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Review Article

Hepatoprotective activity of *Boerhaavia diffusa* L

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ABSTRACT

Boerhavia diffusa is also known as Punarnava in Ayurveda, which is widely spread during warmer climate throughout the India and other countries. 6 species are available in India of which B. diffusa is one among them. In Ayurveda this plant is used for so many diseases like liver, kidney, heart, diseases. Also it cures different types of cancers caused by different mechanisms. It is also used as antimicrobial, it also deals with other properties. All these properties are due to different essential phytochemical components. Here in this review we have discussed, hepatoprotective activity property of developing protection against injuries, toxicity and other mode which put liver into dangerous condition/ toxicity.

1. Introduction

Boerhaavia diffusa L. known as Punarnava in Ayurveda and 'Hog weed' in English, belonging to the family of Nyctaginaceae. In Ayurveda means one which renews our body and helps to regain the youthness. The genus *Boerhavia diffusa* (often spelled as Boerhaavia) was named in honour of Hermann Boerhaave (1668–1738), an Eighteenth century Dutch botanist, humanist and physician at the University of Leiden, while the species got the name from typical diffuse branching. The botanical name of the plant is often written in the literature as Boerhaavia diffusa,[1] but Linnaeus Latinized Boerhaave's name to Boerhavius and adopted the spelling *Boerhavia diffusa*, which is the correct spelling to be used.[2] Boerhavia is distributed in the temperate, tropical and sub-tropical regions like Asia, U.S.A., and Africa. In India it is found throughout the warmer parts of the country and grows up to 2000 m in the Himalayas.[3] Mainly six species are found in India out of 40 i.e., *B. diffusa, B. chinensis, B. erecta, B. repens, B. rependa, and B. rubicunda.*

The herbal medicine has evolved and changed through the years. Similarly, it has been used in raw form as well as extract form in various disorders.[4] In Ayurveda, this drug is known to be used as *Mootrala* (diuretic), *Sothaghna* (Anti-inflammatory), *Kasahara* (Antitussive), *jwarahara* (antipyretic), *Rasayana* (rejuvenator). The roots have clinical, pharmacological and antimicrobial properties which helps to cure many diseases like diabetes, liver diseases and kidney problems. The antiaging attributes also incorporates being Adaptogenic, Antioxidant and as Immunomodulator. It also has ethno botanical uses as leaves are used as vegetable and juice is made from the roots which cures asthma, urinary disorders, rheumantism etc.,

A number of phytochemicals e.g. flavonoids: (C-methylflavone, 5,7-dihydroxy-3',4'-dimethoxy- 6,8-dimethylflavone, 3,5,4′- dihydroxy-6,7-dimethoxyflavone, 6', 5'-dimethoxy-5,7, 3-trihydroxyflavone, borhavone, 3,3',5-trihydroxy-7-methoxyflavone, 4,7-dihydroxy-3'-methylflavone), alkaloids: punarnavine, glycosides: (punarnavoside, eupalitin 3-O-β-D-galactopyranosyl-(1'2')-O-β-D-galactopyranoside, 3,4- dimethoxyphenyl-

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1-O-β-D apiofuranosyl-(1'3')-O-β-D-glucopyranoside), rotenoids:(boeravinone A-H), steroids, triterpenoids, lipids, lignans, carbohydrates, proteins, and glycoproteins etc., have been reported from the herb. Several researchers have confirmed biological, pharmacological and clinical activities of the plant and its phyto-constituents. [5–8]

1.1. Pharmacognosy

Scientific Name: *Boerhaavia diffusa* Linn.
Kingdom: Plantae
Phylum: Angiosperms
Division: Magnoliophyta
Class: Magnoliopsida
Order: Caryophyllales
Family: Nyctaginace (four o'clock)
Group: Dicotyledons

1.2. Vernacular names

It is called by several different names owing to its wide distribution throughout the world that is, Alena (Hawaii); Ervatostao, Agarra- pinto and Amarra-pinto (Brazil); Hogweed (Barbados); Red spiderling, Spreading hogweed (English); Huang Xi Xin (Chinese); Ipecacuanha de Cayenne (French Guiana); and Hierba de cabra (Spanish).

