

BOERHAVIA DIFFUSA: A POLYPHARMACOLOGICAL HERB BRIDGING ETHNOMEDICINE AND MODERN THERAPEUTICS

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ABSTRACT

As per WHO reports, around 70–80% of people residing in developing nations rely upon herbal medicines as a source for their health care needs. There are countless medicinal plants that have been used throughout the world, but one of them is *Boerhavia diffusa* L., which belongs to family Nyctaginaceae. Its common name is Punarnava, and it is considered as a medicinal plant. *Boerhavia* is named after Dutch botanist and physician Hermann Boerhaave. The meaning of Punarnava in Sanskrit is "renewed again" (Punar=again, Nava=new).

Among the total number of about 40 species of *Boerhaavia*, six species are found in India, that include *Boerhaavia diffusa*, *B. erecta*, *B. repanda*, *B. chinensis*, *B. hirsuta*, and *B. rubicunda*. *Boerhaavia diffusa* is referred to as Punarnava, and it grows in two types: namely, Rakta Punarnava (red type) and Shweta Punarnava (white type). It holds great medicinal importance due to its high content of phytochemicals and nutritional constituents. It is composed of various bioactive substances, for instance, 15 amino acids in the whole plant (six being essential amino acids) and 14 amino acids in the roots (seven of them being essential). Furthermore, it includes fatty acids and their derivatives such as isopalmitate acetate, behenic acid, arachidic acid (6.3%) along with other saturated fatty acids (around 38%).

The use of medicinal herbs is known since antiquity and is practiced for disease prevention and treatment. A lot of knowledge regarding medicinal herbs was gained from indigenous communities. *Boerhaavia diffusa* (Punarnava) is a medicinal herb and has gained popularity in the traditional medical system for the treatment of many chronic and metabolic diseases. It contains a good number of secondary metabolites such as alkaloids (punarnavine), flavonoids, rotenoids, lignans, steroids, and glycosides. It is used in Ayurveda, Unani, and Siddha for the management of its diuretic, nephroprotective, cardioprotective, hepatoprotective, anti-inflammatory, immunomodulatory, antimicrobial, antioxidant, and anticancer inflammation. Another point covered by the review is the present use of *B. diffusa* and its presence in some of the commercially sold medicinal products. The increasing significance of the herb in healthcare practice today has been emphasized.

KEYWORDS: *Boerhavia diffusa*, Punarnava, current market formulation and application pharmacological activity, phytochemistry, nutritional or isolated compound, ethnobotany, and plant parts value (PPV), BD.

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1. INTRODUCTION

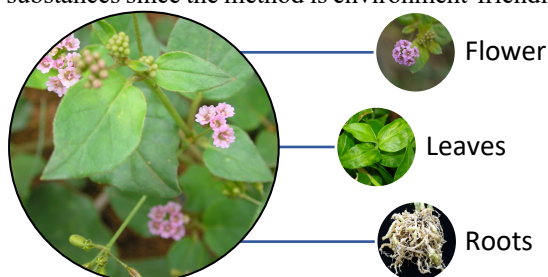
The Indian community, characterized by its vibrant social culture and deep old-style medicine classification system, has always appreciated the benefits that come from natural means of treatment (Patel N et al., 2025). According to the World Health Organisation, about 70–80 percent of newly developed populations rely heavily on plant-based medicine for the management of various diseases. There are more than 80,000 varieties of plants that are known to be utilized worldwide for their medicinal value. Plants that exist in nature and are considered underutilized have been said to have multi-utilization prospects for use in the pharmaceutical and nutraceutical industries due to the high nutritional and therapeutic value that is possessed by them without having any side effects. From among the many herbs utilized in the ancient practice of Ayurvedic medicine, one herb that holds an important position is *Boerhaavia diffusa* (BD), also called as *Punarnava*. It belongs to the botanical family of *Nyctaginaceae* and can be found all over tropical and subtropical parts of the globe. Because of its wide-ranging medicinal values, *Boerhaavia diffusa* is commonly used for treating ailments. BD occurs in tropical and subtropical areas in the continents of Asia, Africa, and elsewhere in the world. The plant has an ability to adapt to different conditions and can grow in several types of land-based environments. It is usually abundant in grasslands, wastelands, roadside verges, agricultural fields, uncultivated areas, and forested areas. Being quite resistant in nature, the plant is able to adjust itself in varying environmental conditions; hence, it is widespread and readily available in nature. The *Boerhaavia diffusa* plant has been researched extensively because of the wide range of phytochemicals that it has and its use in treating many health problems (Forte AJ et al., 2025). Being a tiny plant, it has an interesting background when it comes to medical significance, and it is highly valued in the traditional medicine systems of India. This plant has been extensively utilized in the past by humans because of its varied medicinal uses and benefits in Ayurvedic medicine as well as folk medicine for the treatment of diseases (Ahire SA et al., 2022). The genus name, *Boerhaavia*, has been named after the 18th-century Dutch physician, Hermann Boerhaave. Due to its ability to regenerate itself during the rainy season with the help of perennial roots in case all above-ground tissues get dried up in the summer season, *Boerhaavia* is also referred to as “*Punarnava*,” where *Punar* means again, *nava* means new. (Patil & Bhalsing., 2016) As such, it is considered a rejuvenator in Ayurveda. To date, the practitioners of Ayurveda follow the convention and use BD in treatments for conditions from liver problems to arthritis, breathing problems, and many others. (Sravani T et al., 2024).

Nevertheless, apart from being used in Ayurveda, scientific research has shown that the effectiveness of *Boerhaavia diffusa* is scientifically proven and does not depend on folklore (Wendlocha et al., 2024). Genus *Boerhaavia* consists of approximately 40 species which are widespread in tropical and subtropical zones around the globe; many species grow in South and North America. An increased interest in medicinal herbs and plants can be seen through their growing commercial value, since the global market of herbs and medicinal plants amounts to more than \$100 billion per year (Bairwa K et al., 2014).

The study of chemical components of plants via phytochemistry and pharmacology is an essential basis for finding new drug targets from natural sources. The discovery of new biologically active substances with enhanced efficiency and reduced toxicity will always be the main aim of natural products research. Natural products will keep their role as an essential source of medicinal agents, and their biologically active components will keep attracting much attention for disease prevention and therapy. Therefore, medicinal plants will be a good source of lead compounds for drug discovery (Pal and Rakshit, 2021).

Several scientific researches have been undertaken in order to evaluate the phytochemistry of *Boerhaavia diffusa*, confirming that a rich array of biologically active ingredients has been identified in this plant. The complexity of the chemical structure of *Boerhaavia diffusa* includes the presence of such substances as alkaloids, flavonoids, rotenoids, lignans, steroids, and glycosides (Mahesh AR et al., 2012). BD contains several bioactive substances in its thin leaves, roots, and stems, which confer its medicinal properties (Mustafa M et al., 2024). Alkaloids, flavonoids, phenolics, glycosides, saponins, steroids, and terpenoids are among the biochemical substances identified in BD, each playing a role in making BD healthy for people (Apu AS et al., 2012). It is the presence of these biochemical components within BD that makes it a natural remedy for different diseases (Pant & Husen, 2025). Alkaloids and flavonoids are well-known due to their anti-inflammatory activity. That is why BD can be considered a powerful medicine in the treatment of diseases caused by inflammatory processes (for instance, arthritis and asthma). Besides the pharmacological actions typical for herbal medicine, BD also has many others (Khoza BS et al., 2016). A variety of studies conducted by researchers prove the effectiveness of BD's influence on people. (Yarmolinsky L et al., 2012). BD can affect the human organism in different ways. Many scientists have been conducting investigations related to the study of plants' phytochemical composition. This is in line with the knowledge

shared by traditional medicine practitioners who are well aware of the medicinal importance of BD (Kumar PV et al., 2014). The use of BD to treat cancer is one of the most studied uses of BD. Scientific research has proven that the extracts from the plant are effective inhibitors of cancer cell growth as well as angiogenesis in cancer patients (Nguyen HH et al., 2022). These abilities, coupled with BD's antioxidant activities, indicate its possible use as an alternative medicine against cancer (Olaleye MT et al., 2010). It is also considered suitable for treating medical conditions characterized by excessive inflammation or immune response dysfunctions because of its anti-inflammatory and immunomodulatory actions. There has been research into the medicinal uses of this plant regarding the diuretic property of this plant (Sreeja S. 2009). The herb has been known for many years for being effective in the treatment of kidney and urinary ailments. Its diuretic nature has been confirmed scientifically (Shimu MS et al., 2025). This aspect is specifically important in the reduction of swelling, thus making BD useful in cases such as edema and congestive heart failure. Recently, the use of BD for therapy has been maximized by the concept of green nanotechnology, a technology characterized by scientific innovation and environmental conservation (Patel N et al., 2025). The application of green nanotechnology in the fields of pharmacy and medicine has been very successful in maximizing medicinal products (Kulkarni AS et al., 2025). The technology involves developing biocompatible nano-materials that are not only efficacious but also environmentally friendly, hence eliminating the utilization of dangerous chemicals during manufacture (ANILKUMAR K, 2024). The most notable advancement in this technological domain is the adoption of BD within nano carriers, which refers to artificially created minute substances used in transporting therapeutic molecules directly to the required biological site (Oliveira da Silva L et al., 2023). The use of such nano carriers ensures that there is an effective way of administering medicinal substances since the method is environment-friendly



1.1 BOTANICAL DESCRIPTION

1.1.1 Taxonomical Classification Boerhavia diffusa

L. is classified under the family Nyctaginaceae, which has medicinal uses. The complete taxonomical classification is given in Table 1.

