2.1. Vitex negundo Linn.

Figure 2.1 Vitex negundo plant

2.1.1. Classification

- **Kingdom**: Plantae
- **Order**: Lamiales
- **Family**: Lamiaceae
- **Genus**: Vitex
- **Species**: Negundo

2.1.2. Synonyms

*Vitex paniculata*

2.1.3. Vernacular names

- **Hindi** - Sambhalu, Nisinda, Sambhalu
- **Sanskrit** - Shephalika, Nilamanjari, Shvetapushpa, Suvaha,
- **Telugu** - Indhuvara, Vavili, Tella-vavili, Lekkali
2.1.4. Plant part used: Leaf, root, seed

2.1.5. Description of Plant

It is tall about 3 meter, multi branched bushy plant, covered with very fine hair.

The leaf stalk is long having 3-5 leaves at its tip. The margin of leaves is serrated.

The inflorescence, 2-3 inch long and are blue or white coloured with purple tint. Flowering is in the month of June to August and Fruit starts during December.

The fruits are small, and rounded, whitish and blackish in colour.

The root bark is yellow inside and green outside.

Nirgundi is a word derived from Sanskrit which means, protection of the body from diseases. There nirgundi is differentiated into two types blue and white flowered. *Vitex negundo* is blue flowered and *Vitex trifolia* is white flowered.

2.1.6. Geographical distribution

It is indigenous of tropical Africa and Asia. It is indigenous to countries which include India, Afghanistan, Bangladesh, Bhutan, Cambodia, China, Indonesia, Japan, Korea, Kenya, Madagascar, Malaysia, Nepal, Pakistan, Sri Lanka, Thailand, Taiwan, Tanzania, and Vietnam.

2.1.7. Pharmacological activities

The pharmacological activities reported in *Vitex negundo* are as below

2.1.7.1 Antimicrobial Activity
Nyiligira et al., 2008 evaluated antimicrobial properties of *V. obovata*, *V. pooara*, *V. rehmannii* and *V. zeyheri* and it was also checked their various traditional effectiveness to treat wound, malaria and analgesic properties. Mostly significant antimicrobial property was found against Gram positive bacteria and Gram negative bacteria at dose 0.02–8.00 mg/mL, and 0.50–8.00 mg/mL respectively. The above antimicrobial fraction of *V. rehmannii* was further purified to offer a labdane type diterpenoid. The antioxidant activity of all the species failed to show its effectiveness as anti-inflammatory at 100µg/mL. The isolated labdane diterpene and all species showed significant anti-malarial activity.

2.1.7.2. Antifungal Activity

Hernandez et al., 1999 performed anticancer and antifungal properties of *Vitex trifolia* aerial hexane and dichloromethane extracts. The results found that it was significant against different cancer cell lines. The hexane extract exhibited significant antifungal property against fungal Fusarium species.

2.1.7.3. Analgesic activity

Zheng at al., 2009 investigated analgesic properties of *Vitex negundo* L. seeds and its isolated constituents. The analgesic bioactive fraction of the acetoacetate extract offered two lignans i.e. 6-hydroxy-4-(4-hydroxy-3-methoxy-phenyl)-3-hydroxymethyl-7-methoxy-3,4-dihydro-2-naphthaldehyde(1) and vitedoamine A (2). Upon given orally, compound (1), which showed significant analgesic and anti-inflammatory activities in a dose-dependent manner.

2.1.7.4. Anti-inflammatory and Analgesic activity

Gupta and Tandon, 2004 evaluated antinociceptive activity of *Vitex negundo* leaf ethanolic extract at dose 100, 250 and 500mg/kg by using tail flick and acetic acid induced writhing method. The results showed that extract had both central and peripheral analgesic activity.
Dharmasiri et al., 2003 evaluated analgesic, anti-inflammatory, and anti-histamine properties of *Vitex negundo* L. leaves (Verbenaceae). The results were found significant at dose 2.5 and 5 g/kg. The extracts further evaluated for analgesic property by hot plate method at dose 2.5 and 5 g/kg and exhibited most significant activity.

Utpalendu et al., 1999 performed anti-inflammatory activity by using cotton pellet granuloma and carrageenan induced rat paw oedema in rats. The *V. negundo* extract showed significant anti-inflammatory activity in both these models suggesting its acute and sub-acute response.

Telang et al., 1999 evaluated analgesic and anti-inflammatory activity of hydroalcoholic extract of *V. negundo* leaf at dose 500 and 1000mg/kg b.w.by using acetic acid induced writhing test, carrageenan induced rat paw oedema and granuloma pouch method, respectively. The results suggested that the hydroalcoholic extract was found effective as analgesic and anti-inflammatory in subacute inflammation. The activity was due to flavonoid content in the plant extract.

