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Raktapushpa: A Comprehensive Review of Its Phytochemistry and Therapeutic Potential

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ABSTRACT

Punarnava (*Boerhavia diffusa* Linn.), a well-known medicinal plant in traditional Ayurvedic systems, has gained significant attention for its wide range of pharmacological properties. This review compiles and evaluates the pharmacognostic characteristics and the diverse therapeutic bioactive compounds of *Punarnava*, highlighting its potential as a versatile herbal remedy. Pharmacognostically, *Punarnava* is identified by its spreading habit, thickened root system, and glandular hairy stems and leaves, with distinct macroscopic and microscopic features essential for proper identification and standardization of raw materials. Plant has demonstrated notable efficacy in managing liver disorders, edema, arthritis, and urinary tract infections in both experimental and clinical settings.This review also emphasizes the importance of standardization, quality control, and future research to explore the synergistic effects of these phytoconstituents and their potential for novel drug development. Comprehensive understanding and further exploration of its pharmacognostic and phytochemical profiles can pave the way for evidence-based applications in modern medicine.

Key Words:

Boerhaavia diffusa, Punarnava, rotenoids, Punarnavine, and anti-cancer action.

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1. Introduction

Plants have been utilized medicinally throughout history and in many different civilizations. They provide a wealth of potential novel medications. For their fundamental medical care, 80% of people globally heavily rely on botanical medicine, according to the World Health Organization (WHO). 'Punarnava' is the widespread name for *Boerhaavia diffusa L.*

(Nyctaginaceae) in Indian medicine. It is a creeping perennial herb that grows over the wastelands of India. [1] Punarnava was initially administered both inside and externally during the Vedic era. Punarnava signifies "a renewer of the body".*B. diffusa* is a plant that has the name of Hermann Boerhaave, a well-known 18th-century Dutch physician. [2] Punarnava helps with the treatment and management of obesity. Punarnava works well to cure dropsy, a disorder in which the body accumulates too much watery fluid in its tissues and cavities. The root of Punarnava is a remedy for illnesses that affect different body systems, such as Pandu (anemia), Gulma (abdominal tumor), Arsas (haemorrhoids), Vasthisoola (bladder pain), Hridroga (cardiac disorders), Soola (abdominal colic), Pleeharoga (splenic disorders), Kasa (cough), Gara (poison), Vrana (wounds), and so on. [3] As its name indicates, it revitalizes the entire body. *Punarnava* (*B. diffusa*), a plant of significant medicinal value, was first documented and described in the ancient Indian text, the *Atharva Veda*. Its extensive distribution across different regions of the world has led to a variety of local names. In Spanish-speaking countries, it is referred to as "Hierba de cabra," while in Barbados, it is known as "hogweed." English-speaking regions recognize it as "red spiderling" or "spreading hogweed." In Brazil, it carries names such as "erva tostão," "agarra-pinto," and "amarra-pinto." Additionally, in China, it is called "Huang Xi Xin," and in French Guiana, it is known as "ipecacuanha de Cayenne" (**Fig. No.1**). [4] It works very effectively as a diuretic. It has an important effect on the urinary system and targets specifically the impaired nephrons, which are the main functioning unit of the kidney. [5] This is especially true for diabetics, who have elevated blood sugar levels. Punarnava improves the kidneys' filtration process and removes extra fluid and other waste.

(A) (B)

Fig. No.1Punarnava *Boerhaavia diffusa* L. (*Nyctaginaceae*)
Whole Plant (A) Flower (B)

Taxonomical classification: -The plant has been detailed as *Boerhaavia diffusa* Linn. in 'The Indian Medicinal plants' by Kirtikar K R and Base BD, [9] 'Flora of the presidency of Madras', [10] 'Indian Medicinal Plants -A compendium of 500 species','Ayurvedic Drugs and their Plant sources by V.V Sivarajan', 'The wealth of India. [11]

Table 1: Taxonomical classification of *Punarnava Boerhaavia diffusa Linn.*

Botanical name	*Boerhaavia diffusa Linn.*
Botanical synonyms	*Boerhaavia procumbens Roxb,Boerhaavia repens Linn, Boerhaavia erecta*.
Family	Nyctaginaceae
Kingdom	Plantae
Class	Dicotyledons
Subclass	Monochlamydeae
Series	Curvembryeae
Genus	Boerhaavia
Species	diffusa

