

REVIEW ARTICLE

Boerhaavia diffusa from Traditional Use to Scientific Assessment- A ReviewLaxmi Banjare^{1*}, Anand kumar Prasad¹ and M.L. Naik²¹Department of Pharmacy, Sarguja university, Ambikapur-497001, (C.G), India²Department of Farm Forestry, Sarguja University, Ambikapur-497001, (C.G), India

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ABSTRACT:

The present review describes the microscopic, chemical constituents, and pharmacology aspects of *Boerhaavia diffusa* (Nyctaginaceae). This paper explains the evidence-based information regarding the pharmacological activity of this plant. The whole plant or its specific parts (leaves, stem, and roots) are known to have medicinal properties and have a long history of use by indigenous and tribal people in India. *B. diffusa* is used as an Ayurvedic medicine in India and Unani medicine in Arab countries. Herbs play an important role in our day to day life. They were the only source of medicine in olden days. Even today herbs are equally important to modern drugs as they have side effects when compared to synthetic drugs. It may be seen that the ancient Ayurvedic physicians clearly understood the process of digestion and metabolism. *Boerhaavia diffusa* (Punarnava) is one of the most famous medicinal plants in the treatment of a large number of human ailments is mentioned in Ayurveda, CharakaSamhita, and Sushrita Samhita. 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.

Key words: Punarnava, macroscopy, microscopy, pharmacological action.**INTRODUCTION:**

Boerhaavia diffusa L. is a herbaceous member of the family Nyctaginaceae. It is widely distributed in the tropics and subtropics. It has a long history of uses by indigenous and tribal people and in Ayurvedic or natural herbal medicines *Boerhaavia diffusa* L. is a wild perennial herb which may be encountered in different terrestrial habitats, ranging from managed grass lands, waste lands, agro eco systems to large forest gaps. The species of *Boerhaavia* ('Punarnava') have been in use for medicinal purpose in different parts of India. The whole plant and preferably the roots are effectively used to cure several diseases including Jaundice². The root and aerial parts of *Boerhaavia diffusa* were used in Ayurveda for the treatment of diabetes. It has many ethno-botanical 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 a herb, which is very useful for curing kidney diseases. It has English

name also called spread hogweed. It is very useful in curing all type of health problems.

Botanical Name: *Boerhaaviadiffusa* L.**Family:** Nyctaginaceae**Division:** Magnoliophyta**Class:** Magnoliopsida**Order:** Caryophyllales**Family:** Nyctaginaceae**Genus:** *Boerhaavia***Species:** *B. diffusa***Part used:** Root, Leaves and Seeds**VERNACULAR AND SYNONYMS OF PUNARNAVA IN VARIOUS LANGUAGES:**

Syn: *Boerhaaviadiffusa*, *Boerhaaviarepens* Linn; *Punarnava* (Sanskrit); *Lal Punarnava*, *Beshakapore*, *Santh* (Hindi); *Spreading Hogweed*, *Shothagni*, *Red Hogweed*, *Raktapunarnava* (English); *Thazhuthama* (Malayalam); *Punarnnava* (Bangali); *Kommegida* (Kanarese); *Vakhakhaparo*, *Dholia-saturdo* (Gujarati); *Tambadivasu*, *Ghetuli* (Marathi); *Chattarani* (Tamil); *Galijeru* (Telugu); *Lalapuiruni* *Nalipuruni* (Oriya); *Icit* (Ial), *Khattan* (Punjabi);

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Komma (Kannada); *Vanjula*
Punarnava(Kashmiri); *Ranga*
Punarnabha(Assamese).

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.

DISTRIBUTION:

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

DESCRIPTION:

Macroscopic characters of Punarnava

Stem: Greenish purple, stiff, slender, cylindrical, swollen at nodes, minutely pubescent or nearly glabrous, prostrate divaricately branched, branches from common stalk, often more than a meter long.

Root: Well developed, fairly long, somewhat tortuous, cylindrical, 0.2-1.5 cm in diameter, yellowish brown to brown coloured, surface soft to touch but rough due to minute longitudinal striations and root scars, fracture, short, no distinct odour, taste, slightly bitter, sweet, pungent .