(Bansal M. et al., 2025). For example, in the case of cancers, where the conventional treatments such as chemotherapy may cause damage not only to cancerous cells but also to healthy cells, BD nano-carriers can be used to deliver anti-cancer medicines selectively at the location of the tumor without causing any side effects, making the therapy much more effective (Kulkarni AS et al., 2025). The nano-carriers are non-toxic and are biodegradable, thus posing no harm to the environment or patients. Apart from cancers, the use of BD in green nanotechnology is also showing promise in treating wounds and in antimicrobial therapies (ANILKUMAR K, 2024). The antibiotic properties of the plant in combination with nano-carriers hold the potential to improve the treatment of infection and wounds (Oliveira da Silva L et al., 2023). BD's ingredients become readily available owing to its nanosized structure, which promotes faster healing. Incorporation of green nanotechnology in the field of cosmetics is yet another advantage of BD. The growing popularity of green skin care products that are chemical-free has created high demand for the use of green nanotechnology (Sreeja S, 2009). It occurs in India, but it is found in areas where there is less water, and its height can reach 2000 m in the Himalayan region. Since ancient times, Punarnava has occupied an important place amongst medicinal plants of India (SM S et al., 2022). This medicinal plant is recorded in ancient Indian literature to treat several diseases (Gayathri Devi S, 2023). Some recent studies have also proved its medicinal values to be effective in treating inflammatory diseases, liver disorders, and kidney problems (Rembiałkowska N et al., 2025). Punarnava is one of the well-known ethnomedicinal plants of Ayurvedic folklore." Alkaloids such as punarnavine and isomers of boeravinone are some of the compounds isolated from Punarnava (Febriyanti RM et al., 2025). The investigation into the chemical components of the plant will provide a basis for the discovery of the novel lead molecule, thus favouring the natural product drug discovery process. (Gupta S. et al., 2025).

Table 1. Taxonomical Classification Boerhavia diffusa L.

Seri al no.	Parameter	Details	Reference
01	Kingdom	Plante	(Yadav et, al., 2024)
02	Subkingd om	Tracheobion ta	(Mishra S.et al., 2014)
03	Division	Magnolioph yte	(ANILKUMAR K., 2024)

04	Super division	Spermatophyta	(Ravichandran AP et al., 2020)
05	Class	Magnoliopsida	(Nandi and Ghosh, 2016)
06	Subclass	Caryophyllidae	(Pandey S. 2025)
07	Order	Caryophyllales	(Mochanla and Aluri. 2021)
08	Family	Nyctaginaceae	(Yadav et al., 2024)
09	Genous	Boerhavia	(Mishra S. et al., 2014)
10	Species	B. diffusa	(Yadav et al., 2024)
11	Scientific name	Boerhavia diffusa Linn	(Ravichandran AP et al., 2020)
12	Family name	Hog Weed, horse purslane	(ANILKUMAR K., 2024)
13	Useful parts	Roots, leaves, and seeds, steam	(Mishra S. et al., 2014)

B. diffusa has been known not just for its medicinal properties but also because of its nutritive importance. From phytochemical studies, it has been found that the whole plant has about 15 amino acids, of which 6 are essential amino acids, while the roots have 14 amino acids, 7 of which are essential amino acids. In addition, B. diffusa is also a rich source of certain important fatty acids like isopalmitate acetate, behenic acid, arachidic acid, and saturated fatty acids. Additionally, the roots contain vitamin C, B2, and B3, as well as calcium. The nutritional content of BD means that both the roots and plant serve as dietary components for various tribal societies.

A wide range of phytochemicals can be found in Boerhaavia diffusa that includes secondary metabolites like flavonoid glycosides, rotenoids (isoflavonoids), alkaloids, phenols, lignan glycosides, and steroidal components like ecdysteroids. This rich chemical composition makes it possible to use the medicinal herb for various pharmacological and therapeutic purposes. The secondary metabolites are the agents responsible for the pharmacological actions displayed by the herb. Several metabolites have been extracted and analyzed from different parts of BD, indicating structural variation and biological importance. Among various metabolites, isoflavonoids, especially rotenoid-type metabolites termed boeravinones, are interesting compounds having a

Table-3

1.2.1 Chemical Constituents of Boerhaavia Diffusa

Table-2

1.1.2 Vernacular Names of Boerhavia diffusa L.

Seria l no.	Languag e	Different Name	Reference
01	Sanskrit	Kahtilla, Sophagni, Varshabhu, Punarnava, Raktakanda	(Mishra S. et al., 2014)
02	Hindi	Gadahpurna, Lalpunarnava, Snathikari, Beshakapori	(Yadav et al., 2024)
03	English	Horse purslane, Spreeding hogWeed	(Nandi and Ghosh, 2016)
04	Assames e	Ranga Punarnabha	(Ravichandran AP et al., 2020)
05	Gujrati	Dholisaturdi, Motosatodo	(Pandey S. 2025)

1.2 CHEMISTRY

broad range of biological properties. The extensive research on the phytochemistry of Boerhavia diffusa resulted in the identification of many boeravinones exhibiting possible biological activities such as antioxidants, anti-inflammatory agents, antimicrobials, and anticancer agents. In addition, advancements in techniques of phytochemistry led to the development of an accurate analytical technique for quantitative determination of boeravinones from Boerhavia diffusa (Bansal M et al., 2025).

The rotenoids represent a distinct group of isoflavonoid derivatives wherein rotenone is regarded as the prototype structure. It was found that rotenone interferes with the mitochondrial electron transport system and disrupts the ATP formation pathway through Complex I inhibition. Several investigations confirmed that the toxicity of rotenoids is attributed to the presence of a prenyl-based ring and dimethoxy substituents on ring A of the molecule. The rotenoids obtained from Boerhavia diffusa (BD), on the other hand, are believed to be non-toxic because the absence of the isoprenoid residue on ring D or the presence of monosubstituted or unsubstituted ring A disqualifies them from being toxic rotenoids. As far as rotenoids in BD are concerned, boeravinone B is a very important chemical marker. Genuine specimens of Boerhavia diffusa should contain no less than 0.005% of boeravinone B.

antihypertensive activity by animal model (Thajudeen KY *et al.*, 2022).

In this study, *Boerhavia diffusa* is well known as a medicinal plant rich in Rotenoids, or isoflavonoid compounds. The roots of the plant are collected, washed, or shade-dried and converted to powder form. The powder is extracted in maceration at room temperature with a methanol, ethanol, or hydro-alcoholic mixture. After extraction, the solvent is evaporated under reduced pressure, thereby concentrating the extract to form a crude fraction that is rich in bioactive

The author of this study is collecting leaves of *Boerhavia diffusa* that were shade-dried and made into powder. 2kg of powder was extracted by percolation four times with 5liter ethanol at room temperature. The ethanolic extract was filtered and triturated

For the first time, Kaempferol obtained from leaves and roots of *Boerhavia diffusa* has been analyzed by reverse phase HPLC along with a photodiode array detector and electrospray ionization mass spectrometry. Many phytochemical constituents have been identified from the plant extract, such as

The author investigated Fresh boerhavia diffusa leaves are collected, washed, and then made into a powder. Then, the powder was subjected to Soxhlet extraction for 24-72 hours. The extract was filtered, and a nonpolar crude extract was obtained. The non-polar extract was treated with 5-10% alcoholic KOH

2. ETHNOMEDICINAL PROPERTIES

Out of the 40 known species of the genus *Boerhaavia*, there are six species of *Boerhaavia* recorded from India, including *Boerhaavia diffusa*, *Boerhaavia erecta*, *Boerhaavia repanda*, *Boerhaavia chinensis*, *Boerhaavia hirsuta*, and *Boerhaavia rubicunda*. However, among these species, *Boerhaavia diffusa* is the most commonly found and valuable species. It is widely prevalent in all warmer



As a part of the systematic study carried out at the Department of Botany, Lucknow University, Lucknow, Uttar Pradesh, India, nearly three decades

secondary metabolites. The crude extract is a mixture of several phytoconstituents, which include flavonoids, alkaloids, phenolics, and rotenoids like Boeravinone B. These phytoconstituents are thought to be behind most of the pharmacological actions of *Boerhaavia diffusa*. These compounds possess typical pharmacological activities of antioxidants, including anti-inflammatory, antioxidant, anticancer, and anti-aging. (Piao X *et al.*, 2023)

with Hexane (to remove non-polar lipids), and refrigerated for 2 days. A yellow crystalline solid was separated; this solid was recrystallized from methanol to obtain pure *quercetin-3-o-α-D-ramnoside*. (Sharma K, Sahai M. 2017)

flavanols and phenolic compounds, including kaempferol, quercetin, caffeoytartric acid. Kaempferol can be used as a medicinal agent due to its potential anti-oxidant and anti-cancer possessions, with the help of MCSF, GM-CSF, AND HCT116 cell lines (De S *et al.*, 2023)

for 1-2 hours. Then, water and chloroform were added to the mixture and subjected to column chromatography, leading to the formation of white crystals of β -Sitosterol. β -Sitosterol is a plant steroid that acts as an anti-inflammatory, antioxidant, and anti-cancer agent. (Oseni TE *et al.*, 2024).

parts of India and grows up to an elevation of about 2,000 meters in the Himalayan region. This species is an annual, sprawling herb and grows abundantly in wasteland, along roadsides, ditches, marshy land, and other moist areas, especially in the monsoon season. Due to its medicinal properties and versatility, *B. diffusa* is also grown to approximately degree in West Bengal (Mahesh AR *et al.*, 2012).

ago on the antiviral effects of *Boerhaavia diffusa* extracts prepared from various parts of the plants, thousands of plants of various taxonomic groups

have been screened against a wide variety of phytopathogenic viruses. This research study has made considerable contributions to the discovery of new medicinal plants possessing significant antiviral activities, with special emphasis on the antiviral properties of *B. diffusa* extracts (Awasthi LP et al., 2006).

