Review Article

# Hair Growth-Promoting Potential of *Eclipta prostrata* (L.) L.: A Comprehensive Review of Pharmacological Mechanisms, Preclinical Evidence, and Clinical Perspectives

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**ABSTRACT**

Hair loss (Alopecia) is a common dermatological condition that adversely affects quality of life and is associated with multiple etiologies, including androgenetic alopecia, alopecia areata, chemotherapy-induced alopecia, and age-related hair thinning. Although currently available pharmacological treatments, such as minoxidil and finasteride, demonstrate clinical efficacy, their use is often limited by adverse effects, variable therapeutic responses, and poor long-term compliance. Consequently, there is growing interest in medicinal plants as safer and more effective alternatives for hair growth promotion. *Eclipta prostrata* (L.) L. (syn. *E. alba* (L.) Hassk.), commonly known as *Bhṛṅgarāja* or *Keśarāja*, has been extensively used in traditional medicine for maintaining hair health and preventing hair loss. This review critically summarizes the current evidence on the hair growth-promoting potential of *E. prostrata*, emphasizing its pharmacological mechanisms, preclinical efficacy, and emerging clinical evidence.

**Keywords:** *Eclipta prostrata, Eclipta alba,* Bhṛṅgarāja, Alopecia, Hair growth-promoting, Hair follicles.

## INTRODUCTION

Hair is an important determinant of physical appearance and personal identity, with cultural significance across populations worldwide. Consequently, hair related disorders, including excessive hair fall, premature greying, dandruff, and hair thinning, have substantial cosmetic, psychological, and social impacts. Among these conditions, hair fall is one of the most common dermatological concerns, affecting millions of individuals globally and substantially impairing quality of life.[1] The hair follicle is a highly specialized mini-organ of the skin that exhibits remarkable structural and functional complexity. Hair growth is regulated through a continuous and highly regulated cycle consisting of three distinct phases: the active growth phase (anagen), the apoptosis-driven regression phase (catagen), and the resting phase (telogen). Throughout an individual's lifetime, hair follicles undergo repeated cycles of degeneration and regeneration, which are tightly controlled by complex molecular signaling pathways. Disruption of these regulatory mechanisms can result in abnormal hair cycling and excessive hair loss.[2] Hair loss disorders, particularly alopecia areata, represent a significant global health burden. Recent epidemiological analyses estimate that alopecia areata contributes to more than 4.1 million disability-adjusted life years worldwide, underscoring its substantial clinical, psychosocial, and public health impact.[3] Beyond the physical manifestations, hair loss can adversely affect self-esteem, emotional well-being, and overall quality of life. Despite the availability of conventional therapies, many treatments are associated with limited efficacy, adverse effects, or high recurrence rates following discontinuation. Therefore, there is a growing need to develop safe, effective, and evidence-based therapeutic strategies for the prevention and management of hair loss, including novel pharmacological agents and scientifically validated natural products.

*Eclipta prostrata* (L.) L. (Syn: *E. alba* (L.) Hassk.) (Asteraceae) is an important medicinal herb extensively used in traditional systems of medicine, including Ayurveda, Siddha, traditional Chinese medicine, and other Southeast Asian practices. In Ayurveda, it is commonly known as *Bhṛṅgarāja* or *Keśarāja* ("King of Hair"), reflecting its longstanding use in promoting hair growth and maintaining hair health. The plant is an annual or perennial, erect or prostrate herb widely distributed in moist and tropical regions of India, China, Thailand, and several other Asian countries. Traditionally, the leaves and aerial parts have been employed in the form of fresh juice, paste, and medicated oils for the management of various disorders, particularly those affecting the hair, skin, and liver, as well as for general health promotion. Owing to its broad spectrum of traditional applications, *E. prostrata* has attracted considerable scientific interest, with numerous studies investigating its phytochemical composition and pharmacological properties. Its hair growth promoting potential has been attributed to its ability to support scalp health, strengthen hair follicles, improve hair quality, and delay premature greying, thereby supporting its widespread use as a key botanical ingredient in traditional hair care formulations.[1,4-5]

