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# Pharmacognosy of *Vachellia farnesiana* (L) Wight and Arn: A Compressive Review

**[*1]VE Chavan and [2]HS Jagtap**

[*1]Research Scholar, Department of Zoology, MSP Mandal's Shri Shivaji College Parbhani, Maharashtra, India.

[2]Research Supervisor, Professor & Head, Department of Zoology, MSP Mandal's Shri Shivaji College Parbhani, Maharashtra, India.

**Abstract**

*Vachellia farnesiana* (L.) Wight and Arn represents a resilient and multifunctional plant species that bridges ecological adaptability with significant medicinal potential. Widely distributed across the arid and semi-arid landscapes of India and other tropical regions, the species exhibits remarkable tolerance to drought, poor soils, salinity, extreme temperatures, and environmental pollutants, including heavy metals. Its extensive root system, high seed productivity, and symbiotic associations with nitrogen-fixing and mycorrhizal microorganisms enable survival under harsh conditions while contributing to soil stabilization, ecological restoration, and phytoremediation of degraded habitats.

Beyond its ecological relevance, *V. farnesiana* holds a prominent position in traditional medicine, where various plant parts are used to manage gastrointestinal, respiratory, inflammatory, and infectious disorders. Contemporary phytochemical investigations have identified diverse bioactive constituents such as alkaloids, flavonoids, glycosides, sterols, phenolics, and seed-derived proteins, many of which demonstrate potent antioxidant, anti-inflammatory, analgesic, antimicrobial, and cytotoxic activities in experimental studies. Evidence from *in vitro* and *in vivo* models supports its role in modulating oxidative stress and inflammatory pathways, highlighting its promise in drug discovery research.

This innovative review integrates ecological, ethnomedicinal, and pharmacological perspectives to portray *V. farnesiana* as both an environmental resource and a reservoir of therapeutically valuable compounds. The synthesis underscores the need for advanced phytochemical profiling, mechanistic studies, and clinical validation to translate traditional knowledge into scientifically standardized and sustainable therapeutic applications.

**Keywords:** *Vachellia farnesiana*, Phytochemical Analysis, Ethnobotany, Antimicrobial Activities of Acacia.

## Introduction

*Vachellia farnesiana* commonly grows in sandy substrates and riverine habitats and is widely distributed throughout several parts of India, particularly in Maharashtra, Gujarat, Andhra Pradesh, and Karnataka. The plant is generally characterized as a small, hardy tree, well adapted to dry and semi-arid ecological conditions (Pawar and Bhoite, 2025) [25].

*Vachellia farnesiana* is multistemmed, deciduous shrub or small tree having height of five to 12 feet characterized by dense, spreading crown of spiny branches with fragrant yellowish flowers, leaves are petiolate in to 3 to7 pairing of rachies. It is also known to be sweet acacia, huisache or Aroma while domesticated around the tropical and subtropical regions of globe although native to the Mediterranean littoral zone (The Plant list 2013). The species is oftenly useful in the hinterland as small timber, fuel, fencing due to spiny bushes and also for ecological revegetation of degraded arid lands.

In some regions, it is considered a nuisance or invasive species due to its strong ability to invade and spread in pastures and other anthropogenically disturbed habitats (Parrotta 1992) [24]. It is grown throughout Indian subcontinent produce much for local use, flowering around winter season to initiative of summer with having dark brown coloured pods comprising on an average six to 17 seeds in each fruit varying according to various factors like geographical conditions, temperature, edaphic factors and rainfall etc. (Biradar 2013) [3]. The shrub having high no. of seeds around 12000 to 13000 due to its flowering and fruiting over the year. The scarification of seeds having high germination potential through passing after alimentary canal of grazers (Mutz *et al* 1978; cheek and Boon 2019) [21, 6].

The tropics having range from 400 to 650 mm annual rainfall yields better rather less than 350 meanwhile shows strong resistance for survival in arid seasons upto 8 months (Badi K.H.1967) [1]. Various researchers having various considerations regarding the biological characteristics of v. farnesiana as Gilman and Watson (1993) [11] remarks in native habitat very slow growing species with life span of 50 years while Soliman and Sakr (2017) [30] suggests it is rapidly growing shrub all over the world.

**Ecological Requirements:** The tree grows in dense shading canopy and can tolerate nutrient poor, loamy, saline and rocky

***Corresponding Author:** VE Chavan

soils. Regardless of great tolerance it performs in more fertile substrates. It having trait of specialized root system gives high drought resistance and deciduous in prolonged arid conditions. (Vozzo, 2002; Maldonado-Mangana *et al* 2011) [35, 20].

