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Ophthalmic uses of *Boerhaavia Diffusa L.* (Punarnava): Review

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Abstract

Boerhaavia diffusa L. popularly known as “Punarnava” and ‘Hog weed’ in English, belonging to the family of Nyctaginaceae. Various parts of *B. diffusa* i.e. root, leaves, aerial parts or the whole plant have been employed for the treatment of numerous disorders in Ayurveda and other system of medicine with its mystic effects. Medicinally, punarnava Root is useful as diuretic, anti-inflammatory, hepatoprotective etc. It is used as a single remedy and also as a chief content in many medicinal preparations. Recent reports from all over the world reveals several scientific studies have been conducted on *B.diffusa* shows that existence of a wide range of chemical compounds and having good efficacy in different disorders. The present review summarizes its description, phytochemistry, therapeutic activity, pharmacological activity of the *Boerhaavia diffusa*, which may be helpful to establish a standard natural drug for eye disease.

Keywords: Anti-inflammatory, *Boerhaavia diffusa* L., Diuretic, Eye disease, Punarnava.

1. Introduction

Boerhaavia diffusa (One of the renowned medicinal plant) used to treat large number of diseases as mentioned in Ayurveda. The plant was named as *Boerhaavia diffusa* in honor of Hermann Boerhaave, a famous Dutch physician of the 18th century [1]. The name Punarnava (*Punah punarnava bhawati iti*, in Sanskrit, translates as “that which becomes fresh again and again.”) is probably derived from the perennial habit of the plant, which remains dry and dormant during summer and regenerates from the same old root stock in the rainy season. (*Karoti shariram punarnavam*, in Sanskrit, translates as “that which rejuvenates the body”) [2]. In Charaka Samhita it comes in Vayahsthapana Mahakashaya and in Rasayana prakrana by name of Punarnava. In Sushruta Samhita it is explained in Vidarigandhadi gana, Vatasansamana and Tiktavarga. It has two varieties as described in Ayurvedic text i.e. Swetha/white (*Boerhavia diffusa* L.) and Raktha/red (*Boerhavia verticillata* Poir.) variety of Punarnava. One more variety Nela (blue) Punarnava also be found as mentioned in Rajanighantu. The various parts i.e. root, leaves, aerial parts or the whole plant of *B. diffusa* are used for the treatment of numerous disorders in Ayurveda and other system of medicine with its mystic effects.



Fig 1: *Boerhavia verticillata* Poir.

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2. Pharmacognosy

Scientific Name: *Boerhaavia diffusa* Linn.

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Caryophyllales

Family: Nyctaginace (four o'clock)

Group: Dicotyledons and

Phylum: Angiosperms.

Other Synonyms of this drug are *B. adsendens*, *B. caribaea*, *B. coccinea*, *B. paniculata*, *B. repens* [3].

2.1 Vernacular names

Sanskrit: Punarnava, Raktakanda, Shothaghni, Varshabhu
Telugu: Galigeru, Atikamamidi, Punarnava, English: Spreading Hog weed (Red), horse purslane (White) Hindi: Snathikari Gujarati: Dholia saturdo, Moto-satoda, Tamil: Mukaratee-Kirei, Kannada: Kommegida Marathi: Tambadivasu Bengali: Punarnava.

2.2 Morphology

Boerhaavia diffusa is a perennial creeping weed, prostrate or ascending herb, up to 1 m long or more, having spreading branches. The stem is prostrate, woody or succulent, cylindrical, often purplish, hairy, and thickened at the nodes. Leaves are simple, thick, fleshy, and hairy, arranged in unequal pairs, green and glabrous above and usually white underneath. The shape of the leaves varies considerably – ovate-oblong, round, or subcordate at the base and smooth above [4]. Flowers are minute and subcapitate. These are hermaphrodite, pedicellate, and white, pink, or pinkish-red in color. The roots are stout and fusiform with a woody. This trailing herb is mainly collected after rainy season in India [5].

2.3 Distribution

The genus *Boerhaavia* has several species, and is distributed in the tropical, subtropical, and temperate regions of the world [6]. It is found in Australia, China, Egypt, Pakistan, Sudan, Sri Lanka, South Africa, USA and in several countries of the Middle East. Out of the 40 species of this genus, 6 species are found in India – *B. diffusa*, *B. chinensis*, *B. erecta*, *B. repens*, *B. rependa*, and *B. rubicunda*. It is found throughout the warmer parts of the country up to an altitude of 2000 m in the Himalayan region. It grows well on wastelands and in fields after the rainy season [1].