The plant is a rich source of diverse bioactive phytoconstituents, including coumestan derivatives (wedelolactone, demethylwedelolactone, isodemethyl wedelolactone, strychnolactone, and dimethyl wedelolactone glucoside); triterpenoid and steroidal saponins (eclalbasaponins I–XIII and eclalbasaponins A–D); triterpenes (α-amyrin, ursolic acid, oleanolic acid, machaeroceric acid, and silphioside C); steroids (β-

sitosterol, stigmasterol, stigmasterol-3-*O*-glucoside, and daucosterol); flavonoids (luteolin, tricetin, diosmetin, kaempferol, kaempferol-7-*O*-α-D-rhamnoside, quercetin, apigenin, and acacetin); phenolic acids (protocatechuic, 4-hydroxybenzoic, vanillic, syringic, chlorogenic, and caffeic acids); coumarins (psoralen and isopsoralen); alkaloids (crinumaquine and 2,3,9,12-tetramethoxyprotoberberine); thiophene derivatives; and several other minor phytochemicals.[6]

The diverse pharmacological activities of *E. prostrata* have been extensively documented and scientifically validated through numerous in vitro and in vivo studies. These include antioxidant,[7,8] antimicrobial,[9,10] hepatoprotective against $CCl_4$-induced hepatotoxicity,[11-13] antihyperlipidemic,[14,15] cerebroprotective and neuroprotective,[16-18] antihyperglycemic,[19-23] anticancer,[24-27] and immunomodulatory effects.[28-29]

Based on the extensive pharmacological evidence available, this review provides a comprehensive overview of its hair growth-promoting potential of *E. prostrata* by critically examining the available preclinical evidence, bioactive phytoconstituents, and the mechanistic pathways underlying its therapeutic efficacy.

## METHODS

A comprehensive literature search was conducted to identify published studies on *Eclipta prostrata* (L.) L. using major electronic databases, including ScienceDirect, PubMed, Scopus, Web of Science, Google Scholar, and SciFinder. Additional relevant information was obtained from books, conference proceedings, and reference lists of eligible publications. The literature search included articles published up to June 2026 using combinations of the keywords "*Eclipta prostrata*", "*Eclipta alba*", phytochemistry, phytoconstituents, traditional uses, ethnopharmacology, biological activities, pharmacological activities, hair growth, alopecia, and hair follicle. Original research articles, review articles, and relevant book chapters published in English were considered for inclusion. Studies were selected based on their scientific quality, methodological rigor, and relevance to the objectives of this review. Duplicates, non-English publications, abstracts without full-text availability, and studies lacking sufficient experimental details were excluded. The retrieved literature was critically evaluated and organized according to major themes, including botanical description, traditional uses, phytochemical constituents, pharmacological activities, safety profile, and evidence supporting the hair growth-promoting potential of *E. prostrata*. Particular emphasis was placed on experimental and mechanistic studies investigating its effects on hair follicle biology, hair growth regulation, and the molecular pathways underlying its therapeutic potential.

### Hair growth-promoting potential of *Eclipta prostrata*: experimental evidence and mechanistic insights:

Accumulating experimental evidence has provided substantial scientific support for the traditional use of *Eclipta prostrata* as a hair growth-promoting medicinal plant. Its beneficial effects are attributed to multiple mechanisms, including induction of the anagen phase, stimulation of dermal papilla cell proliferation, modulation of key hair growth-related signaling pathways, and protection against androgen- and chemotherapy-induced hair follicle damage. Collectively, these findings highlight the therapeutic potential of *E. prostrata* for the management of various forms of alopecia.

Roy et al. (2008) demonstrated that the petroleum ether extract of *E. prostrata* significantly promoted hair growth by inducing the transition of hair follicles from the telogen to the anagen phase. Histological analysis revealed that treatment with 2% and 5% petroleum ether extracts increased the proportion of anagen follicles to approximately 68% and 70%, respectively, compared with untreated controls. The hair growth-promoting activity was primarily attributed to wedelolactone and β-sitosterol, suggesting that these phytoconstituents play important roles in anagen induction and follicular regeneration.[30] Subsequently, Datta et al. (2009) demonstrated that the methanolic extract of *E. prostrata* promotes hair growth by inducing premature anagen transition in telogen-phase hair follicles in C57BL/6 mice. The effect was dose-dependent, with the highest dose (3.2 mg/15 $cm^2$) exhibiting efficacy comparable to minoxidil. Histological findings showed enhanced melanogenesis, increased hair follicle density, deeper follicular penetration into the subcutis, and increased skin thickness, indicating accelerated follicular regeneration. Mechanistically, the extract upregulated fibroblast growth factor-7 (FGF-7) and Sonic hedgehog (Shh) while suppressing bone morphogenetic protein-4 (BMP4), thereby stimulating anagen-associated signaling and inhibiting the telogen phase. These findings provide pharmacological evidence supporting the traditional use of *E. prostrata* as a natural hair growth-promoting agent.[31]

