

MORPHOLOGY, PHYTOCHEMISTRY & PHARMACOLOGICAL PROFILE OF BOERHAVIA DIFFUSA: AN OVERVIEW

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Received: 22 March 2012, Revised and Accepted: 01 May 2012

ABSTRACT

Medicinal plants contribute an important group of non-wood forest products. Large number of the world population uses plants as a source of medicine as Home-Remedy for curative purpose on most of the Health Illness. India has been one of the leading country in the development and practice of indigenous systems of medicine, particularly Ayurveda, Siddha and Unani. The pharmacological potential of Punarnava is mentioned in books like Ayurveda, Charaka Samhita, and SushritaSamhita. Boerhaviadiffusa (Punarnava) is one of the most famous medicinal plants in the treatment of a large number of human ailments. This paper explains the evidence based information on the detail Morphology, Phytochemistry and Pharmacological activity of this plant. In most instances leaf, stem and root extracts has been used to study various activities of the drug. It has many ethno botanical uses (the leaves are used as vegetable, analgesic, antioxidant, antidiabetic; the root juice is used to cure asthma, urinary disorders, leucorrhea, rheumatism, and encephalitis, immunomodulation, hepatoprotective), and many pharmacological potential of drug has been evaluated.⁵

Keywords: Boerhaviadiffusa (Punarnava), Boerhavine, Immunosuppressive activity.

INTRODUCTION

In Ayurveda, Punarnava has many medicinal properties. It is called as Punarnava (Punar + nava). Punar means - once again, nava means - becoming new. This is also known as spiderlings as this plant grows low and spreads like spider. Boerhaaviadiffusa (Nyctaginaceae) commonly known as Raktapunarnava, Shothaghni, Kathillaka, Kshudra, Varshabhu, Raktapushpa, Varshaketu, Shilatikais a herbaceous plant species growing prostrate or ascending upward in habitats like grasslands, agricultural fields, fallow lands, wastelands and residential compounds. The plant was named in honor of Hermann Boerhaave, a famous Dutch physician of the 18th century. Plant dries up during the summer season and regenerates again during the rainy season. Thus the plant generally perennates through the roots in the soil. The whole plant and preferably the roots are effectively used to cure several diseases including Jaundice. The root and aerial parts of Boerhaaviadiffusa were used in ayurveda for the treatment of diabetes. It has many ethnobotanical uses (the leaves are used as vegetable the root juice is used to cure asthma, urinary disorders leukorrhea, rheumatism, and encephalitis), and is medicinally used in the traditional, Ayurvedic system. Besides, the B. diffusa plant is reported to possess many pharmacological, clinical, and antimicrobial properties. Punarnava is an herb, which is very useful for curing kidney diseases.²



Fig. 1: Boerhaaviadiffusa

Scientific Classification

- Botanical Name: Boerhaaviadiffusa
- Family: Nyctaginaceae
- Division: Magnoliophyta
- Class: Magnoliopsida
- Order: Caryophyllales
- Genus: Boerhaavia
- Species: Diffusa, hirsute

Vernacular names of punarnava in various languages

- Linn (Latin)Boerhaviadiffusa, Boerhaaviarepens
- SanskritPunarnava
- Hindi LalPunarnava, Beshakapore, San
- EnglishSpreading Hogweed, Shothagni, Red Hogweed, Raktapunarnava
- BangaliPunarnava
- Punjabi Khattan
- Kannada Kommeberu, Komma

Common Names

ErvaTostão, ErvaToustao, Pega-pinto, Hog Weed, Pig Weed, Atikamaamidi, Biskhapra, Djambo, Etiponia, Fowl's Lice, Ganda'dar, Ghetuli, Katkatud, Mahenshi, Mamauri, Ndandalida, OulouniNiabo, Paanbalibis, Patal-jarh, Pitasudu-pala, Punar-nava, Punerva, Punnarnava, Purnoi, Samdelma, San, Sant, Santh, Santi, SatadiThikedi, Satodi, Spreading Hog Weed, Tellaaku, Thazhuthama, Thikri, Touri-touri, Tshrana, Yoegbe, Beshakapore, Raktpunarnava.^{2,7}

Distribution

The herb is distributed throughout India, Antilles, South America and Africa.