Chawla et al., 1992 performed isolation of four triterpenoids from chloroform extract of *Vitex negundo* seeds and evaluated its anti-inflammatory activity. The results showed significant anti-inflammatory activity.

### 2.1.7.5. Mosquito Larvicidal and mosquito repellent activity

Kannathasan et al., 2011 performed isolation of methyl-hydroxy benzoate from *Vitex trifolia* leaves. It was characterized by NMR and X-ray diffractometer. Pure compound was further evaluated for its larvicidal property against *Culex quinquefasciatus* and *Aedes aegypti* larvae. The isolated compound exhibited 100% larvicidal property.

Hebbalkar et al., 1992 performed mosquito repellence activity of fractions of *V. negundo* oil against *Aedes aegypti*. The protection against the mosquitoes was found significant in most polar fraction and it was for the duration 1-3 hours.

Karunamoorthi et al., 2008 performed evaluation of larvicidal activity against *Culex tritaeniorhynchus* larvae and mosquito repellent activity of *V. negundo*
petroleum ether leaf extract. The results suggested that the extract is effective as larvicidal and mosquito repellent for 6 hour protection time.

2.1.7.6. Antioxidant activity

Tiwari et al., 2007 performed antioxidant activity in polar and nonpolar fraction such as hexane by DPPH, lipid peroxidation and superoxide radical scavenging assay. The results showed the effectiveness as antioxidant in polar fraction and hexane fraction did not show any activity.

Preveen Kumar et al., 2010 performed antioxidant activity by DPPH scavenging assay and evaluated total phenolics and flavonoids present in Vitex negundo leaf. The plant under study exhibited significant antioxidant potential.

Laxmanashetty et al., 2010 performed antioxidant assay of ethanolic extract of Vitex negundo leaf by using DPPH, ferric oxide chelating method. In addition total phenolics and flavonoid content was also studied. The results concluded that the extract was effective as antioxidant due to flavonoids and phenolics.

2.1.7.7. CNS activity

Gupta et al., 1999 performed CNS activity of V. negundo methanolic extract. The extract showed the significant potentiation of sleeping time induced by diazepam, chlorpromazine and pentobarbitone sodium in mice. Therefore concluded as CNS depressant activity. The extract also showed significant anticonvulsant activity induced by strychnine and leptazole.

Tandon and Gupta, 2005 evaluated ethanolic extract of Vitex negundo leaves for its anticonvulsant activity by using MES and PTZ method. The results suggested that the plant extract is active only in PTZ model and found insignificant in MES model.

2.1.7.8. Antibacterial activity
Khokra et al., 2008 performed extraction of volatile oil from leaves and flowers of *V. negundo* and evaluated the oil for its antibacterial activity against various bacterial strain such as *S. aureus, B. subtilis* and *E. coli*. The essential oil showed significant activity against bacteria *B. subtilis* and *E. coli*. Dutta et al., 2009 performed evaluation of antibacterial activity of *Vitex negundo* leaf and bark extracts against Gram positive and Gram negative bacteria. The petroleum ether, chloroform, ethanol and methanol extracts were prepared and subjected for its antibacterial property. The results showed that only ethanol and methanol extract was potential to inhibit the bacterial growth in agar cup, disc diffusion and broth dilution method.

2.1.7.9. Antiandrogenic activity

Bhargava, 1989 evaluated antiandrogenic effect of flavonoid rich fraction obtained from *Vitex negundo* seeds.

2.1.7.10. Anthelmintic activity

Trapti et al., 2009 performed comparative study of ethanolic extracts of *Moringa oleifera* and *Vitex negundo* for its anthelmintic activity. The results showed that *M. oleifera* was found more significant than *V. negundo* extract.

2.1.7.11. Anxiolytic activity

Adnaik et al., 2009 evaluated anti-anxiety activity of ethanolic extract of *Vitex negundo* roots by using elevated plus maze and light dark exploration method. The extract showed significant activity.

2.1.7.12. Hepatoprotective activity

Avadhoot et al., 1991 evaluated hepatoprotective activity of *Vitex negundo* seeds ethanolic extract in carbon tetrachloride induced liver toxicity model. The extract showed significant liver protection.

Tasduq et al., evaluated hepatoprotective activity of isolated constituents from *Vitex negundo* leaves i.e. p’hydroxybenzoylmussachosidic acid by using
carbon tetra chloride induced liver toxicity. The constituent showed significant hepatoprotective effect.

2.1.8. Phytochemical studies

Sundaram et al., 2012 performed isolation of iridoid glucoside from Vitex negundo leaves and evaluated its anti-diabetic property in streptozotocin induced diabetes. The administration of isolated compound orally at 50 mg/kg b.w. once daily for 30 days, significantly reduced the hyperglycemia and results were comparable with standard drug Glibenclamide.