1.3. In Indian languages

Sanskrit: Punarnava, Raktakanda, Shothaghni, Varshabhu
Kannada: Kommegida, Sanadika, Kommeberu and Komma
Telugu: ErraGaligeru, Atikamamidi, Punarnava,
English: Spreading Hog weed (Red), horse purslane (White)
Oriya: Lalapuiruni, Nalipuruni;
Assamese: Ranga Punarnabha
Kashmiri: VanjulaPunarnava;
Hindi: Snathikari, Gadapurna, Lalpunarnava
Gujarati: Dholiasaturdo, Motosatoda, Dholisaturdi,
Tamil: Mukaratee-Kirei, Mukurattai (Shihappu)
Malayalam: ChuvannaTazhutawa
Marathi: Tambadivasu, Ghetuli, Vasuchimuli, Satodimula, and Khaparkhuti;
Bengali: Punurnava, RaktaPunarnava
Punjabi: ltcit (Ial), Khattan;

1.4. Hepatoprotective Activity

Liver is an important vital organ of the body and protects the body against xenobiotics and it is highly targeted by many toxic and harmful chemicals. Many studies have shown the hepatoprotective activity of BD. [9] Researchers studied that protection against paracetamol induced hepatotoxicity for BD extracts. Jaundice is a disease for which BD has been constantly used either in traditional system of medicine or in ethnopharmacological reports. Also studied against liquor toxicity of liver. Some of the phytoconstituents present in the plant are also responsible for the protection of liver from the foreign bodies/ substances

1.5. Invitro studies

The hydro alcoholic extract of roots of *Boerhavia diffusa* (HEBD) exhibited a significant protective action on liver. 1% HEBD is mixed with 0.5% of 1.0 M magnesium acetate to prepare equal amount of supernatant solution and poured into the gels set in the test tubes in aseptic medium. The growth of crystals without and with herbal extracts was monitored at regular time intervals. The inhibition of crystals increased as the concentration of BD increases in the gel media as well as the dissolution of crystals at the gel-liquid interface increases. The de-fragmentation of some grown crystals was also noticed.

1.6. Animal studies

Olaleye and co-workers evaluated the aqueous and ethanolic extracts of fresh leaves. Animals pre-treated with aqueous ethanolic extracts shows reduction in enzymatic activities serum bilirubin caused by acetaminophen. The increase in alkaline phosphatase was reduced by almost 50% by aqueous and ethanolic extracts (both 400 mg/Kg, orally for 7 days) whereas the increase in ALT and AST was decreased by more than 70% and serum LDH level was restored. The increase in TBARS was also neutralized by aqueous and ethanolic extracts. [10]

Devaki and co-workers studied the effect of ethanolic extract of BD on tissue defence system against ethanol induced hepatic injury in rats. The administration of BD extract (150 mg/kg/day for 30 days, orally) reversed the increase in the levels of lipid peroxides and increased the activities of superoxide dismutase, catalase, glutathione peroxidase, and glutathione-S-transferase and reduced glutathione levels. [11]

Rawat and co-workers reported that the 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, and suggested that the proper size and time of collection of *Boerhavia diffusa* roots for the most desirable results. Further, the study proved that the aqueous form of drug (2ml/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. It has been noted in this study that the roots, which were thin, showed maximum protection of serum parameters. [12]

Chandan and co-workers evaluated the 50% aqueous ethanolic extract of BD whole plant given orally for its hepatoprotective activity in carbon tetrachloride induced hepatotoxicity in rats. The extract significantly decreased the sleeping time from 225 mins to 200 mins induced by CCl4 due to increase in phenobarbitone. It also lowers the SGPT level from 260 μmol/min to 200 μmol/min. It showed reduction of the serum levels of SGPT, SGOT and bilirubin from 270 to 205, 140 to 120, and 1.95 to 1.2 μmol, respectively. It also significantly decreased the increase in prothrombin time induced by CCl4 from 30.43 to 19.01 sec. Also, the bromosulphalein clearance was reduced to 3 times from 16 times by administration of BD extract. It also almost doubles the flow of bile.[13]

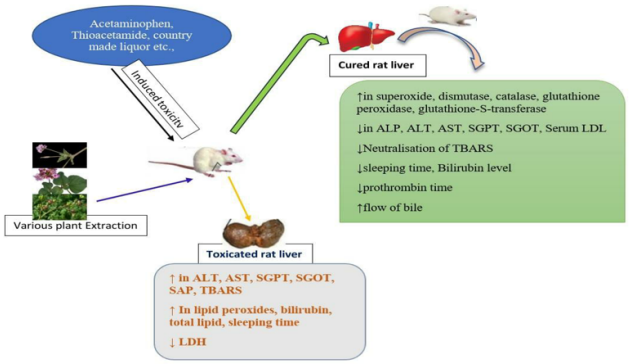

Fig. 1: Mechanism of Hepatoprotection by BDE

Gulati and co-workers prepared 50% aqueous ethanolic extract of BD roots and evaluated hepatoprotection at a dose of 100 mg/100 g in hepatotoxicity induced by country made liquor. BD extract reduced the increment in serum parameters indicative of damage to the liver. The increase in SGPT, SAP, triglycerides, and total lipid levels was decreased by almost 50% by administration of BD extract while the level of cholesterol was completely restored. SGOT level was not much affected. Histopathological study of the liver showed minimal fatty cysts in BD treated group. The author suggested an additional antilipidemic activity along with hepatoprotective activity.[14]