Habitant

This is found throughout India. It grows up to an altitude of 70 centimeters especially during the rainy season. It has a large root system and produces yellow and white flowers. It can be found in many tropical and warm-climate countries.³

Phytochemicals present in punarnava

Generally whole plant consists the following phytochemical constituents; those are punarnavine (Alkaloids), B-sitosterol (Phytosterols), Liriodendrin (lignans), Punarnavoside (Rotenoids),

Boerhavine (Xanthones) and Potassium nitrate (Salts). The roots contain the rotenoidsboeravinones A1, B1, C2, D, E and F besides the new dihydroisofurenoxanthin, Alanine, Arachidic Acid, Aspartic Acid, Behenic Acid, Beta-Sitosterol, BoeravinoneA - F, Boerhaavic Acid, Borhavine, Borhavone, Campesterol, Daucosterol, 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, Proline, hydroxy, Serine, SitosterolOleate, SitosterolPalmitate, Stearic Acid, Stigmasterol, Syringaresinol-mono-beta-d-glucoside, Threonine, Triacontan-1-OL, Tyrosine, Ursolic Acid, Valine, Xylose, triacontanollhentriacontane, β -sitosterol, ursolic acid, 5, 7-dihydroxy-3, 4-dimethoxy-6, 8-dimethyl flavone, and an unidentified ketone (mp 86°). The roots contain the rotenoidboeravinones A1, B1, 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.^{3,6}

Classical Ayurvedic Preparationspunarnavarita

- Punarnavasav
- Punarnavadimandura
- Punarnavasataka
- Punarnavambu
- Punarnavaguggula

Pharmacological and Biological Activity

The plant has drawn lot of attention due to following biological activities.

Immunomodulatory effects

The alkaloidal fraction of Boerhaaviadiffusa was studied for its effect on cellular and humoral functions in mice. Orally administration is significantly inhibited SRBC-induced delayed hypersensitivity reactions in mice. However, the inhibition was observed only during post-immunisation drug treatment, while no effect during pre-immunization drug treatment was observed.¹⁰

Immunosuppressive activity

B. diffusa hexane, chloroform and ethanol extracts, and two pure compounds Bd-I (eupalitin-3-O-h-Dgalactopyranoside) and Bd-II (eupalitin) were evaluated in vitro for their effect on T cell mitogen (phytohemagglutinin; PHA) stimulated proliferation of human peripheral blood mononuclear cell (PBMC), mixed lymphocyte culture, lipopolysaccharide (LPS) stimulated nitric oxide production by RAW 264.7, PHA and LPS induced IL-2 and TNF- α production, in human PBMCs, superoxide production in neutrophils, human natural killer (NK) cell cytotoxicity and nuclear translocation of nuclear factor- κ B and AP-1 in PHA stimulated PBMCs. The chloroform and ethanol extracts inhibited PHA stimulated proliferation of peripheral blood mononuclear cells, two-way MLR, NK cell cytotoxicity as well as LPS induced NO production by RAW 264.7; the hexane extract showed no activity. Bd-I purified from the ethanolic extract at equivalent dose, inhibited PHA-stimulated proliferation of peripheral blood mononuclear cells, two-way MLR and NK cell cytotoxicity as well as LPS induced NO production by RAW 264.7 equally or more effectively than the parent ethanolic extract. Bd-I inhibited production of PHA stimulated IL-2 at the protein and mRNA transcript levels and LPS stimulated TNF- α production in human PBMCs it also blocked the activation of DNA binding of nuclear factor- κ B and AP-1, two major transcription factors centrally involved in expression of the IL-2 and IL-2R gene, which are necessary for T cell activation and proliferation. Our results report selective immunosuppressive activity of *B. diffusa* leaf.¹

Antidiabetic activity

A study was carried out to investigate the effects of daily oral administration of aqueous solution of Boerhaaviadiffusa 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.¹

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.

Anti-metastatic activity

Administration of Punarnavine (40 mg/kg body weight) prophylactically (95.25 %), simultaneously (93.9 %) and 10 days after tumor inoculation (80.1 %) could inhibit the metastatic colony formation of melano main lungs. Survival rate of the metastatic tumor - bearing animals were increased significantly by the administration of Punarnavine in all the modalities compared to the metastasis bearing untreated control. These results correlated with the biochemical parameters such as lung collagen hydroxyproline, uronic acid, hexosamine, serum sialic acid, serum γ glutamyl transpeptidase and serum vascular endothelial growth factor (VEGF) level sand histopathological studies. Punarnavine administration could suppress or down regulate the expression of MMP-2, MMP-signal- regulated kinase) and VEGF in the lung tissue of metastasis-induced animals.

