EJPMR, 2026, 13(5), 44-49 **Review Article** **Impact Factor: 8.158**

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

ISSN (O): 2394-3211
ISSN (P): 3051-2573
Coden USA: EJPMAG

A REVIEW ON PHYTOCHEMISTRY AND PHARMACOLOGY OF *HOLIGARNA ARNOTTIANA*

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DOI: https://doi.org/10.5281/zenodo.19883502

How to cite this Article: Harsha J.1*, Karunakar Hegde2. (2026). A Review on Phytochemistry and Pharmacology of Holigarna Arnottiana. European Journal of Biomedical and Pharmaceutical Sciences, 13(5), 44–49.

Article Received on 24/04/2026 **Article Revised on 13/04/2026** **Article Published on 01/05/2026**

ABSTRACT

Holigarna arnottiana Hook. F., a medicinal tree belonging to the family Anacardiaceae and endemic to the Western Ghats of India, has attracted scientific interest due to its rich phytochemical composition and pharmacological relevance. Traditionally, the plant has been used in Ayurvedic medicine for the treatment of inflammation, skin ailments, arthritis, and infectious diseases. Photochemical investigations have revealed the presence of diverse secondary metabolites, including flavonoids, phenolic compounds, terpenoids, diarylheptanoids, triterpenes, and glycosides. Advanced analytical techniques such as GC-MS and LC-MS have further enabled the identification of bioactive constituents responsible for its therapeutic potential. Pharmacological studies demonstrate that various extracts of H. Arnottiana exhibit significant antioxidant, antimicrobial, anti-inflammatory, cytotoxic, and anticancer activities. Recent research also highlights its role in green synthesis of metal nanoparticles with enhanced biological efficacy. Despite promising experimental evidence, systematic studies on photochemistry-pharmacology correlations and clinical validation remain limited. This review compiles and critically evaluates existing literature on the photochemistry and pharmacological properties of H. Arnottiana, aiming to identify research gaps and future prospects for drug discovery and therapeutic development.

KEYWORDS: *Holigarna arnottiana*, photochemistry, pharmacology, traditional medicine, bioactive compounds.

INTRODUCTION

Holigarna arnottiana Is a lesser-known tropical tree belonging to the family Anacardiaceae, a family well recognized for its chemically diverse and biologically active members.[1] The genus *Holigarna* is native to the Western Ghats of India and parts of Southeast Asia, where several species are traditionally used in folk medicine.[2] H. Arnottiana has attracted scientific attention due to its reported toxic properties and the presence of bioactive secondary metabolites, which suggest potential pharmacological relevance despite its limited ethnomedicinal documentation.[3]

Phytochemical investigations of *H. arnottiana* have revealed the presence of phenolic compounds, resorcinol's, flavonoids, and other aromatic constituent's characteristic of Anacardiaceae species.[4] Many of these compounds are known to exhibit strong photochemical reactivity, contributing to both therapeutic and toxic effects.[5] The photochemical behaviour of these constituents, particularly their interaction with light and oxygen, plays a significant role in mediating biological activities such as cytotoxicity, antimicrobial action, and inflammatory responses.[6]

Pharmacological studies on *H. arnottiana*, though relatively limited, indicate promising activities including antimicrobial, antioxidant, and cytotoxic effects.[7] However, the presence of allergenic and irritant compounds necessitates careful evaluation of its safety profile.[8] This review aims to summarize the available literature on the phytochemistry and pharmacological properties of *Holigarna arnottiana*, highlighting its bioactive compounds, photochemical characteristics, and potential therapeutic applications, while emphasizing the need for further systematic and toxicological studies.[9,10]

The purpose of this comprehensive review is to critically evaluate and synthesize the current body of knowledge surrounding *H. arnottiana*, with a particular focus on its phytochemical constituents and pharmacological properties. This review aims to provide a detailed analysis of the diverse bioactive compounds found in *H. arnottiana*, elucidating their chemical structures and potential biological roles, while critically assessing the pharmacological activities attributed to its extracts and isolated compounds. By exploring the potential therapeutic applications of *H. arnottiana* in modern medicine and drawing parallels with its traditional uses, we seek to bridge the gap between traditional knowledge and modern scientific inquiry. Furthermore, this review endeavours to identify significant knowledge gaps in the current research landscape, propose specific directions for future investigations, and evaluate the potential of *H. arnottiana* as a source of novel pharmaceutical agents, considering both its promise and limitations. Through this multifaceted approach, we aim to offer a comprehensive understanding of *H. arnottiana' s* potential in pharmacology and drug discovery, providing insights that could guide future research and development efforts while contextualizing its importance within the broader framework of natural product research and medicinal plant studies.

