

Review Article

**PUNARNAVA-A NATURAL REMEDY BY AYURVEDA**

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**ABSTRACT**

This review aims to provide comprehensive affirmations on the phytochemical and pharmacological aspects of *Boerhaavia Diffusa*, Nyctaginaceae also known as "Punarnava". It possesses a vast ethnomedical history and represents a phytochemical reservoir of heuristic medicinal value. It is one of the oldest oriental medicines mentioned in Ayurveda as potential remedy for various ailments. The whole plant is rich in glycosides, steroids, flavonoids and also contains various polyphenolic compounds. Many pharmacological studies have demonstrated the ability of its antioxidant, ophthalmic, anti-inflammatory, spermatogenic, aphrodisiac, immunostimulant, hepatoprotective, antiasthmatic, supporting its traditional uses. In this review article, we have focused our interest on phytochemistry, enlistment of phytochemicals, responsible for therapeutic values, traditional uses and its reported pharmacological properties.

**Keywords:** Eye disorders, *Boerhaavia diffusa* (BD), Ayurveda, Ocular, Ophthalmia.

**INTRODUCTION**

The use of medicinal plants is based on the experience of many generations of physicians and traditional systems of medicine from different ethnic societies [1].

Based on the experience of many generations of physicians and traditional systems of medicine from different ethnic societies, medicinal plants have been used to cure many ailments [2]. Indian system of medicine (Ayurveda) is playing a vital role in control and management of various health disorders and it depends on plant resources and used as a whole drug [3]. This is the time to enlist and analyze the phytochemicals which are responsible for therapeutic values found in medicinal plants and scientific validation of folk claims. It may also prove to be a new

discovery of unique biomolecule to cure alarming health disorders [4].

In this regard, we have chosen Punarnava (*Boerhaavia Diffusa*) for establishing its medicinal richness. *Boerhaavia Diffusa* L. (Nyctaginaceae), commonly known as 'Punarnava' in the Indian system of medicine, is a perennial creeping herb found throughout the waste land of India.

The plant has drawn lot of attention due to its uses in Indian Traditional Medicine. The various parts of the plant are used in the treatment of cancer, jaundice, dyspepsia, inflammation, ophthalmic, enlargement of spleen, abdominal pain and as an anti-stress agent [5].

Taxonomical classification, common names and photographs of leaves, flower and plant of (*Boerhaavia Diffusa*) is given in Figure1.



**Fig. 1: Taxonomical classification, common names and photographs of leaves, flower and plant of *BoerhaaviaDiffusa*, Part used: Root, Leaves and seeds [7]., Habitant: Grows as common weed [6].**

**Geographical distribution and habitat**

Genus *Boerhaavia*, consisting of 40 species is distributed in tropical and subtropical regions and warm climate. It is found in Ceylon, Australia, Sudan and Malay Peninsula, extending to China, Africa, America and Islands of the Pacific. Among 40 species of *Boerhaavia*, 6 species are found in India, namely *B. diffusa*, *B. erecta*, *B. rependa*, *B. chinensis*, *B. hirsute* and *B. rubicunda*. *Boerhaavia Diffusa*, in India is

found in warmer parts of the country and throughout up to 2,000 m altitude in the Himalayan region. It is a perennial, spreading hogweed, commonly occurring abundantly in waste places, ditches and marshy places during rains. The plant is also cultivated to some extent in West Bengal [8, 9, 10, 11].

*Boerhaavia Diffusa* is a perennial creeping weed, prostrate or ascending herb, up to 1 m long or more having spreading branches.

The plant grows profusely in the rainy season, and mature seeds are formed in October-November. Due to its sticky nature, the plant gets stuck on the clothes of human beings and on the legs of animals, which helps in its dispersal from one place to another [12].

The shape of the leaves varies considerably - ovate-oblong, round, or sub cordate at the base and smooth above. Margins of the leaves are smooth, wavy, or undulate. The upper surface of the leaves is green, smooth, and glabrous, whereas it is pinkish white and hairy beneath. Leaves are up to 5.5 × 3.3 cm<sup>2</sup> in area. The seeds germinate before the onset of the monsoon [7].

Flowers are minute, usually fascicled or sub umbellate on the ultimate branch lets, pink, white and about 1.5 mm long. These are hermaphrodite, pedicellate, and white, pink, or pinkish-red in color. Bracts are deciduous and involucrate. A perianth is present in the place of a calyx and corolla, which is tubular in shape, the tube being short and narrow at the base and funnel-shaped at the top and constricted above the ovary. There are five lobes, which are small and acute. Two or three stamens are present and are slightly exerted. The stigma is peltate. The achene fruit is detachable, ovate, oblong, pubescent, five-ribbed and glandular, anthocarpous, and viscid on the ribs[6, 7, 8, 13].

