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Multifunctional Potential of *Vitex negundo* L.: Phytochemistry and Sustainable Pest Management in Agriculture

*Sourabh Suman, Aditi Kundu and Supradip Saha
ICAR-Indian Agricultural Research Institute, New Delhi 110012
*Corresponding Author's email: sourabhsuman551@gmail.com

Vitex negundo L. is a medicinal and aromatic shrub widely recognized for its traditional and therapeutic properties. Rich in bioactive phytochemicals it exhibits insecticidal, antifeedant, repellent, antifungal, antimicrobial, and anti-inflammatory activities against a wide range of agricultural pests and pathogens. Its effectiveness against stored-grain insects, lepidopterans, mosquitoes and mites highlights its potential as an eco-friendly botanical pesticide. With increasing concerns over pesticide resistance and environmental pollution, *V. negundo* represents a promising natural resource for sustainable crop protection and integrated pest management.

Keywords: Nirgundi, botanical pesticide, antifeedant, insecticidal activity, phytochemicals,

Introduction

Vitex negundo L. (Lamiaceae), commonly known as Nirgundi, Sindhuvara, Nishinda, or the five-leaved chaste tree, is an aromatic woody shrub belonging to the genus *Vitex*. The Sanskrit name *Nirgundi*, meaning "that which protects the body from diseases," reflects its long-standing medicinal significance (Vimal et al., 2011). The plant is widely distributed throughout South and Southeast Asia, including India, Pakistan, Bangladesh, Sri Lanka, Myanmar, China, and Thailand, and has also been reported from parts of Africa. It commonly occurs along riverbanks, roadsides, wastelands, forest margins, agricultural boundaries, and up to 1,500 m elevation in the outer Himalayas. The plant has been highly valued in Ayurveda, Unani, Siddha, and folk medicinal systems for its ethnopharmacological properties. The plant has been used for centuries to treat a wide range of ailments, owing to its diverse pharmacological properties. Leaf paste and oil are commonly applied externally to relieve joint pain, arthritis, sprains, muscular pain, and swelling. Decoctions of the leaves and roots are used for the management of fever, cough, bronchitis, asthma, digestive disorders, and skin diseases. The plant contains diverse bioactive phytochemicals such as flavonoids, lignans, terpenoids, and steroids, documenting a broad spectrum of biological activities. The plant demonstrated strong insect-repellent properties, making it valuable for traditional agricultural and veterinary practices. The pesticidal potential of *V. negundo* is particularly relevant at a time when conventional crop protection is facing several challenges. Intensive and repeated use of synthetic insecticides has contributed to resistance development in many pest populations, contamination of soil and water, residues in agricultural commodities, and adverse effects on beneficial organisms. Therefore, safer botanicals such as *Vitex* sp. provide an alternative option for management of agriculturally important pest and diseases.

Botanical description of plant

The plant is generally an erect, branched shrub or small tree that can reach approximately 2-5 m in height. Young branches are characteristically quadrangular, while older stems become more woody. The leaves are palmately compound and commonly consist of five lanceolate leaflets. The leaves release a characteristic aromatic odour when crushed. The combination of

aromatic foliage, palmately compound leaves, and purple inflorescences makes the plant relatively easy to recognize in natural habitats. The grows best under warm temperatures and full sunlight, although it can tolerate a range of environmental conditions. The plant prefers well-drained loamy or sandy-loam soils with moderate fertility and can tolerate slightly acidic to alkaline soil conditions. *V. negundo* can be propagated through seeds, stem cuttings, or root suckers, with planting generally carried out at the beginning of the rainy season under Indian conditions.