Table 2: Vernacular name of*Punarnava Boerhaavia diffusa Linn.*

Language	Names
Sanskrit	Kahtilla, Raktakanda, Sophaghni, Sothaghni, Varshabhu
Assamese	Pananua, Ranga Punarnabha, Ponounua
Bengali	Punarnova, Rakta punarnava, Gadapushpa
English	Hog Weed, Pigweed, Spiderling, Horse Purslane, Red Spiderling, Tarvine
Gujrati	Dholisaturdi, Vasedo, Motosatodo
Hindi	Snathikari, Lalpunarnava, shothaghna, Biskhapara, Gadahpurna, Beshakapori
Kannada	komme gida, Kommeberu, Komma, Sanadika
Kashmiri	Vanjula Punarnava
Malayalam	hamizhamam, Chuvanna Tazhutawa, Talutama, Tavilama
Marathi	Satodimula, Ghetuli, Vasuchimuli, Tambadivasu, Punarnava, Khaparkhuti
Oriya	Nalipuruni, Lalapuiruni
Punjabi	Khattan
Tamil	Saarai, Sarandai, Mukurattai (Shihappu), Mukaratee-Kirei
Telugu	Atikamamidi, Raktakunda, Punernava, Erra galijeru

Table 3: Historical background

Vedic period	In the Atharvaveda, the medication Punarnava is referenced, and its interior and external medicinal indications are described. pachaka (that which digests), mootrala (which raises urination), agni deepaka (increases digestive fire), and the kapha nissaraka (removes excess kapha) are some of the names given to the medicine. Diseases such as pandu (anemia), sotha (oedema), kamala (jaundice), and mootrakrichra (dysuria) are associated with the internal use of the medicine. Additionally, external application for keeta visha damsa (insect bite) is mentioned. [3]
Samhita period	The Caraka Samhita, Susruta Samhita, Ashtanga Sangraha, and Ashtanga Hridaya are among the Samhitas that mention the drug Punarnava. In the Samhithas, the helpful parts—such as the root and leaf—are referenced in a variety of contexts. Punarnava was mentioned by Charaka Samhita and Ashtanga Sangraha in relation to ganas such as swedopaga, anuvasanopaga, kasahara, madhura skandhas, and ushna veerya dravyas, Punarnava was categorized under a number of vargas, such as Shaka varga, by Acharya Susruta and Vagbhata. [4,5]

Ghantu period	The medication Punarnava is thoroughly explained via various Nighantus under different vargas, along with its names, characteristics, and applications. Raja Nighantu especially mentions the implication of Punarnava in vikaras (diseases) affecting the rakthavaha srotas. Nighantus also describes its therapeutic indications for pandu (anemia). In Kamala, Priya Nighantu described the medication Punarnava (jaundice). [3] In Nighantu Adarsha, it is said that one tola (12 gm) is its matra (dosage) [6].

Table 4: Morphology of *Punarnava Boerhaavia diffusa Linn.*

Height	Prostrate divaricately branched; branches from common stalk about 1 m in length.
Leaves	Unequal pairs, ovate-oblong or sub orbicular, size is larger ones 25-37 mm long and smaller ones 12-18 mm long and colour is green and whitish below, glabrous above
Stem	Pale greenish below and light reddish brown
Flowers	tiny, ovoid, greenish lower part, pink top part, funnel-shaped, nearly sessile or short-stalked, 10–25 cm.
Fruits	Glandular, narrowlyoblong obovoid, about 3 mm long.
Roots	elongated, fusiform, tapering, cylindrical, 0.2–1.5 cm in diameter, and either moderately tortuous or somewhat tuberous.

1) **Stems:** In *B. diffusa*, the stems are stiff, thin, cylindrical, greenish purple, hardly pubescent, or almost glabrous, and expanded at the nodes or thick at the nodes. With branches from a common stalk that are approximately one meter long, they are prostrate and variably branched. Light reddish-brown top and pale greenish below, stems. [7]

2) **Roots:** *B. diffusa's* roots are long, fusiform, tapering, cylindrical, 0.2–1.5 cm across, soft to the touch, yet rough due to small fractures, longitudinal striations, and root scars. *B. diffusa* roots reach deeply into the ground and grow vertically downward. Knotty scars from dropped rootlets are frequently seen on old roots. The taste of roots is strong, sweet, and slightly bitter; they don't have a specific smell. They have very smooth skin and are cream or light brownish yellow in color. (**Fig. no.2**) [8]
3) **Leaves:** The ovate-oblong or suborbicular leaves of *B. diffusa* have a subcordate or rounded base and a rounded or slightly pointed apex. They also contradict each other in uneven pairs. Larger leaves are 25–37 mm long, while smaller leaves are 12–18 mm long. The leaves are glabrous above and green and pale below. Petioles are thin, almost as long as the blade, thick in texture, dorsal side pinkish in some situations, and the margin is whole or subundulates.