2.4 Properties

It having madhura, tiktha, kasaya rasa, and madhura vipaka and ushna veerya [7]. This drug has laghu, ruksha property. Swetha Punarnava works as thridoshahara whereas the Raktha Punarnava aggravates the vata dosha and suppresses the pitta dosha. It works like Deepana (Enhance appetite), Shothaghna (Reduce oedema), Kasahara (Alleviates cough), Vayasthapana (Promoter longevity), Rasayana (Rejuvenative), Hridaya (Nourishes the heart), Stambhana (stop bleeding and excessive secretions), Chakshushya (Benefits the eyes), Arshoghna (Reduces haemorrhoids), Grahihara (Alleviates dysentery), Shula prashamana (Alleviates colic), Mutrala (Diuretic), Mutravaha rasayana (Rejuvenation of the urinary system), Ashmarighna (Lithotriptic), Mutrakricchaghna (Alleviates dysuria).

2.5 Adulterants and Substitutes

Market samples of Raktapunarnava (*Boerhaavia diffusa* Linn.) are often adulterated with *Trianthema portulacastrum* Linn.

Two plants are the sources of two different Ayurvedic drugs punarnava and Varshabhu possibly with similar therapeutic effects [8].

3. Research works

Various phytochemical, pharmacological, experimental and clinical investigations are done on Punarnava by many scientist, researchers etc., to clearly understand the different usages. A number of plant products have been identified through phyto-chemistry and the extract of their different plant parts are useful in various diseases without side effects [9].

3.1 Phytochemistry

Chemically the plant contains some bioactive compounds such as flavonoids, alkaloids, steroids, triterpenoids, lipids, lignins, carbohydrates, proteins, and glycoproteins. Punarnavine $C_{17}H_{22}N_2O$ M.P. 236–237 °C [10, 11], Hypoxanthine 9-Larabinofuranoside [12], Ursolic acid [13], Punarnavoside [14], Lirodendrin [15], and a glycoprotein having a molecular weight of 16–20 k Da have been isolated and studied in detail for their biological activity [16].

The herb and roots are rich in proteins and fats. The herb contains 15 amino acids, including 6 essential amino acids, while the root contains 14 amino acids, including 7 essential amino acids. Plant contained large quantities of potassium nitrate, besides punarnavine [17].

The seeds of this plant contain fatty acids and allantoin and the roots contain alkaloids [18]. The green stalk of the plant has also been reported to contain boerhavin and boerhaavic acid [19].

Plant also includes a series Pharmacological Potential of *Boerhaavia diffusa* boeravinones viz., boeravinone A-F. Punarnavoside, a phenolic glycoside, is reportedly present in roots [20, 21].

3.2 Pharmacological and Biological activity

The pharmacological studies have demonstrated that the roots of *B. diffusa* exhibit a wide range of properties such as anti-inflammatory [22], diuretic [23], laxative [24], antiurethritis [25], anticonvulsant [26], antinematodal [27], antifibrinolytic [28], antibacterial [29], antihepatotoxic [30], anthelmintic, antileprotic, antiasthmatic, antiscabby and antistress activities. The leaf extracts from *B. diffusa* has been shown to have hepatoprotective, antioxidant, antinociceptive, antibacterial and antidiabetic properties [31]. Toxicological studies conducted on *B. diffusa* demonstrated the absence of teratogenic and mutagenic effects [32].

3.3 Experimental and Clinical Investigations

3.3.1 Antistress/Adaptogenic/Immunomodulatory activity

Boerhaavia diffusa has the ability to support both adrenal over and under activation. In stressful conditions it has demonstrated the ability to buffer the elevations of serum cortisol and prevent the suppression of the immune system that takes place with elevated cortisol [33].

3.3.2 Antibacterial and very high Antiviral activity

The aqueous and ethanolic extracts of *B. diffusa* leaves had activity on *E. coli*, *S. aureus* and *P. aeruginosa* [34]. The aqueous extracts of large plant materials were prepared and tested in vitro as well as in vivo against phyto-pathogenic viruses on their hypersensitive and systemic hosts. Of the large number of plants screened, *Boerhaavia Diffusa* root extracts were found to have a broad spectrum and very high antiviral activity [35]. So, Punarnava is working in all infective eye diseases due to its anti-microbial activity.