Antioxidant activity

Leaves revealed stronger antioxidant activity than roots, the first analysis of volatile compounds of a widely used medicinal plant, *B. diffusa*, using a HS-SPME-GC-MS technique directly into the headspace of the aqueous extract of the leaves and roots. In addition to phenolic (determined by HPLC-DAD), the organic acids (HPLC-UV) profile and in vitro antioxidant and anti acetylcholinesterase activities are described for the first time, providing further knowledge on this species chemistry and biological potential.

Ethanol and methanol extracts were prepared and screened for in-vitro antioxidant activities using Ferric reducing power and Hydrogen peroxide scavenging activity. The activity was compared to standard antioxidant like ascorbic acid. Both the extract showed strong antioxidant activity in both the methods.

Antiproliferative and Antiestrogenic activity

Treatment with varying concentrations of BME (20-320 μ g/mL) resulted in moderate to very strong growth inhibition in MCF-7 cell lines. BME competed with [3H]-estradiol for binding to ER with IC₅₀ value of 320 \pm 25 μ g/mL. RT-PCR analysis revealed that BME reduced the mRNA expression of pS2 indicating the antiestrogenic action of BME. BME treatment for 48 h resulted in a remarkable increase in the number of MCF-7 cells in the G0-G1 fraction from 69.1% to 75.8 %, with a reciprocal decrease of cells in all other phases indicating cell cycle arrest at G0-G1 phase. The extract of *B. diffusa* was studied for anti-proliferative effects on the growth of HeLa cells and for its effect on cell cycle. Bio-assays of extracts from *B. diffusa* root showed that a methanol: chloroform fraction (BDF 5) had an antiproliferative effect on HeLa cells. After 48 h of exposure, this fraction at a concentration of 200 μ g/mL-1 significantly reduced cell proliferation with visible morphological changes in HeLa cells. Cell cycle analysis suggests that antiproliferative effect of BDF 5 could be due to inhibition of DNA synthesis in S-phase of cell cycle in HeLa cells, whereas no significant change in cell cycle was detected in control cells. The fraction BDF 5 caused cell death via apoptosis as evident from DNA fragmentation and caspase-9 activation. Thus the extract has potential to be evaluated in detail to assess the molecular mechanism-mediated anticancer activities of this plant.^{1,4}

Analgesic and Anti-inflammatory activity

The analgesic property of aqueous extracts obtained from *B. diffusa*, mainly from the leaf juice of the plant. The data also confirmed the traditional indications. The mechanism underlying this analgesic effect remains unknown, but the aqueous extract obtained from leaf juice is endowed with an apparently morphinomimetic central analgesic property.

Antilymphoproliferative Activity

It inhibited T cell mitogen phytohemagglutinin and concanavalin A-stimulated proliferation of human peripheral blood mononuclear cells (PBMC). It also inhibited purified protein derivative antigen-stimulated PBMC proliferation and human mixed lymphocyte culture. In addition, *B. diffusa* extract inhibited the growth of several cell lines of mouse and human origin, such as mouse macrophage cells (RAW 264.7), human macrophage cells (U937), human monocytic cells (THP-1), mouse fibroblast cells (L929), human embryonic kidney cells (HEK293), mouse liver cells (BNLCL.2), African green monkey kidney cells (COS-1), mouse lymphoma cells (EL-4), human erythroleukemic cells (K562), and human T cells (Jurkat).

Anti-viral activity

The *Boerhaaviadiffusa* 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.

Hepatoprotective Activity

The effect of 50 % ethanolic extract of roots of *Boerhaaviadiffusa* on country made liquor (C. M. L.) induced hepatotoxicity was studied in albino rats. *B. diffusa* (100 mg/100 g body weight/day) protected the rats from hepatotoxic action of C. M. L. as evidenced by changes in serum alanine aminotransferase (ALT), Triglycerides (TG), Cholesterol and total lipid levels in both serum and tissues. Histopathological studies showed marked reduction in fat deposits in animals receiving *B. diffusa* along with C. M. L. An alcoholic extract of whole plant *Boerhaaviadiffusa* 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.