Taxonomical Classification[2]
Kingdom: Plantae
Order: Sapindales
Family: Ancardiaceae
Genus: Holigarna
Species: Arnottiana

Synonyms[11]
The plant *H. arnottiana* is known by several names. The synonyms are given below:
Kannada: Holigeru
Malayalam: Cheru
Tamil: Karinjai
Tulu: Chere
Telugu: Nalleru

Distribution of the plant[2,12]
Holigarna arnottiana is endemic to the Western Ghats mountain range in southwestern India, with its distribution confined to this biodiversity hotspot. The species occurs from the central Sahyadri's in Maharashtra southward through Karnataka and Kerala to the southern parts of Tamil Nadu, encompassing a linear range along the ghats from approximately Lonavala in the north to Kanyakumari in the south.

Populations are primarily found at low to moderate elevations (0-800 meters above sea level), though some records extend up to 1200 meters in evergreen forest zones. Scattered occurrences are noted in semi-evergreen and moist deciduous forests within this elevational band, with higher densities reported in districts such as Hassan, Kodagu, Shivamogga, and Uttara Kannada in Karnataka.

The plant prefers well-drained lateritic and loamy soils, which are abundant in forested regions of the Western Ghats. High humidity and consistent monsoon rainfall play a crucial role in its growth and survival. These environmental factors strongly influence its geographical spread and population density.

Outside India, the genus *Holigarna* is distributed across parts of Sri Lanka and Southeast Asia, including regions of Thailand and Myanmar. However, *H. arnottiana* itself is largely endemic to the Indian subcontinent. This restricted distribution highlights its ecological importance and vulnerability.

Within forest ecosystems, *H. arnottiana* is often found growing alongside other members of the Anacardiaceae family and dominant tropical tree species. It contributes to forest structure and biodiversity, although it is not typically a dominant species. Its presence is more common in primary forests than in secondary or degraded habitats.

Anthropogenic activities such as deforestation, agricultural expansion, and urbanization have led to a reduction in suitable habitats for *H. arnottiana*. As a result, its natural populations are increasingly fragmented. Habitat loss poses a significant threat to the long-term survival of this species.

Due to its limited distribution and ecological specificity, *H. arnottiana* requires conservation attention, particularly within protected forest areas. Sustainable forest management and habitat preservation are essential to maintain its populations. Understanding its distribution is crucial for future pharmacological exploration and conservation planning.

Morphology
Holigarna arnottiana is a medium to large-sized evergreen tree that can attain considerable height under favourable forest conditions. The tree exhibits a straight, cylindrical trunk with a dense and spreading canopy. Its overall growth form is typical of tropical forest trees adapted to humid environments (Figure 1).

Figure 1: *H. arnottiana* Leaves.

The leaves are simple, alternately arranged, and measure 10-25 cm in length, exhibiting obovate or oblanceolate shapes with leathery texture, entire margins, and

prominent veins that include a raised midrib and secondary nerves numbering 10-20 pairs. These leaves are clustered toward the ends of branchlets, providing a dense foliage typical of canopy trees in its native habitats.

Venation in the leaves is prominent, with a strong midrib and numerous lateral veins that are clearly visible on the underside. Petioles are stout and of moderate length, supporting the large lamina. The Leaf blade (lamina) of *Holigarna arnottiana* is typically about 6 – 15 cm long and 2- 5 cm wide in mature leaves. These features contribute to efficient photosynthesis and water transport.

Flowers are small, occurring in axillary or terminal panicles that extend up to 20 cm long, arranged in a polygamous inflorescence that includes unisexual and bisexual forms, with each flower featuring 5 petals and 10 stamens. The calyx is copular and 5-lobed, while the petals cohere at the base, contributing to the subtle, greenish-white appearance of the blooms.

The fruit is an obliquely ovoid drupe measuring 2-2.5 cm in length, initially greenish but turning black when ripe, enclosing a single seed and almost entirely included within a fleshy hypo carp with resinous pericarp. This fruit structure is adapted for dispersal in forest understories, with the black coloration aiding in camouflage among leaf litter. (Figure 2).

Figure 2: *H. arnottiana* tree.