Leaves: Opposite in unequal pairs, larger ones 25-37 mm long and smaller ones 12-18 mm long ovate-oblong or suborbicular, apex rounded or slightly pointed, base subcordate or rounded, green and glabrous above, whitish below, margin entire or sub-undulate, dorsal side pinkish in certain cases, thick in texture, petioles nearly as long as the blade, slender.

Flowers: Very small, pink coloured, nearly sessile or shortly stalked, 10-25 cm, in small umbells, arranged on slender long stalks, 4-10 corymb,

axillary and in terminal panicles, bracteoles, small, acute, perianth tube constricted above the ovary, lower part greenish, ovoid, ribbed, upper part pink, funnel-shaped, 3 mm long, tube 5 lobed, stamen 2-3.

Fruit: One seeded nut, 6 mm long clavate, rounded, broadly and bluntly 5 ribbed, viscidly glandular.

Microscopic characters of punarnava

Stem: Transverse section of stem shows epidermal layer containing multi cellular, uniseriate glandular trichomes consisting of 9-12 stalked cells and an ellipsoidal head, 150-220 μ long, cortex consists of 1-2 layers of parenchyma, endodermis indistinct, pericycle 1-2 layered, thick-walled often containing scattered isolated fibres, stele consisting of many small vascular bundles often joined together in a ring and many big vascular bundles scattered in the ground tissue, intra fascicular cambium present.

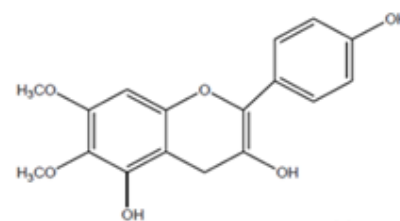
Root: Transverse section of mature root shows a cork composed of thin-walled tangentially elongated cells with brown walls in the outer few layers, cork cambium of 1-2 layers of thin walled cells secondary cortex consists of 2-3 layers of parenchymatous cells followed by cortex composed of 5-12 layers of thin-walled, oval to polygonal cells, several concentric bands of xylem tissue alternating with wide zone of parenchymatous tissue present below cortical regions, number of bands vary according to thickness of root and composed of vessels, tracheids and fibres, vessels mostly found in groups of 2-8 in radial rows, having simple pits and reticulate thickening, tracheids, small, thick walled with simple pits, fibre saseptate, elongated, thick-walled, spindle shaped with pointed ends, phloem occurs as hemispherical or crescentic patches outside each group of xylem vessels and composed of sieve elements and parenchyma, broad zone of parenchymatous tissue, in between two successive rings of xylem elements composed of thin-walled more or less rectangular cells arranged in radial rows, central regions of root occupied by primary vascular bundles, numerous raphides of calcium oxalate, in single or in group present in cortical region and parenchymatous tissue in between xylem tissue, starch grains simple and compound having 2-4 components found in abundance in most of cells of cortex, xylem elements in parenchymatous tissue between xylem elements, simple starch grains mostly rounded in shape and measure 2.75-11 μ in diameter.

Leaves: Transverse section of leaf shows anomocytic stomata on both sides, numerous, a few short hairs, 3-4 celled, present on the margin and on veins, palisade one layered, spongy parenchyma 2-4 layered with small air spaces, idioblasts containing raphides, occasionally cluster crystal of calcium oxalate and orange-red resinous matter present in mesophyll. Palisade ratio 3.5-6.5, stomatal index 11-16, and Vein islet number 9-15.

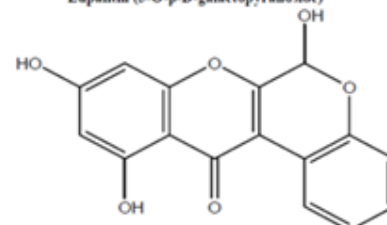
CHEMICAL CONSTITUENTS:

