

Review Article

A Comprehensive Review on Phytochemical Analysis of *Eclipta alba*

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Abstract

Eclipta alba (L.) Hassk., commonly known as False Daisy, is a traditionally valued medicinal herb widely recognized in Ayurvedic, Unani, and Chinese systems of medicine. It is extensively used for its hepatoprotective, antimicrobial, antioxidant, anti-inflammatory, and anti-aging properties. This comprehensive review provides a detailed analysis of the phytochemical constituents present in various extracts of *Eclipta alba*, including alkaloids, flavonoids, coumarins, terpenoids, polyacetylenes, saponins, and tannins. Advanced analytical techniques such as Thin Layer Chromatography (TLC), High-Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectrometry (GC-MS), and Fourier Transform Infrared Spectroscopy (FTIR) have been utilized in various studies to identify and quantify these bioactive compounds. The review highlights the correlation between specific phytoconstituents and their pharmacological activities, emphasizing the potential of *Eclipta alba* as a source for drug development and nutraceutical formulations. Furthermore, the review identifies research gaps and suggests future directions for in-depth metabolomic and bioavailability studies to validate traditional claims with modern scientific evidence.

Keywords: *Eclipta alba*, phytochemical analysis, bioactive compounds, flavonoids, HPLC, GC-MS, medicinal plant, pharmacognosy

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Introduction

Eclipta alba, commonly known as false daisy, holds a prominent position in traditional medicine systems, particularly in Ayurveda, where it is revered for its diverse therapeutic properties. This plant, belonging to the Asteraceae family, thrives in tropical and subtropical regions, including India, Nepal, and Bangladesh, where it has been traditionally employed to address a wide array of ailments^(26 & 31). Its traditional applications span across various health conditions, including gastrointestinal disorders, respiratory ailments, fever, hair loss and premature graying, liver disorders, skin diseases, spleen enlargement, and wound healing, underscoring its versatile therapeutic potential⁽²⁰⁾. Phytochemicals, the bioactive compounds produced by plants as secondary metabolites, play a crucial role in mediating these therapeutic effects, acting as a defense mechanism against predators and environmental stressors⁽²³⁾. These compounds are responsible for the plant's diverse pharmacological activities⁽⁴⁾. A comprehensive understanding of the phytochemical composition of *Eclipta alba* is crucial for unlocking its full therapeutic potential and for developing standardized herbal formulations with consistent efficacy and safety profiles.



Fig 1. Benefits of *E. alba*

Phytochemical Profile of *Eclipta alba*

The phytochemical analysis of *Eclipta alba* reveals a rich reservoir of bioactive compounds, encompassing a diverse array of chemical classes, each contributing to the plant's multifaceted pharmacological activities. Among the key phytochemical constituents identified in *Eclipta alba* are flavonoids, known for their antioxidant, anti-inflammatory, and cardioprotective properties, which are frequently found in medicinal plants⁽²⁸⁾.

Coumarins, another class of compounds present in *Eclipta alba*, exhibit anticoagulant, anti-inflammatory, and anticancer activities, contributing to the plant's therapeutic potential⁽²⁾. Terpenoids, including triterpenoids and steroids, constitute a significant portion of the phytochemical profile of *Eclipta alba*, imparting diverse pharmacological effects, such as anti-inflammatory, antimicrobial, and anticancer activities (Qualitative and Quantitative Analysis of the Biochemical Components in Plant Samples Gathered from Muzaffarnagar, n.d.). Saponins, glycosidic compounds found in *Eclipta alba*, possess expectorant, anti-inflammatory, and immunostimulatory properties, further enhancing the plant's therapeutic value. Phenolic acids, such as gallic acid and caffeic acid, are also present in *Eclipta alba*, contributing to its antioxidant, anti-inflammatory, and hepatoprotective effects.



Fig 2. Different parts of *E. alba* plant

Literature Review

The presence of these diverse phytochemicals in *Eclipta alba* underscores its potential as a valuable source of natural remedies for various health conditions. The plant also contains wedelolactone, a coumestan with hepatoprotective and anti-inflammatory properties, and ecliptalbine, an alkaloid with potential anticancer activity. Other notable constituents include stigmasterol, a plant sterol with anti-inflammatory and cholesterol-lowering effects, and luteolin, a flavonoid with antioxidant, anti-inflammatory, and anticancer properties. Polyacetylenes, polypeptides, and thiophene derivatives have also been isolated from *E. prostrata*⁽³⁾. The presence of tannins, alkaloids, flavonoids, and saponins in the plant extracts may contribute to its medicinal properties. The synergistic interactions between these diverse phytochemicals are believed to contribute to the overall therapeutic efficacy of *E. alba*. *Eclipta alba* is known to contain secondary compounds like alkaloids, flavonoids, terpenoids, and phenolic compounds, all of which contribute to the plant's various therapeutic effects⁽²²⁾. These compounds play a crucial role in the plant's medicinal properties, offering a wide range of pharmacological activities.

The extraction and analysis of phytochemicals from *Eclipta alba* involve a range of sophisticated techniques aimed at isolating, identifying, and quantifying the bioactive compounds present in the plant material. Solvent extraction, maceration, and Soxhlet extraction are commonly employed methods for extracting phytochemicals from *Eclipta alba*, utilizing solvents such as methanol, ethanol, and water to selectively dissolve the desired compounds⁽⁶⁾.