Phytochemical constituents

The plant is characterized by a rich diversity of secondary metabolites, with considerable variation in phytochemical composition according to the plant part, geographical origin, developmental stage and extraction method. *V. negundo* is a rich and diverse array of secondary metabolites distributed across its leaves, seeds, flowers, roots, trichomes etc. Phytochemical investigations of *V. negundo* have identified flavonoids, iridoid glycosides, phenolic compounds, lignans, terpenoids, steroids, alkaloids, fatty acids and volatile constituents as major chemical groups. Among these, flavonoids constitute one of the most important classes and include vitexin, isovitexin, casticin (vitexicarpin), luteolin, luteolin-7-O-glucoside, artemetin, chrysosplenol and other polymethoxylated flavonoids. Essential oil is comprising of β-caryophyllene, sabinene, 4-terpineol, viridiflorol and caryophyllene oxide as predominant compounds. Seeds contain diterpenoid acids and the lignan vitedoin-A, an antioxidant reported to be more potent than vitamin E and L-cysteine (Ono *et al*., 2004), while roots contain vitexin, isovitexin, negundin-A and negundin-B. Another characteristic group of constituents in *V. negundo* is the iridoid glycosides, among which negundoside, agnuside and vitegnoside have been reported as important compounds. These glycosides are considered chemotaxonomically significant and have been isolated from different parts of the plant, particularly leaves and roots. The plant also contains several phenolic acids, including caffeic acid, chlorogenic acid, isochlorogenic acid, ferulic acid, vanillic acid and *p*-hydroxybenzoic acid, which contribute to its phenolic antioxidant potential. The lignan fraction represents another biologically important group, with compounds such as vitedoin A and vitedoin B reported from *V. negundo*. In addition, triterpenoids such as ursolic acid and oleanolic acid, together with other diterpenoid and sesquiterpenoid constituents, have been identified. Leaves also contains pentamethoxy-flavone, mussaenosidic acid, protocatechuic acid, oleanolic acid, betulinic acid, ursolic acid, casticin as major components.

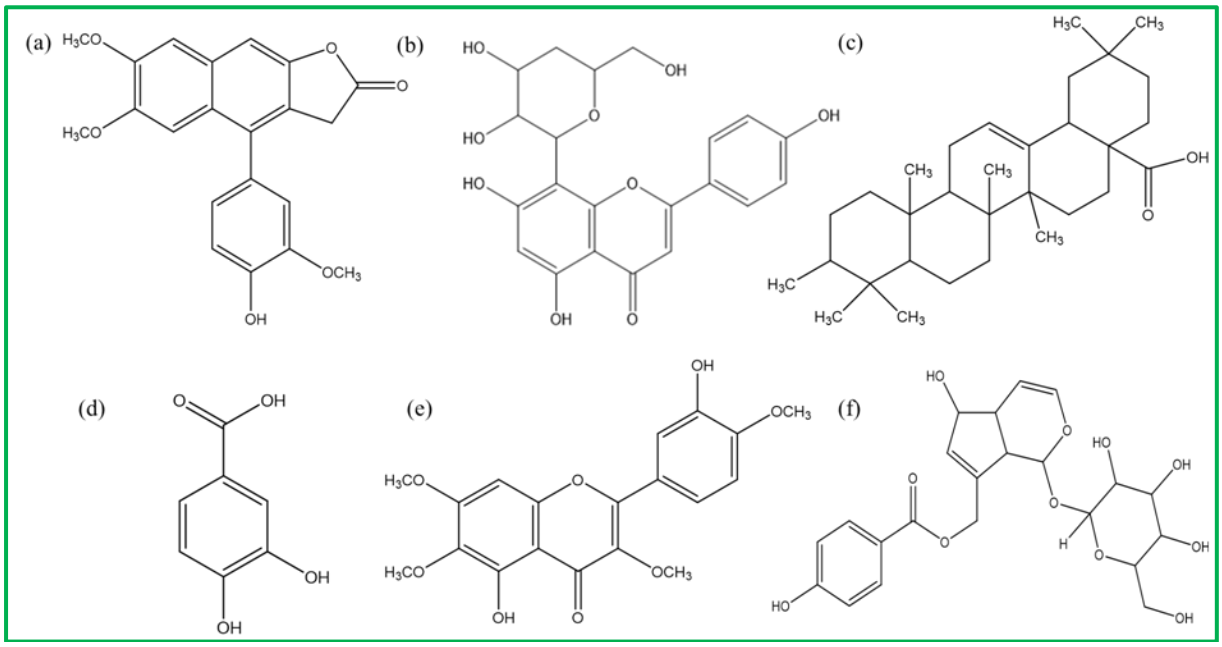

Fig - Structures of compounds (a) Vitexin, (b) Negundin A, (c) Oleanolic acid, (d) Protocatechuic acid, (e) Casticin, and (f) Anguside found in *V. negundo*

