



Review Paper

## Detail Study on Boerhaavia Diffusa Plant for its Medicinal Importance- A Review

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### Abstract

*Boerhaavia diffusa* is one of the renowned medicinal plants used to treat large number of human ailments as mentioned in Ayurveda, Charaka Samhita, and Sushruta Samhita. The Plant in whole or its peculiar parts (Aerial parts and Roots) have a numerous medicinal properties and are used by endemic and tribal people in India and Unani medicine in Arab countries to show Anti-bacterial, Anti-nociceptive, hepato-protective, hypo-glycemic, anti-proliferative, anti-estrogenic, anti-inflammatory, anti-convulsant, anti-stress and anti-metastatic activities and also in treatment of stress, dyspepsia, abdominal pain, inflammation, jaundice. Various phytochemical, pharmacological, experimental and clinical investigations are done on *Boerhaavia diffusa* by many scientist, researchers etc., to clearly understand the ancient Ayurvedic, Endemic and tribal usage of *Boerhaavia diffusa*. This paper includes the evidence-based overview of pharmacological and phytochemical properties of the aerial parts and the roots of *Boerhaavia diffusa*, which may be helpful to establish a standard natural drug for further research.

**Keywords:** *Boerhaavia diffusa*, ayurveda, unani, pharmacology, phytochemistry.

### Introduction

It is been recorded in history that Medicinal herbs have been used as form of therapy for the relief of pain. The exploration of the chemical constituents from plants, pharmacological and phytochemical screening would provide the basis for developing the new lead molecules in strategic favour of natural product drug discovery. The aim and subject of many researchers is the discovery and development of isolating a new efficient, active and less toxic molecule for systemic activities. The biologically active agents from natural sources have always been of great interest to working on various diseases<sup>1</sup>.

Tribal community are using their traditional knowledge system to cure different diseases. They use plant as a source of drug through trial and error method and the process is experienced over hundreds of years, which says that the medicinal plants have been in the focus as lifesaving drugs right from the beginning of the human civilization. The medicinal plants have been the object of research in both systematic and advanced areas of plant sciences<sup>2</sup>.

The traditional knowledge of these herbal recipes is popular among the indigenous and local communities. Even today the Tribal communities are solely dependent on plants for their medication; hence they are using them against different. They have preserved the wealth of traditional knowledge as a part of

their belief and customs. They are practicing these methods generation after generation successfully<sup>3</sup>.

Apart from medicinal uses phytochemical components which are environment friendly, economical and effectively shows anti corrosive properties<sup>4, 5</sup> and also phyto-compounds are used as biofuels<sup>6, 7, 8</sup>.

*Boerhaavia diffusa* L. (Nyctaginaceae), figure-1 commonly known as 'Punarnava' in the Indian system of medicine, is a perennial creeping herb found throughout the waste land of India. The roots are reputed to be diuretic and laxative and are given for the treatment of anasarca, ascites and jaundice<sup>9</sup>. The *Boerhaavia* sp. has ancient medicinal use in different societies from the times of the B.C. The herbal medicine has evolved and changed through the years. 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<sup>10</sup>.

**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<sup>10</sup>.

**Pharmacognosy: Scientific Name:** *Boerhaavia diffusa* Linn. Syn. *B. repens*; *B. repens* **Family:** Nyctaginaceae, **Family Name:** Hog weed, Horse Purslane, **Common Indian Names** Gujarati: Dholia-saturdo, Moto-satoda. Hindi: Snathikari Kannada: Kommegida Marathi: Tambadivasu Sanskrit: Punarnava, Raktakanda, Shothaghni, Varshabhu Bengali: Punarnava Tamil: Mukaratee-Kirei Telugu: Punernava, **Habitat:** Grows as common weed., **Useful Parts:** Root, leaves and seeds<sup>11</sup>.