The adaptability is from extreme temperatures from freezing to fire and other growth limiting factors (Gilman and Watson, 1993) [11]. Certain examples showing growth in heavily polluted areas with heavy metals. Heavy metals like Pb, Cu and Zn bioaccumulate in the leaves as exhibit great potential of phytoremediation by using endosymbiotic bacterial associations (Salazer- Remirez *et al* 2020). Socioeconomic and ecological importance of V. Farnesiana as deciduous shrub having variety of importance in relation to prevent erosion of soil, raising infiltration of water, and fertility through symbiosis of nitrogen fixing microflora of genus Rhizobium and Mycorrhizal fungi (Maldonado-Mandana *et al* 2011, Boukhatem, 2012) [20, 12].

**Methodology of Literature Review**

The gathered data for this article has been availed from a variety of computerized databases such as PubMed, Google scholar, Scopus, Elsevier, ResearchGate, Science Direct and Various Journals etc. The literature was examined and reviewed with focusing on Phytochemistry, pharmacognosy and various human clinical trials in ethnobotanical antient and modern practices around the globe. Taxonomical characteristics of *V. farnesiana* mentioned in the publication were analyzed from website: http;//www.worldfloraonline.org.

**Ethnomedicinal Uses:**

In Indian traditional medicine and other ethnomedical systems, species of the genus *Acacia* (currently classified under *Acacia*, *Vachellia*, and *Senegalia*) have long been recognized for their diverse medicinal applications. Fresh plant materials, including the bark, leaves, pods, roots, and gum, are traditionally employed as astringents, demulcents, spasmolytic, anthelmintic, and abortifacients**.** These therapeutic properties have supported their widespread use in the management of numerous ailments, particularly disorders affecting the gastrointestinal, respiratory, and reproductive systems (Tchatchedre *et al*., 2019) [31].

Ethnomedicinal records indicate that *Vachellia* species are commonly used to treat diarrhea, dysentery, intestinal cramps, stomachaches, and acute gastrointestinal infections, which is largely attributed to their high tannin and phenolic content that promotes antimicrobial activity and mucosal protection. The astringent properties of these plants have also justified their application in oral health, including the treatment of tooth decay, gingivitis, and oral ulcers. Additionally, preparations derived from *Acacia* are traditionally administered for respiratory conditions such as cough, bronchitis, pneumonia, asthma, and congestion, reflecting their reported spasmolytic, expectorant, and anti-inflammatory effects (Deshmukh *et al*., 2018) [10].

Overall, the extensive traditional use of *Vachellia* species across multiple disease conditions underscores their significant ethnopharmacological importance. While many traditional claims are increasingly supported by experimental evidence, further studies—particularly well-designed clinical trials—are required to establish standardized dosages, safety profiles, and precise mechanisms of action. Continued research may facilitate the development of *Vachellia* derived compounds as effective therapeutic agents in modern medicine.

Phytochemical investigations of *Vachellia farnesiana* have led to the identification of several bioactive compounds, including (3β,22E)-stigmasta-5,22-dien-3-ol β-D-glucopyranoside, (3β,22E)-stigmasta-5,22-dien-3-yl, and (2S)-2,3-dihydroxypropyl tetracosanoate, which have been reported to play a protective role against reactive oxygen species (ROS)-induced cellular damage. The antioxidant potential of these compounds supports earlier findings demonstrating the strong free-radical scavenging capacity of *A. farnesiana* pod extracts (Delgadillo *et al*., 2015; Claudia *et al*., 2018) [8, 7].

Experimental evaluations have shown that pod extracts of *V. farnesiana* exhibit remarkable antioxidant activity, reaching approximately 95% inhibition at a concentration of 200 µg/mL and nearly 80% inhibition at 120 µg/mL, as determined by *in vitro* antioxidant assays (Delgadillo *et al*., 2015; Claudia *et al*., 2018) [8, 7].

In addition to antioxidant effects, the anti-inflammatory activity of methanolic pod extracts has been confirmed in rodent models of induced ear edema, where significant suppression of inflammation was observed. These effects were associated with modulation of key inflammatory mediators, including interleukins (ILs) and cyclooxygenase (COX) enzymes, suggesting inhibition of prostaglandin synthesis (Claudia *et al*., 2018) [7].