Antibacterial Activity

We conclude that the methanol extract of *Boerhaaviadiffusa*, leaves had significant in vitro antimicrobial activity, hence, further results revealed that among several pathogenic bacteria, only *Staphylococcus aureus* was susceptible for *Boerhaaviadiffusa*. In *Boerhaaviadiffusa*, maximum inhibition was observed in *Staphylococcus aureus* followed by *Bacillus megaterium* and *Bacillus cereus* respectively at 50 µl concentration.

Antistress&adoptogenic Activity

The extract improved the stress tolerance by significantly increasing the swim duration & reducing the elevated WBC, blood glucose & plasma cortisol. Immunomodulatory activity was evaluated by carbon clearance & delayed hypersensitivity test. The extract significantly increased carbon clearance, indicating the stimulation of reticuloendothelial system. The extract also produced an increase in DTH response to SRBC in mice.¹²

Nitric Oxide Scavenging Activity

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 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 bioregulatory molecule, which has a number of physiological effects including control of

blood pressure, neural signal transduction, platelet function, antimicrobial and antitumor activity.

Adaptogen Activity

Adaptogens seem to be useful during 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*, *Boerhaaviadiffusa*, and *Holybasil Leaf Extract*. *Boerhaaviadiffusa* (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, *Boerhaaviadiffusa* has also demonstrated the ability to improve cortisol levels with end stage adrenal exhaustion.¹³

Growth Inhibition of Struvite Crystals

This in vitro study had been carried out in the presence of herbal extract of *Boerhaaviadiffusa* 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 defragmentation of some grown crystals was also noticed.¹⁴

Anti fibrinolytic activity

A study that evaluates the effect of anti-fibrinolytic agents; α -aminocaproic acid (α -ACA), tranexamic acid (AMCA); anti-inflammatory drugs (indomethacin, ibuprofen, naproxen); and plant extract (root extract of *Boerhaaviadiffusa*) on endometrial histology of IUD-fitted menstruating monkeys. It is effective in reducing stromal edema, inflammation, & tortuosity of glands, & in increasing the degree of deposition of fibrin & platelets in the vessel lumen.¹

Chemopreventive action

In the present study, cancer chemopreventive 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.¹

Genetic diversity analysis

Boerhaaviadiffusa 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 *Boerhaaviadiffusa* 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 BDJ plant in set II also showed least similarity estimate.

Fragments of 5.62 Kb and 4.47 Kb with primer GN59 was found to be unique for BDP and BD2 having ovate leaf character, whereas ovoid leaf genotype exhibited 0.79 Kb (GN34 primer) fragment.¹

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 (*Boerhaaviadiffusa*) and then combined with ginger juice and black pepper.⁸

TOXICITY

Vomiting may be associated with larger doses of Punarnava. Major thrust by whole of the pharmaceutical industry is focused towards design and development of new innovative/indigenous plant based drugs through investigation of leads from traditional system of medicine recent years, ethno-botanical and traditional uses of natural compounds, especially of plant origin received much attention as they are well tested for their efficacy and generally believed to be safe for human use. It is best classical approach in the search of new molecules for management of various diseases. Thorough screening of literature available on *Boerhaaviadiffusa* depicted the fact that it is a popular remedy among the various ethnic groups, Ayurvedic and traditional practitioners for treatment of ailments.¹

Medicinal use

Healing power and curative properties:

For liver disorders (jaundice, hepatitis, cirrhosis, anemia, flukes, detoxification, chemical injury, etc), for gallbladder disorders (stones, sluggish function, low bile production, emptying, and detoxification), for kidney and urinary tract disorders (stones, nephritis, urethritis, infections, renal insufficiency/injury, etc), for menstrual disorders (pain, cramps, excessive bleeding, uterine spasms, water retention), to tone, balance, and strengthen the adrenals (and for adrenal exhaustion and excess cortisol production and in the treatment of following disorders. The herb has been used in indigenous medicine from time immemorial.¹

Dropsy (edema)