The tap root is tuberous, cylindrical to narrowly fusiform to conical or tapering, light yellow, brown or brownish gray. It is thick, fleshy and very bitter in taste. Some workers have studied the regeneration of this plant through tissue culture [13]. Bhansali *et al.* (1978) reported induction of adventitious shoots using stem explants of *B. diffusa*<sup>14</sup>. Roots were also regenerated from the leaf segments of *B. Diffusa* when cultured *in-vitro*.

These roots contained 0.15% alkaloid punarnavine. Increase in levels of indole- acetic acid (IAA) in MS medium reduced the number of roots regenerated from the leaf segment, their length and alkaloid content[15].

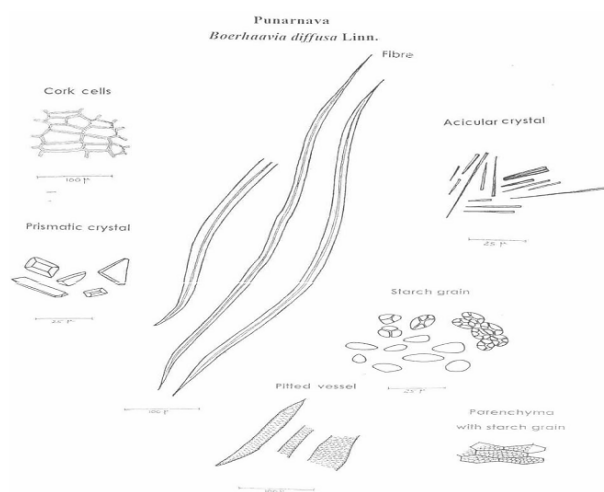
**Microscopic characters**

The powder shows characters like cork cells in surface view, acicular crystals of calcium oxalate up to 50µ in length, prismatic crystals of calcium oxalate about 25µ in length, thin long narrow fibers with sharp pointed ends and narrow lumen measuring up to 800µ in length, simple to 5-compound oval to rounded starch grains measuring up to 15µ in length, simple pitted vessels up to 200µ in length and few parenchyma with starch grains.

In Figure 2.The leaves of plant upper and lower epidermis show the presence of numerous multicellular glandular hairs and anomocytic stomata. Palisade is one layered, spongy parenchyma 2-4 layered, cells polyhedral or isodiametric in shape with distinct intercellular spaces[16].

**Phyto-chemical constituents**

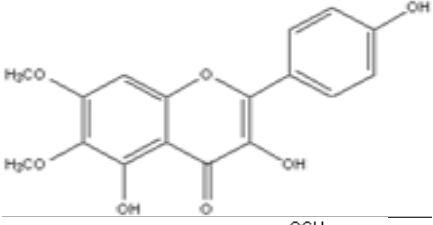
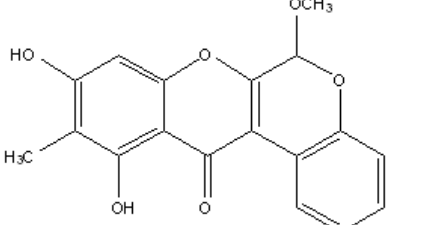
Generally whole plant consists the following phytochemical constituents; those are Punarnavine (Alkaloids), β -sitosterol (Phytosterols), Liriodendrin (lignans), Punarnavoside (Rotenoids), Boerhavine (Xanthenes) and Potassium nitrate (Salts). The roots contain the rotenoidsboeravinones AI, BI, C2, D, E and F besides the new dihydroisofurenoxanthin, Alanine, Arachidic Acid, Aspartic Acid, Behenic Acid, Boerhaavic Acid, Boerhavone, Campesterol, Daucoesterol, Beta-Ecdysone, Flavone, 5-7-dihydroxy-3'-4'-dimetho, XY-6-8-dimethyl, Galactose, Glutamic Acid, Glutamine, Glycerol, Glycine, Hentriacontane N,Heptadecyclic Acid, Histidine, Hypoxanthine-9-l-arabinofuranoside, Leucine, Liriodendrin, Methionine, Oleic Acid, Oxalic Acid, Palmitic Acid, Proline, hydroxyl Serine, Sitosterol Oleate, Sitosterol Palmitate,