Boerhaavia erecta is an extensive species belonging to the Nyctaginaceae family, which was previously indigenous to the United States, Mexico, Central America, and southwestern parts of South America. As a result of its exceptional adaptability to varying climatic environments, the species has become naturalized around the globe, being now prevalent in most tropical and subtropical zones. The extensive geographical range of *Boerhaavia erecta* demonstrates its adaptability to numerous habitats (Mochanla & Aluri, 2021).

Boerhaavia diffusa is lengthily rummage-sale in Ayurveda as well as in Unani and acts as one of the key ingredients in many traditional formulations. This herb has been used traditionally for treating various ailments like anemia, gastric issues, cough, cold, and breathing problems. The roots of *Boerhaavia diffusa* are known for their diuretic, laxative, and expectorant actions, whereas the leaves have been traditionally used to improve appetite and detoxification. Seeds of this herb act as a digestive aid as well as a health tonic (Moulick SP et al., 2025).

For instance, in Iran, *Boerhaavia diffusa* has been applied to treat diseases such as edema, gonorrhea, hives, flatulence, jaundice, nephritis, arthritis, and lumbago. In addition, it has been appreciated due to its medicinal uses as an appetizer, diuretic, and an expectorant (Kaur J et al., 2020).

Recent exploration has sparked interest in understanding its possible involvement in cell regeneration. Cell regeneration, a fundamental biological process, plays a pivotal role in maintaining tissue integrity, repair, and overall health. Several factors, including oxidative stress, inflammation, and cellular damage, can impact the regenerative capacity of cells. The quest for natural agents capable of influencing cell regeneration has led researchers to investigate the properties of *Punarnava*. (Patil NS et al., 2023).

Boerhaavia diffusa has found its applications for medicinal as well as nutritive reasons in a number of Indian states. The tribal people residing in Purulia in

the state of West Bengal have been using the herb as a vegetable dish whereas the leaves are widely consumed in the state of Assam. Furthermore, besides being used as a food item, the roots of this species have also been found useful by the natives of the Garhwal Himalayas (Uttarakhand) in treating ailments like piles (Awasthi LP et al., 2006)

Boerhaavia diffusa in Brazil is known to have medicinal properties for the treatment of multiple diseases either through its whole plant form or as an extract. Some of the conditions that are treated with this plant include albuminuria, beri-beri, cystitis, edema, gallstones, gonorrhea, hepatitis, high blood pressure, jaundice, nephritis, and kidney diseases. This herb can also be used to treat urinary diseases, urinary retention, spleen enlargement, and inflammation in addition to being beneficial for kidney and liver diseases (Chaudhary G et al., 2011). *B. diffusa* has been largely used in the systems of traditional Indian medicine for the cure of many diseases. Its usage has been reported in cases of abdominal pain, anemia, ascites, asthma, constipation, cough, dyspepsia, edema, fever, jaundice, rheumatism, menstrual disturbances, and urinary ailments. The plant possesses some valuable properties for the treatment of diseases of kidneys and liver, kidney failure, kidney stones, cardiac problems, inflammatory conditions, hemorrhoids, intestinal parasites, and enlargement of the spleen. Moreover, *B. diffusa* has been widely used in the treatment of blood purification, promotion of lactation, diuretic purposes, and expectoration (Nayak P et al., 2016).

These leaves which are pounded are used as topical applications to treat skin disorders, injuries and insect bites. It is said that taking this plant as tea or decoction thrice within the seasons will strengthen the plant's life. This plant is used as an eye drop for curing conjunctivitis and night blindness in rural India. The seeds of *Boerhaavia diffusa* have been long appreciated for their broad spectrum of medicinal uses. These are taken as a tonic, expectorant, and carminative to maintain overall wellness. The use of seeds in the treatment of various ailments like lumbago, scabies, scorpion bite, and muscle pains can also be seen in traditional medicine. Moreover, the blood purifying nature of these seeds makes them even more significant (Yadav A, et al., 2024).

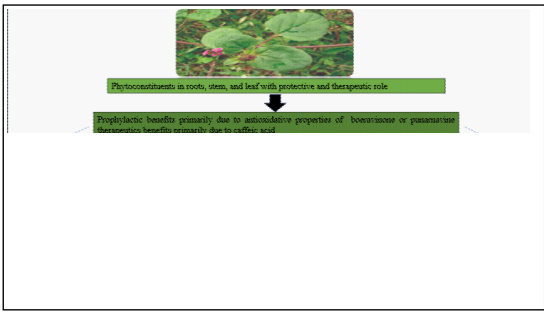


Figure 10: Ethnomedicinal properties of *B. diffusa*

Table-4

2.1 Ethnomedicinal Property of *Boerhavia diffusa*

Sr. No.	Ailment treated	Mode of preparation/Method of treatment	Locality/communities in India	Reference
01	ROOTS			
a	Stomach disorder	Paste given on an empty stomach	Among the tribal communities of Bhiwani district, Haryana, <i>Boerhaavia diffusa</i> is traditionally used for the treatment of various ailments, particularly digestive disorders, urinary problems, and general weakness.	(Singh et, al.,2015)
		Decoction	The tribals of Hukumpeta Mandal, Alluri Sitarama Raju district, Andhra Pradesh	(Varma et al.,2023)
		Juice	the natives of Jorbeer Conservation Reserve, Bikaner, Rajasthan;	(Devraan Jain 2024)

b	Kidney disorder	Powder	The Irular tribals of Nilgiri district, Tamil Nadu, have been using <i>Boerhaavia diffusa</i> as a traditional medicinal plant against different ailments and diseases	(Panner Selvam .et, al.,2017)
		Paste	Traditional practitioners in Tripura	(Roy and Datta,2019)
		Decoction	Local inhabitants of Kapurthala, Punjab	(Kaur. Et, al, 2020)
		Juice	The Jorbeer Conservation Reserve located in Bikaner, Rajasthan, houses indigenous populations that have been using the plant <i>Boerhaavia diffusa</i> as one of the most integral components in their traditional folk medicine practices.	(Devraan Jain 2024)
c	Asthma	Decoction	Indigenous community, Chamba district, Himachal Pradesh	(Sharma et, al., 2018)
		Extraction	Traditional medicines farmers,	(Panday et, al., 2025)

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			Uttarakhand	
		Root mix with Turmeric Powder	Indigenous community, Gandhamardan Mountain, Bargarh, Odisha	(Pandey et al., 2024)
d	Heart disease	NR	Ethnomedicinal studies have reported that <i>Boerhaavia diffusa</i> is traditionally used by the Valmiki tribes of Munching Putt Mandal, Visakhapatnam (Andhra Pradesh)	(Padal et al., 2012)
		NR	Tribal communities of Bhiwani district (Haryana)	(Singh et al., 2015)
		Powder mixed with honey or milk	Local participants in Ranchi (Jharkhand), highlight its wide acceptance in indigenous healthcare practices across India.	(Pandey et al., 2025)
		Infusion	The indigenous and tribal population of the Kurmunda block of Sundargarh district, Odisha, has also been seen	(Bagartee D Choudhury, 2020)

			using Boerhaavia diffusa as part of their traditional medicinal system for various ailments, indicating that this species is still widely valued ethnobotanically in rural healthcare systems.	
e	Gall stone	Decoction	Local inhabitants of Kapurthala (Punjab)	(Kaur et al., 2020)
f	Drops	Juice	Indigenous communities of the Jorbeer Conservation Reserve in Bikaner (Rajasthan) have been reported to utilize <i>Boerhaavia diffusa</i> as part of their traditional medicinal practices, reflecting its continued ethnobotanical relevance across different regions of India.	(Devra and Jain, 2024)
g	Eye disease	Paste	Tribal people in Kurmunda block, Sundargarh, Odisha	(Bagartee D Choudhury, 2020)

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		Extract	Traditional medicines farmers, Uttarakhand	(Panda y et, al., 2025)
		Powder with honey	Local populations in Koatdwara range in Uttarakhand	(Rawat 2023)
h	Jaundice	NR	Local communities in Malshiras, Solapur (Maharashtra)	(Ajwal e et, al., 2022)
		Extract	Traditional medicinal practitioners in Uttarakhand have been reported to use <i>Boerhaavia diffusa</i> in their ethnomedicinal practices, indicating its widespread acceptance in rural and traditional healthcare systems across India.	(Panda y et, al., 2025)
		Paste and powder	Boerhaavia diffusa is one of the plants used by traditional healers from the Malayali tribe residing in the Bodamalai Hills of Namakkal	(Panner Selvam .et, al.,2017)