Rajkumari and co-workers also studied that the root extract of the plant have hepatoprotective effect in carbon tetra chloride induced hepatotoxicity in rats, which is evident by modulation in titre of serum alanine aminotransferase (ALT), triglycerides (TG), cholesterol and total lipid.[15]

Chakraborti and co-workers studied the hepatoprotective action and it was evident from the reduction in the increased levels of serum glutamate oxaloacetate transaminase (SGOT), glutamate pyruvate transaminase (GPT) and alkaline phosphatase (ALP) in the treated rats. They also reported that hepatoprotective activity of a steroid androst-5-ene analogue (200 μg/ml) and a flavone 6, 5'-dimethoxy-5, 7, 3'-trihydroxyflavone (50 μg/ml) isolated from the aerial parts against CCl4 intoxication in *in-vitro* models.[16]

Surange and Pendse evidenced that the Ethanol extract of root of *Boerhavia diffusa* have hepatoprotective effect against country made liquor induced liver toxicity in albino rats, the protective effect of same is evidenced by reduction of elevated alanine aminotransferase (ALT), triglyceride, cholesterol and total lipids in both serum and tissues and the histopathological studies showed that marked reduction in fat deposits in animals receiving *Boerhavia diffusa* along with country made liquor.[17]

2. 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. Majorly the leaves and the roots are used earlier for the treatment of jaundice, either in the form of raw powder or decoction form. But later when the pharmaceutical era evolved the whole plant from flower to its roots are used for the treatment of diseases. Numerous reports have supported its protective activity on liver diseases. An invitro study conducted on inhibition of crystal growth in liver showed that mixture of magnesium acetate and the herbal extract had effect on inhibiting the growth of crystals when the concentration of herbal extract was increased, when compared to control which had no herbal extract.

Animal studies confirmed that the ethanolic extract of leaves of the plant increased the levels on ALT, AST and decreased the acetaminophen induced toxicity in rats. In other study conducted on ethanol induced hepatic injury showed that the ethanolic extract increased the serum enzymes like superoxide dismutase, catalase etc., and their activities which confirm the protective activity on hepatic injury.[11]

Rawat and others have worked on roots of plant that are collected in different seasons with different sizes and confirmed that the roots collected during summer with thin size had more protection of serum parameters like GOT, GPT, ACP, ALP conducted on thioacetamide induced liver toxicity in rat and showed more protection.[12] A study conducted on country made liquor induced toxicity in albino rats showed that increase in ALT, TG, total lipid and cholesterol levels and decreased fat deposits, which reduced the toxicity of liver.[17]

All these studies showed that the *Boerhavia diffusa* has protective effect on liver from its diseases. But in vitro tests using laboratory animals and very few clinical studies were available. So, the results obtained may not necessarily be extrapolated to the situation in humans. So further toxicity test on the plant especially during prolonged administration is essential. While there are gaps in the studies conducted so far, which need to be bridged in order to exploit the full

Table 1: Plant part and type of extract used for the Hepatoprotective activity

Plant part used	Type of extract	Type of Induced toxicity	Activity	References
Fresh leaves	Aqueous Ethanolic	Acetaminophen	↓ enzymatic activities ↓Serum bilirubin ↓ALP, ALT, AST ↓Serum LDL ↓Neutralisation of TBARS	10
Plant extract	Ethanolic	Ethanol induced hepatic injury	↑lipid peroxides ↑superoxide, dismutase, catalase, glutathione peroxidase, glutathione-S-tranferase ↓glutathione levels	11
Root	Aqueous	Thioacetamide	Protection of serum parameters like GOT, GPT, ALP, ALP	12
Whole plant	Aqueous	Carbon tetra chloride	↓sleeping time ↓SGPT, SGOT& Bilirubin ↓prothrombin time ↑flow of bile	13
Whole plant	Aqueous	Country made liquor	↑SGPT, SAP, TG, Total lipid level ↓other serum parameters	14
Root	Aqueous	Carbon tetra chloride	Modulation in titre level of serum ALT, TG, Total lipid, cholesterol	15
Aerial parts	phytochemicals	Carbon tetra chloride	↓SGOT, GPT, ALP	16
plant	Ethanol	Country made liquor	↓ALT, TG, Total lipid, cholesterol	17

medicinal potential of *Boerhavia diffusa*, it is very clear that this is a plant with tremendous widespread use now and also with extraordinary potential for the future. Further researchers can take up and continue with the human studies since it has been already used in Ayurveda, and several ayurvedic products are in market with regard to kidney, joints and other disease. Pharmaceutical industries can make a great effort in doing animal and human studies and can evolve with the new pharma products.

3. Conflicts of Interest

All contributing authors declare no conflicts of interest.

4. Source of Funding

None.

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