Insecticidal Activity

V. negundo has attracted considerable scientific attention because of its broad-spectrum insecticidal activity against agricultural, stored-product, and public health pests. Studies have demonstrated that methanolic leaf extracts contain bioactive compounds such as 22,23-dihydro-α-spinasterol-β-D-glucoside and salicylic acid, which exhibited 100% repellency and significant adult toxicity against the red flour beetle highlighting their potential for protecting stored grains. Similarly, ethanol, chloroform, and n-hexane leaf extracts significantly increased mortality of the *Sitophilus granarius* in a dose and time dependent manner while, markedly suppressing the emergence of the subsequent generation, indicating their usefulness in stored-grain pest management (Jawalkar and Zambare, 2020). The insecticidal efficacy of *V. negundo* also extends to economically important Lepidopteran pests where crude leaf extracts produced an antifeedant index of 98.37 against third-instar of Fall armyworm larvae without causing phytotoxic effects on maize, demonstrating its promise as a botanical insecticide for sustainable crop protection (Haji *et al*., 2024). In addition, extracts of *V. negundo* have shown toxicity and feeding deterrence against other destructive caterpillars, including *Spodoptera litura*, *Spodoptera exigua*, and *Plutella xylostella*, further supporting its broad-spectrum activity against Lepidopteran pests. Beyond agricultural insects, the plant exhibits potent larvicidal and repellent properties against disease vectors. Petroleum ether leaf extracts caused high mortality of *Culex tritaeniorhynchus* larvae, while fabrics treated with the extracts provided up to eight hours of protection against mosquito bites under field conditions (Karunamoorthi *et al*., 2008).

Table 1. Insecticidal activity of *Vitex negundo*

Plant part	Major constituents	Target organism	Activity	Reference
Leaves	Flavonoids, terpenoids, phenolics	*S. frugiperda*	Antifeedant	Haji et al., 2024
Leaves	Various secondary metabolites	*S. granarius*	Toxicity/repellency	Jawalkar and Zambare, 2020
Seeds	Volatile compounds	*C. albicans*	Antifungal	Ai *et al*., 2014
Leaves	Volatile/semi-volatile compounds	*Culex* spp.	Larvicidal/repellent	Karunamoorthi et al., 2008
Leaves/roots	Terpenoids and other metabolites	*R. microplus*	Acaricidal	Singh *et al*., 2014

The insecticidal activity of *V. negundo* is probably multifactorial. Volatile terpenoids may affect insect behaviour through olfactory pathways and may also interfere with nervous-system function. Certain terpenoids can influence ion channels, neurotransmission, respiration, or membrane integrity. Non-volatile flavonoids, phenolics, and other secondary metabolites may contribute through feeding deterrence, digestive enzyme inhibition, oxidative imbalance, disruption of development, or interference with detoxification mechanisms.

Acaricidal activity

Methanolic leaf extract produced concentration-dependent mortality of *Sarcoptes scabiei* mites, reaching 90% mortality at a 30% concentration, comparable to the reference drug Ivermectin. Against ticks, ethanolic extracts of *V. negundo* leaves and roots showed acaricidal activity against synthetic-pyrethroid-resistant strains of the cattle tick *Rhipicephalus microplus* and against the multi-host tick *Hyalomma anatolicum* in both cases reducing egg mass weight and inhibiting oviposition alongside direct mortality (Singh *et al*., 2014).

