoprotective properties of the *B. diffusa* aqueous root extract also demonstrated [37] against the toxic effects of carbon tetrachloride on the liver. Aqueous root extract of *B. diffusa* (2ml/kg) had significant hepatoprotective activity against thioacetamide-induced hepatotoxicity, as well as significant protection against the majority of serum parameters, including GOT, GPT, ACP, and ALP, but not GLDH and bilirubin. The above information provided by Rawat et al. in 1997 [47]. In addition, study shows that providing a medicine in aqueous form (2ml/kg) has more hepatoprotective action than providing it in powder form [47].

Antifertility-

The albino female pregnant rats received an ethanolic extract of the root throughout the entire time of gestation, and neither teratogenic effects nor abnormalities in the foetus were shown.

Antimicrobial-

Aqueous extract of the root was active against *Escherichia coli* and antifungal activity against three keratinophilic fungi, but the alcoholic extract was antibacterial against *Staphylococcus aureus*. According to Ramchandra et al. (2012) [74], the antibacterial activity of a crude methanol extract from the plant's aerial section is greater than that of extracts made from petroleum ether and chloroform. In pulmonary tuberculosis, Boerhaviadiffusa worked well as an adjunct to chemotherapy. At the end of the 4-week study period, Boerhaviadiffusa supplementation had a faster clinical recovery rate and had alleviated the cough in

80% of patients as opposed to only 52% of patients in the control group. Similar to this, 88% of the patients were afebrile in 4 weeks as opposed to 60% of the control group (Kant et al., 2001)[51].

Antihelmintic activity-

According to Singh and Udupa[14], dried root powders of *Boerhaaviadiffusa* showed effective as treating helminth infections. If taken orally with the powder, they discovered that children or adults with helminth infections became worm-free within five days. Acetylcholine (ACh)-induced reflexes mostly isolated guinea pig ileum might be inhibited by a methanol extract made from *B. diffusa* roots, according to Borrelli et al. [59]. The 9-O-methyl-10-hydroxycoccineone B was discovered after a comprehensive phytochemical analysis of this methanol extract, along with six other rotenoid derivatives, including boeravinone D, boeravinone E, 6-Odemethylboeravinone H, boeravinone H, boeravinone G, boeravinone C, 10-demethylboeravinone C, coccineone E, 2'-Omethylabronisoflavone, boeravione F and coccin.

Anti-hepatotoxic Activity or Hepatoprotective activity-

The reduction in elevated serum levels of glutamate oxaloacetate (SGOT), pyruvate transaminase (SGPT), and alkaline phosphate (SALP) in carbon tetra chloride-induced hepatotoxicity in rats (Chakraborti and Handa, 1989) [32] seems to be proof of the root and aerial parts' anti-hepatotoxic activity in petroleum, chloroform, and methanol extracts. The protective effect of the same indicated by reduction of increased alanine aminotransferase (ALT), triglyceride, cholesterol and total lipids in both serum and tissues (Surange and Pendse, 1972) [15]. Ethanol extract of the root of *Boerhaaviadiffusa* provides hepatoprotective activity against country manufactured liquor caused liver damage in albino rats. Alcoholic extracts of the entire plant (Chandan et al., 1991) [37] and the roots (Rajkumari et al., 1991) [38] possess hepatoprotective effects in carbon tetra chloride-induced hepatotoxicity in rats; the above said property is demonstrated by modulation in serum ALT, TG, cholesterol, and total lipid titers. *Boerhaaviadiffusa* additionally increases the rate of bile flow by two times and decreases the prothombin time increase brought on by carbon tetra chloride (Chandan et al., 1991) [37]. For the highest hepatoprotective action against thiocet-amide-induced liver damage in rats, the proper size (1-3cm diameter), timing (summer is ideal), and dosage form (compared to powder, aqueous form is more beneficial due to greater absorption) of roots be essential (Rawat et al., 1997) [47].

Insecticidal activity-

Ecdysone, a hormone that causes insect moulting, was discovered in the roots of *Boerhaaviadiffusa* (Babita et al., 2011) [71]. According to Deshmukh et al. (1982), the insecticidal properties of twig extracts in hexane and acetone highly active against *Culex p. fatigans* and *Muscadomesticanebulo*.

Anti-Plasmodial activity-

Plasmodium berghei NK 65 showed resistant to the crude methanolic root extract of *B. diffusa*'s anti-plasmodial properties (chloroquine resistant strain). It has ability for suppressive, curative, and preventive against malaria (Adefokun et al., 2015) [76].

Antiulcer activity-

According to Gharate M and Kasture V. (2013) [75], the plant extract of *B. diffusa* exhibited antacid action and the aqueous extract improved % protection with dramatically lowering the ulcer index. It might be helpful for treating gastric ulcers.

Anti-cancer properties-

Bharali et al. [54] exhibited its chemopreventive action against 7, 12-dimethyl benz(a)anthracene (DMBA) caused skin papillomagenesis, and Manu et al. [63] proved the protective activity of the plant's hydro-alcoholic extract against gamma radiation-induced damage. The antiproliferative and antiestrogenic qualities of the methanol extract of *Boerhaaviadiffusa* also observed by Sreeja and Sreeja[66] in MCF-7 breast cancer cell lines, indicating its therapeutic significance in estrogen-induced breast malignancies.

CONCLUSION-According to the phytochemical and nutritional analysis of *B. diffusa*, the plant has a significant nutritional and medicinal value. Due to the presence of numerous compounds that are essential for good health, the plant that was examined for its phytochemical constituents appears to have the potential to both serve as a source of beneficial medications and to improve the health of its users. The significance of the species for nutraceuticals will be revealed through a thorough investigation. This will then direct research into medications with complex side effects.

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