			(Tamil Nadu) as a means to treat various illnesses using indigenous medicine.	
i	Abdominal pain	<i>Boerhaavia diffusa</i> powder is mixed with honey or milk for use	This practice is reported among village and local participants in Ranchi, Jharkhand	(Panda y et, al., 2025)
j	Skin disease	Juice	Indigenous peoples of the Jorbeer Conservation Reserve in Bikaner, Rajasthan, traditionally utilize <i>Boerhaavia diffusa</i> for the treatment of various ailments as part of their folk medicinal practices.	(Devra and Jain, 2024)
k	Fever	Paste	Local communities, North Eastern UP	(Qayum et al., 2016)
		Powder mixed with honey or milk	Village and local participant, Ranchi, Jharkhand	(Panda y et, al., 2025)
l	Anti-ageing	<i>Boerhaavia diffusa</i> is used in the form of extract, oil, and decoction	This traditional use is reported among indigenous groups in Dakshin Dinajpur, West Bengal	(Sarkar et, al., 2023)

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m	Menstrual cycle	Powder of <i>Boerhaavia diffusa</i> is mixed with honey or milk for administration	This practice is reported among village and local participants in Ranchi, Jharkhand	(Sharma et al., 2010)
n	Ulcer	Paste and powder	<i>Boerhaavia diffusa</i> is traditionally utilized by Malayali tribal healers in the Bodamalai Hills of Namakkal, Tamil Nadu for various ethnomedicinal purposes.	(Panner Selvam et al., 2017)
o	Cough	Powder mixed with sugar	<i>Boerhaavia diffusa</i> is traditionally used by indigenous communities of Gandhamardan Mountain, Bargarh (Odisha) for various medicinal purposes.	(Pandey et al., 2024)
p	Vomiting	Extract	<i>Boerhaavia diffusa</i> is also used by local people and traditional healers in Mahendergarh, Haryana for its traditional medicinal applications.	(Yadav and Bhandoria, 2013)

q	Liver problem	Extract	Traditional medicine practitioners and farmers in Uttarakhand also report its use	(Ravikant et al., 2022)
02	LEAVES			
a	Asthma	Extraction	Local community, Amaravati, Maharashtra	(Gawai and Tippat 2024)
b	Cough	Infusion and juice	Tribal people in Kurmunda block, Sundargarh, Odisha	(Bagarteenand Choudhury, 2020)
c	Jaundice	Extract	<i>Boerhaavia diffusa</i> is traditionally used by Kurichiyas, Kurumas, and Paniyas tribes of Wayanad, Kerala. These tribal communities utilize it as part of their indigenous medicinal practices	(Marjana et al., 2018)
d	Anemia	NR	Chakma tribes, Tripura	(Guha and Chakma, 2015)
e	Kidney problem	Extract	Tribes, Jashpur, Chhattisgarh	(Afsana et al., 2020)
		Lives consumed orally	Ethnic groups, Barjala area, West Tripura district, Tripura	(Dhar et al., 2025)

BOERHAVIA DIFFUSA: A POLYPHARMACOLOGICAL HERB BRIDGING ETHNOMEDICINE AND
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		Powder with milk	Local inhabitants , Kapurthala , Punjab	(Kaur et, al., 2020)
f	Skin disease	Paste	<i>Boerhaavia diffusa</i> is used by ethnic communities in Buxoi, Chhatarpur (Madhya Pradesh)	(Rai 2017)
		Juice	It is also utilized by indigenous people of the Jorbeer Conservation Reserve, Bikaner (Rajasthan)	(Devra n and Jain 2017)
G	Liver disease	Powder with milk	<i>Boerhaavia diffusa</i> is used by local inhabitants of Kapurthala (Punjab)	(Kaur et, al., 2020)
H	Eye lotion	Juice	It is also reported among Malama Lasar tribe in Parambikulam Wildlife Sanctuary (Kerala)	(Yesodhanara n and Sujana, 2007)
I	Blood purification	Juice	Local and tribal communities in Una and Hamirpur (Himachal Pradesh) also utilize the plant in traditional medicine	(Chand et, al., 2016)
j	Fever	Infusion and juice	Tribal people in Kurmunda	(Bagart eenand Choud

			block, Sundargarh , Odisha	hury, 2020)
K	Diabetes	Powder taken orally	Lrular tribes, Nilgiri, Tamil Nadu	(Panneer Selvam et, al., 2017)
03	ENTIRE PLANT			
a	Jaundice	NR	This plant is employed by tribes, locals, and healers in Nagri block, Dhamtari (Chhattisgarh)	(Afsana et al., 2020)
b	Fever	Juice taken 2-3 spoons daily	It is also recorded among villagers and locals in Ranchi, Jharkhand.	(Panday et al., 2025)
c	Asthma	NR	Local and tribal, Una and Hamirpur, Himachal Pradesh	(Chand et al., 2016)
		Powder, paste, infusion	<i>Boerhaavia diffusa</i> is used by tribal people in Kurmunda block, Sundargarh (Odisha)	(Bagart eenand Choudhury, 2020)
d	Urinary problem	Extract	<i>Boerhaavia diffusa</i> is traditionally used by Bhil, Gond, and Shariya tribes as well as rural communities in Guna district, Madhya Pradesh for various	(Samar et al., 2020)

			<i>medicinal purposes.</i>	
e	Skin disease	Powder mixed with ginger	Native communities, Koatdware-Bhabhar range, Uttarakhand	(Rawat 2023)
f	Liver disorder	Decoction	Boerhaavia diffusa is also known to be used by tribal people of Peth taluka, Nashik (Maharashtra).	(Jondhale et al., 2018)
g	Heart disease	Juice taken 2-3 spoons daily	It is also found among the villages and locals of Ranchi (Jharkhand).	(Afsana et al., 2020)
04	STEM			
a	Urinary problem	Tender shoot	Tribal community, north-east Gujarat	(Punjan i 2010)
		Bark decoction	Tribes, Vindhya region, MP	(Samar et al., 2020)
b	Snake bite, indigestion	Stem powder mixed	Boerhaavia diffusa is used by	(Bagarteen and Choud

2.2. Boerhavia diffusa used for curing ailments

Ethnomedicinal reports reveal that different portions of *B. diffusa* have been used by indigenous people in various forms such as powder, paste, juice, and infusion to cure different diseases. Plant-based medicines have been used for snakebites along with *T. cordifolia* (Giloy) and *Ocimum sanctum* (Tulsi) and leaf infusions, leaf juice, and plant-based formulations for the treatment of jaundice, fever, and gastric problems (Bagarteen & Choudhury, 2020). Likewise, in Malshiras Tehsil, Solapur district, Maharashtra, leaves and root extracts of *B. diffusa* are used for jaundice and wound healing (Ajwale et al., 2022). The rural tribes in the Nilgiri area of Tamil Nadu utilized roots and leaf powder for the treatment of kidney disorders. (Panneer Selvam et al., 2017). In Kapurthala, Punjab, the local population uses roots and leaf mix with cow milk to

	stion, coughing, and vomiting	with Giloy and Tulsi	tribes in Kuarmunda block of Sundargarh (Odisha).	hury, 2020)
05	FLOWER			
a	Cataracts	NR	<i>Boerhaavia diffusa</i> is used by the Banraji community in Kumaun, Uttarakhand	(Bisht and Adhikari, 2018)
06	SEEDS			
	Fever, constipation,	NR	<i>Boerhaavia diffusa</i> is used by tribal communities in Bhiwani, Haryana	(Sing et al., 2015)

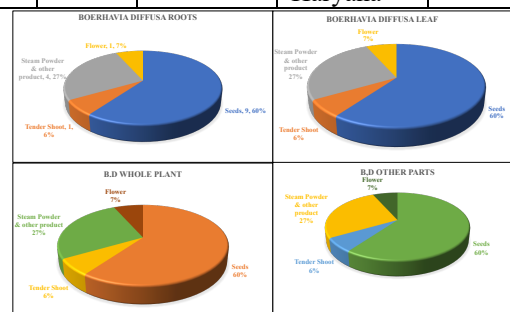


Figure 11: Mode of administration of the plant part of *Boerhavia diffusa* in India

treat kidney problems (Kaur et al., 2020). *Boerhaavia diffusa* is used by the indigenous people of Jorbeer Conservation Reserve, Bikaner, Rajasthan for the treatment of several ailments such as gastric problems, kidney-related issues, eye problems, and skin conditions (Devra and Jain, 2024).

2.2.1 Plant Parts Value (PPV)

Analysis of the PPV (plant part preference value) showed that the roots, leaves, and entire plant of *B. diffusa* are the preferred plant parts used locally for ethnomedicinal applications. Roots had the highest PPV value of 34.51%, representing the highest usage of the plant part medicinally, then followed by leaves at 27.43%, while entire plants had a PPV value of 24.78%. Seed had a PPV of 7.96%, stems had 4.42%, and flowers were the least used with PPV at 0.88%.

Boerhaavia diffusa has been identified as an excellent provider of nutrition and medicinal compounds. Various phytochemical analyses on the whole plant have revealed the existence of 15 amino acids, out of which six are essential amino acids. The plant has also been found to be a rich source of Figure 13. Essential or non-essential amino acid.