**Phytochemistry:** The *Boerhaavia diffusa* plant contains a large number of such compounds as flavonoids, alkaloids, steroids, triterpenoids, lipids, lignins, carbohydrates, proteins, and glycoproteins. Punarnavine C<sub>17</sub>H<sub>22</sub>N<sub>2</sub>O m.p. 236–237°C<sup>12,13</sup>. boeravinone A-F<sup>14,15</sup>, hypoxanthine 9-Larabinofuranoside<sup>16</sup>, ursolic acid<sup>17</sup>, punarnavoside<sup>18</sup>, lirodendrin<sup>19</sup>, and a glycoprotein having a molecular weight of 16– 20 kDa have been isolated and studied in detail for their biological activity<sup>20</sup>. Punarnava also contains arachidic acid, β-Sitosterol, α-2-sitosterol, palmitic acid, ester of β-sitosterol, tetracosanoic, hexacosanoic, stearic, urosilic acid, Hentriacontane, β-Ecdysone, triacontanol etc. Phytochemical screening of the roots from garden-grown in vivo plants of *B. diffusa* of different ages revealed that the

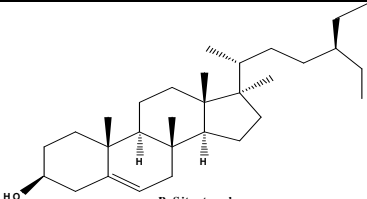
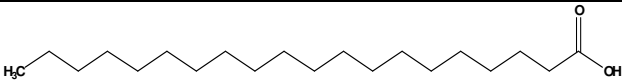
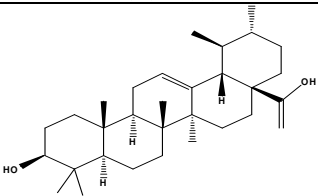
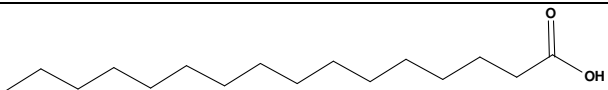
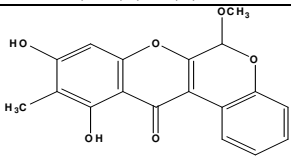
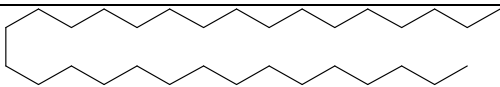
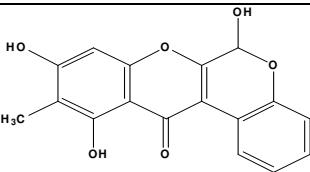
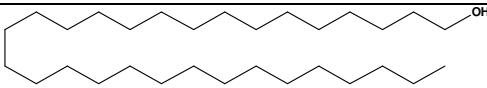
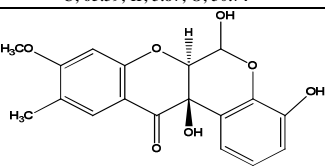
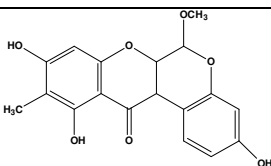
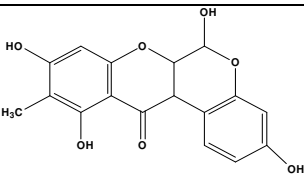
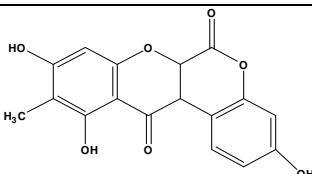
maximum alkaloid content (2%) accumulated in the roots of 3-yearold mature plants. The herb and roots are rich in proteins and fats. The herb contains 15 amino acids, including 6 essential amino acids, while the root contains 14 amino acids, including 7 essential amino acids. Plant contained large quantities of potassium nitrate, besides punarnavine<sup>21</sup>. Previous studies reported the presence of flavonoids, alkaloids, steroids, triterpenoids, lipids, lignins, carbohydrates, proteins and glycoproteins in *B. diffusa*<sup>22, 23, 24</sup>.