Datta et al., (2012) further evaluated the hair growth-promoting potential of *E. prostrata* using an etoposide-induced alopecia mouse model. The ethyl acetate fraction of the methanolic extract of *E. prostrata* was applied topically as a cream at 1.6% and 3.2% concentrations in Swiss albino and C57BL/6 mice. Etoposide treatment resulted in complete inhibition of hair growth, whereas ethyl acetate fraction application significantly reversed chemotherapy-induced alopecia in a dose-dependent manner. Histological analysis revealed enhanced hair follicle regeneration and increased skin thickness, indicating the potential of *E. prostrata* ethyl acetate fraction as a promising natural agent for the management of chemotherapy-induced alopecia.[32] Begum et al. (2014) compared the hair growth-promoting potential of *E. prostrata* with other traditionally used medicinal plants, including *Asiasarum sieboldii* and *Panax ginseng*. Methanolic extracts of these plants were evaluated using a nude mouse model exhibiting genetically induced hair deficiency associated with abnormal keratinization. Topical application of *E. prostrata* extract significantly increased hair density, hair length, and hair coverage compared with

untreated controls. Histomorphometric analysis revealed a marked increase in the number of hair follicles, while BrdU incorporation studies confirmed enhanced proliferation of follicular keratinocytes, indicating stimulation of follicular regeneration and growth. In contrast, *A. sieboldii* and *P. ginseng* extracts exhibited comparatively weaker and short-lived hair growth effects. These findings suggest that *E. prostrata* possesses superior hair growth-promoting activity and supports its potential as a promising botanical candidate for managing hair loss.[33]

In a genetically hair-deficient nude mouse model, the petroleum ether extract of *E. prostrata* demonstrated potent hair growth-promoting activity. Histological analysis revealed marked follicular hypertrophy, while immunohistochemical studies showed increased proliferation of follicular keratinocytes in the basal epidermis and hair matrix. The extract also significantly suppressed transforming growth factor-beta 1 (TGF-β1) expression during early anagen and the anagen–catagen transition, thereby delaying catagen onset. These findings indicate that the petroleum ether extract promotes hair growth by stimulating follicular keratinocyte proliferation and modulating TGF-β1 signaling, highlighting its potential as a natural therapeutic agent for alopecia.[2] Mondal et al. (2016) evaluated the hair growth-promoting potential of the ethanolic leaf extract of *E. prostrata* in Wistar rats. The extract induced complete hair growth within 19 days, compared with 16 days in the 2% minoxidil-treated group. Hair lengths in the extract-treated group reached 8.91, 16.01, and 21.08 mm on days 10, 20, and 30, respectively, while the corresponding values for the 2% minoxidil group were 9.23, 17.63, and 22.13 mm. Although the extract exhibited slightly lower efficacy than minoxidil, it significantly enhanced hair growth compared with the control group, indicating that *E. prostrata* possesses substantial hair growth-promoting activity and supports its traditional use as a natural hair tonic.[34]