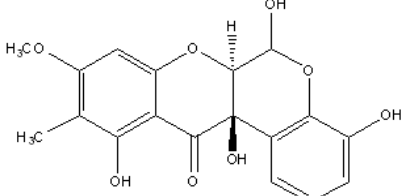
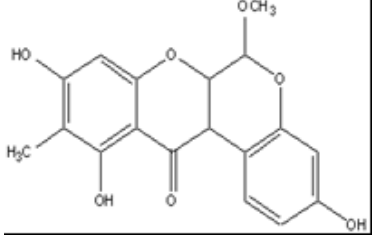
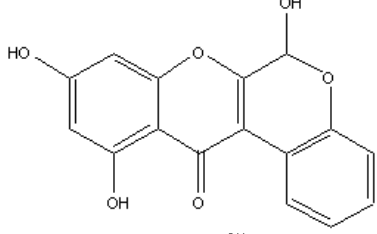
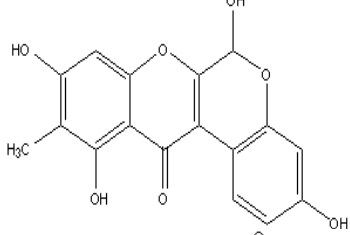
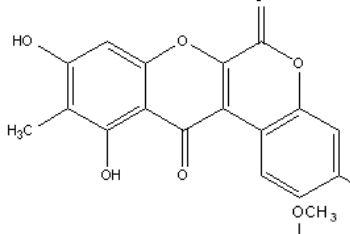
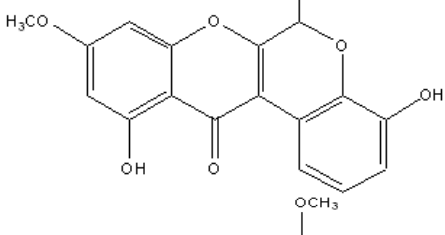
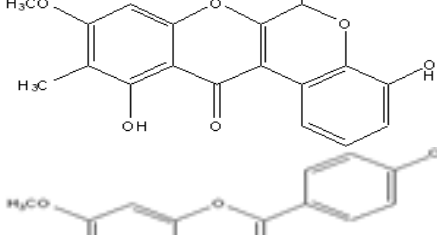
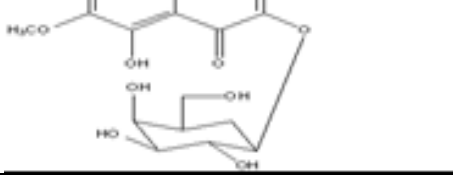


**Fig. 2: Microscopic: characters of powder BoerhaaviaDiffusaLinn**

Stearic Acid, Stigmasterol, Syringaresinol-mono-beta-d-glucoside, Threonine, Triacontan-1-OL, Tyrosine, Ursolic Acid, Valine, Xylose, triacantanolhentriacontane5, 7-dihydroxy-3, 4-dimethoxy-6, 8-dimethyl flavone, and an unidentified ketone (mp 86°). The roots contain the rotenoidboeravinones AI, BI, C2, D, E and F besides the new dihydroisofurenoxanthin and an antifibrinolytic agent, twolignans, liriodendrin and syringaresinol mono-β-D-glucoside, have also been reported in the root [11, 17].

**Table 1: Some important phyto-chemical constituents and mode of action of Punarnava**

S. No.	Name	Chemical Constituents	Mode of action	References
1	Eupalitin		Antioxidant	[9]
2	Boeravinone B		Antistress agent, antihepatotoxic agent.	[11]

3	Boeravinone C		Immunostimulant	[12]
4	Boeravinone D		Immunostimulant	[13]
5	Coccineone B		Spasmolytic effects	[14]
6	Coccineone E		Spasmolytic effects	[15]
7	Boeravinone F		Immunostimulant	[16]
8	Boeravinone G		Anti-oxidant effects	[16]
9	Boeravinone H		Immunostimulant	[17]
10	Rotenoids		Antioxidant, Diuretic, Antifibrinolytic	[16, 18]

### Ethno medicinal uses

**Boerhaavia Diffusa** occupied a reputed position of having valuable medicinal properties in both folk and classical streams of indigenous medicinal systems. It is pungent, astringent and bitter in taste; the various parts of the plant are used in the treatment of cancer, jaundice, dyspepsia, inflammation, enlargement of spleen, abdominal pain and as an anti-stress agent[19].