Some people inhale smoke from dried plant material, and others take apple cider vinegar nasally to ward off respiratory issues, headaches, or sinus congestion. The variety of parts used and the way in which the plant is used as medicine, illustrate its versatility and diversity in the ethnomedical uses (Yadav A et al., 2024)

Boerhaavia diffusa leaves are widely eaten as a source of green leafy vegetables in many parts of India. They have been found to be useful for the treatment of numerous ailments associated with eyes such as corneal ulcers and night blindness. They are also thought to boost vigor and vitality among men (Riaz H et al., 2014)

The entire plant of *Boerhaavia diffusa*, also known as Punarnava, is extensively used in conventional Ayurvedic treatment practices for treating a wide range of illnesses. For instance, the Sharangadhara Samhita mentions its use in diseases associated with eyes where preparations made with milk, ghee, oil, or rice water are prescribed for soothing irritated eyes, eye ulcers, poor eyesight, and night blindness. Moreover, in some traditional treatments, the juice of the whole plant, when taken orally with a pinch of baking soda, has been used for stomach disturbances like heartburn, flatulence, and other related symptoms (Mondal S. et al., 2024).

3. MORPHOLOGICAL CHARACTERISTIC

Stem *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 (Pandey S. et al., 2019) common stalk that are approximately one meter long, and they are prostrate and variably branched. Light reddish-brown top and pale greenish below, stems. (Banjare L et al., 2012). The *Boerhaavia diffusa* roots have a thick, tuberous, and fusiform appearance with a woody base and several rootlets. They are cylindrical, plump, and firm, having a pale yellow-brown to light brown-grey color with an acrid taste. The *Boerhaavia diffusa* roots comprise 0.15% of alkaloids. Structurally, the cortex is composed of two to three layers of parenchymatous cells and five to twelve layers of thin walled, oval to polygonal cells. Several bands of xylem tissues are also present. The morphological features observed microscopically serve as important markers for the identification of this species of plant. The cortex of the root consists of abundant parenchymatous tissues. Alternating rings of vascular tissues are seen below the cortical layer. Xylem vessels show a radial arrangement in groups of 2 to 8 with simple pits having reticulate thickening (Kumar et al., 2018). Tracheids are small

various fatty acids like isopalmitate acetate, behenic acid, arachidic acid (6.3%), and saturated fatty acids (38%). The powdered root is extensively used for promoting male reproductive functions in folk medicine, often combined with cow milk or honey (Mishra S. et al., 2014).

and thick-walled with simple pits, and the fibres are long, spindle-shaped with thick walls that are sharp at the ends (Rijuraj et al., 2017). The phloem is seen in curved patches external to the xylem groups, containing sieve elements and parenchyma. Abundant areas of parenchymatous tissue occur between successive xylem rings and contain rectangular, thin-walled cells arranged radially. The primary vascular bundles lie in the centre of the root. Calcium oxalate raphides, either individually or in clusters, occur in the cortical and parenchymatous tissues (Riaz et al., 2014). Starch grains, simple or compound (consisting of 2 to 4 parts), are abundant in the cortical and parenchymatous tissues. Simple starch grains are mostly rounded with a size of about 2.75 to 11 μm in diameter (Vendrapati et al., 2024).

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. (Gour R, 2021) 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 subundulate. (Sravani T et al., 2024).

Flowers: Flowers are quite minute, delicate, and



normally pink in colour, while green underneath and possessing a greenish perianth tube shaped like a funnel. Flowers are nearly sessile or on very short stalks and occur in little umbels arranged in terminal and axillary panicles. Inflorescences are usually stalked with many corymbose heads that bear little acute bracteoles (Swamy M. et al., 2025). Fruits are quite small, one-seeded, glandular nuts, ovate-clavate, measuring around 5-6 mm and possessing

five ridges. The entire herb is known to be bitter in taste without any special smell (Ghosh S., 2018).

Height Prostrate divaricately branched; branches from a common stalk about 1 m in length. (Ghosh S.,2018)

Table-6

3.1 Characteristics of Boerhavia diffusa, along with part of the plant.

Table-7

4. NUTRITIONAL COMPOUNDS BASED ON PART OF THE PLANT.

Sr. no.	Part of the plant	Characteristics of the part	Reference
01	Height	The Boerhaavia diffusa plant is a spreading plant whose many stems grow from one common point at the base and branch out in all directions, reaching a maximum length of 1 meter along the ground.	Ghosh S.2018
02	Leaves	The leaves appear in pairs of unequal sizes and are broadly ovate to suborbicular. Big leaves are about 25-37 mm long, while small leaves are 12-18 mm long. The top side of the leaf is smooth and green in color, whereas the underside is whitish-green.	Saravni et al., 2024
03	Steam	Pale greenish below and light reddish brown	Banjare L et al., 2012
04	Flowers	tiny, ovoid, greenish lower part, pink top part, funnel-shaped, nearly sessile or short-stalked, 10–25 cm.	SWAMY M et al 2025
05	Fruits	Glandular, narrowly obovoid, about 3 mm long	Gour R, 2021
06	Roots	elongated, fusiform, tapering, cylindrical, 0.2–1.5 cm in diameter, and either moderately tortuous or somewhat tuberous	Rijuraj MP et al.,2017

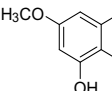
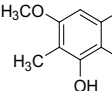
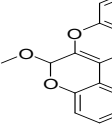
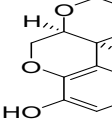
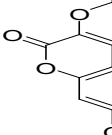
Sr. no.	Part of the plant	Name of the nutritional Compound	Location of the plant	Use	Reference		01	Seeds	linoleic acid, palmitic acid	Tropical or subtropical	anti-inflammatory and skin-	(Kumar et al.)
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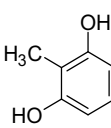
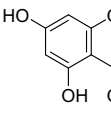
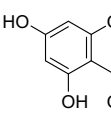
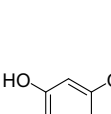
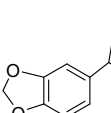
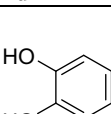
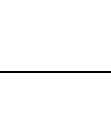
			region of India	protective properties.	
02	Leaf	Carbohydrate 44.30mg/100g dry	India	Primary source of energy	(Panday et al. 2019.)
03	Leaf	Vitamin C, 97.00 mg/100g	South India	Collagen Production	(Sivadas B et al.,)
04	Leaf	Vitamin B, 162.50mg /100g		Energy Production	(Kaviya M et al., 2022)
05	Leaf	Sodium, 174.09mg/100g		Muscle Contraction, Relaxation	Moullick SP et al. 2024
06	Leaf	Magnesium 0.002mg/100g		Bone Formation	(Panday et al. 2019.)
07	Leaf	Thiamin b1, 20.20mg/100g	Dhaka, Bangladesh	Treatment of Beriberi disease	Moullick SP. Et, al., 2024
08	Leaf	Riboflavin B2, 99.37mg/100g		Anemia Prevention	Sarvani et al., 2024
09	Leaf	Niacin B3, 30.25mg/100g		Dyslipidemia management	(Kumar et al.)
101	Leaves	Amino acid 0.1g/100g	Dhaka, Bangladesh	Liver and Kidney Disease	Moullick SP et al. 2024
11	Roots	Proteins 4.80g/100g	South West Nigeria	Tissue Repair	(Kaviya M et al.,

					2022)
12	Roots	Fibre 23.42/100g	Anambra State, Nigeria	Digestive Health and Regularity	(Ujowundu CO et al., 2008)
13	Flower	Carbohydrate	Africa	Primary Energy Source	{Sugunan et al., 2025}

Table-8

4.1 Bioactive constituents reported from *Boerhavia diffusa* with pharmacological uses.

Sr. no.	Bioactive constituent	Structure	Pharmacological use	Part of the plant	Reference
01	Rotenoids				
a	Boeravinone G		Anti-inflammatory Potential	Roots	(Aviello G et al., 2011)
b	Boeravinone H		Antioxidant Effects	Roots	(Nguyen HH et al 2022)
c	Boeravinone A		Anti-microbial and anti-inflammatory	Roots	(Aviello G et al., 2011)
d	Boeravinone C		Anti-diabetic	Roots	(Nguyen HH et al 2022)
e	Boeravinone F		Anti-microbial and cardiovascular	Roots	(Aviello G et al., 2011)

	Boeravinone B		Nephroprotective	Roots	(Riaz H et al., 2014)
02	Flavonoids				
a	Quercetin		Antidiabetic Activity	leaves, stem, or roots.	(Mishra S et al., 2014)
b	Kaempferol		Anticancer Potential	Leaves and roots	(Yadav A et al.,)
c	Luteolin		Anti-inflammatory	Roots, leaves, and stem	(Mishra S et al., 2014)
03	Alkaloids				
a	Punarnavine		Analgesic	roots	(Nayak P, et al 2016)
04	Phenolic compound				
a	Caffeic acid		Hepatoprotective	leaves	(Thajudeen KY et al., 2022)
b	Syringic acid		Cardioprotective	Whole plant	(Kaviya M et al., 2022)

5. PHARMACOLOGICAL ACTIVITY

There is a lot of scientific research on *Boerhaavia diffusa* due to its abundance of chemicals and extensive therapeutic actions. Scientific investigations have found that *Boerhaavia diffusa* contains various pharmacological actions such as antioxidants, antimicrobial agents, anti-

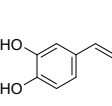
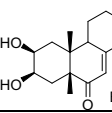
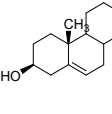
c	Caffeoyl tartaric acid		Anti-Carcinogenic	Roots	(Jun a Bee gum GR et al., 2017)
05	Steroids				
a	Ecdysteroids/ beta-Ecdysone		anti-inflammatory	Roots	(Mondal S, et al)
b	Phytosterols/ beta-sitosterol		Liver-Protecting	Leaves	(Sahu AR, et al)

Table-9

4.2 Some of the secondary metabolites reported from *Boerhaavia diffusa* with biological importance

Serial no.	Organic group	Reported compounds	Reported property	Parts used	References
01	Lignin	Liriodendrin	Ca ²⁺ channel antagonist	Roots	(Bhat tarai K et al., 2024)
02	Isoflavone	2'-O-Methyl abronisoflavan	-	Leaves	(Borrelli et al., 2005)
03	Phenolic glycoside	Punarnavoside	Antifibrotic	Roots	(Jain & Khanna, 1989)
04	Flavonol	Quercetin, kaempferol	Antiinflammation	Leaves	(Mishra et al., 2014)

inflammatory agents, antidiabetics, anticancer drugs, anticonvulsive drugs, anti-malarial drugs, anti-obesity drugs, and antibacterial drugs. Furthermore, it acts as a hepatoprotector, nephroprotective agent, immunomodulator, wound healer, diuretic, and anti-angiogenesis drug (Patel N et al, 2025).