3.3.3 Hypoglycemic activity

A significant decrease in blood glucose and significant increase in plasma insulin levels were observed in daily oral administration of aqueous solution of *Boerhaavia diffusa* L. leaf extract (BLEt) (200 mg/kg) for 4 weeks on blood glucose concentration and hepatic enzymes in normal and alloxan induced diabetic rats [36].

The reduction in blood glucose in streptozotocin-induced NIDDM rats produced by the Chloroform extract of *B. diffusa* leaf is probably through rejuvenation of pancreatic beta-cells or through extra pancreatic action [37]. Punarnava having capacity to rejuvenate the pancreatic beta-cells, and decrease in blood glucose and significant increase in plasma insulin levels. So, punarnava can be effective in diabetic retinopathy.

3.3.4 Anti Fibrinolytic activity

A study evaluated the effect of antifibrinolytic agents; -aminocaproic acid (-ACA), tranexamic acid (AMCA); anti-inflammatory drugs (indomethacin, ibuprofen, naproxen); and plant extract (root extract of *Boerhaavia diffusa*) on endometrial histology of IUD-fitted menstruating monkeys. It is effective in reducing stromal edema, inflammation, and tortuosity of glands, and in increasing the degree of deposition of fibrin and platelets in the vessel lumen [38].

3.3.5 Antiproliferative and Anticarcinogenic activity

There are only few reports which have strongly shown the antiproliferative and anti carcinogenic potential of *B. diffusa* [39].

3.3.6 Antioxidant activity

Excessive generation of free radicals, known as oxidative stress, is one of the major causes of various diseases like diabetes, cancer, cardiovascular diseases etc. There are several antioxidants or plant phytochemicals which are known to ameliorate the various damages caused by oxidative stress [40]. *B. diffusa* possess a rotenoid named boeravinone G, which has been shown to be a very powerful antioxidant and genoprotective agent [41, 42]. The ethanolic extract of *Boerhaavia diffusa* possess preventive and productive role to maintain the cell survival, cellular interaction and maintenance of cell membrane architecture [43].

3.3.7 Anti-inflammatory activity

Ethanol extract of *B. diffusa* leaves have exhibited anti-inflammatory effect with carrageen, serotonin, histamine and dextran induced rat paw edema models, respectively [44].

3.3.8 Hepatoprotective activity

The aqueous root extract of *B. diffusa* also showed the hepatoprotective activity against the toxic effects generated by carbon tetrachloride in the liver [45].

3.3.9 Hypolipidemic activity

In a recent study, all the plasma lipid parameters were found to be significantly increased in hyperlipidemic control rats and administration of *B. diffusa* extract significantly reduced the overall oxidative burden and effectively ameliorated the above altered parameters [40].

The root powder, when mixed with mamira (*Thalictrum foliolosum*), is used to treat eye diseases. It cures corneal ulcers and night blindness [46].

4. Medicinal use

Abdominal Pain, Anemia, Ascites, Asthma, Calculi, Cancer (abdominal), Cataract, Cholera, Cough, Debility, Dropsy,

Dyspepsia, Edema, Fever, Gonorrhoea, Guinea Worms, Hemorrhages (childbirth) Hemorrhages (thoracic) Hemorrhoids, Inflammation (internal), Jaundice, Liver, Heart, Menstrual, Ophthalmic, Renal & Urinary Disorders, Rheumatism, Snakebite, Spleen (enlarged), Weakness, Albuminuria, BeriBeri, Blenorrhagia, Chologogue, Cystitis, Hepatitis, Hydropsy, Nephritis, Sclerosis (Liver), Sterility, Yaws, Erysipelas, Joint Pain, Lumbago, Nephritis, Urticaria, Abscess, Boil, Convulsions, Epilepsy [47].

4.1. Some classical Ayurvedic preparations:

Punarnavasava, Punarnavarita, Punarnavadi mandura, Punarnavadi kvata, Punarnavasataka kvatha, Punarnava kshara, Punarnavadi guggulu, Sukumara ghruta etc.

4.2. Punarnava in Eye Diseases:

Punarnava is also helpful for many eye disorders. Leaf juice with honey, dropped into the eyes for chronic ophthalmia. Punarnava can even be used to treat cataract. Fresh root juice of Punarnava is put into eyes so as to get relief from various eye ailments like night blindness and conjunctivitis. Due to its multi-dimensional activity it adapted as well as a topical agent and orally. In Ayurveda, herbs are taken in combination with other herbs to neutralize the toxicity of one herb or to enhance the particular effect of one herb with the help of other. So, some diseases it's given as a single drug and some cases it's included in compound preparation.