**Other Chemical Constituents:** Many rotenoids have been isolated from the roots of the *Boerhaavia diffusa*<sup>25, 26, 27, 28</sup>. Plant also includes a series Pharmacological Potential of *Boerhaavia diffusa* boeravinones viz., boeravinone A, boeravinone B, boeravinone C, boeravinone D, boeravinone E and boeravinone F. Punarnavoside, a phenolic glycoside, is reportedly present in roots<sup>29,30</sup>. C-methyl flavone also has been isolated from *Boerhaavia diffusa* roots<sup>31</sup>. Two known lignans viz., liriiodendrin and syringaresinol mono-β-D-glycoside have been isolated<sup>32</sup>. Presence of a purine nucleoside hypoxanthine 9-L-arabinose<sup>33</sup>, dihydroisofuroxanthone-borhavine<sup>34</sup>, phytosterols<sup>35,36</sup> have been isolated from the plant. It contains about 0.04 % of alkaloids known as punarnavine and punarnavoside, an antifibrinolytic agent. It also contains about 6 % of potassium nitrate, an oily substance, and ursolic acid<sup>37</sup>. The seeds of this plant contain fatty acids and allantoin and the roots contain alkaloids<sup>38</sup>. The green stalk of the plant has also been reported to contain boerhavin and boerhaavic acid<sup>39</sup>.

**Table-1**  
**Botanical Charecteristics of Boerhaavia Diffusa<sup>3</sup>**

%	Boerhaavia diffusa	Boerhaavia elegans
Plant	A perennial herb from a fusiform root	An erect glabrous shrub
Stem	Prostrate, decumbent or ascending, 4-10 cm long, rather slender, divaricately branched	Annual, woody below, glabrous above, thinly pubescent near the base.
Leaves	Opposite or sub-opposite, two of a node unequal, broadly ovate or sub-orbicular, obtuse to rounded or sub-cordate at the base.	Linear-oblong or oblong- lanceolate, obtuse and often mucronulate at the apex.
Flowers	In pendunculate, glomerulate clusters arranged in slender, long stalked, axillary or terminal corymbs	In large, lax, much branched, leafless, glabrous compound cymes above the leaves
Fruit	Ovoid or sub-ellipsoid, rounded above, slightly cuneate, below, broadly and bluntly 5-ribbed, very glandular throughout	
Flowering and Fruiting	Throughout the year in Indian conditions	September to December in Indian conditions