These extraction methods are optimized based on the solubility characteristics of the target phytochemicals and the desired yield and purity of the extract. Following extraction, various analytical techniques are employed to identify and quantify the phytochemical constituents in the extract. High-performance liquid chromatography, coupled with diode-array detection or mass spectrometry, is a widely used technique for separating, identifying, and quantifying phytochemicals in *Eclipta alba* extracts due to its high resolution and sensitivity⁽¹⁾.

Eclipta alba, commonly known as false daisy, holds a significant position in traditional medicine systems, particularly in Ayurveda, where it is revered for its diverse therapeutic properties. This plant, belonging to the Asteraceae family, has been extensively utilized for treating a wide array of ailments, ranging from skin disorders and liver conditions to gastrointestinal and respiratory issues^(20, 26 & 31). Understanding the intricate phytochemistry of *E. alba* is crucial to elucidating its pharmacological mechanisms and validating its traditional uses. Plants produce phytochemicals as secondary metabolites to defend themselves from predators⁽²³⁾. The medicinal properties of plants are correlated to the bioactive phytochemicals they possess⁽⁴⁾. Natural products from plants continue to be a major source of pharmaceuticals⁽²⁸⁾. Comprehensive investigations into the phytochemical composition of *E. alba* have revealed the presence of a diverse array of bioactive compounds, including coumestans, flavonoids, terpenoids, steroids, and alkaloids. These compounds contribute significantly to the plant's therapeutic potential, exhibiting antioxidant, anti-inflammatory, antimicrobial, and hepatoprotective activities⁽⁵⁾. The chemical and biological sciences emphasize that biological or medical phenomena have a chemical foundation⁽¹⁴⁾. Squalene and other triterpenes have been isolated and identified from *E. alba* (Qualitative and Quantitative Analysis of the Biochemical Components in Plant Samples Gathered from Muzaffarnagar).

The exploration of *E. alba*'s phytochemistry reveals a complex profile of bioactive molecules, each contributing uniquely to its therapeutic efficacy. Flavonoids, a ubiquitous group of polyphenolic compounds, are abundant in *E. alba* and are known for their potent antioxidant and anti-inflammatory properties⁽²⁴⁾. These compounds scavenge free radicals, inhibit lipid peroxidation, and modulate inflammatory signaling pathways, thereby protecting cells from oxidative stress and inflammation⁽²⁷⁾. Terpenoids, another major class of phytochemicals found in *E. alba*, exhibit a wide range of biological activities, including antimicrobial, anticancer, and immunomodulatory effects. Coumestans, such as wedelolactone, are particularly noteworthy components of *E. alba*, demonstrating significant hepatoprotective and anti-inflammatory actions. Steroids present in *E. alba* have also been reported to possess anti-inflammatory and analgesic properties, contributing to the plant's traditional use in pain management.

The study of phytochemicals involves extraction, screening, identification, and characterization from

various biological materials ⁽²²⁾. Different solvent extraction techniques exist for optimum recovery of phytochemicals, like maceration, decoction, soxhlet extraction, hydro distillation, and microwave-assisted extraction. Phytochemical analysis techniques such as thin-layer chromatography, gas chromatography-mass spectrometry, and high-performance liquid chromatography play pivotal roles in identifying and quantifying the various bioactive compounds present in plant extracts. Spectroscopic techniques, including nuclear magnetic resonance spectroscopy and mass spectrometry, are indispensable for elucidating the chemical structures of novel phytochemicals.

The essential oils derived from plants contain complex mixtures of numerous chemicals, sometimes exceeding 400 different compounds, depending on the plant species, extraction method, and plant parts used ⁽²⁹⁾. The growing trend of comparing phytochemical constituents isolated from plants with their pharmacological actions underscores the importance of understanding the relationship between a plant's chemical composition and its therapeutic effects ⁽¹⁷⁾. Herbal extracts contain essential nutrients and diverse bioactive compounds with antioxidant properties, such as flavonoids, phenolics, sterols, alkaloids, carotenoids, and glucosinolates ⁽¹⁷⁾. These compounds act as substrates, cofactors, or inhibitors in biochemical and enzymatic reactions, influencing physiological functions ⁽³²⁾. Plants exhibiting differences in physical properties, such as color variations, may indicate the presence of diverse medicinal compounds, with flavor and special compounds being important features of medicinal plants ⁽³⁰⁾.

The use of medicinal plants in healthcare is increasing, emphasizing the importance of discovering new medicinal plants to meet people's needs ⁽²¹⁾. The study of pharmacophylogeny, which examines the relationships between plant kinship, chemical composition, and medicinal effects, guides the research and improvement of medicines ⁽¹⁹⁾. In addition, environmental factors, including cultivation area, climate, planting and harvesting times, and post-harvest storage, can affect the consistency of plant extracts. Furthermore, processing and extraction methods, processing time, particle size, and the ratio of sample to solvent can influence the compositional diversity of phytochemicals present in natural extracts ⁽³³⁾.

Conclusion

This study reveals that both *Eclipta alba* is rich in bioactive phytochemicals, especially phenolics and flavonoids. These findings provide scientific validation for their ethnomedicinal usage and indicate their potential as sources for natural therapeutic agents.

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