Xin et al., 2013 isolated lignans from Vitex negundo and its anti-cancer property were determined by using SRB assay by using MDA-MB-435 and SMMC-7721 cell lines. The compound EVn-50 exhibited anti-cancer property with the mechanism by arresting cancer cells at G2/M phase in cell cycle.

Zheng et al., 2010 isolated five labdane type diterpenes from Vitex negundo seeds dichloromethane fraction. The compounds were characterized by NMR, IR, and MS spectra. The compound 3 and 5 exhibited strong anti-inflammatory activity.

Ping et al., 2015 isolated vitex negheteroins A–D (phenolic compounds) from Vitex negundo var. Heterophylla seeds. These compounds were further studied for its antioxidant and anti-inflammatory activity and found significant.

Deng et al., 2011 isolated phytonoic acid derivative from the leaves of Vitex quinata (Lour.). The anticancer activity of isolated compounds were evaluated and compound 3 found cytotoxic significant.

Zheng et al., 2011 isolated a new furanofuran lignan, vitelignin A from Vitex negundo seeds. The compounds were identified as (+)-4-oxo-8-hydroxy-2,6-di(3,4-methylenedioxy)phenyl-3,7-dioxabicyclo[3.3.0]octane (1), 4-oxosesamin (2), (+)-sesamin (3), (+)- paulownin (4), 4-hydroxyhesamin (5), 4,8-dihydroxyhesamin (6), 4-oxopaulownin (7), (+)-2-(3- methoxy-4-hydroxyphenyl)-6-(3,4-methylenedioxy)phenyl-3,7dioxabicyclo[3.3.0]octane (8), and (+)-pinoresinol (9), respectively, based on extensive NMR and MS spectra. In-vitro antifungal activity of all the compounds were performed, the compounds 1, 2, and 7 showed moderate antifungal activity.
Jiao, 2014 isolated various compounds from *V. negundo* and structures were characterized by various spectroscopic data. Four compounds were isolated and identified as 2α, 3α, 24-trihydroxyurs-12, 20(30)-dien-28-oic acid-28-O-β-D-glucopyranosyl ester (1), corosolic acid (2), vulgarsaponin A (3) and 2α, 3α, 24-trihydroxyurs-12-en-28-oic acid-28-O-β-D-glucopyranosyl ester (4), respectively.

Lee et al., 2013 isolated three new diterpenes, neolignans from the *Vitex rotundifolia* fruits. The isolated compounds were evaluated for antioxidant activity in RAW264.7 cells. Out of these compounds only 3, 4, 7, 13, 15, 19, and 24 found to inhibit nitric oxide production.

Sathiamoorthy et al., 2007 isolated flavone glycoside from *Vitex negundo* leaves. The antimicrobial activity of the compounds was performed and flavone glycoside 4 and compound 5 were exhibited significant antifungal activity at MIC 6.25 lg/mL.

Tiwari et al., 2013 isolated two sesquiterpenes from *Vitex negundo* L. stem and characterized by NMR and X-ray diffraction.

Ping et al., 2016 isolated phenyl naphthalene type lignans, vitexnegheteroins E-G, triterpene, vitexnegheteroin H from *Vitex negundo* var. Heterophylla seeds. Anticancer properties of these compounds were performed against cancer cell lines, and antioxidant activities for ABTS radical scavenging and results showed significant activity.

Guha et al., 2010 performed extraction of methanolic and aqueous extracts of *Vitex negundo*. The antioxidant activity of above extract was estimated by DPPH and Ferric reducing power assay. Both the extracts showed significant DPPH scavenging, Fe$^{3+}$–Fe$^{2+}$ reduction and percentage decrease in H$_2$O$_2$ induced cytotoxicity. It was concluded that both *V. negundo* extracts exhibited considerable potential of free radical toxicity.

Zheng et al., 2012 isolated sesquiterpenoids containing furan negunfurol, norlabdane-type diterpenoid, negundoal and triterpenoids, negundonorins A and B from *Vitex negundo* seeds. It was further evaluated for its anticancer property against ZR-75-30 cell line and the results exhibited that compound 3 has significant anticancer property.
Manohar et al., 2003 performed isolation of ursolic acid and betulinic acid from leaves of *V. negundo*. Apart from this β-sitosterol, p-hydroxy benzoic acid and n-hentriacontanol were also isolated. The antifeedant and antibacterial activity of the above isolated constituents was performed and results showed that ursolic acid was found effective than betulinic acid as antifeedant but failed to show any antibacterial activity. The β-sitosterol, p-hydroxy benzoic acid and n-hentriacontanol showed little antifeedant activity and did not show any antibacterial activity.

Diaz et al., 2003 performed isolation of vitexicarpin from *Vitex negundo* chloroform fraction. Further Vitexicarpin was acylated and methylated to yield 9 compounds which were new and further studied for its anticancer property *in-vivo*. The results showed that these compounds were found insignificant as anticancer.