Lee et al., (2019) further elucidated the promising hair growth-promoting activity of *E. prostrata* through regulation of follicular growth pathways. In a C57BL/6N mouse model, *E. prostrata* administration enhanced anagen induction, increased hair shaft formation, and promoted hair follicle development. Mechanistic investigations revealed that *E. prostrata* increased the expression of fibroblast growth factor-7 (FGF-7), a positive regulator of hair growth, while reducing fibroblast growth factor-5 (FGF-5), which is associated with catagen transition. Furthermore, treatment of human dermal papilla cells with *E. prostrata* stimulated FGF-7 expression and activated the mTOR signalling pathway, indicating enhanced follicular cell proliferation. These findings suggest that *E. prostrata* promotes hair growth by modulating key molecular regulators involved in the hair follicle cycle.[35] The anti-androgenic potential of *E. prostrata* has been proved through its inhibitory activity against 5α-reductase (5αR), a key enzyme involved in the conversion of testosterone to the more potent androgen dihydrotestosterone (DHT), which plays a central role in androgenetic alopecia. Methanolic and petroleum ether extracts of *E. prostrata* were evaluated for their 5αR inhibitory activity following phytochemical characterization. Although phytosterols were detected only in the petroleum ether extract during preliminary phytochemical screening, HPTLC analysis confirmed the presence of β-sitosterol in both extracts, with the petroleum ether extract containing 0.11% β-sitosterol. In the enzyme inhibition assay, the petroleum ether extract exhibited significant 5αR inhibitory activity with an $IC_{50}$ value of 150.76 µg/mL**,** while β-sitosterol showed a stronger inhibitory effect with an $IC_{50}$ of 77.09 µg/mL**,** compared with the standard inhibitor finasteride. These findings suggest that *E. prostrata*, particularly its petroleum ether extract and the phytosterol β-sitosterol, possesses promising anti-androgenic activity and may contribute to hair growth promotion by suppressing 5α-reductase-mediated DHT formation.[36]

Using a cyclophosphamide-induced alopecia model, Wuji Wang et al. (2024) reported that petroleum ether extract of *E. prostrata* effectively promoted hair regrowth by protecting hair follicles from apoptosis. Phytochemical profiling identified several bioactive constituents, including wedelolactone, dimethyl-wedelolactone, luteoloside, linarin, and hispidulin, while network pharmacology predicted their interaction with key molecular targets such as TP53, AKT1, ESR1, IL6, TNF, and EGFR. In cyclophosphamide-induced alopecia models, the extract significantly promoted hair regrowth, restored hair follicle density, and reduced follicular apoptosis. In vitro studies further showed enhanced viability of HaCaT keratinocytes and protection against chemotherapy-induced cellular damage. The hair growth-promoting effect was primarily attributed to inhibition of the P53/Fas-mediated apoptotic pathway, highlighting the therapeutic potential of *E. prostrata* as a natural agent for preventing chemotherapy-associated hair loss.[37] Recent studies support the hair growth-promoting potential of *E. prostrata* through multiple complementary mechanisms. Phytochemical analyses have identified wedelolactone, ecliptine, phytol, and linolenic acid as key bioactive constituents with antioxidant and anti-inflammatory properties. Molecular docking studies suggest that wedelolactone interacts with β-catenin and vascular endothelial growth factor receptor, indicating activation of the Wnt/β-catenin signaling pathway and angiogenic processes involved in hair follicle regeneration. In vitro studies further demonstrated that *E. prostrata* extracts enhance human dermal papilla cell proliferation without cytotoxicity and increase nuclear β-catenin expression, confirming activation of Wnt/β-catenin signaling. Collectively, these findings indicate that *E. prostrata* promotes hair growth by stimulating dermal papilla cell activity, activating hair follicle regenerative pathways, and improving the follicular microenvironment.[5]

A prospective, open-label, 24-week clinical study evaluated the efficacy and safety of standardized oral *E. prostrata* extract tablets in adults with increased hair shedding. Treatment significantly reduced hair loss, with approximately 62.5% reduction in the 60-second comb test

and 59.9% reduction in weekly hair shedding counts compared with baseline. Most participants (84%) reported overall improvement in hair condition, and the treatment was well tolerated, with only mild, self-limiting gastrointestinal adverse effects. These findings provide preliminary clinical evidence supporting the efficacy and safety of standardized *E. prostrata* extract for reducing hair shedding.[3]