4) **Flowers:** The flowers of *B. diffusa* are tiny, with an ovoid, greenish lower part and a pink upper part. They are funnel-shaped, nearly sessile or short-stemmed, and measure 10 to 25 cm. They are arranged in small umbells on slender, long stalks with 4–10 corymbs, axillary, perianth tubes, small, acute bracteoles, and terminal panicles. The small, sessile umbels that form inside the blooms range in length from

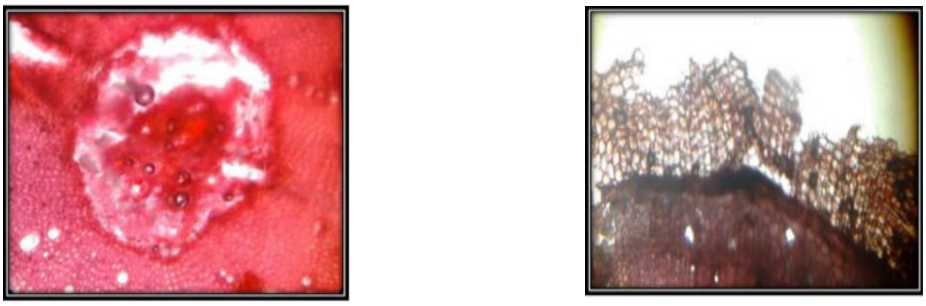
10 to 25 mm. The fruits are a single-seeded, spherical, glandular nut that is nearly 0.5 cm in size, with a clavate that is 6 mm long and clearly five ribbed. The entire *B. diffusa* plant has a bitter flavor and no scent. [9]

(A) **(B)**

Fig no.2 Morphology of various species of Punarnava A: Entire plant of T. portulacastrums (B) and B. verticillata (A); B: Roots of T. portulacastrum (B), B. verticillata (Centre) and B. diffusa (A)

2. Microscopy: -

1) **Stem**: The transverse section of the stem of *B. diffusa* shows the endodermis is indistinct; the pericycle is one to two layered and thick-walled, often with isolated fibers scattered throughout the ground tissue; the stele is made up of multiple small vascular bundles that are frequently joined in a ring; the cortex, which is 150–220 µm long, is composed of one to two layers of parenchyma; and there is interfascicular cambium. The epidermal layer contains uniseriate glandular trichomes and multicellular cells with an ellipsoidal head and nine to twelve stalked cells.
2) **Roots:** The cork of *B. diffusa* was well-developed and multilayered with four to five levels of tiny, compact, suberized cells sandwiched between eight to ten layers of massive, thin-walled cells. The cork was supported by four to five layers of parenchymatous cortical cells that included starch grains, brownish materials, and acicular calcium oxalate crystals. The discontinuous aberrant vascular bundles that developed of alternating and consecutive layers of xylem and phloem, lie beneath the cortex. Normally, the center's phloem breaks down to create a hollow (Fig. 2a, b).
3) **Leaves:** In a transverse section of a leaf of *Boerhaavia diffusa*, Numerous anomocytic stomata are visible on both sides, along with a few short hairs, palisade that is one layered, spongy parenchyma that is two to four layered, and microscopic air holes. Periodically, idioblasts with raphides cluster crystals of calcium oxalate with the orange-red resinous material found in mesophyll. Vein islet numbers 9–15, stomatal index 11–16, along with palisade ratio 3.5–6.5. [9]



(A) (B)

Fig. No. 2a: Detailed T. S. of B. diffusa root in 10x cork and cortex (B); vascular bundles (A)

(A) (B)

Fig. No. 2b: Detailed T. S. of B. diffusa root in 45x cork and cortex (B); vascular bundles (A)