Ono et al., 2004 performed isolation of lignan compound vitedonin and lignin alkaloid known as vitedoamine from the *Vitex negundo* seeds. Further antioxidant activity of these compounds were performed by ferric thiocyanate method and were found significant antioxidant when compared with α-tocopherol as a reference standard.

Chawla and Dhar, 1992 performed isolation of lignin from *Vitex negundo* seeds and it was characterised by various spectroscopic methods.

Achari et al., 2001 performed and characterised new isoflavonone from *Vitex negundo* leaves.

Singh et al., 1999 performed isolation of essential oil from *Vitex negundo* leaf and the constituents were characterized by GC MS study and it was found that total 65 compounds were identified in which viridiflorol was reported first time in this plant.

Zheng et al., 2009 performed isolation of various constituents from *Vitex negundo* seeds from ethanolic extract. The analgesic activity of the extract was done by using acetic acid induced writhing test. The extract was further fractionated to offered lignans. The lignans were also examined for its effect as anti-inflammatory and analgesic. The results suggested that lignans showed significant activity.
Mohmud et al., 2009 performed antifungal activity of ethanolic extract of Vitex negundo seeds against various strains of fungi. The extract showed significant action against Fusarium solani and moderate action in Candida albicans.

Sehgal et al., 1983 isolated iridoid glucoside from Vitex negundo ethanol extract and which has been characterised as 6-p’hydroxybenzoylmussachosidic acid.

2.1.9. Traditional uses

Leaves are used as ant-inflammatory in the treatment of the joints from acute rheumatism and also over sprained limbs, leech bites etc. fresh leaves are heated on earthen pot and applied to affected area to get relief from pain. Leaves bruised are applied to relief from headache. Dried leaves when smoked are used to relieve catarrh and headache. Paste of leaves applied as plaster to enlarged spleen. The decoction of leaves along with black pepper is given in the treatment of fever (Bhavprakash, 1998).

Powdered root is given in treatment dysentery, bronchitis, cough, rheumatism, worms, and leprosy.

Flowers are given in diarrhoea, cholera, fever and liver diseases and cardiac tonic. Blood discharge can be stopped by administration of powder of flowers and stalks. In mysore, febrile, catarrhal and rheumatic affections are treated by means of a vapour bath prepared with this plant (Nadkarni, 2007; Longmann, 2005).

2.1.10. Phytoconstituents reported

The reported chemical constituents from Vitex negundo are phenol, para hydroxyl benzoic acid, monoterpenes, β-sitosterol, aucubin, orientin, vitricine, camphene, and artemetin. It also contains casticin, chrysophanol and vitexin (Khare, 2007).
2.1.11. Chemical Structure of Major Constituents

- **Artemetin**

- **(+)-(−)-Pinoresinol**

- **(+)-Luyoniresinol**

- **(+)-Lyoniresinol-3αA-O-βB-Glucoside**
(+)-Syringaresinol

(E)-Nerolidol

β-caryophyllene

1-oceten-3-ol
4-terpineol

5,3-dihydroxy-7,8,4'-trimethoxy flavone

5-hydroxy-3,6,7,3'-pentamethoxy flavone

Acetyl oleanolic acid
\[ \text{β-Sitosterol} \]

\[ \text{Caryophyllene epoxide} \]

\[ \text{Caryophyllene oxide} \]
Casticin

Friedelin

Germacren-4-ol

Germacrene D
Globulol

Isoorientin

Isovitexin

luteolin-7-O-Glucoside
Negundin A

Negundin B

P-cymene

P-hydroxy benzoic acid
Valencene

Viridiflorol

Vitedoin A

Vitedoin B
γ-terpinene

δ-guaiene
References


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2.2. **Boerhavia diffusa** Linn.

![Boerhavia diffusa plant](image)

**Figure 2.2 Boerhavia diffusa plant**

### 2.2.1. Classification

- **Kingdom** - Plantae
- **Division** - Magnoliophyta
- **Class** - Magnoliopsida
- **Order** - Caryophyllales
- **Family** - Nyctaginaceae
- **Genus** - Boerhavia
- **Species** – Diffusa

### 2.2.2. Synonyms

*B. erecta, B. procumbeno, B. repens*

### 2.2.3. Common Names

- **Telugu** - Atikamamidi
2.2.4. Plant part used: Whole plant, root, leaf

2.2.5. Description of Plant

The plant 0.75-1m in length and is perennial herb which has creeping and purple colour stem.

Leaves are short petiolate, simple, opposite, and in unequal pairs, shape is ovate oblong, acute, rounded at base.

Flowers are small and pink colored small short stalked, in irregular clusters of terminal panicles.

Fruits are nuts which are one seeded, round, about 1cm long.

Roots are long, circular and yellowish brown to brown in colour, surface is twisted on drying. It is soft to touch but presence of minute longitudinal markings causes it to rough, root scars are present, fracture is short. Plant flowering and fruiting during winter. It has two varieties Red Punarnava and White Punarnava (Longman, 1994).