**Table-2**  
**Chemical Constituents of Boerhaavia Diffusa**

 <p><b>β-Sitosterol</b>  <math>C_{28}H_{48}O</math>                  Exact Mass: 428.40                  Mol. Wt.: 428.73                  C, 84.04; H, 12.23; O, 3.73</p>	 <p><b>Arachidic acid</b>  <math>C_{20}H_{40}O_2</math>                  Exact Mass: 312.30                  Mol. Wt.: 312.53                  C, 76.86; H, 12.90; O, 10.24</p>
 <p><b>Urosolic acid</b>  <math>C_{31}H_{50}O_2</math>                  Exact Mass: 454.38                  Mol. Wt.: 454.73                  C, 81.88; H, 11.08; O, 7.04</p>	 <p><b>Palmitic acid</b>  <math>C_{16}H_{32}O_2</math>                  Exact Mass: 256.24                  Mol. Wt.: 256.42                  C, 74.94; H, 12.58; O, 12.48</p>
 <p><b>Boeravinone A</b>  <math>C_{18}H_{14}O_6</math>                  Exact Mass: 326.08                  Mol. Wt.: 326.30                  C, 66.26; H, 4.32; O, 29.42</p>	 <p><b>Hentriacontane</b>  <math>C_{31}H_{64}</math>                  Exact Mass: 436.50                  Mol. Wt.: 436.84                  C, 85.23; H, 14.77</p>
 <p><b>Boeravinone B</b>  <math>C_{17}H_{12}O_6</math>                  Exact Mass: 312.06                  Mol. Wt.: 312.27                  C, 65.39; H, 3.87; O, 30.74</p>	 <p><b>Triacontanol</b>  <math>C_{30}H_{62}O</math>                  Exact Mass: 438.48                  Mol. Wt.: 438.81                  C, 82.11; H, 14.24; O, 3.65</p>
 <p><b>Boeravinone C</b>  <math>C_{18}H_{16}O_7</math>                  Exact Mass: 344.09                  Mol. Wt.: 344.32                  C, 62.79; H, 4.68; O, 32.53</p>	 <p><b>Boeravinone D</b>  <math>C_{18}H_{16}O_7</math>                  Exact Mass: 344.09                  Mol. Wt.: 344.32                  C, 62.79; H, 4.68; O, 32.53</p>
 <p><b>Boeravinone E</b>  <math>C_{17}H_{14}O_7</math>                  Exact Mass: 330.07                  Mol. Wt.: 330.29                  C, 61.82; H, 4.27; O, 33.91</p>	 <p><b>Boeravinone F</b>  <math>C_{17}H_{12}O_7</math>                  Exact Mass: 328.06                  Mol. Wt.: 328.27                  C, 62.20; H, 3.68; O, 34.12</p>

**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. The two species differ widely in their stomatal indices and palisade ratios, *Trianthema portulacastrum* possessing higher values<sup>40</sup>.

**Pharmacological and Biological Activity:** The plant has gained lot of importance in the field of phytochemistry because of its various pharmacological and biological activities such as immunomodulatory effects, immunosuppressive activity, anti-metastatic activity, antioxidant activity, antidiabetic activity antiproliferative and antiestrogenic activity, analgesic and anti-inflammatory activity, antibacterial activity, antistress and adoptogenic activity, antilymphoproliferative activity, nitric oxide scavenging activity, hepatoprotective activity, anti-viral activity, bronchial asthma, anti fibrinolytic activity, chemopreventive action, genetic diversity analysis, anticonvulsant activity.

**Antidiabetic Activity:** The study indicates that *Boerhaavia diffusa* and ethanolic extracts exhibit significant anti-hyperglycemic activities in alloxan induced as well as streptozotocin induced hyperglycemic rats. They can also improve the condition of diabetes as indicated by parameters like body weight along with serum cholesterol and triglyceride levels. The number of functionally intact  $\beta$ -cells in the islet organ is of decisive importance for the development course and outcome of diabetes. The renewal of  $\beta$ -cells in diabetes has been studied in several animal models. The total  $\beta$ -cell mass reflects the balance between the renewal and loss of these cells. It was also suggested that regeneration of islet  $\beta$ -cells following destruction by alloxan may be the primary cause of the recovery of alloxan-injected guinea pigs from the effects of the drug. In alloxan-induced diabetes, (-)Epicatechin and Vinca rosea extracts has also been shown to act by  $\beta$ - cells regeneration. Similar effects in streptozotocin-treated diabetic animals were reported by pancreas tonic, ephedrine, and *Gymnema sylvestre* leaf extracts. In the current studies, the damage of pancreas in streptozotocin-treated diabetic control rats and regeneration of  $\beta$ -cells by glibenclamide was observed. The comparable regeneration was also shown by methanolic extracts of *Boerhaavia diffusa*<sup>41</sup>.

A study was carried out 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<sup>42</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<sup>43</sup>.

**Antibacterial Activity:** A Potent antibacterial activity against gram positive and gram negative bacteria shown by the leaves of *B.diffusa* might be due to the phytochemicals present in the leaves. Ethanol extract showed inhibitory an effect on grampositive 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*<sup>44</sup>.

The antibacterial activity of the various extracts of the stem bark of *Prosopis cineraria* (Linn.) Druce, was evaluated by the agar well diffusion method<sup>45</sup>.