The bark of *H. arnottiana* is greyish-brown to dark brown in colour and becomes rough and fissured with age. When injured, the bark exudes a resinous sap that is known to be irritant in nature. This exudate is characteristic of many members of the Anacardiaceae family.[13]

Phytochemistry

Holigarna arnottiana contains a range of bioactive secondary metabolites responsible for its traditional medicinal use. GC-MS analysis of the ethyl acetate extract identified 3,7,11,15-tetramethyl-2-hexadecen-1-ol as the major compound (42.1%), followed by 1-iodo-2-methylundecane (34.5%) and squalene (11.1%). Smaller amounts of vitamin E (8.5%) and heptadecane, 2,6,10,14-tetramethyl- (3.7%) were also detected, suggesting a complex phytochemical profile. These compounds belong to diverse classes including long-chain alcohols, hydrocarbons, terpenoids, and antioxidants. The presence of flavonoids, phenolics, saponins, and glycosides has also been reported in extracts, though exact percentages for these classes are not fully quantified. The rich complement of terpenes and unsaturated hydrocarbons may contribute to the plant's biological activities. Extraction methods (e.g., ethyl acetate) influence the relative abundance of these constituents. Overall, the chemical composition supports both antioxidant and antimicrobial potential (Table 1).[2,14]

Table 1: Phytochemical constituents of *H. arnottiana.*

Compound Class	Isolated Compounds	Source	Description
Phenolics	Flavonoids, Tannins	Leaf, Bark	Polyphenolic compounds with antioxidant, anti-inflammatory, and antimicrobial properties.
Alkaloids	General alkaloids	Bark	Nitrogen containing bioactive compounds; cytotoxic and antimicrobial activities reported
Terpenoids/Steroids	Squalene, 3,7,11,15-Tetramethyl-2-hexadecen-1-ol	Leaf, Bark	Triterpenoid and long-chain alcohols with antioxidant and anti-inflammatory properties.
Saponins	Glycosidic saponins	Leaf, Bark	Surface-active glycosides; known for antimicrobial and immunomodulatory effects.

Fatty acids / Hydrocarbons	1-Iodo-2-methylundecane, Heptadecane, 2,6,10,14-tetramethyl-	Leaf	Long chain hydrocarbons with potential bioactivity; structural components of plant resins
Antioxidants	Tocopherol	Leaf	Lipid soluble antioxidant; protects against oxidative stress
catechol derivatives		Latex	Toxic phenolic compounds typical of Anacardiaceae; may cause contact dermatitis

Traditional uses

Holigarna arnottiana has long been utilized in traditional Ayurvedic medicine, particularly in the regions of Kerala and Karnataka, where it is documented in regional herbal manuscripts dating back to the 15th century CE. The leaves is commonly prepared as decoctions to treat cancer, obesity, gastrointestinal issues, anti-inflammatory conditions such as arthritis and rheumatism, often combined with cow's ghee for enhanced efficacy in chronic cases. The resin serves as a topical application for skin ailments, including eczema, wounds, and ulcers, functioning as a natural varnish to promote healing and draw out toxins, though its irritant properties require careful handling. In folk practices among indigenous tribes of the Western Ghats, such as those near Agumbe and Kudremukh in Karnataka, leaf poultices and bark extracts are applied for dermatological issues like jellyfish stings and infections, while infused teas provide immune support during monsoons to prevent seasonal ailments.[4] These preparations highlight its role as a Tikta-Kashaya rasa herb that balances Vata and Kapha doshas, contributing to its classification in classical texts for musculoskeletal and rejuvenate health.

Modern studies have begun to correlate traditional medicinal uses with phytochemical and pharmacological profiles, providing scientific validation for their antioxidant, antimicrobial, and anti-inflammatory potentials. This growing body of evidence highlights the importance of traditional knowledge as a valuable foundation for contemporary research, continuing to guide drug discovery and the development of new therapeutic applications.[14,15,16]