A polyherbal formulation containing petroleum ether extracts of *Cuscuta reflexa*, *Citrullus colocynthis*, and *Eclipta alba* exhibited significant hair growth–promoting activity in rats. Topical application significantly accelerated hair growth by reducing the onset of hair regrowth and shortening the time required for complete hair coverage compared with the untreated control. Histopathological examination demonstrated an increased number of hair follicles in the anagen phase, with effects comparable to those of 2% minoxidil. These findings provide experimental evidence supporting the traditional use of these medicinal plants as hair growth promoters and highlight the therapeutic potential of the polyherbal formulation for alopecia management.[38] Thorat et al., (2009) evaluated the hair growth-promoting potential of a polyherbal hair oil formulation containing *Eclipta prostrata*, *Hibiscus rosa-sinensis*, and *Nardostachys jatamansi*. Among the tested formulations, DF3 (10% *E. prostrata*, 10% *H. rosa-sinensis*, and 5% *N. jatamansi*) exhibited superior hair growth-promoting activity, achieving complete hair growth within 18 days compared with 22 days for DF2 (10% *E. prostrata*, 5% *H. rosa-sinensis*, and 10% *N. jatamansi*). DF3 also demonstrated greater efficacy than 2% minoxidil. The mean hair length was 4.6 mm in the DF3-treated group, compared with 3.6 mm in the DF2-treated group. Histological evaluation revealed that DF3 significantly increased the proportion of hair follicles in the anagen phase (82%) compared with the standard minoxidil-treated group (67%) and the DF2-treated group (65%). These findings suggest that the DF3 polyherbal formulation possesses potent hair growth-promoting activity by accelerating the transition of hair follicles into the anagen phase.[39]

## CONCLUSION

*Eclipta prostrata* has emerged as one of the most extensively investigated medicinal plants for hair growth promotion, with substantial evidence supporting its traditional use in the management of alopecia. Extensive in vitro, in vivo, and emerging clinical studies demonstrate that *E. prostrata* exerts multifaceted hair growth-promoting effects by targeting several key biological processes involved in hair follicle development and cycling. Unlike agents that act through a single mechanism, *E. prostrata* modulates multiple molecular pathways associated with hair follicle regeneration, including activation of FGF-7, Sonic hedgehog (Shh), mTOR, and Wnt/β-catenin signaling, while suppressing catagen-promoting mediators such as FGF-5, BMP4, and TGF-β1. In addition, inhibition of 5α-reductase activity, attenuation of oxidative stress and inflammation, and protection against chemotherapy-induced follicular apoptosis further contribute to its broad therapeutic potential across different forms of alopecia.

The pharmacological activities of *E. prostrata* are attributed to a diverse array of bioactive phytochemicals, including wedelolactone, dimethyl-wedelolactone, β-sitosterol, luteoloside, linarin, hispidulin, ecliptine, phytol, and linolenic acid, which appear to exert complementary and potentially synergistic effects on hair follicle biology. These phytoconstituents collectively promote dermal papilla cell proliferation, stimulate follicular keratinocyte activity, enhance angiogenesis, prolong the anagen phase, and improve the follicular microenvironment, thereby supporting sustained hair regeneration. Furthermore, studies on polyherbal formulations incorporating *E. prostrata* suggest that rational combinations with other medicinal plants may further enhance therapeutic efficacy through synergistic pharmacological interactions.

Although the preclinical evidence is highly encouraging, translation into clinical practice remains limited by the relatively small number of well-designed human studies. Existing clinical investigations indicate that standardized *E. prostrata* preparations can significantly reduce hair shedding and improve overall hair quality with an acceptable safety profile; however, these findings require confirmation in large-scale, multicenter, randomized, double-blind, placebo-controlled clinical trials. Future research should prioritize the standardization of plant materials and extracts, identification of reliable phytochemical markers for quality control, elucidation of pharmacokinetic and pharmacodynamic characteristics, optimization of dosage regimens and delivery systems, and comprehensive long-term safety assessments. Moreover, advanced omics technologies, systems pharmacology, molecular docking, and artificial intelligence-assisted drug discovery may provide valuable insights into the complex molecular networks underlying the hair growth-promoting effects of *E. prostrata* and facilitate the identification of novel therapeutic targets.

In conclusion, the current evidence strongly supports *E. prostrata* as a promising multifunctional botanical agent capable of promoting hair growth through the coordinated regulation of hair follicle cycling, cellular proliferation, androgen metabolism, oxidative stress, inflammation, and apoptosis. Its broad spectrum of biological activities, coupled with its long history of traditional use and favourable preliminary clinical outcomes, highlights its potential as an effective natural alternative or adjunct to conventional hair growth therapies. Continued multidisciplinary research integrating phytochemistry, molecular pharmacology, pharmaceutical formulation, and clinical investigation will be essential for translating the therapeutic promise of *E. prostrata* into standardized, evidence-based phytopharmaceuticals for the management of alopecia and other hair growth disorders.

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