The aqueous and ethanolic extracts of *B. diffusa* leaves had activity on *E. coli*, *S. aureus* and *P. aeruginosa*. This activity occurred at varying concentrations, indicating that the plant extracts contained active principle with broad antibacterial spectrum. *E. coli* displayed the highest susceptibility in ethanolic extract, followed by *S. aureus* and the least susceptible was *P. aeruginosa*. In aqueous extract, *P. aeruginosa* showed the highest susceptibility, followed by *S. aureus* and *E. coli* exhibited the least susceptibility. The antimicrobial activity of the different extracts increased with increase in concentration. The results of the investigations support the ethnomedicinal use of this plant by local practitioners. Results from this study showed that the aqueous and ethanolic extracts of *B. diffusa* had antibacterial activity on *E. coli*, *S. aureus* and *P. aeruginosa*<sup>46</sup>.

**Antistress / Adoptogenic / Immunomodulatory Activity:** Hydroethanolic extract (80%) of *Boerhaavia diffusa* (HEBD) and a polyherbal formulation (Punarnava mandur) PHF-09 containing *Boerhaavia diffusa* were compared for their antistress activity using cold restraint stress model. Stress was induced by subjecting animals to cold restraint. Due to cold restraint stress there was an imbalance in the levels of biochemical parameters like glucose, triglycerides, cholesterol, SGOT, SGPT which were near normalized following the administration of HEBD and PHF-09. HEBD and PHF-09 were found to have comparable anti-stress activity<sup>47</sup>.

The ethanol extracts of roots of *B. diffusa* was evaluated for antistress, adoptogenic activity in albino mice, by swim endurance test and cold restrains stress and the extract showed improved stress tolerance in immunomodulatory 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<sup>48</sup>.

Adaptogens is useful in both adrenal hyperstress as well as adrenal hypofatigue. By definition, an adaptogen implies the capability for bi directional or normalizing effects. The most important adaptogens for the adrenals include *Panax Ginseng*, Siberian Ginseng, Ashwagandha, Rhodiola, *Boerhaavia diffusa*, and Holybasil Leaf Extract. *Boerhaavia diffusa* (PUNARNAVA) 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. On the other hand, *Boerhaavia diffusa* has also demonstrated the ability to improve cortisol levels with end stage adrenal exhaustion<sup>49</sup>.

**Hepatoprotective Activity:** The hepatoprotective activity of roots of different diameters were collected in three seasons, rainy, summer and winter, and examined in thioacetamide intoxicated rats. The results showed that an aqueous extract (2 ml/kg) of roots of diameter 1-3 cm, collected in the month of May (summer), exhibited marked protection of a majority of serum parameters, i.e., GOT, GPT, ACP and ALP, but not GLDH and bilirubin, thereby suggesting the proper size and time of collection of *B. diffusa* L. roots for the most desirable results. Further, the studies also proved that the aqueous form of drug (2 ml/kg) administration has more hepatoprotective activity than the powder form; this is probably due to the better absorption of the liquid form through the intestinal tract. The hepatoprotective activity of *Boerhaavia diffusa* L. roots showed marked protection of serum parameters in thioacetamide toxicity in rats. Furthermore, the aqueous extract of thin roots collected in the summer has more activity suggesting the proper time and type of root collection for the most desirable result. The investigation also validates the use of *B. diffusa* L. roots in hepatic ailments by the several tribes in India<sup>50</sup>.

An alcoholic extract of whole plant *Boerhaavia diffusa* given orally exhibited hepatoprotective activity against experimentally induced carbon tetrachloride hepatotoxicity in rats and mice. The extract also produced an increase in normal bile flow in rats suggesting a strong choleric activity. The extract does not show any signs of toxicity up to an oral dose of 2 g/kg in mice<sup>51</sup>.