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Anti-Cancer Properties: The ability of *Boerhaavia diffusa* to act as an anti-cancer drug has been proven through both in vitro and in vivo tests. Bioactive rotenoids such as boeravinones have been found to have antiproliferative properties against several cancer types, including breast and colon cancer. This is attributed to the ability of the compounds to cause apoptosis and cell cycle arrest and hence preventing cell proliferation (Yadav A. et al., 2025). In another experiment, the anti-cancer properties of *B. diffusa* were analyzed using Swiss albino mice models with 7,12-dimethylbenz[a]anthracene-induced skin papillomas. Based on the results obtained, the plant extract could delay carcinogenesis by promoting detoxification processes and inhibiting tumor promoters via its antioxidant action, or by stopping precursors from turning into active carcinogens. (Borah B, Bharali R, 2016) Punarnavine, an alkaloid

Boerhavia diffusa shows antiproliferative effects on breast cancer by apoptosis and cell cycle arrest. Boerhavia diffusa phytochemical constituent punarnavine increases the immune response. B.D extracts inhibit HeLa cell growth in S-phase with cytotoxicity.

B.D. has a contained number of phytochemicals that are responsible for a multi-target profile because it is a valuable chemotherapeutic adjunct. (SWAMY M. et, al., 2025) (Yadav A et, al.,2025)

Cardiovascular Health: *Boerhaavia diffusa* (Punarnava) shows cardiovascular benefits through its antioxidant and anti-hypertrophic

Analgesic and Anti-inflammatory Properties:

There have been several reports on the presence of important analgesic (antinociceptive) and anti-inflammatory properties of *Boerhaavia diffusa*, especially with respect to the whole plant extract and leaf juice extracts (Babita et al., 2011). According to research evidence, the herb demonstrates considerable analgesic and anti-inflammatory effects, thereby corroborating the herbal application in treating inflammation-related disorders. The analgesic action of the plant is considered to be central in nature, similar to morphine, due to its antinociceptive properties (Ahmed S. et al., 2024). Moreover, ethanol extract of the stem bark exhibited COX-1, a mediator of inflammation (Banjare L et al., 2012).

There is ample evidence about the anti-inflammatory activity of *Boerhaavia diffusa*. As per tradition, *B. diffusa* had been used in Martinican folk medicine to cure pain and inflammatory ailments (Kumar R. et al., 2018). Laboratory studies indicate

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produced from *B. diffusa*, improved the immune response in mice against invasion and metastases of B16F-10 melanoma cells. The development of the HeLa cell line was slowed down in the S-phase, and there were indications of *B. diffusa* cytotoxicity. (Manu KA, Kuttan G. 2007). More proof of the cancer fighting abilities of *B. diffusa* was shown through research conducted on punarnavine, an alkaloid found in its roots. According to Manu and colleagues, punarnavine demonstrated antimetastatic activity, thus indicating its capability to stop cancer cell metastasis (Sandhya K.D. et al., 2011). Due to its numerous bioactive compounds that work through various modes of action, *B. diffusa* provides a multimodal strategy in the fight against cancer that can prove to be very useful in addition to conventional chemotherapy (SWAMY M. et al., 2025).

properties in preclinical studies. (Nimbal and Koti, 2016). The inclusion of 9,12-octadecadienoic acid ethyl ester and cis-vaccenic acid in *Boerhaavia diffusa* indicates its possible utility for the regulation of lipid metabolism as well as its cardioprotective nature. Fatty acids in these compounds have been related to lowering the level of cholesterol in blood, improving lipid profile, and maintaining vascular function. The presence of such compounds in the plant makes it possible to assume its effectiveness in managing hypertension and other cardiovascular disorders (Varsha S et al,202)

that aqueous extracts derived from various organs like roots, stems, leaves, and flowers inhibit the production of carrageenan-induced edema in laboratory animals, and the maximum inhibitory action occurs during the rainy season (Kaur H. et al., 2019). The extracts derived from roots using aqueous and acetone solvents were also found to possess anti-inflammatory activity against formaldehyde-induced arthritis and inflammatory edema in rats. Apart from anti-inflammatory activity, these extracts were seen to normalize increased aminotransferase serum concentrations and improve the enzymatic activity of liver enzymes, which reflects an improvement in the functioning of the organ (Das S. et al., 2023). Also, the root extracts had proven efficacy in experimentally induced urinary tract infection in decreasing bacterial load and inflammation in kidneys in pyelonephritis caused by *Escherichia coli* (Das S., 2020).

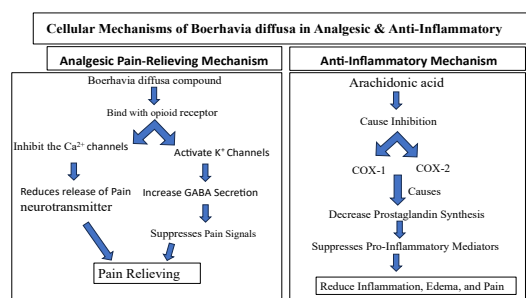


Figure 18: Cellular MOA of BD.

Diuretic and Nephroprotective Activity: Several pharmacological research studies have confirmed the potent diuretic properties of *Boerhaavia diffusa*, justifying the use of this plant for managing renal and urinary issues (Santhosh S. et al., 2023). These properties are mainly due to increased sodium excretion and the presence of active substances such as potassium, glycosides, and ecdysteroids throughout the plant. Root is the part that exhibits highest diuretic effects, with specimens collected during rainy seasons exhibiting maximum diuretic action (Dixit N. et al., 2025). Not only does this plant induce diuresis but has also shown its ability to affect kidney enzymes, specifically through the modulation of succinate dehydrogenase in a dose-dependent manner where low concentrations of this extract stimulate whereas high concentrations inhibit succinate dehydrogenase. Moreover, extracts from this plant also enhance the activity of D-amino acid oxidase but show no considerable change in kidney phosphatase activity. (Das S et al., 2023). A number of studies have demonstrated significant benefits associated with the use of *Boerhaavia diffusa* for the treatment of several kidney-related and urinary conditions. Based on laboratory and clinical studies, it can be stated that the extract from the above plant can prove to be useful in several conditions including pyelonephritis caused by *Escherichia coli*, polycystic kidneys, nephritic syndrome, edema, ascites, as well as urolithiasis related to the formation of oxalates and ammonium magnesium phosphate crystals (Sadayan S. et al., 2024). The plant's diuretic effect facilitates the maintenance of body's fluid balance and removal of metabolic products which makes it effective in cases of inflammatory renal disorders. Moreover, the plant's hepatoprotective properties provide an additional benefit in the treatment of kidney disorders associated with liver pathologies such as cirrhosis and peritonitis (Mishra S et al., 2014).

Anti-hepatotoxic Activity or Hepatoprotective and Choleretic activity: Being involved in metabolic processes, detoxification, and protecting organisms from xenobiotic agents, the liver is an organ very sensitive to the action of toxic chemicals and medicinal drugs. The hepatoprotective capacity of *Boerhaavia diffusa* for different diseases and hepatotoxic substances has been proven by many researchers (Mishra S. et al., 2014). Experiments

conducted in laboratory conditions have established the hepatoprotective effect of the ethanol extract of the roots of *B. diffusa* in case of alcohol-induced liver damage in albino rats via decreasing high concentrations of such biochemical parameters of liver function as ALT, triglycerides, cholesterol, and total lipids in blood serum and liver tissues (Monali P. et al., 2014). Besides, the extract has also shown considerable hepatoprotective effect when it was tested on carbon tetrachloride-induced damage as reflected by normalizing the levels of SGPT and SALP in serum (Beedimani SR, Shetkar S., 2015). Hepatoprotective properties of *B. diffusa* are due to various bioactive agents such as rotenoids (including 6,11-dihydroxy-9,10-dimethyl-4-methoxyrotenoid), steroid derivatives (androst-5-ene), and flavonoids (for example, 6,5'-dimethoxy-5,7,3'-trihydroxyflavone). Both alcoholic extract of *B. diffusa* and root have shown pronounced protective effects towards CCl_4 induced hepatotoxicity in rats (Kumar R. et al., 2018). Such hepatoprotective activity of *B. diffusa* extract is expressed through normalization of biochemical parameters, like the level of ALT in serum, triglycerides, cholesterol, and total lipids. Moreover, *B. diffusa* extract is able to prevent CCl_4 -induced elongation of prothrombin time and stimulate bile secretion (Thajudeen KY et al., 2022). Choice of root size (about 1-3 cm diameter), harvesting time (summer has better results) and formulation play an important role in hepatoprotection provided by *B. diffusa* in case of liver toxicity due to thioacetamide administration in rats (Pandey S., 2025). Furthermore, histopathological investigations demonstrated the presence of minimal fat deposits in cases under examination, which suggests recovery of hepatocytes. Also, it is worth mentioning that this plant exhibits restorative effects on paracetamol-induced liver damage (Venkatalakshmi et al., 2011).