Punarnava increases the secretion and discharge of urine. It is effective in the treatment of dropsy, a disease marked by an excessive collection of a watery fluid in the tissues and cavities or natural hollows of the body. The fresh boiled herb should be given in the treatment of this disease. A liquid extract of the fresh or dry plant can also be given in doses of 4 to 6 gms. The antiedema action is beneficial for congestive heart failure, when it is often administered with arjuna bark.³

Ascites

Ascites is a large belly full of toxic fluid resulting from liver failure. The herb is useful in the treatment of ascites, a disease characterized by accumulation of fluid inside the peritoneal cavity of the abdomen. Punarnava is a much more powerful effect on certain types of ascites which caused due to the cirrhosis of the liver and chronic peritonitis.^{1,3}

Stomach disorders

The herb is useful in strengthening the stomach and promoting its action. It is beneficial in the treatment of several stomach disorders, particularly intestinal colic. A powder of the root is given in doses of 5 gms (1 tsp) three times a day. It is also useful in killing or expelling intestinal worms.³

Asthma

Punarnava promotes the removal of catarrhal matter and phlegm from the bronchial tubes. It is, therefore, beneficial in the treatment of asthma. A powder of the root can be taken in small doses three times a day.³

Fevers and hot flashes

Punarnava is beneficial in the treatment of fevers. It brings down temperature by inducing copious perspiration. A plant with uses in

the Ayurvedic system, including the treatment of jaundice recently.^{1,7}

Skin diseases

The root of the plant is an effective remedy for several skin diseases. A paste of the root can be applied beneficially as a dressing for edematous swellings. A hot poultice of the root can be applied with gratifying results to ulcers, abscesses and similar skin diseases.⁸

Other discomforts

The root of the plant is useful in the treatment of several diseases – particularly of the kidney and heart as well as gonorrhoea. It is also valuable in anemia, cough, pleurisy, nervous weakness, constipation and paralysis. The tender shoots are eaten as a vegetable. The plant has an official status in the Indian Herbal Pharmacopoeia, 2002, as a diuretic and hepato-protective agent¹.

Other pharmacological uses

Abdomen, Abdominal Pain, Anemia, Anthelmintic, Anti-inflammatory, Ascites, Asthma, Blood Purifier, Calculi, Cancer (abdominal), Cataract, Childbirth, Cholera, Cough, Debility, Diuretic, Dropsy, Dyspepsia, Edema, Emetic, Expectorant, Eye, Fever, Food, Gonorrhoea, Guinea Worms, Heart Disease, Heart Ailments, Hemorrhages (childbirth) Hemorrhages (thoracic) Hemorrhoids, Hepatoprotective, Inflammation (internal), Jaundice, Kidney Disorders, Lactagogue, Laxative, Liver, Menstrual, Ophthalmic, Renal, Rheumatism, Snakebite, Spleen (enlarged), Stomachic, Urinary, Urinary, Urinary Disorders, Weakness, Albuminuria, BeriBeri, Blenorrhagia, Chologogue, Cystitis, Gallbladder, Hepatitis, Hepatotonic, Hepatoprotective, Hydropsy, Liver, Nephritis, Sclerosis (Liver), Spleen (enlarged), Urinary Disorders, Childbirth, Sterility, Yaws, Erysipelas, Anti-flatulent, Appetite Stimulant, Joint Pain, Lumbago, Nephritis, Tonic, Urticaria, Abscess, Anti-convulsant, Boil, Convulsions, Epilepsy, Emetic, Expectorant³

ADULTERANTS AND SUBSTITUTES

Market samples of Raktapunarnava (*Boerhaaviadiffusa* Linn.) are often adulterated with *Trianthemafortulacastrum* 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, *Trianthemafortulacastrum* possessing higher values.¹¹

CONCLUSION

The multiple benefits of *Boerhaaviadiffusa* made it a true miracle of nature. Numerous studies have been conducted on different parts of *Boerhaaviadiffusa*, but this plant has not yet developed as a drug by pharmaceutical industries. A detailed and systematic study is required for identification, cataloguing and documentation of plants, which may provide a meaningful way for the promotion of the traditional knowledge of the herbal medicinal plant.

ACKNOWLEDGEMENT

The authors are grateful to Dr.R.Irchhaiya, Head Institute of pharmacy, Bundelkhand University, Jhansi, India for providing the necessary laboratory facilities and we are also thankful with our deepest core of heart to Dr.S.K. Jain for his valuable guidance.

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