**Analgesic / Anti-Inflammatory Activity:** The Decoction (DE) or Juice (JE) of the leaves of *Boerhaavia diffusa* were used to study the antinociceptive effect in chemical (acetic acid) and thermal (hot Plate) models of hyperalgesia in Mice. The DE, raised the pain thresholds during the first period (30 min) of observation. In the acetic acid-induced abdominal writhing in mice, pre-treatment of the animals with naloxone (5 g/kg, i.p.) significantly reversed the analgesic effect of morphine and JE but not that of DE. The study proves that the active antinociceptive principle of *B. diffusa* is present mainly in the juice of fresh leaves and has a significant antinociceptive effect when assessed in these pain models<sup>52</sup>.

Ethanol extract of leaves at dose of 400mg/kg exhibited maximum anti-inflammatory effect with 30.4, 32.2, 33.9 and 32% with carrageenin, 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. Anti-inflammatory activity was assessed using extract of latex of plant by using a carrageenan induced inflammatory model<sup>53</sup>.

**Antitumor Activity:** 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). The cancer chemopreventive efficacy was assessed by its ability to modulate the activities of enzymes associated with drug metabolism and bifunctional modulators reduced the availability of ultimate carcinogen metabolites in the epithelial stage. A significant increase in the activities of hepatic phase I, phase II system enzymes and antioxidant enzymes (glutathione peroxidase, glutathione reductase, superoxide dismutase, catalase and glutathione level) were observed when mice were fed by oral gavage with *Boerhaavia diffusa* extract at a dose level of 125 mg and 250 mg/kg body weight for a period of 14 days in our laboratory. This lead to an assumption 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<sup>54</sup>.

**Anti-Convulsant Activity:** The study was carried out to investigate the methanolic root extract of *B. diffusa* and its different fractions including lirioidendrin-rich fraction for exploring the possible role of lirioidendrin in its anti-convulsant activity. Air-dried roots of *B. diffusa* were extracted with methanol by cold maceration. The methanol soluble fraction of extract thus obtained was successively extracted to obtain lirioidendrin rich fraction and two side fractions, that is, chloroform fraction and phenolic compound fraction. Anti-convulsant activity of methanolic extract and its different fractions, that is, lirioidendrin-rich fraction and phenolic compound fraction were studied in pentylenetetrazol (PTZ)-induced seizures. The crude methanolic extract of *B. diffusa* and only its lirioidendrin-rich fraction showed a dose-dependent protection against PTZ-induced convulsions. The lirioidendrin-rich fraction showed significant protection against seizures induced by BAY k-8644. These findings reiterated the anti-convulsant activity of methanolic extract of *B. diffusa* roots and also it can be concluded that the observed anticonvulsant activity was due to its calcium channel antagonistic action as this activity was retained only in the lirioidendrin-rich fraction, which has additionally been confirmed by significant anti-convulsant activity of lirioidendrin-rich fraction in BAY k-8644-induced seizures<sup>55</sup>.

Study showed the crude methanolic extract of *B. diffusa* and its liriiodendrin-rich fraction showed a dose-dependent protection against PTZ-induced convulsions<sup>56</sup>.

**Antiproliferative and Antiestrogenic Activity:** Antiproliferative and antiestrogenic properties of methanol extract of *Boerhaavia diffusa* (BME) in MCF-7 breast cancer cell lines.

*Boerhaavia diffusa* extracts exhibited a strong inhibitory effect on the proliferation of human breast cancer cells in vitro and the antiestrogenic effects are mediated by ER. Phytochemical studies have revealed the presence of alkaloids, flavonoids, phenols and saponins in BME. The antiestrogenic activity shown by the extract may be attributed to these diverse compounds<sup>57</sup>.