*Vachellia farnesiana* (L.) Willd., a species with 28 recorded taxonomic synonyms according to the World Flora Online database, has attracted scientific interest due to the bioactivity of its seed proteins. In an *in vitro* study, five distinct protein fractions—albumins, globulins, prolamins, acidic glutelins, and basic glutelins were successfully isolated from the seeds using a sequential extraction protocol (Leal *et al*., 2016) [19]. Pharmacological evaluation demonstrated that the globulin fraction exhibited significant anti-inflammatory and analgesic activities. The findings demonstrate that the seeds of *A. farnesiana* represent a valuable source of bioactive proteins with pronounced anti-inflammatory and analgesic properties, highlighting their potential for further development as natural therapeutic agents.

Several compounds isolated from *Vachellia farnesiana* have demonstrated moderate antioxidant and anti-inflammatory activities, along with notable cytotoxic effects against human cancer cell lines, indicating their potential relevance in drug discovery research. In line with these findings, the bark of *V. farnesiana* collected from Bangladesh, together with its organic and aqueous soluble fractions, has been systematically investigated as part of ongoing studies focused on the evaluation of medicinal plants native to Bangladesh. These studies aim to identify bioactive secondary metabolites and to validate the traditional use of this species through pharmacological screening, particularly in relation to oxidative stress, inflammation, and cancer-related pathways (Rahman *et al*., 2014; Islam *et al*., 2017) [26, 15].

**Phytochemical Analysis**

Screening of Phytochemicals using various tests: Alkaloids were identified using standard precipitation reactions:

- Dragendorff's Test: Addition of Dragendorff's reagent to the extract produced a scarlet precipitate, indicating the presence of alkaloids.
- Mayer's Test: Treatment with Mayer's reagent resulted in a creamy white precipitate, confirming alkaloidal constituents.
- Wagner's Test: The formation of a reddish-brown

precipitate after adding Wagner's reagent further supported the presence of alkaloids. (Harborne, 1998) [13]

**Test for Flavonoids**

Flavonoids were detected using the following assays:

- **Shinoda Test:** The addition of magnesium turnings and concentrated hydrochloric acid produced a pink coloration, indicating flavones.
- **Sulfuric Acid Test:** Treatment with 66–80% sulfuric acid resulted in a deep yellow coloration, confirming flavonoids.
- **Lead Acetate Test:** Formation of a yellow precipitate upon addition of lead acetate solution indicated the presence of flavonoid compounds. (Kokate, 2001)

**Test for Glycosides**

- **Keller–Killiani Test:** The extract was treated with glacial acetic acid, ferric chloride, and concentrated sulfuric acid. The appearance of a reddish-brown ring at the interface and a blue-green coloration in the upper layer confirmed the presence of cardiac glycosides. (Harborne, 1998) [13].

**Conclusion**

Vachellia farnesiana emerges from this comprehensive review as a botanically resilient, ecologically significant, and pharmacognostically valuable species with wide traditional and scientific relevance. Its remarkable adaptability to diverse and often harsh environmental conditions—including arid climates, nutrient-poor soils, salinity, and anthropogenic stress—highlights its importance in ecological restoration, soil conservation, and phytoremediation. Beyond its ecological role, the species has long been integrated into traditional medical systems for the management of gastrointestinal, respiratory, inflammatory, and infectious disorders, underscoring its ethnopharmacological significance.

Phytochemical investigations have revealed a rich spectrum of bioactive constituents, including alkaloids, flavonoids, glycosides, phenolics, sterols, and bioactive proteins, which collectively contribute to its antioxidant, anti-inflammatory, analgesic, antimicrobial, and cytotoxic properties. Experimental studies validating these activities—particularly antioxidant and anti-inflammatory effects—provide scientific support for many traditional claims and position V. farnesiana as a promising source of natural therapeutic agents. The identification of potent seed protein fractions and secondary metabolites further expands its potential applications in drug discovery and nutraceutical development.

Despite substantial progress in phytochemical and pharmacological research, gaps remain in terms of standardized extraction methods, dosage determination, toxicity profiling, and well-controlled clinical trials. Future research should focus on isolating and characterizing novel compounds, elucidating precise mechanisms of action, and translating preclinical findings into clinical applications. Overall, Vachellia farnesiana represents a valuable medicinal plant whose multifaceted ecological, socioeconomic, and pharmacognostic attributes warrant continued and systematic investigation for its sustainable utilization in modern medicine and environmental management.

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