Antifungal and antimicrobial activity

Beyond insects, *V. negundo* also shows genuine antifungal and antimicrobial power. Essential oil hydrodistilled from its seeds rich in *n*-hexadecanoic acid, eudesm-4(14)-en-11-ol, and caryophyllene oxide exhibited significant antifungal activity against *Candida albicans*, with a minimum inhibitory concentration of just 4.0 µg/mL (Ai *et al*., 2014). Broader antimicrobial

screening of leaf, flower, and fruit extracts and essential oils has repeatedly shown inhibition of common bacterial pathogens including *Bacillus subtilis, Escherichia coli, Staphylococcus aureus,* and *Pseudomonas aeruginosa,* with ethyl acetate and ethanol extracts being the most potent. Extracts obtained from leaves, flowers, fruits, roots, and other plant parts have shown antibacterial activity against a variety of microorganisms, such as *Bacillus subtilis*, *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. Further, the plant could be explored for natural preservatives, surface disinfectants, veterinary applications, and protection of agricultural commodities.

Role in Integrated Pest Management

The greatest agricultural value of *V. negundo* may lie not in replacing every synthetic pesticide but in becoming one component of integrated pest management (IPM). *V. negundo*-based product could potentially be incorporated into IPM schedule as botanical pesticide along with cultural practices, resistant crop varieties, pheromone-based monitoring, mechanical control, and selective chemical insecticides. Its insect antifeedant and repellent properties may be particularly useful during periods when pest populations are below economic thresholds but continued feeding could cause crop damage. Essential oil-based formulations could potentially be used as repellents or short-residual protectants, while standardized extracts could be evaluated for direct larvicidal or insecticidal activity.

Conclusions

V. negundo exemplifies how traditional knowledge and modern scientific research can converge to provide sustainable solutions for contemporary agriculture. Extensive studies have demonstrated the multi-functional properties of the versatile plant, possessing a wide range of biological activities, insecticidal, antifeedant, repellent, antifungal, antimicrobial, and acaricidal effects against diverse agricultural pests. These properties reinforce its long-standing reputation as a "village pharmacy" and highlight its potential as an eco-friendly resource for sustainable crop protection and integrated pest management.

References

1. Ai, H.-W., Kang, Y.-X., Cao, Y., & Zheng, C.-J. (2014). Antifungal properties and chemical analysis of essential oil from *Vitex negundo* seeds. *Journal of Pharmaceutical Research International, 4*(5).
2. Haji, N. B., Nur, E., Nur, K., Anjar, L. S., & Idham, I. (2024). Toxicity of *Vitex negundo* L. and *Calotropis gigantea* L. crude extract on fall armyworm *Spodoptera frugiperda* J. E. Smith (Lepidoptera: Noctuidae). *International Journal of Design & Nature and Ecodynamics*.
3. Jawalkar, N., & Zambare, S. (2020). Bioinsecticidal activity of *Vitex negundo* L. leaf extracts against *Sitophilus granarius* L. in stored maize grains. *Journal of Entomology and Zoology Studies, 8*(2).
4. Karunamoorthi, K., Ramanujam, S., & Rathinasamy, R. (2008). Evaluation of leaf extracts of *Vitex negundo* L. against larvae of *Culex tritaeniorhynchus* and repellent activity on adult vector mosquitoes. *Parasitology Research, 103*, 545–550.
5. Ono, M., Nishida, Y., Masuoka, C., Li, J., Okawa, M., Ikeda, T., & Nohara, T. (2004). Lignan derivatives and a norditerpene from the seeds of *Vitex negundo*. *Journal of Natural Products, 67*, 2073–2075.
6. Singh, N. K., Jyoti, Vemu, B., Nandi, A., Singh, H., Kumar, R., & Dumka, V. K. (2014). Acaricidal activity of *Cymbopogon winterianus*, *Vitex negundo*, and *Withania somnifera* against synthetic pyrethroid-resistant *Rhipicephalus (Boophilus) microplus*. *Parasitology Research, 113*, 341–350.
7. Vimal, A., Vikram, L., Singhal, S., & Anil, B. (2011). *Vitex negundo: A Chinese chaste tree*. *International Journal of Pharmaceutical Innovations, 1*(9).