Some Compound preparations having Punarnava as an ingredient and used in eye diseases. Few preparations are collected from different classical texts and tabulated below. (Table 1.)

Table 1: Compound preparations having Punarnava as an ingredient

Text	Compound Preparation	Indication
Baisajya ratnavali [48]	Nayanasonitanjana	Timira, Patala, Puspam
	Nrupativallaba tailam	Timira, Patala, Kacha, Nakthandhya, Arbudam, Divandhyam, Linganasha
	Kanaka taila	Caksu sula
	Taptaraja tailam	Netra sula, Timira
Basavarajeeyam [49]	Karparadyanjana	Timram, Patalam, Kacam, Pushpam
Saranghadhara Samhita [50]	Triphala ghrta	Naktandhya, nakulandhya, kandu, pilla, netrasrava, patala, timira, and kacha.
	Punarnava rasakriya	If Punarnava used as anjana with milk - kandu; with honey - discharge from the eyes; With ghee - puspa (corneal scars); with oil - defects of vision and with kanjika (rice-wash water) - night blindness dispels just like the sun dispels darkness.

Punarnava is mentioned as Pathya in netra roga by baisajya ratnavali.

4.3 Formulations from Gupta vaidya prakasika [51]

Swetha Punarnava root is pasted with different items is having many functions. It's tabulated below. (Table - 2)

Table 2: Root used as Collyrium

Punarnava Root grounded with	Gupta vaidya prakasika	Sarangadhara Samhita
Ghee	Corneal opacity	Corneal opacity
Honey	Watering from eye	Watering from eye
Tila taila	Itching in eye	Cataract
Water or rice flour water	Night blindness	--
Kanjika	--	Night blindness
Milk	Itching in eye	Itching in eye

4.3.1 Few other utilities from Gupta vaidya prakasika

1. Punarnava root, daruharidra is rubbed on stone and applied as collyrium to eyes is cured all eye diseases.
2. Plain punrnava root rubbed on stone and applied to eyes for few days its cure all type of eye diseases.
3. Make a tablet with Powder of Punarnava root (dried in shade) is grounded with honey and water. This tablet applied with water cures all types of swellings in eyelids.
4. Root of Punarnava is grounded with and applied as collyrium cures all types of eye diseases.
5. Punarnava root is wash with cow milk and rubbed with haridra, hareetaki and breast milk. Application of this paste as collyrium clears the corneal ulcer, corneal opacity and cataract within 3 weeks.
6. Root of Punarnava grounded with leaf juice of devakanchana (red verity) is applied as collyrium cures the night blindness.
7. Juice of Swetha Punarnava leaf is put 2 drops in eyes cures all types of cataracts, corneal ulcers, corneal opacities, pterygium and itching in eyes.
8. Punarnavaanjanam: Soveranjana is grounded with juice of Punarnava whole plant for five days (12 hrs per day) is made as tablets and preserved air free container. This collyrium is effectively curing all types of eye diseases.

5. Punarnava as Rasayana

Rasayana drug, rejuvenates the body by cleansing it with its unique property of flushing out the toxins from the body tissues, balances the doshas and cleaning, opening and nourishing the various body channels, so that each and every tissue of the body gets proper nutrition. Traditionally, 'Rasayana' drugs are known to possess strong anti-oxidant activity. Antioxidant effect of active principles of *Boerhaavia Diffusa* reported that anti-stress, immunomodulatory, anti-inflammatory and anti-aging effects produced in experimental animals, and in clinical situations. It is used in Ayurvedic practice by Ayurvedic practitioners for multiple purpose may be because of its potent antioxidant activity since, reactive oxygen species plays important role in many pathological conditions and diseases.

6. Conclusion

It is concluded that *Boerhaavia Diffusa* is used for many eye diseases due to its various medicinal properties. It's detoxifies and excretes the toxins and increase the immune system in the body. And from the above review we can conclude that the plant *Boerhaavia Diffusa* which is having a wide range of medicinal value due to their variety of chemical constituents can be further investigated on toxicological and other parameters to obtain a valuable marketed product. Apart from that the chemical constituents, who were found effective can also be synthetically prepared for better yield and obtain a pharmacophore which may be useful for drug design. However, further extensive biochemical and molecular investigations are needed in order to identify the active components involved in various pharmacological activities.

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