Adaptogenic and Antistress Activity: Adaptogens refer to natural products that improve the body's ability to cope with various stress factors such as physical, chemical, and biological ones. They also help restore physiological abnormalities caused by stress and offer protection from environmental and psychological challenges. Adaptogens are very beneficial when there is overactivation of adrenals and fatigue (Ghosh S., 2018).

The adaptogenic properties of *Boerhaavia diffusa* have been explained by its biologically active substances such as flavonoids, alkaloids, glycosides, and sterols. All of these contribute to a high carbon clearance rate that implies the stimulation of the reticuloendothelial system (Sumanth and Mustafa, 2007). Moreover, this medicinal plant extract stimulates leucocytosis and offers restorative action with regard to biochemical parameters like glucose, cholesterol, SGPT, and triglycerides levels. Finally, the substance also regulates the levels of plasma and adrenal cortisol and increases the production of antibodies (Mungantiwar et al., 1997).

Antibacterial activities The authors Umamaheswari et al. (2010) conducted a qualitative analysis of extracts of different solvents and aqueous extracts of the leaves of *Boerhaavia diffusa* in order to determine their antibacterial action. The preliminary qualitative analysis of phytochemicals revealed that there were some active ingredients that are supposed to be responsible for antimicrobial action of this medicinal plant (Riaz et al., 2014). According to previous scientific works, *Boerhaavia diffusa* shows its significant antibacterial action with regard to Gram-positive and Gram-negative bacteria due to the presence of numerous phytochemicals found in its leaves (UTI PO, 2014). In their study, Malhotra et al. (2013) assessed the antimicrobial potential of root extracts of *Boerhaavia diffusa* that had been isolated via *Agrobacterium rhizogenes*-mediated transformation technique. This was carried out using extracts that were subjected to various microorganisms in order to determine their antimicrobial potential under in vitro conditions. The test was conducted using 12 pathogenic bacteria associated with UTI, with two of the bacterial isolates being antibiotic resistant. Antibiotic resistance was compared to positive controls such as gentamicin, ciprofloxacin, and chloramphenicol (Sahu et al., 2014). A study conducted by Mahadevamurthy et al. (2016) explored the possible antibacterial properties of fungal endophytes in *Boerhaavia diffusa*. The study revealed the presence of a total of 12 endophytic fungi that were grouped into seven different taxonomic categories. Four isolates were found to have remarkable antimicrobial effects by inhibiting individual or all pathogens under study and comprising more than 33% of the total isolates.

The above research, together with other related research work, proves the broad medical applications of herbal plants in treating microbial infections. In recent times, the CDC has sounded a wake-up call about a coming age of antibiotics in which many antibiotics are failing to treat microbial pathogens (Palms et al., 2018). The widespread problem of drug-resistant microorganisms has necessitated the search for more efficient antibacterial drugs (Setzer et al., 2016). Against this backdrop, the use of natural products continues to

remain relevant due to their varied structure composition (Umamaheswari et al., 2010).

Immunomodulatory activity: Immunomodulator is an agent whose functions can be altered in any way to affect the performance of the immune system. Though many synthetic immunochemical drugs may reduce the performance of the immune system with negative consequences, plant immunomodulators are safer and are commonly employed as natural adaptogens for boosting the immune system (Khan M.S. et al., 2013).

According to research carried out by Aher et al. (2020), punarnavine (an alkaloid extracted from roots of *Boerhaavia diffusa*) exhibited considerable immunomodulatory activity. The results indicated that punarnavine enhanced the humoral immune response by facilitating antibody production, which then boosted the performance of macrophages and various subsets of lymphocytes. Besides, punarnavine enhanced the functionality of hematopoiesis by boosting the multiplication of stem cells due to increased α -esterase positive cells in the bone marrow. Punarnavine was further found to improve organ weight indices, thereby showing immunological improvement. Several studies have confirmed the significant immunomodulating effect of punarnavine, which is an active compound obtained from roots of *Boerhaavia diffusa*. In the animals administered with punarnavine, there was a substantial increase in the relative weight of immune organs including the thymus and spleen, in comparison with the controls, where significant differences were noted ($p < 0.001$). Also, a significantly increased count of bone marrow cells along with the increased number of α -esterase positive cells was reported in the treated group (Das S. et al., 2023).

Further studies conducted by Manu and Kuttan (2009) showed that punarnavine induced proliferation of bone marrow stem cells both in vitro and in vivo regardless of the presence of mitogens. This indicates the strong immunomodulating effect of punarnavine. The data is in line with the studies conducted previously regarding the immunopotentiating effect of the roots of *Boerhaavia diffusa* as it exhibits anti-stress and adaptogenic effect in experimental conditions (Sandhya KD et al., 2011).

Antiviral Activity: The *Boerhaavia diffusa* plant is known for its ethnobotanical importance. The leaves of the *Boerhaavia diffusa* are usually eaten as vegetables, whereas its root extract is generally used to treat ailments such as asthma, urinary infections, leucorrhoea, rheumatism, and encephalitis (Moulick SP et al., 2025).

Boerhaavia diffusa is a significant medicinal herb which is used traditionally as Ayurvedic medicine. This plant has been shown to possess a variety of pharmacological, clinical, and antimicrobial effects (Aviello G. et al., 2011). Recent studies also show

that Boerhaavia diffusa possesses anti-viral action on phytopathogenic virus. The identified anti-viral constituent of the plant is a glycoprotein having a molecular weight ranging between 16 to 20 kDa. The bio-active compound has been found to have a protective effect against infection due to virus when sprayed on crops in the field (Bibi Y. et al., 2026). Aqueous extracts of diverse plants were produced and tested in vitro as well as in vivo for their ability to act against phytopathogenic viruses using sensitive and systemic host plants. Each individual Table-10

Cellular mechanism of different cancer cells given by B.D

S r. N o .	C h e m i c a l C o n s t i t u e n t C l a s s	Spec ific com pou nds	Targeted Cancer Cell Lines	Mecha nism of action	Re fe re nc e
0 1	Al ka loi ds	Puna rnav ine	B16F-10 melanoma cells, Ehrlich ascites carcinoma, MCF-7 breast cancer cells	Induces apoptosis (programmed cell death) via p53 and caspase -3 activation, while suppressing Bcl-2 (an anti-apoptotic protein). It also inhibits angiogenesis (new blood vessel formation in tumour	[S ar as wa ti S, et al. ,2 01 3]

plant used for the production of its extract was properly authenticated before starting the experiment (Ashrafi S. et al., 2025). From a huge list of tested species, the extracts of the roots of Boerhaavia diffusa were found to have a broad spectrum and potent antiviral effect. This was also confirmed by similar experiments where the aqueous extracts of the roots of Boerhaavia diffusa were found to have a potent antiviral effect against phytopathogenic viruses (Mahesh A.R. et al., 2012).

				s) by down-regulating VEGF and MMP-2/9 expression	
0 2	R ot en oi ds	Boer avin ones [G& H]	Various cancer types (mechanism studies performed on general cell processes) Caco-2, BCRP/ABCG 2	Act as potent antioxidants, protecting DNA from damage. Boerav inones G and H are known to inhibit the BCRP/ABCG 2 multidrug transporter protein, which can help overcome drug resistance in chemotherapy	[K ha n M S et al. ,2 01 3]
0 3	Fl av on	Kae mpf erol,	HCT116 colorectal cancer cells,	Induce apoptosis,	[D as S,

	oids	eupl atin	MCF-7 breast cancer cell MDAMB231, HeLa, H460, HepG2, Huh7, SK-Hep-1, AGS, HCT116, HT-29, OVCAR-3, PC-3, LNCaP, U87 (glioblastoma), HL-60	increas e reactiv e oxygen species (ROS) levels within cells, and activate pathwa ys like p38/M APK, leading to cell death. They also contrib ute signific ant antioxi dant and anti-inflam matory propert ies	et al. ,2 02 2]
04	Fatty acid	9,12- Octa decadi enoic acid (Z, Z)- (Lin oleic acid)	KB oral cancer cells. a misidentified subline of the ubiquitous HeLa cell line	It promotes programmed cell death (apoptosis) and halts cell cycle progression at the G0/G1 stage by increasing Bad expression while suppressing Bcl-2 levels.	[G un as eel an D, et al. , 20 22]

05	Steroids	Beta- sitos terol	Hepatocellular carcinoma (liver cancer) HepG2, Huh7, and Hep3B	Affects the FOXM1-regulated Wnt/beta-catenin pathway, significantly impacting the growth and spread of liver cancer cells.	(C he n Y, et al. , 20 24)
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Table-11