2.2.6 Geographical distribution

It is indigenous of India and found throughout warmer region of the country. It is found in India, Australia, Pakistan, Srilanka, South Africa, Brazil, USA, Myanmar and China (Bhavprakash, 1998).
2.2.7. Pharmacological activities

2.2.7.1. Anti-angiogenic activity

Saraswati et al., 2013 performed isolation of punarnavine, from *Boerhavia diffusa* and evaluated its anticancer property by using Ehrlich ascites carcinoma tumor. It was found that Punarnavine was significantly potent at dose of 15 mg/kg b.w. treatment and exhibited dose dependent anticancer property.

2.2.7.2. Review

Narayana et al., 2017 reviewed ethnopharmacological relevance of Chyawanprash (CP). It is being used as immunomodulator from time being. This review focused on clinical safety and efficacy studies of CP published in the various texts and also briefed on its preparation.

2.2.7.3. Nanoparticle preparation and antibacterial activity

Vijay Kumara et al., 2014 prepared silver nanoparticles of *Boerhavia diffusa*. The prepared AgNPs were evaluated for its antibacterial activity against *Aeromonash hydrophila*, *Pseudomonas fluorescens* and *Flavobacterium branchiophilum* and significant activity was found against *F. Branchiophilum* only.

2.2.7.4. Anti-metastatic activity of Punarnavine

Manu and Kuttan, 2009 isolated Punarnavine from *Boerhavia diffusa* Linn. and it was studied for its anti-metastatic activity using B16F-10 melanoma cells. Administration of Punarnavine at dose 40mg/kg b.w. significantly inhibited the formation of metastatic colony in lungs.

2.2.7.5. Anti-proliferative and Anti-estrogenic effects

Sreeja et al., 2009 evaluated *Boerhavia diffusa* for its anti-proliferative and anti-estrogenic properties. The results exhibited that at dose 20–320µg/mL resulted significant inhibition of growth of MCF-7 cell lines.
Mehrotra et al., 2002 evaluated anticancer and antiproliferative activity of ethanolic extract of *Boerhavia diffusa* in several cells. The same effects were also evaluated in mouse and human cells. The extracts demonstrated significant effect.

### 2.2.7.6. Hepatoprotective activity

Rawat et al., 1997 evaluated hepatoprotective activity of *Boerhavia diffusa* L roots collected in seasons and of various sizes. The results showed that aqueous extract of roots 1-3 cm size collected in May month at dose 2 mL/kg of exhibited strong protection in all the parameters of hepatoprotection.

Chandan et al., 1991 performed evaluation of hepatoprotection of aerial parts of *Boerhavia diffusa* alcoholic extract against CCl₄ induced toxicity. The extract found significant hepatoprotective without any toxicity at maximum dose of 2g.

### 2.2.7.7. Immunomodulator activity

Mungantiwar et al., 1999 evaluated alkaloidal fraction of *Boerhavia diffusa* for its immunomodulatory effect and results found significant at dose 25–100 mg/kg.

Sumanth and Mustafa et al., 2007 performed evaluation of anti-stress, immunomodulation and adaptogenic property of ethanol extract of *Boerhavia diffusa* roots. The results indicated the significant potential of this herb for the activities under study.

### 2.2.7.8. Panchakarma and Ayurvedic treatment in postpartum rheumatoid arthritis: A case study

Deshpande et al., 2016 demonstrated a case study of rheumatoid arthritis (RA) patient, which is developed a month after caesarean section delivery. She was diagnosed as case of a amavata and prescribed Simhanada guggulu, Pratapalankeshwara rasa, Dashamool akatutrayakashaya and combination of Swarnabhupati rasa, Tapyadiloha, Mahavatavidhvansa, Chopachini (*Smilax china*), Shunthi (*Zinziber officinale*) and Guduchi (*Tinospora cordifolia*) for four months and kalabasti along with medicated oil
(Vishagharbhataila abhyanga) for application and sudation (bashpa sweda) for ten days. After the four months it was found that the above ayurvedic treatment showed tremendous results in this case whereas modern medical treatment has restrictions due to lactation.

2.2.7.9. Immunosuppressive properties

Pandeya et al., 2005 evaluated *Boerhavia diffusa* root for its immunomodulatory properties. The phytochemical investigation and isolation offered two pure compounds i.e. Bd-I and Bd-II and were screened for their immunomodulatory property. The extract showed significant activity and concluded that the activity lies in compound BD-I.

2.2.7.10. Antioxidant effect

Olaleye et al., 2010 performed evaluation of antioxidant property by DPPH method and determination of total flavonoid and phenolics and hepatoprotective effect by causing liver damage by acetaminophen from the ethanolic and aqueous extracts of *Boerhavia diffusa* leaves. The above extracts showed significant effect as antioxidant and hepatoprotection.