Medicinal usage on various plant parts of BD in indigenous system of medicines in India and other countries is outlined below:

**LEAVES:** **Punarnava** leaf juice is used in the eyes for topical application<sup>7</sup>. **Punarnava** leaves vegetable is consumed to reduce edema [7]. Leaf juice with honey, dropped into the eyes for chronic ophthalmia [7]. The leaves are useful in dyspepsia, tumors, spleen enlargement; abdominal pains According to Unani system of medicine, the leaves are appetizer, alexiteric, useful in ophthalmia, in joint pains<sup>11</sup>. The leaves of *B. Diffusa* are used as a green vegetable in many parts of India. It cures ulcers of cornea, night blindness and helps to bring back virility in men [20].

**Seeds:** Seeds are tonic expectorant, carminative, useful in lumbago, scabies [7]. The seeds are considered as promising blood purifier<sup>11</sup>. Seeds are used as energizer and for help in digestion[21].

**Roots:** The roots are reputed to be diuretic and laxative and are given for the treatment of anasarca, ascites and jaundice[22]. The root juice is used to cure asthma, urinary disorders, leucorrhea, rheumatism, and encephalitis [23]. *B. Diffusa* roots have been widely used for the treatment of dyspepsia, jaundice, enlargement of spleen, and abdominal pain, and as an anti-stress agent[24]. The worldwide use of *B. Diffusa* roots to treat liver disorders was validated when researchers demonstrated, in 1980 and 1991 that its root extract had antihepatotoxic properties [24].

Punarnava is also valued in ophthalmic disorders, the *Sharangadharasamhita* recommending a *collerium (anjana)* for itching, prepared by mixing the *churna* with milk; mixed with honey to treat ophthalmic discharges; with ghee for corneal wounds; with taila for poor vision; and with rice water (kanjika) for night blindness [25, 26].

### Ayurvedic formulations

Various formulations are available in Ayurvedic texts and the market some of them are listed here:

#### Traditional products [27]

Punarnavasava  
PunarnavadiMandura  
Punarnavasataka  
Punarnavambu  
Punarnava Guggula  
PunarnavasakKwath / Churna  
SukumarGhrit  
SothaghnaLepa

### Ayurvedic marketed ophthalmic products

Itone  
Nayan Jyoti  
Divya Drasti  
Itis

### Contraindications

Punarnava is a laxative; dosage should be determined by a qualified medical professional. Children below 12 years of age and pregnant women should not take this herb [7].

### Therapeutic uses

Herb is used as

- ✓ Diuretic
- ✓ Expectorant
- ✓ Stomachic
- ✓ Prescribed in the treatment of jaundice

- ✓ Given in the loss of digestive power
- ✓ Enlargement of spleen
- ✓ Used for relieving abdominal pains [15,16,17].

### Pharmacological activity

#### Anti-bacterial activity

*YL Ramchandra et al.,2012*[28],proved by evaluating the *in-vitro* antibacterial activity of petroleum ether, chloroform and methanol crude extracts of aerial and root parts from *Boerhaavia Diffusa* plant against six microorganisms like, E.coli ATCC 69314, K. pneumoniae NCIM 2719, P. aeruginosa NCIM 2200, A. tumefaciens NCIM 2943, S.aureus NCIM 2080 and B. subtilis MTCC 441, Which includes Gram-negative and Gram-positive bacteria, by using agar well plate method and reported that, among the three extracts methanol crude extract of aerial part of plant exhibited strong antibacterial activity compared to petroleum ether extract and chloroform extract [28]. The *B. Diffusa* leaves have potent antibacterial activity against various Gram-negative and Gram-positive bacteria which might be due to the phytochemicals present in the leaves [6]. Ethanol extract showed inhibitory effect on gram-positive bacteria like *S. aureus*, *B. subtilis*, *S. faecalis*, *M.luteus* and all gram-negative bacteria selected for the present study. Methanol extract showed inhibitory effect against all gram-positive bacteria selected for the present study except *M. luteus* and gram-negative bacteria like *K.pneumoniae*, *P. vulgaris*, *S.marcescens* and *S. flexneri* the antibacterial activity of the various extracts of the herb of *B. Diffusa*(Linn.) was evaluated by the agar well diffusion method reported by *Murti et al., 2006*[6]