***Boerhavia diffusa* current applications**

S r. No ,	Categ ory	Sub- catego ry	Details	Dos e/us es	Specia l Indica tion
01	Herbal & Homeopathic Medicine	General	Key ingredient in mother tinctures, capsules, juices	N/A	Urinary/liver functions, anemia, swelling
		Mother Tincture	10-20 drops of half a cup of water	2-3 times daily	Liver, heart health, & abdominal swelling
		Dilution	5 drops in water	3 times daily	Managing urinary pain
02	Herbal (Ayurvedic)	Powder (Churna)	Roots powder with water, milk & honey	Half tsp. twice daily	Leucorrhoea, amenorrhoea
		Decoction Kashaya	Boil 10g powder in 2	2-3 times	Urinary obstruction,

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			cups of water to 1cup filter.	dail y	& jaundi ce
		Fresh juice	Extract ed from the whole plant	5-10 ml dail y	Detoxi ficatio n
		Topical paste	Fine paste from fresh leaves.	App ly exte rnall y	Swelli ng (eye/b ody)
		Leaf juice /root paste	2-3 drops of leaf juice, root paste with honey	Insti ll drop s; appl y past e.	Conju nctiviti s, eye rednes s.
		Green Nanote chnolo gy	Ag/Se nanopar ticles	N/A	Target drug deliver y (Cance r)
0 3	Ayurv eda	Classic al formul ation	Rasaya na 35+ formul ation	Vari es by prod uct	Rejuve nation
		Punarn avasava	Liquid tonic	N/A	Diureti cs, liver health
		Punarn ava Mandur	Iron-rich tablets.	N/A	Anemi a, a kidney disorder
		Punarn avadi Guggul u	Tablets .	N/A	Joint pain, gout, sciatic a
		Sukum ara Ghrita	Ghee-based	N/A	Abdo minal/ gynaec ologic al issues.
		Externa l uses	Lepa (paste) or taila (oil)	App ly topi call y	Swelli ng, neuro muscular

					conditi ons.
0 4	Home opath y	Product s	Mother tinctur e	Vari es by pote ncy	Liver/ heart health, abdom inal swell ing, urinar y pain.
0 5	Cosm etics & skin care	general	BD roots extract in creams , serums , and lotions	App ly topi call y	Anti- aging, skin soothi ng
		Skin comfor t	BD extract with hydrox ybenzo ic creams .	App ly topi call y	skin soothi ng
		Anti- aging	High in polyph enols and flavon oids	App ly topi call y	Scave nges free radical preven t oxidati ve stress
0 6	Mode rn nutraceuti cals	Standar dized capsule s	High-potenc y extract capsule	1-3 time s dail y	Liver & kidney detoxif ication
		Nano-formul ation	Nano-carrier.	3 time s dail y	Enhan ced absorp tion for cancer
0 7	Other medic al syste ms	Unani & siddha	Used in Arab/S outh Indian	Vari es by pote ncy	Anti- bacteri al, anti-inflam matory .
		Folk medici ne	Tribal uses globall y	N/A	Snake bite, Asthm a, contra

					ceptiv e
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Boerhavia diffusa is being explored in modern applications beyond its traditional use in Ayurveda. Current applications and research focus on the following properties. (Pandey S, 2025), (Majhi S, et al., 2025), (Vikash A, et. al.,2023). (Sabarirajan S, et.al., 2024). (KUMAR V, et. Al., 2024). (Santhosh S, et.al., 2023). (Kaviya M, et. Al., 2022).

Table-12

***Boerhavia diffusa* current market-available formulation in numerous products.**

S r. No.	Formu lation	Brand /Type s	Uses	Availa bility	Refe rence
01	Punar nava	Himal aya, Patanj ali	Edema, Urinary disorder ,	Capsul e and tablet	(Pan dey S, 2025)
02	Boerh avia diffus a (Moth er tinctur e)	Schw abe India, SBL Home opath y	Asthma , hyperte nsion, jaundic e	Liquid drops	(Ku mar S, et. Al., 2025)
03	Stand arized extrac t (Boer avino ne B/E)	Simso n Phar ma Limit ed	Anti- inflam matory, Analges ic, Arthriti s, Pain	Pharm a compo sition	(Hari ni P, et. Al., 2025)
04	Amor phous solid	Resea rch based	Kidney disorder	Emerg ing nutrac eutical s	(Sata path y BC, er. Al., 2024)

Boerhaavia diffusa (Punarnava) features in numerous market-available herbal, Ayurvedic, and homeopathic products globally. A **list of current market-available formulations and products containing *Boerhavia diffusa* (Punarnava)** — including powders, capsules, tablets, tinctures,

6. Future Perspectives and Research Gaps

6.1 Need for Clinical Validation and Pharmacokinetic Studies *Boerhavia diffusa* still needs strong clinical confirmation, even though there is a lot of conventional and preclinical evidence for it. Only a small amount of data from human trials supports the majority of pharmacological claims, which are

05	Multi- Herb Blend s	Dabur Punar navad i Mand ur	Anemia and liver disorder	Syrups /tablet s	(Wak odka r SB. 2024)
06	Punar nava extrac t	Merli n natura ls	Liver and kidney protecti ve	Tablet	(Sant hosh S, et.al. , 2023)
07	Biotic Punar nava	Biotic	Liver disorder	Capsul e	(Shar ma S, et. Al., 2021)
08	Punar nava vegan	Deep Ayurv eda	Urinary and detox support	Capsul e	(Ku mar A, Jnan esha AC. 2022)
09	Punar nava	Ecohe rbs	Abdomi nal pain	Tablet	(Dor a BB, et. Al., 2018)
10	Punar nava root powde r	Shou dh online	Electrol yte balane	Powde r / Churn a	(Pan dey S, 2025)
11	Medis ynth Moth er tinctur e	Medis ynth	Cardiop rotectiv e and diuretic	Liquid	(Das S, et. Al., 2023)

based on in vitro or animal models (Sani SK et al., 2020).

Randomized controlled studies that include several centers and are well-designed are essential for determining their safety, effectiveness, and recommended dose. To back up its clinical translation, pharmacokinetic profiling, which includes ADME, or absorption, distribution, metabolism, and excretion, of important components, is crucial (Gaurav et al., 2023).

6.2 Quality Control and Standardization Challenges *B. diffusa* is notoriously difficult to standardize because of its chemical complexity as well as differences in plant sections, geographical sources,

and extraction processes. There is a lack of consistency in the active substance of many current formulations. In order to create quality control techniques that have been validated, it is necessary to use advanced analytical technologies such as HPTLC, LC-MS, and DNA barcoding. Fingerprint profiling and bioactive measurement should also be mandated by regulatory frameworks for herbal goods (Mohammed Abubakar B et al., 2017).

6.3 Scope for Nanoformulations and Combinational Herbal Therapies Using nanotechnology-based carriers, like liposomes, nanoparticles, and phytosomes, can greatly improve the bioavailability and targeted delivery of *B. diffusa*, according to growing studies. Possible negative effects and dosage reductions are also possible with these systems. Also, in the treatment of long-term diseases like cancer, inflammation, or diabetes, there is untapped promise in merging *B. diffusa* with additional herbal extracts that exert complementary effects (Aziz ZA, and Setapar SH., 2020).

6.4 Possibilities of Developing a Medicine from Bioactive Compounds and Molecular Targeting. *Boerhavia diffusa* is one of those plants that can offer new drugs based on its rich chemical composition. Interactions with various targets like COX-2, TNF- α , α -glucosidase, and VEGF were observed using molecular docking and in silico methods. Future research will focus on the identification of the most promising candidates with high affinity to target sites and the evaluation of their drug development potential. These compounds may be used as lead substances for the development of semi-synthetic or NCEs (Chiavaroli A et al., 2023).

7. CONCLUSION

The *Boerhavia diffusa*, commonly called punarnava, is an extremely valuable medicinal herb due to its diverse pharmacological activities. These pharmacological actions of *Boerhavia diffusa*, which are relevant both from the latest scientific point of view and traditional medical practice, include diuretic, nephroprotective, hepatoprotective, cardioprotective, anti-inflammatory, immunomodulatory, antibacterial, antioxidative, and anticancer activities. They are justified by the presence of their complex phytochemical composition, including amino acids (essential and non-essential).

It has gone through a lot of studies by various researchers, and its benefits include, but are not limited to, protection and enhancement of the liver and kidney, anti-inflammatory properties, bactericidal properties, lowering of blood sugar levels, fighting cancer, among others. These trials and products in the market have proven the plant's safety and efficacy in the treatment of metabolic disorders, inflammatory conditions, renal, and hepatic conditions. Nonetheless, the scope of utilization of the herb is still tremendous, with a very obvious gap in translational research. Some of the

critical issues in which much attention includes therapy trials, pharmacokinetics, consistency, and delivery systems. Through interdisciplinary research, it would be possible to close the gaps and verify the traditional claims as well as the use of the plant in modern medicine.

Overall, *B. diffusa* can be seen not only as a traditional asset but as an object that holds much promise for the future development of medicinal plant studies.

Conclusively, there is still much work that needs to be done with respect to the exact mechanisms of action and developing a standardized procedure for obtaining extracts from it, along with proving its efficacy through clinical trials. There is a need to study the derivatives of this *Boerhavia Diffusa* for possible anticancer compounds.

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