Premkumar et al., 2010 performed antioxidant activity of ethanolic extract of *Boerhavia diffusa* leaves by enzymatic and non-enzymatic assay. The results were found significant.

Bhardwaj et al., 2014 performed antioxidant property of *Boerhavia diffusa* leaves, roots and aerial parts. The methanolic extract was used for the *in-vitro* determination of antioxidant effect and estimation of total flavonoids. The results suggested significant antioxidant activity in this extract.

2.2.7.11. Phytochemical studies

Nisra and Tiwari et al., 1971 performed isolation of ursolic acid, β-sitosterol from *Boerhavia diffusa* roots.

Apu et al., 2012 performed phytochemical study and various biological activities of *Boerhavia diffusa* aerial parts. The various extracts such as n hexane, ethyl acetate and methanolic extracts were assayed for cytotoxic and
thrombolytic *in-vitro*. The results revealed that methanolic extract exhibited strong antioxidant, thrombolytic and less cytotoxic activity than other extracts. Maurya *et al.*, 2010 performed isolation of flavonoids from *Boerhavia diffusa* leaves.

### 2.2.7.12. Antidiabetic activity

Pari and Satheesh *et al.*, 2004 evaluated for hypoglycaemic effect of aqueous extract of *Boerhavia diffusa* leaves. The results showed reduction of all the parameters related to diabetes.

### 2.2.7.13. Antimicrobial activity

Abo and Ashidi, 1999 performed antimicrobial property of *Boerhavia diffusa*. The results revealed antibacterial property of *B. diffusa* confirming its traditional claim.

Adeyemi *et al.*, 2008 evaluated antimicrobial activity of *Boerhavia diffusa* leaves extract (ethanol and aqueous) against various bacteria such as *H. Pylori*, *Salmonella enteritidis*. The results showed that these extracts showed significant effect in reduction of microbial growth, suggesting its use as antidiarrheal and gastric infections caused by above mentioned bacteria.

Akkinibosun *et al.*, 2009 performed evaluation of antimicrobial activity of ethanolic and aqueous extracts of *Boerhavia diffusa* leaves against *E. Coli*, *S.aureus* and *P. aeruginosa*. The above extracts indicated antibacterial property in a dose dependent manner.

### 2.2.7.14. Toxicity study

Orisakwe *et al.*, 2003 performed acute and subchronic toxicity study of *Boerhavia diffusa* leaves aqueous extract in mice and rats. The results suggested that the extract is safe at dose above 2000mg/kg b.w. orally. There were no any organ toxicity was found in the animals used for study.

### 2.2.7.15. Antifungal activity
Agrawal et al., 2003 performed evaluation of antifungal effect of aerial and roots of Boerhavia diffusa against some dermatophytic fungi. The petroleum ether, chloroform, ethyl acetate and ethanol extracts were screened and it was found that ethyl acetate extract found significant antifungal.

2.2.7.16. Antiinflammatory effect

Gharate and Kasture et al., 2012 performed evaluation of punarnavasava for its anti-inflammatory, analgesic, antipyretic and antiulcer effects. The formulation under study showed positive activities.

2.2.7.17. Anticonvulsant property

Kaur and Goel, 2011 performed evaluation of roots of Boerhavia diffusa methanolic extract and its chloroform, liriodendrin containing fraction and flavonoid rich fraction for its anticonvulsant effect. The results showed that methanolic and liriodendrin rich fraction showed significant anticonvulsant activity.

2.2.8. Traditional uses

The white variety of punarnava is used in anaemia, oedema, heart diseases, cough and intestinal colic (Dhanwantari Nighantu). The red variety is used in the conditions of oedema, haemorrhage, anemia and biliousness. In Rajnighantu the white variety is recommended in diseases of the nervous system and in Bhavprakash in heart disease and piles. Charaka used its ointment in leprosy and skin diseases and as a decoction in stone in the kidney and in oedema. Sushtra mentioned its use in snake poisoning and rat bite infection. Chakradatta used it in the treatment it in insomnia, rheumatism and eye diseases (Nadkarni, 2007).

It is used as bitter, anthelmintic, diuretic, cardiac stimulant, aphrodisiac, emetic, expectorant, anti-inflammatory, febrifuge and laxative. It is also used in scabies, jaundice, anaemia, constipation, cough, and bronchitis (Khare, 2007). In Unani system of medicine leaves are used in ophthalmia and for
joint pain. The seeds are tonic, expectorant, carminative, lumbago, scabies, scorpion sting, purify the blood, hasten delivery (Unani). The root is well known for its diuretic and expectorant effect. In large doses it is emetic. In Punjab the drug is considered for the usefulness of the eye (Kirtikar and Basu, 2008).