3. ADULTERANTS AND SUBSTITUTES

- It is common for *Trianthema portulacastrum Linn.* to be mixed with Raktapunarnava (*B. diffusa Linn*.) in market samples. Punarnava and Varshabhu, two distinct Ayurvedic medications, originate from two plants and may have comparable medicinal effects. The two species' palisade ratios and stomatal indices are very distinct, with *Trianthema portulacastrum* having higher values. [10,11]
- It is also done to enhance the amount of bulk crude powder because it is hard to identify by appearance.
- In the Aizoaceae, *Trianthema portulacastrum L.* grows all year long, while *B. diffusa L.* is an annual herb that blooms during the wet season.
- *Trianthema portulacastrum L.* (Aizoaceae) has the alkaloid "trianthemine" ($C_{33}H_{46}O_6N_2$), which has an M.P. of 127° C, while *B. diffusa L.* contains the quinolizidione alkaloid "punarnavine" ($C_{17}H_{22}N_2O$), which has an M.P. of 236-237° C.
- Tibbi literature claims that a third variance with blue blossoms is less successful than the previously stated types (Debasmita Dutta Pramanick 2015).[11]

4. GEOGRAPHICAL DISTRUBUTION AND HABITATE

In the tropical, warm and subtropical regions of the planet, the 40 species that comprise the genus *Boerhaavia* are found. It is present in many Middle Eastern nations as well as the Malay Peninsula, the United States, the Pacific Islands, Australia, China, South Africa, Sudan, Egypt, Pakistan, Sri Lanka, and Ceylon. Six of the forty species of *Boerhaavia* that are known to exist—*B. hirsute, B. chinensis, B. rependa, B. erecta, B. diffusa, and B. rubicunda*—all occur in India. Native to India, *B. diffusa* is found there as well as in the drier parts of the country, such as the 2000-meter-high Himalayan region. During wet seasons, it spreads widely in swampy areas, dumping grounds, and ditches. On occasion, the plant is also cultivated. [12]

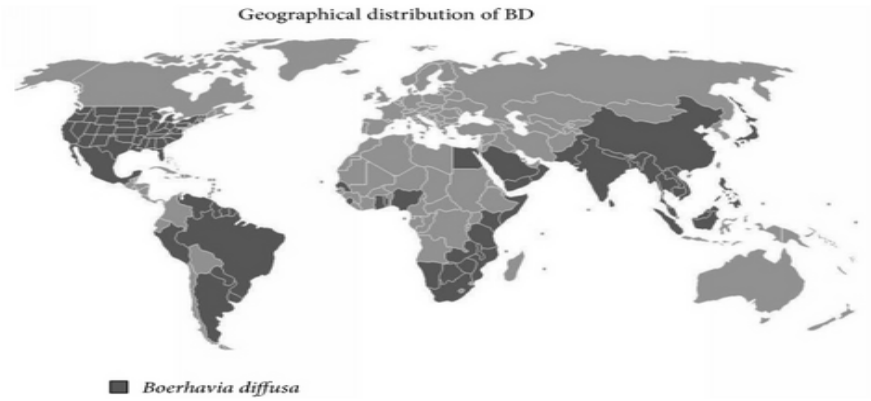


Fig. No 3. Geographical distribution of Boerhaavia diffusa

Cultivation:

B. diffusa is found over the majority of the tropics and subtropics, and it has also spread to some areas of the temperate zone. Prefers soil that drains well and a sunny spot. The plant thrives in a variety of soil types. Often found in drier regions' lawns, the plant is a weed of both farmed and uncultivated soil. Even though it is widespread, it is not a significant weed. The plant emerges from its roots after mechanical cultivation, although it takes comparatively little cultivation to reach its full potential.

Harvesting:

As early as four weeks after seeding, plants might begin to bloom. The plant can bloom and bear fruit throughout the year provided there is enough water available. [13]

5. PHYTOCONSTITUENTS

B. diffusa is a great source of nutritional nutrients with 15 amino acids (6 essential) in the entire plant and 14 amino acids (7 essential) in the roots. It also contains 38% saturated fatty acids, 6.3% isopalmitate acetate, behenic acid, and arachidic acid, and 44.80, 97.00, and 22.00 mg of vitamins C, B_3, and B_2 as well as 174.09 mg of calcium. [14] It also contains Punarnavine $C_{17}H_{22}N_2O$ M.P. 236–237°C, ursolic acid, punarnavoside, lirodendrin, boeravinone A–F, and hypoxanthine 9–Larabinofuranoside. Punarnava also contains