The *Boerhaaviadiffusa* plant contains a large number of such compounds as flavonoids, alkaloids, steroids, triterpenoids, lipids, lignins, carbohydrates, proteins, and glycoproteins. Punarnavine C₁₇H₂₂N₂O m.p. 236–237°C 9-11, boeravinone A-F 12-14, hypoxanthine 9-Larabinofuranoside 15, ursolic acid 16, punarnavoside 17, lirodendrin 18, and a glycoprotein having a molecular weight of 16–20 kDa 19 have been isolated and studied in detail for their biological activity. Punarnava also contains β -Sitosterol, α -2-sitosterol, palmitic acid, ester of β -sitosterol, tetracosanoic, hexacosanoic, stearic, arachidic acid, ursolic acid, Hentriacontane, β -Ecdysone, triacontanoletc Generally whole plant consists the following phytochemical constituents, those are punarnavine (Alkaloids), β -sitosterol (Phytosterols), Liriodendrin (lignans), Punarnavoside (Rotenoids), Boerhavinone (Xanthenes) and Potassium nitrate (Salts). The roots contain the rotenoids boeravinones AI, BI, C2, D, E and F besides the new dihydroisofurenoxanthin, Alanine, Arachidic Acid, Aspartic Acid, Behenic Acid, Beta-Sitosterol, Boeravinone A - F, Boerhaavic Acid, Borhavine, Borhavone, Campesterol, Daucosterol, Beta-Ecdysone, Flavone, 5-7-dihydroxy-3'-4'-dimethoxy, 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, Sitosterol Oleate, Sitosterol Palmitate, Stearic Acid, Stigmasterol, Syringaresinol-mono-beta-d-glucoside, Threonine, Triacontan-1-OL, Tyrosine, Ursolic Acid, Valine, Xylose, triacontanolhentriacontane, β -sitosterol, ursolic acid, 5,7-dihydroxy-3,4-dimethoxy-6,8-dimethyl flavone, and an unidentified ketone (mp 86°). The roots contain the rotenoid boeravinones AI, BI, C2, D, E and F besides the new dihydroisofurenoxanthin and an antifibrinolytic

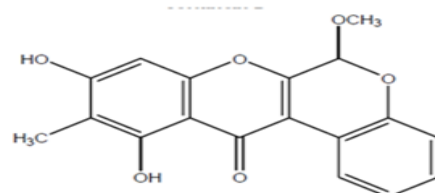
agent, Twolignans, liriodendrin and syringaresinol mono- β -D-glucoside, have also been reported in the roots. Many rotenoids have been isolated from the roots of the *Boerhaaviadiffusa*. Plant also includes a series of boeravinones viz., boeravinone A, boeravinone B, boeravinone C, boeravinone D, boeravinone E and boeravinone F. Punarnavoside, a phenolic glycoside, is reportedly present in roots. C-methyl flavone also has been isolated from *Boerhaaviadiffusa* roots. Two known lignans viz., liriodendrin and syringaresinol mono- β -D-glycoside have been isolated. Presence of a purine nucleoside hypoxanthine 9-L-arabinose, dihydroisofuroxanthone-borhavine, phytosterols 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. The seeds of this plant contain fatty acids and allantoin and the roots contain alkaloids. The green stalk of the plant has also been reported to contain boerhavinone and boerhavic acid.



Eupalitin (3-O- β -D-galactopyranoside) [22]

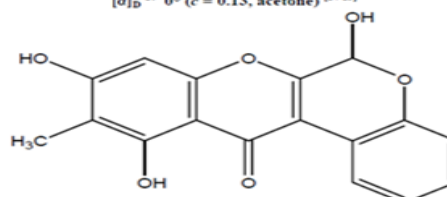


Coccineone B [21]



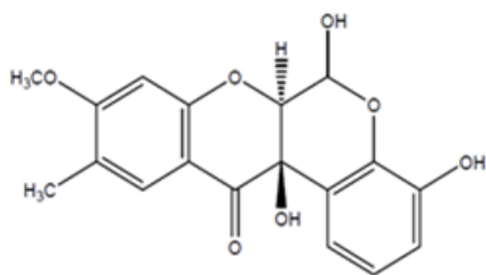
Boeravinone A

M.F. C₁₅H₁₄O₆
M.P. 215–217°C, yellow needles (from CH₂Cl₂-MeOH)
[α]_D²⁰ 0° (c = 0.13, acetone) [24-25]