#### Anti diabetic activity

*Nalamolu et al.,2004*[29], developed an alcoholic extract of the whole plant of *B. Diffusa* exhibited hepatoprotective activity against experimentally induced carbon tetrachloridehepatotoxicity in rats and mice. Study investigating the effect of oral administration of an aqueous solution of *B. Diffusa* leaf extract on normal and All oxan-induced diabetic rats showed a significant decrease in blood glucose and a significant increase in plasma insulin levels in normal and diabetic rats. The effect was more prominent than Glibenclamide<sup>29</sup>. Chloroform extract of *B. Diffusa* leaf produced dose-dependent reduction in blood glucose in streptozotocin- induced NIDDM rats comparable to that of glibenclamide. The results indicate that the reduction in blood glucose produced by the extract is probably through rejuvenation of pancreatic beta-cells or through extra pancreatic action [29]. A study was carried out by *Pari et al.,2004* [30],to investigate the effects of 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. A significant decrease in blood glucose and significant increase in plasma insulin levels were observed in normal and diabetic rats treated with BLEt [30].

#### Anti-nociceptive activity

In the acetic acid-induced abdominal writhing in mice, pre-treatment of the animals with naloxone (5 mg/kg) significantly reversed the analgesic effect of morphine and juice but not that of decoction. It is reported that the active anti-nociceptive principle of *B. Diffusa* is present mainly in the juice of fresh leaves and has a significant anti-nociceptive effect when assessed in these pain models [31]. *Hiruma-Lima et al.,2000*[31].

#### Hepatoprotective activity

According to *Rawat et al.,1997* [22],Aqueous root extract of *B. Diffusa* (2ml/kg) possessed marked hepatoprotective activity against thioacetamide induced hepatotoxicity and marked protection against a majority of serum parameters like, GOT, GPT, ACP and ALP but not GLDH and bilirubin. Study also proved that aqueous form of drug (2ml/kg) administration has more hepato-protective activity than the powder form [22].

#### Antiproliferative and antiestrogenic activity:

*Sreeja S et al.,1993* [32],discussed Ant proliferative and anti-estrogenic properties of methanol extract of *Boerhaavia Diffusa* (BME) in MCF-7breast cancer cell lines [32].

### Anti-inflammatory activity

Ethanol extract of leaves at dose of 400mg/kg exhibited maximum anti-inflammatory effect with 30.4, 32.2, 33.9 and 32% with carrageenan, serotonin, histamine and dextran induced rat paw edema models, respectively. Ethanol extract of stem bark also exhibited COX-1 and IC50 value of 100ng/ml proving the drug use in the treatment of inflammatory condition Bhalla *et al.*, 1978 [33]. Anti-inflammatory activity was assessed using extract of latex of plant by using a carrageenan induced inflammatory model Kulkarni *et al.*, 2003 [34].

G.M. Oladele *et al.* 2011 [35], proved the anti-inflammatory and membrane stabilizing effects of the aqueous extract of its roots was evaluated in rats. Carrageenan-induced rat paw oedema model was used for anti-inflammatory effect while rat red blood cells were used for membrane stabilizing property. The extract in doses of 100-400 mg/kg significantly ( $p < 0.05$ ) inhibit carrageenan-induced rat paw oedema in a dose dependent manner. The concentration of 20-80 mg/ml of the extract also showed a dose dependent inhibition of the rat red blood cells hemolysis induced by hypotonic solution. It was concluded that the extract possesses anti-inflammatory as well as membrane stabilizing properties [35].

### Anticonvulsant activity

Study showed the crude methanolic extract of *B. Diffusa* and its liriiodendrin-rich fraction showed a dose-dependent protection against PTZ-induced convulsions Adesina *et al.*, 1979 [36].

### Antistress/adaptogenic/ immunomodulatory activity

Study of ethanol extracts of roots of *B. Diffusa* showed increased stress tolerance in swim endurance test and cold restrains stress. Immuno modulatory activity was shown by increased carbon clearance, indicating stimulation of the reticuloendothelial system. There was an increase in DTH response to SRBC in mice, corresponding to cell mediated immunity and indicating stimulatory effects on lymphocytes and accessory cell types Sumanth *et al.*, 2007 [37].

### Chemopreventive action

Goyal *et al.*, 2010 [38], proved cancer chemo preventive property of *B. Diffusa* was evaluated on 7, 12-dimethyl benz (a)anthracene (DMBA) induced skin papillomagenesis in male Swiss albino mice (6-7 weeks old). This leads to the supposition that the inhibition of tumorigenesis by the plant extract might have been executed either by preventing the formation of active carcinogens from their precursors or by augmenting detoxification process, preventing promotional events in the mouse skin through free radical scavenging mechanism [38].