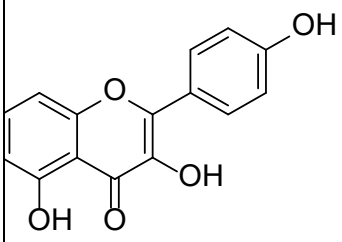
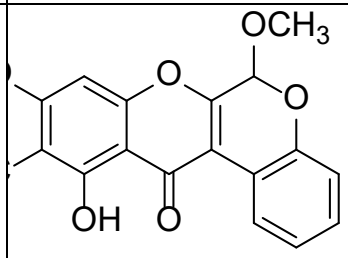
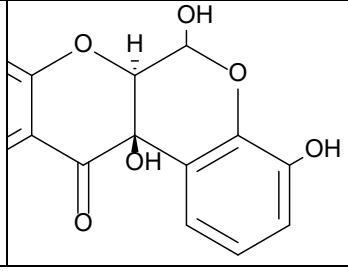
arachidic acid, β-Sitosterol, α-2-sitosterol, palmitic acid, tetracosanoic, hexacosonoic, stearic, urosilic acid, Hentriacontane, β-Ecdysone, triacontanol etc. [6] According to reports, the entire plant and its roots are used as food ingredients in some tribal communities. Alkaloids, phenolic and lignan glycosides, flavonoid glycosides, isoflavonoids (rotenoids), steroids (ecdysteroid), and other secondary metabolites are all present in BD. Boeravinone-B ($C_{17}H_{12}O_6$) is a rotenoid compound [3] with the IUPAC name 6,9,11-trihydroxy-10-methyl-6H-chromeno [3,4-b] chromen-12-one, having a molecular weight of 312.27 g mol^{-1}. It belongs to the isoflavones group of flavonoids, which belong to a larger group of phenolic compounds. , including the archetypal molecule rotenone, which. Inhibits the mitochondria (Figure 4). Within the mitochondria, it generates electrons. [14] Boeravinone-B is reported to have various pharmacological activities like anti-inflammatory , cardio protective , anti-cancer, anti-microbial, immunomodulatory, anti-oxidant, and other healing properties. Boeravinone-B is a multipotentbiomolecule [15] Boeravinone A-H, alkaloids (punarnavine), phytosterols (ß-sitosterol), rotenoids (punarnavoside), lignans (liriodendrin), syringaresinol, ursolic acid, hypothesis 9-L-arabinose, boerhaavic and boerhavin acid, D-isofuroxanthone-borhavine 3,3"5-trihydroxy-7-methoxyflavone, 4,7-dihydroxy3'-methylflavone, and 3,4-dimethoxyphenyl-1-O-beta-D-apiofuranosyl (1"--> 3" O-beta-D-gluco-pyranoside). In Figure 3, some of the chemical components found in *B. diffusa* are listed. [16]

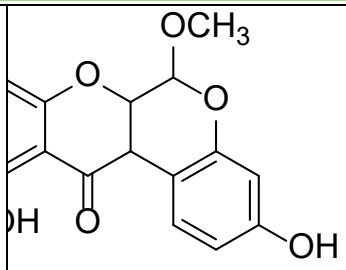
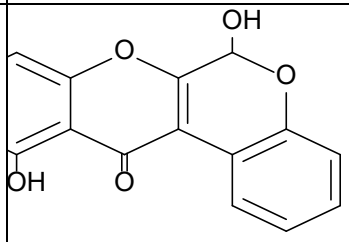
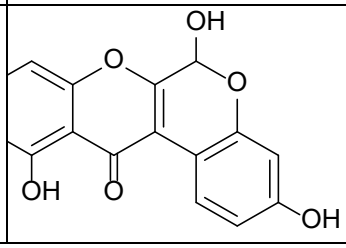
Table no. 5: Pharmacognostic evaluation test of *Boerhaavia diffusa*

Sr No.	Tests	Procedure	Result	Confirmation/
1	**Test for tannins**	About 1 ml of the filtrate extract was taken, and 3-5 drops of 10% lead acetate solution was added to it.	The gelatinous precipitate formation	Presence of tannin.[17]
2	**Test for saponin**	About 1 ml of the filtrate extract was added to 1 ml of distilled water and shaken well.	The formation of persistent froth was observed	Presence of saponin.[17]
3	**Test for flavonoids**	: About 1 ml of the extract was taken. Two ml of 2% NaOH solution and 3 to 4 drops of dilute HCl were added to it.	The colour initially turnedto an intense yellow colour with naoh solution and later became colourless.	Presence of flavonoids.[17]
4	**Test for terpenoids**	Six drops of chloroform were added to 1 ml of the filtrate and placed in the water bath for a few minutes. Then, 6 drops of concentrated sulphuric acid were added.	Reddish-brown interface	Presence of terpenoids [18]