- **Pharmacological uses of *H. arnottiana***

Antimicrobial activity

The bark of *H. arnottiana* have demonstrated significant antibacterial properties. In a comprehensive study, bark was dried and methanolic extracted to isolate bioactive compounds. The antibacterial efficacy of these extracts was assessed using the disc diffusion method against various Gram-negative bacterial strains, including *Escherichia coli, Proteus vulgaris,* and *Klebsiella pneumoniae*. Methanolic extracts exhibited antibacterial activity, with demonstrating superior efficacy. Notably, the antibacterial activity increased in correlation with higher extract concentrations, indicating a dose-dependent response. The methanolic extract produced zones of inhibition measuring 0.5 mm, 0.4 mm, and 0.5 mm against *E. Coli, P. Vulgaris,* and *K. Pneumonia*, respectively at 10% concentration. In contrast, the methanolic bark extract yielded larger zones of inhibition: 0.7, 0.6, and 0.5 mm against the same bacterial strains.[17]

Antioxidant Properties

The antioxidant potential of *H. arnottiana* has been rigorously examined through various established methodologies. A study employing TLC bioautography and the DPPH assay revealed that the methanolic extract of *H. arnottiana* exhibited remarkable antioxidant activity, achieving an impressive 95% DPPH scavenging capability. Furthermore, the ethanolic extract demonstrated significant antibacterial activity, highlighting the plant's multifaceted therapeutic potential. These findings provide a scientific basis for the traditional use of *H. arnottiana* in treating various ailments.[18,19]

Anticancer Activity

In cancer research, *H. arnottiana* has shown promising results. An ethanolic extract prepared from shade-dried leaves of the plant demonstrated significant cytotoxic effects on oral cancer cell lines. Among various concentrations tested, 100 µg/ml of the ethanolic extract exhibited the most pronounced efficacy in producing significant growth inhibition. The cytotoxic effects were measured at a wavelength of 540 nm, and the concentration necessary to achieve a 50% reduction in cell viability was meticulously calculated. Notably, the genotoxic activity of the extract was markedly higher compared to both untreated cell lines and the standard chemotherapeutic agent, 5-fluorouracil. These findings highlight the potential of *H. arnottiana* in the development of novel anticancer therapies.[20]

Hepatoprotective Activity

The hepatoprotective activity of *H. arnottiana* has been evaluated. The ethanolic extract significantly attenuated the levels of hepatic marker enzymes, demonstrating a notable hepatoprotective effect. At the same time, the standard reference compound silymarin was effective in restoring these enzyme activities to their normal physiological values. This finding suggests the potential of *H. arnottiana* in liver protection and treatment of liver disorders, opening up new avenues for research in hepatology.[21]

Knowledge gaps and future research for *H. Arnottiana*

Despite the promising pharmacological activities demonstrated by *H. arnottiana,* several significant knowledge gaps persist, necessitating further research. Foremost among these is the need for comprehensive

isolation and characterization of specific bioactive compounds responsible for the observed therapeutic effects. The molecular mechanisms underlying the plant's biological activities, particularly its anticancer and anti-obesity properties, remain largely unexplored and require in-depth investigation. There is a notable absence of well-designed clinical trials to evaluate the efficacy and safety of *H. arnottiana* extracts or isolated compounds in human subjects, which is crucial for translating preclinical findings into potential therapeutic applications. Future research should also focus on developing standardized extracts, exploring potential synergistic effects between compounds, and conducting thorough toxicological assessments. Investigating sustainable cultivation methods and the plant's ecological role in forest regeneration could provide valuable insights for pharmaceutical development and conservation efforts. Comparative analyses with related plant species and established pharmacological agents would further elucidate *H. arnottiana' s* unique therapeutic potential. Addressing these research gaps will be essential for fully understanding and harnessing the medicinal properties of *H. arnottiana*.

CONCLUSIONS

H. arnottiana, a prominent pioneer tree species in western ghats of India demonstrates significant potential as a source of bioactive compounds with diverse therapeutic applications. Its rich phytochemical profile, including Phenolic compounds, tannins, terpenoids, flavonoids, squalene and resins contribute to its wide range of pharmacological activities. Scientific studies have validated its traditional medicinal uses, revealing antimicrobial, antioxidant, anticancer and antifungal properties. The plant's versatility extends beyond medicine to agriculture and industrial applications, highlighting its economic importance. While current research provides a strong foundation for understanding *H. arnottiana' s* therapeutic potential, further investigations are necessary to isolate specific bioactive constituents, elucidate their mechanisms of action, and explore their potential in areas, such as cancer treatment. This comprehensive review underscores the significance of *H. arnottiana* in bridging traditional medicine with modern pharmacological research, paving the way for novel therapeutic developments.

CONFLICT OF INTEREST

None declared.

FUNDING

None declared.

ETHICAL STATEMENT

None declared.

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