**Cytological Activity:** The extract of *B. diffusa* exhibited a strong depressive effect on the mitosis of *C. jagus* roots. The study was conducted using *B. diffusa* extract, the mitotic index of the control experiment was found to be 5.27. There was a negative correlation between the concentrations of the treatment extracts and the mitotic indices obtained from their action. This points to an inhibition of mitosis by this extract. Inhibition of the mitotic index increased significantly with an increase in the concentration of treatment solution of *B. diffusa*. This again shows a very negative correlation between the concentration of the extract and the mitotic indices produced by the observed action. Owing to the ability of the root extracts of *B. diffusa* to accumulate metaphase and hence inhibit mitosis, it is possible to use these extracts as an alternative to the rather expensive colchicine for cytological studies<sup>58</sup>.

**Bronchial Asthma:** Dried leaves of *Punarnava* can be used in *dhoomapana* in treatment of bronchial asthma. The leaf decoction is said to be an excellent expectorant when decocted with *punarnava* (*Boerhaavia diffusa*) and then combined with ginger juice and black pepper<sup>59</sup>.

**Anti Fibrinolytic Activity:** A study evaluated the effect of anti-fibrinolytic agents;  $\alpha$ -aminocaproic acid ( $\alpha$ -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<sup>60</sup>.

**Antioxidant Activity:** The evaluation of the antioxidant potential of ethanolic extract of *Andrographis echinoides* and *Boerhaavia diffusa* was carried out by determining the levels of enzymatic and non-enzymatic antioxidants. The results showed that both the plant extracts possessed significant levels of enzymatic and non-enzymatic antioxidants. The results of the enzymatic and non-enzymatic antioxidants in *Andrographis echinoides* and *Boerhaavia diffusa* exhibits that they possess

preventive and productive role to maintain the cell survival, cellular interaction and maintenance of cell membrane architecture. *Andrographis echinoides* and *Boerhaavia diffusa* have effective and therapeutic antioxidant potential against various inflammatory diseases<sup>61</sup>.

The study was undertaken to evaluate antioxidant activity of Chloroform, Ethanol, and Ethyl acetate fraction of *Boerhaavia Diffusa L* roots which might have improved its hepatoprotective action. *In vitro* nitric oxide scavenging activity, the percentage inhibition was 71.35%, 33.74%, 23.85% in ethanol, chloroform and ethyl acetate extracts at 250mcg/ml when compared with Curcumin at 62 mcg/ml showed only 84.7% inhibition respectively. The ethanol extract and ethyl acetate showed a biphasic response whereas the chloroform extract showed a dose dependent increase. In DPPH radical scavenging activity, the ethanol extract showed 81.94% inhibition and the chloroform extract showed 42.58% inhibition at 1000mcg/ml compared with 88.02 % inhibition by Quercetin. The above results suggest that roots of *Boerhaavia Diffusa* were found to reveal antioxidant potential which supports the use of this plant in traditional medicine<sup>62</sup>.

**Antiviral Activity:** *Boerhaavia diffusa* has many ethno-botanical uses (the leaves are used as vegetable; the root juice is used to cure asthma, urinary disorders, leucorrhoea, rheumatism, and encephalitis), and is medicinally used in the traditional, Ayurvedic system. Besides, the *Boerhaavia Diffusa* plant is reported to possess many pharmacological, clinical, and antimicrobial properties. Recently, the authors 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.

The aqueous extracts of plant material were prepared and tested in vitro as well as in vivo against phytopathogenic viruses on their hypersensitive and systemic hosts. The botanical identity of each plant was established before the extracts were prepared. Of the large number of plants screened, *Boerhaavia Diffusa* root extracts were found to have a broad spectrum and very high antiviral activity. The aqueous extracts of plant material were prepared and tested in vitro as well as in vivo against phyto-pathogenic viruses on their hypersensitive and systemic hosts. The botanical identity of each plant was established before the extracts were prepared. Of the large number of plants screened, *Boerhaavia Diffusa* root extracts were found to have a broad spectrum and very high antiviral activity<sup>63</sup>.

## Conclusion

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.

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Figure-1  
Boerhaavia Diffusa Leaves