5	**Test for phenolic groups**	About 1 ml of the filtrate extract was taken. A few drops of 5% ferric chloride solution were added.	Dark bluish-black appearance	Presence of phenolic compounds. [17]
6	**Test for reducing sugars**	About 1 ml of the extract was taken, and 2 drops of Fehling's solution A followed by Fehling's solution B were added and kept in the water bath for some time.	Red-orange precipitate	Presence of reducing sugars [19]
7	**Test for steroids**	About 1 ml of the extract was taken. One ml of chloroform and one ml of concentrated sulphuric acid were added	The appearance of upper red and lower yellow with green	Presence of steroids.[17]
8	**Test for alkaloids**	To about 1 ml of the extract, 3 to 4 drops of Dragendroff's reagent were added.	Reddish-brown precipitate	Presence of alkaloids [17]
9	**Test for carbonyl compounds**	About 1 ml of the filtrate extract was taken, and 3 to 4 drops of 2,4-Dinitrophenylhydrazine (DNPH) reagent were added	The formation of yellow crystals	Presence of carbonyl compounds [20]

Table no. 6*:* Structures of the Bioactive compound in *Boerhaavia diffusa* [2]

Sr No.	Name	Chemical constituent	Mode of action
1	**Eupalitin**		Antioxidant
2	**Boeravinone B**		Antihepatotoxicagent and Antistress agent.
3	**Boeravinone C**		Immunostimulant

4	**Boeravinone D**		Immunostimulant
5	**Coccineone B**		Spasmolytic effect
6	**Coccineone E**		Spasmolytic effect

TRADITIONAL MEDICAL USES OF PUNARNAVA

The plant's numerous pharmacological and biological properties, including [21] have made it extremely significant in the study of phytochemistry. In Ayurvedic herbal medicine, Punarnava's leaves, root, aerial parts, or entire plant have all been utilized to treat a variety of ailments. Gonorrhea, the many forms of internal inflammation, dyspepsia, oedema, jaundice, menstruation problems, anemia, liver, gallbladder, andkidney disorders, spleen enlargement, abdominal pain, abdominal tumors, and cancer are the principal conditions that the root is used to treat. It can also be used as a laxative, menstruation promoter, digestive aid, and diuretic. The powdered root is used to treat eye disorders in conjunction with Mamira (*Thalictrum foliolosum*). It treats night blindness and corneal ulcers and helps males become more virulent again. It is used by tribal societies to expedite childbirth. *B. diffusa* leaf juice is used as a lotion in ophthalmic preparation. It is also administered. [6]

6. PHARMACOLOGICAL ACTIVITIES

1. Anti-bacterial activity

B.diffusa leaves have potent antibacterial activity against various Gram-negative and Gram-positive bacteria which might be due to the phytochemicals present in the leaves Ethanol extract showed inhibitory an effect on gram-positive bacteria such as *S. aureus, Bacillus subtilis, Streptococcus faecalis,* and *Micrococcus luteus* and all Gram-negative bacteria selected for the present study .Where Methanol extract showed inhibitory effect against all gram-positive bacteria except M. luteus and gram-negative bacteria like *K. pneumoniae, P.vulgaris, S.marcescens and S. flexneri Prosopis cineraria (Linn.)* drupe root bark extracts were assessed using the agar diffusion method. According to studies, water extract and

methanol extracts of*Hedyotis diffusa*have strong antibacterial activity against a variety of human diseases, including Gram-positive bacteria like *Staphylococcus aureus. Pneumococcal bacteria, Streptococcus aureus, Bacillus subtilis, Streptococcus faecalis, Bacterium luteus, Klebsiella pneumoniae, and Smarcescens, S. flexner, Bacillus cereus, Bacillus subtilis, Escherichia coli, Klebsiella, Proteus mirabilis, Pseudomonas aeruginosa, Salmonella typhi, and Shigella* are examples of gram-negative bacteria. *Yersinia enterocolitica with Staphylococcus aureus* at a 50-um concentration. [22]

2. Antiviral activity

Basal proteins found in *B. diffusa* roots exhibit strong virus-inhibiting properties against plant viruses. This plant's root extract gives the vulnerable host plant a strong systemic resistance. We discovered in the study that BD-SRIP causes resistance to TMV infection. [23]