2.2.9. Phytoconstituents reported

The air dried plant contains a large quantities of potassium nitrate therefore it has diuretic action. Apart from this it also contain an alkaloid i.e. punarnavine, in very small quantities (0.01% w/w). It also contains of β-Sitosterol, Hentriacontane, tetracosanoic, hexacosanoic, stearic, arachidic acid, urosilic acid, b-ecdysone, triacontanol etc (Nadkarni, 2007).

2.2.10. Chemical Structure of Major Constituents

![Boeravinone A](image1.png)

![Boeravinone B](image2.png)
Boeravinone D

Boeravinone E

Boeravinone F

Boeravinone G
Arachidic acid

Ursolic acid

β-Sitosterol
References


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2.3. *Euphorbia neriifolia* non Linn.

Figure 2.3 *Euphorbia neriifolia* plant

### 2.3.1. Botanical classification

**Kingdom:** Plantae  
**Order:** Malpighiales  
**Family:** Euphorbiaceae  
**Subfamily:** Euphorbiaceae  
**Tribe:** Euphorbiaceae  
**Subtribe:** Euphorbiinae  
**Genus:** Euphorbia

### 2.3.2. Synonyms

*E. lingularia*
2.3.3. Vernacular names

Hindi- Thuhar, Thohar  
Sanskrit- Vajradruma, Snuk  
English- Milk bush, Milk hedge  
Bengali: Manasasi  
Gujrati: Thor, Kantalo  
Hindi: Thuhar, Sehunda  
Marathi: Nivadung  
Punjabi: Thohar  
Tamil: Elaikkali, Perumbukalli  
Telugu: Kadajemudu  
Siddha: Ielaikkali, Perumbukalli.  
Urdu: Zaqqum

2.3.4. Plant Part used: Whole plant

2.3.5. Botanical description

The plant is large fleshy, glabrous, branched shrub or a small tree, 1.8-4.5 m high Green and with sharp stipular spines. Leaves are fleshy, deciduous, obovate, spathulate, shortly acute, nerves visible only in transmitted light. Fruits tricoccus, seeds are greenish brown about the size of mustard (Longman, 2005).

2.3.6. Geographical distribution

It occurs in dry and hilly areas of North, South and Central India (Bhavprakash, 1998).

2.3.7. Pharmacological activities

2.3.7.1. Anti-inflammatory and Analgesic activity

Palit et al., 2016 evaluated hydro-alcoholic extract obtained from Euphorbia neriifolia stem for its anti-inflammatory, analgesic and anti-arthritic activity.
The STF-HAENS fraction demonstrated significant anti-inflammatory and analgesic activity.

Pracheta et al., 2014 performed antioxidant activity of hydroalcoholic extract of *E. neriifolia* leaves by using DPPH, H$_2$O$_2$, reducing power, FRAP assay. The total phenolics, flavonoids and tannin content were also evaluated. The results showed antioxidant property significantly to the extract.

Gaur et al., 2009 performed evaluation of anti-inflammatory and analgesic activity of hydroalcoholic extract of *E. neriifolia* leaves. The results showed significant activities as anti-inflammatory and analgesic to the extract under study.

2.3.7.2. Antioxidant Activity

Sharma et al., 2014 evaluated antioxidant activity of *Euphorbia neriifolia* leaves by TBA, FRAP, TAC and FTC methods. The EN possesses strong antioxidant property in all the models used.

Bigoniya and Rana 2009 isolated triterpenoidal sapogenin from *E. neriifolia* leaf and performed its in-vitro antioxidant activity. The Radioprotective property of isolated fraction was also studied against F1 B16 melanoma. The results suggested that sapogenin fraction showed significant antioxidant, radioprotective and anticancer activities.

Pracheta et al., 2014 evaluated antioxidant property of alcoholic extract of *E. neriifolia* leaf. The study were conducted by using *in-vitro* TBA, FTC, FRAP methods. The extract was showed potent activity. In addition total flavonoids, phenolic content and proanthocyanidins were also evaluated.

2.3.7.3. Antimicrobial Activity

Swamy et al., 2011 evaluated *Euphorbia neiirifolia* various extracts for its antibacterial activities against *S. aureus, K. pneumonia, E. coli, P. vulgarius, P. fluroscens*. The results found that the maximum activity was resided in chloroform extract.
2.3.7.4. Wound healing property

Rasik et al., 1996 evaluated wound healing property of aqueous extract obtained from *E. neriifolia* latex. The various parameters studied were epithelisation, angiogenesis, DNA content etc.

2.3.7.5. Phytochemical studies

Liu et al., 2012 isolated nine diterpenoids from *Euphorbia neriifolia* Linn. stems with their structures characterized by NMR spectra.

Ilyas et al., 1998 isolated a novel triterpene, 9,19-cyclolanost-20(21)-en-24-ol-3-one, named neriifolione, and cycloartenol from *Euphorbia neriifolia* latex. Their structures were elucidated by using $^1$H NMR, $^{13}$C NMR, IR and mass spectra.