### Growth inhibition of struvite crystals

This in vitro study had been carried out in the presence of herbal extract of *Boerhaavia Diffusa* Linn. by using single diffusion gel growth technique. Sodium metasilicate solution of specific gravity 1.05 and an aqueous solution of ammonium dihydrogen phosphate of 0.5 M concentration were mixed so that the pH value 7.0 could be set. After the gelation, equal amount of supernatant solution of 1.0 M magnesium acetate prepared with 0.5 and 1 % concentrations of the herbal extract of *B. Diffusa* Linn. were gently poured on the set gels in the respective test tubes in the aseptic medium. The growth of crystals without and with herbal extracts was monitored at regular time intervals. As the concentration of *B. Diffusa* Linn. increased, the inhibition of crystals also increased in the gel media as well as the dissolution of crystals at the gel-liquid interface increases. The degradation of some grown crystals was also noticed Chauhan *et al.*, 2009 [39].

### Nitric oxide scavenging activity

Jagetia *et al.*, 2004 [40], invented the extracts of various polyherbal drugs exhibited dose-dependent NO scavenging activities and the potency was in the following order:

Abana > chyavanaprasha > triphala > geriforte > septilin > mentat > Gingko o biloba. The present results suggest that the traditional Indian polyherbal crude drugs may be potent and novel therapeutic agents

for scavenging of NO, and thereby inhibit the pathological conditions caused by excessive generation of NO and its oxidation product, peroxynitrite. These findings may also help to explain, at least in part, the pharmacological activities like rejuvenating, adaptogenic, anti-infection, anti-inflammatory, cardioprotective and neuroprotective activities of these traditional, clinically used nontoxic drugs, because NO is an important bio regulatory molecule, which has a number of physiological effects including control of blood pressure, neural signal transduction, platelet function, antimicrobial and antitumor activity [40].

### Bronchial asthma

Dried leaves are used in dhoomapana (smoking) in treatment of bronchial asthma. The leaf decoction is an excellent expectorant, when decocted with Punarnava (*Boerhaavia Diffusa*) and then combined with ginger juice and black pepper Sasikala *et al.*, 2009 [41].

### Genetic diversity analysis

According to Shukla *et al.*, 2003 [42], *Boerhaavia Diffusa* is extensively used in herbal medicines as well as in the Ayurvedic system, because it contains a set of clinically important compounds. In the present study, the genetic variability in *Boerhaavia Diffusa* between accessions of different geographical origin within the Indian Territory is assessed through random amplified polymorphic DNA (RAPD) markers. Twenty-eight accessions of *Boerhaavia* were screened with eighteen primers of which nine were found to be the most informative. The degree of polymorphism was found to be high in accessions collected from different places of Uttar Pradesh (Set II) in comparison to other states of India (Set I). A relatively lower level of polymorphism was recorded in accessions collected from diverse locations around Lucknow (Set III). Accessions from neighboring geographical regions exhibited more similarity than those from distant regions (as revealed by the set I analysis). Certain diagnostic markers may be correlated with morphological character (s) such as plant type. BDL appeared most distinct and divergent from the rest of the accessions and the BD plant in set II also showed least similarity estimate [42].

### Anti-viral activity

According to research of Verma and Awasthi *et al.*, 1979 [12], maximum antiviral activity, in each case, was recorded with the aqueous extract of dried root powder applied before virus inoculation. The active principle was purified and isolated. The *Boerhaavia diffusa* plant is reported to possess many pharmacological, clinical, and antimicrobial properties. Recently, it is observed potent antiviral efficacy of this plant against phytopathogenic viruses. The antiviral agent isolated from this plant was found to be a glycoprotein with a molecular weight of 16-20 kDa. Administered by foliar spraying in the field, this antiviral agent could protect some economically important crops against natural infection by plant viruses [12].

### CONCLUSION

As the name affirmed Punarnava (Punar + Nava). Punar means - once again, nava means becoming new, really because of its multiple benefits and pharmacological actions, Punarnava proved itself as magical natural remedy by Ayurveda. Further research needs to be undertaken to establish the authentic activities. Confirmation of these activities will be assured by pharmacological activity on experimental animals.

### future scope

- ✓ Isolation and purification of pure compounds from BD flowers root or leaves.
- ✓ Therapeutic validation of these pure compounds to validate traditional claims.
- ✓ Translation of these findings into a possible therapeutic alternative for human consumption that is potent with minimal side effects.
- ✓ Preclinical toxicological evaluation of various biologically active BD extracts.

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