3. Anticonvulsant activity

According to the study,the crude methanolic extract of *B. diffusa* and a liriodendrin-rich fraction demonstrated dose-dependent protection against PTZ-induced convulsions. [23]

4. Immunomodulatory effects

The impact of the alkaloidal fraction of *B. diffusa* on humoral and cellular processes in mice was investigated. In mice, SRBC-induced delayed hypersensitivity reactions are considerably reduced when taken orally. But the inhibition only occurred during post-immunization medication treatment; no effect was seen during pre-immunization drug treatment. [23]

5. Antistress and adaptogenic activity

By considerably extending the swim time and lowering the increased plasma cortisol, blood glucose and WBC, the extract enhanced stress tolerance. Carbon clearance and the delayed hypersensitivity test were used to assess immunomodulatory efficacy. The reticuloendothelial system was stimulated by the extract, as evidenced by the notable increase in carbon clearance. Additionally, the extract increased the mice's DTH response to SRBC. [23]

6. Hypoglycemic activity

An investigation into the effects of oral administration of an aq. solution of *B. diffusa* leaf extract on both normal and alloxan-induced diabetic rats indicated that both groups' plasma insulin levels significantly increased and their blood glucose levels significantly decreased. Compared to glibenclamide, impact was more noticeable. [6]

In streptozotocin, chloroform extract of *B. diffusa* leaves induced a dose-dependent drop in blood glucose. After 48 hours of treatment, the number of MCF-7 cells in the G_0-G_1 fraction raised significantly from 69.1% to 75.8%, while the number of cells in all other phases reduced reciprocally, indicating cell cycle detainment at the G_0-G_1 phase. The alcoholic

extract of the aerial part of *B. diffusa* has been shown to have antidiabetic activity in rats. This study proved that *B. diffusa* alcoholic extracts have good antidiabetic effect in rats. The whole plant of *Boerhaavia erecta L.* was shown to have antidiabetic and antihyperlipidemic properties in Wistar rats with type 2 diabetes induced by STZ by *Mohan Nisha et al.* (2018). *Krishna Murti and colleagues* (2011) also assessed. [6]

7. Analgesic and Anti-Inflammatory Activity

B. diffusa, often known as "Martinican folk medicine," is used for its anti-inflammatory and analgesic properties. An ethanolic extract of *B. diffusa* leaves was evaluated for its anti-inflammatory qualities in Wistar rats by Santhosh Kumar Muthu et al. (2014). Both in vitro and in vivo, the leaves of *B. diffusa* can demonstrate anti-inflammatory qualities, substantiating conventional wisdom and providing a scientific basis for anti-inflammatory actions in inflammatory diseases. [24] An Ayurvedic compound of *B. diffusa* called Punarnavasava has anti-inflammatory, analgesic, antipyretic, and antiulcer qualities, according to Manisha Gharate et al. (2013). Mudgal examined the anti-inflammatory effects of a water-insoluble extract of *B. diffusa* in mice. Leaf and flower extracts have been shown to have anti-inflammatory properties, but they only reduce rat paw edema by 55.78%. [11,25]

8. Diuretic Activity

An aqueous extract of the roots of the plant *B. diffusa* was tested for diuretic action in albino rats, and its efficacy was contrasted with that of the commonly used diuretic furosemide. The maximum "diuretic dose-response relationship" for the *B. diffusa* extract was found to be 300 mg/kg (oral). Additionally, the test drug showed a maximal increase in electrolyte excretion and urine volume [11]*B. diffusa Linn*. increased urination, decreased oxalate excretion, probably by interfering with metabolism, improved the removal of nitrogenous waste products, and sped up the clearance of accumulated crystal deposits, all of which improved renal function. Together, these activities provide *B. diffusa Linn* its anti-urolithiatic qualities. [5]

9. Antioxidant activity

The first investigation of volatile components of a commonly used medicinal plant, *B. diffusa*, utilizing an HS–SPME–GC–MS approach straight into the headspace of the aqueous extract of the roots and leaves, showed that the leaves had greater antioxidant activity than the roots. Further information on the chemistry and biological potential of this species is provided by the first description of the organic acids (HPLC–UV) profile, in vitro antioxidant, and anti-acetylcholinesterase activities, in addition to phenolics (as assessed by HPLC–DAD). [12] Using hydrogen peroxide scavenging activity and ferric reducing power, ethanol and methanol extracts were produced and examined for in-vitro antioxidant properties. Standard antioxidants such as ascorbic acid was used to compare the activity. Strong antioxidant activity has been shown by both extracts in both techniques. Ethanolic extract showed superior antioxidant activity in both activities as compared with methanolic extract.