Yadav et al., 2012 isolated Neriifolin S enzyme with molecular mass 94 kDa from *Euphorbia neriifolia* latex. Enzyme was found stable toward chemical denaturants, pH and temperature.

Sharma et al., 2017 isolated flavonoid from *Euphorbia neriifolia* leaves and elucidated by IR, $^1$H NMR, and MS and elucidated as 2-(3,4-dihydroxy-5-methoxy-phenyl)-3,5-dihydroxy-6,7-dimethoxychromen-4-one.

2.3.8. Traditional uses

Milk juice exuded from freshly injured stems is used by Vaidyas as drastic cathartic and to relieve earache. Dr M C Koman tried it and found it very beneficial in asthma. Externally juice was used for treatment of wart and earache. Clarified juice is largely applied to unhealthy ulcers and scabies with fresh butter. Root bark is used for dropsy after boiling it with rice water (Nadkarni, 1998). In Ayurveda the drug is used in treatment of laxative, carminative, improves appetite, useful in abdominal troubles, bronchitis, tumours, loss of consciousness, leucoderma, piles, inflammations, anaemia, ulcers. The milk obtained after incision is pungent, laxative, good for abdominal troubles, tumours, leucoderma. The leaves are carminative, good for pains, tumours, abdominal swellings and inflammations, In Unani
treatment the juice is purgative, carminative, useful in gonorrhoea, whooping cough, asthma, dropsy, leprosy, enlargement of the spleen, dyspepsia, jaundice, colic, tumours, stone in bladder (Kirtikar and Basu, 2008).

2.3.9. Phytoconstituents reported

The chemical constituents reported are Euphorbon, resin, gum, euphol, 24-methylenecycloartenol, euphorbol, haxacosonate, glut-5 (10)-en-1-one, glut-5-en-3 beta-yet-acetate, taraxerol, friedelan-3-alpha-ol and 3 beta-ol (Khare, 2007).

2.3.10. Chemical structure of major constituents

Cycloartenol

Euphol
Neriifolin

Neriifolin-S

Neriifoliol

Quercetin
Taraxerol

Rutin
References


- Palit, P., Subhash, C., Mandal, B. B., 2016. Total steroid and terpenoid enriched fraction from *Euphorbia neriifolia* Linn offers protection against nociceptive pain, inflammation, and *in-vitro* arthritis model: An


2.4. Research envisaged and plan of work

Asthma is a chronic inflammatory disease with recurrent reversible airway obstruction (WHO, 2002). It is a disease which crossed the boundaries of race, age, and gender. It is currently a worldwide problem with 300 million people globally suffering from it and estimated world deaths of about 250 thousand annually. Asthma has universal prevalence of 1% to 18%.

Asthma is caused by release of histamine, leukotrienes, prostaglandins, and cytokines. The treatment of the disease involves rapid relief for the patient and because of involvement of various mediators, the disease is more complex hence single drug therapy is difficult to establish.

Inhaled corticosteroids are preferred for the first-line treatment of persistent disease. In spite of maximum doses of single drug and in combinations many patients are unable to control the symptoms of asthma. The children are mostly having asthma and due to fear of side effects of inhaled corticosteroids such as osteoporosis allopathic medication has restriction and mostly traditional medicines are preferred. But the scientific basis of most of the traditional drugs are yet to be proven for its safety and efficacy (Lee, 2011; Oghale, 2016; Akaha, 2003; Shirole, 2014).

Phytochemical studies are now a day creating interest to plant scientists because of new innovations and sophisticated drug discoveries. These chemical substances produced from plants having medicinal values and that shows various biological properties. Most important examples are glycosides, alkaloids, tannins, flavonoids and phenolic compounds. These chemical constituents are not useful for the discovery of therapeutic agents, but also for disclosing new resources of such chemicals (Oghale, 2016).

2.5. Plan of Work

*Vitex negundo* Linn. (Verbenaceae), *Boerhavia diffusa* Linn. (Nyctaginaceae) and *Euphorbia neriifolia* auct. Non Linn. (Euphorbiaceae) have been used in the treatment of asthma traditionally but there is no evidence for their pharmacological screening for anti-asthmatic activity.
Therefore these plants have been selected for the proposed research work. The Research work will be performed as given below.

1. Identification, collection and drying of plant material (*Vitex negundo*, *Boerhavia diffusa* and *Euphorbia neriifolia*)
2. Successive solvent extraction and qualitative chemical tests
3. Chemo profiling of the extracts with TLC
4. Screening of extract (ethanolic and its chloroform and ethyl acetate fractions) for anti-asthmatic activity
5. Bio-activity directed fractionation
6. Chromatographic studies so as to isolate bio-active components
7. Characterization by modern instrumental techniques.
References