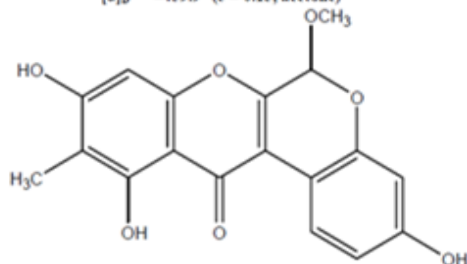


Boeravinone B

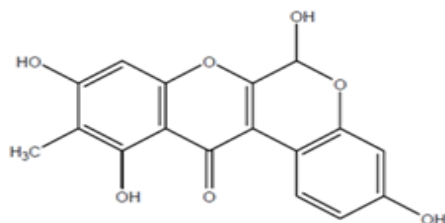
M.F. C₁₇H₁₂O₆
[α]_D²⁰ 0° (c = 1.0, acetone) [24-25]



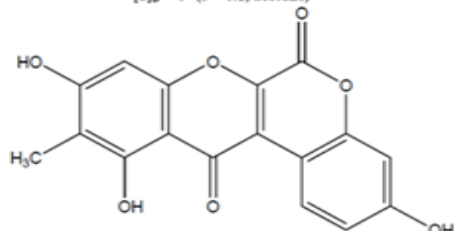
Boeravinone C
M.F. $C_{31}H_{34}O_7$
M.P. 248–249°C, pale yellow needles (from $CHCl_3$)
[α]_D²⁷ -459.9° (c = 0.15, acetone) [24,27]



Boeravinone D
M.F. $C_{31}H_{34}O_7$
[α]_D²⁷ 0° (c = 0.1, acetone) [28]



Boeravinone E
M.F. $C_{31}H_{32}O_7$
[α]_D²⁷ 0° (c = 0.1, acetone) [28]



Boeravinone F
M.F. $C_{31}H_{34}O_7$ [28]

ADULTERANTS AND SUBSTITUTES:

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

PHARMACOLOGICAL AND BIOLOGICAL ACTIVITY:

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-immunisation drug treatment was observed.

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. A research is also carried out to evaluate the immunomodulatory properties of this plant extract on various in vitro tests such as human natural killer (NK) cell cytotoxicity, production of nitric oxide (NO) in mouse macrophage cells, RAW 264.7, interleukin-2 (IL-2), tumor necrosis factor- α (TNF- α), intra-cytoplasmic interferon- γ (IFN- γ) and expression of various cell surface markers on human peripheral blood mononuclear cells (PBMCs). Ethanolic extracts of *B. diffusa* roots inhibited human NK cell cytotoxicity in vitro, production of NO in mouse macrophage cells, IL-2 and TNF- α in human PBMCs. Intracytoplasmic

IFN- γ and cell surface markers such as CD16, CD25, and HLA-DR did not get affected on treatment with *B. diffusa* extract. Hence, it demonstrates immunosuppressive potential of ethanolic extract of *B. diffusa*.

Antidiabetic activity

A study was carried out to investigate the effects of daily oral administration of aqueous solution of *Boerhaavia diffusa* L. leaf extract (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. Chloroform extract of *B. diffusa* leaf produced dose-dependent reduction in blood glucose in streptozotocin- 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. Hence, it demonstrates that *Boerhaavia diffusa* possess antiproliferative and Antiestrogenic properties and suggest that it may have therapeutic potential in estrogen dependent breast cancers.

Analgesic and Anti-inflammatory activity

Ethanol extract of leaves at dose of 400mg/kg exhibited maximum anti-inflammatory effect with 30.4, 32.2, 33.9and 32% with serotonin, histamine and dextran induced rat paw edema models, respectively. Ethanol extract of stem bark also exhibited COX-1 and IC50value of 100mg/ml proving the drug use in the treatment of inflammatory condition³⁰. Anti-inflammatory activity was assessed using extract of latex of plant by using a induced inflammatory model.

Anti lymphoproliferative 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).

Hepatoprotective Activity

The effect of 50 % ethanolic extract of roots of *Boerhaavia diffusa* on country made liquor 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 *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. The hydro alcoholic extract of roots of *Boerhaavia diffusa* (HEBD) exhibited a significant protective action on liverwere 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 de-fragmentation of some grown crystals was also noticed.

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 *Boerhaavia diffusa*) 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.

Chemopreventive action

In the present study, cancer chemopreventive property of *B. diffusa* was evaluated on 7,12-dimethyl benzanthracene (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.