10. Anti-ulcer activity

The *Boerhaavia chinensis* aqueous leaf extract shown significant antiulcer activity when compared to the popular drug Rabeprazole. The index of ulcers was reduced significantly by the aqueous extract, and the percentage protection was enhanced in a dose-dependent manner. There were antacid qualities in the plant extract from *B. diffusa.* [26]

11. Nephroprotective activity

B. diffusa was investigated in an animal model of nephrotoxicity caused by lead acetate. Because lead acetate is nephrotoxic, healing from lead acetate-induced nephritic damage is accelerated by *B. diffusa* extract treatment. [27]

12. Anti fibrinolytic activity

The study looks into how BD root extracts, anti-inflammatory medications, and anti-fibrinolytic medications affect endometrial histology in menstruating monkeys with IUDs. The data indicate that stromal edema, inflammation, and tortuosity are declining in the arterial lumen, but fibrin and platelet deposition are increasing. [28]

13. Hepatoprotective activity

In rats and mice, oral *B. diffusa* alcohol extract has shown hepatoprotective efficacy against liver damage induced by carbon tetrachloride. When albino rats were given CCl_4 to cause hepatotoxicity, the plant extract of *B. diffusa* showed a hepatoprotective effect. [29] Rats suffering from carbon tetrachloride (CCl_4)-induced rat liver poisoning were tested for hepatoprotective properties using an alcoholic extract of the stem and leaves of *B. diffusa*. CCl_4 (in olive oil) was administered intraperitoneally to Albino rats of both sexes, causing hepatotoxicity. The hepatoprotective effects of the extracts were tested using glutamate pyruvate transaminase (SGPT), serum glutamate oxidase transaminase (SGOT), serum alkaline phosphatase (SALP), and the total direct serum bilirubin. It was found that the extract of alcohol. [30,31,32]

14. Anticancer activity

There may be anti-cancer qualities in boerhaavia. The ability of *B. diffusa* to prevent cancer was evaluated in Swiss albino male mice (6-7 weeks old) that had skin papillomas from 7,12-dimethylbenzanthracene (DMBA). This relates to the hypothesis that the plant extract postponed carcinogenesis by either enhancing the cleansing process and limiting the encouragement of movements in the mouse's skin through an antioxidant pathway, or by stopping precursors from turning into active carcinogens. Punarnavine, an alkaloid produced from *B. diffusa*, improved the immune response in mice against invasion and metastases of B16F-10 melanoma cells. [33] The development of the HeLa cell line was slowed down in the S-phase, and there were indications of *B. diffusa* cytotoxicity. The study found that the crude ethanolic extracts of the root and leaf demonstrated 30% and 40% cell death, respectively, while the alkaloidal fraction caused 40% cell death Additionally, by lowering skin-promoting events via an antioxidant mechanism, it prevents the formation of cancer cells in rats with DMBA-induced cancer carcinogenesis. The life expectancy of mice

with metastatic tumors that received a dosage of punarnavine was considerably lower than that of the control group.In a number of studies, extracts from various plant sections have demonstrated the presence of possible anticancer chemicals (both in vitro and in vivo). Manu and his associates investigated the alkaloid punarnavine, which was isolated from the roots, for its antimetastatic qualities. [34] So as a chemotherapeutic medication, BD provides a multi-target approach. It has anticancer, radioprotective, and immunomodulatory properties. As a result, it could be considered a beneficial supplement to cancer treatment.

7. Conclusion

B. diffusa (Punarnava) remains a cornerstone of traditional medicine, owing to its diverse array of pharmacologically active constituents and its broad spectrum of therapeutic effects. Comprehensive phytochemical analyses have highlighted the presence of bioactive alkaloids, flavonoids, phenolics, and steroids, which contribute to its hepatoprotective, anti-inflammatory, diuretic, antioxidant, and anticancer properties. Rigorous pharmacognostic characterization has further reinforced its significance in ensuring authenticity and quality assurance of medicinal preparations. Given its extensive pharmacological potential and ethnomedical significance, Punarnava offers valuable opportunities for the development of novel therapeutic agents. Future research should prioritize detailed mechanistic studies, bioavailability enhancement, and robust clinical validations to facilitate its integration into evidence-based medical practices.

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