Adaptogenic Activity

Adaptogens seem to be useful during both adrenal hyper stress as well as adrenal hypo fatigue. 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, and Holy basil Leaf Extract. *Boerhaavia diffusa* has the ability to support both adrenal over and under activation. In stressful conditions it has demonstrated the ability to buffer the elevations of serum cortisol and prevent the suppression of the immune system that takes place with elevated cortisol. On the other hand, *Boerhaavia diffusa* has also demonstrated the ability to improve cortisol levels with end stage adrenal exhaustion.

Antibacterial Activity

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

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 phenolics (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. Between these two extracts, ethanolic extract has shown better antioxidant

activity as compared to methanolic extract in both the activities.

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 glutamyltranspeptidase 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. Punarnavine could inhibit MMP-2 and MMP-9 protein expression in gelatin zymographic analysis of B16F-10 cells. These results indicate Punarnavine could inhibit the metastatic progression of B16F-10 melanoma cells in mice. Prophylactic administration of the methanolic extract (0.5 mg/dose) inhibited the metastases formation by about 95 % as compared to untreated control animals. There was 87 % of inhibition in the lung metastases formation in syngenic C57BL/6 mice, when the extract was administered simultaneously with tumour challenge. The total WBC count prior to irradiation was 7500 ± 500 cells/mm³, which was reduced to 1500 ± 500 cells/mm³ in the irradiated control group on day 9 after radiation exposure. But in the *B. diffusa* treated group, irradiated animals showed the lowest count on day 3 after irradiation (4000 ± 400 cells/mm³), where the count for irradiated control animals was 2100 ± 440 cells/mm³. By day 9, the level reached 6250 ± 470 cells/mm³ in *B. diffusa* treated irradiated animals.

TRADITIONAL USES:

Each part has a different therapeutic value and must be prepared in its own way for maximum benefits. This plant rejuvenates liver, male reproductive system and other organ system; detoxifies liver and skin; aphrodisiac; increases libido, erection and quality and quantity of semen; reduces cough, asthma etc. It is used in Vajikarana preparations. This plant cleanses the kidneys and helps to get rid of renal calculi (kidney stones).

Mainly, the roots and the whole plant is used for the medicinal purpose, externally punarnava is used for alleviate the pain and swelling. The fresh juice of its roots instilled into eyes, mitigates the ailments of the eyes like night blindness and conjunctivitis. The paste applied on the wounds, dries up the oozing. Internally, punarnava is beneficial to treat a wide range of diseases. Punarnava is the most commonly used and the best herb to alleviate swelling, due to its potent diuretic property. It boosts up the filtration, rejuvenates the renal functions and takes out the excessive fluids and Kelda by augmenting the urinary output. The sesame oil, medicated with punarnava is very useful as an adjunct to operating enemas in the treatment of ascites of vata type and flatulence. In large doses, punarnava acts as a purgative. Punarnava effectively reduces fever, especially in malaria. The decoction of rasna, sunthi and punarnava is the best panacea for rheumatic swollen joints, as rasna alleviates the pain and vata, sunthi destroys ama and punarnava reduces the swelling. Punarnava enhances the quality of 6 of the 7 categories of bodily tissues, including nutrient plasma (Rasa Dhatu), blood (RaktaDhatu), muscle (MamsaDhatu), fat (MedaDhatu), bone marrow and nerves (MajjaDhatu), and reproductive fluids (ShukraDhatu).

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.

Obesity

The herb has been used in indigenous medicine from time immemorial. Punarnava is highly beneficial in the treatment of obesity as almost all anti-obesity herbal preparations contain it in one or the other form. It is beneficial in the treatment of several common ailments.

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 gm. The anti edema action is beneficial for congestive heart failure, when it is often administered with arjuna bark.

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.

Stomach disorder

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.

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.

Fevers and hot flashes

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

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.

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 innovative/indigenous plant based drugs through investigation of leads from traditional system of medicine recent years, ethnobotanical 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 *Boerhaavia diffusa* depicted the fact that it is a popular remedy among the various ethnic groups, Ayurvedic and traditional practitioners for treatment of ailments. Researchers are exploring the therapeutic potential of this plant as it has more therapeutic properties which are not known.

CONCLUSION:

The multiple benefits of *Boerhaavia diffusa* made it a true miracle of nature. Numerous studies have been conducted on different parts of *Boerhaavia diffusa* 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 plants. In view of the nature of the plant, more research work can be done on humans so that a drug with multifarious effects will be available in the future market.

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