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Research

Unveiling the Therapeutic Wealth of *Eclipta Prostrata*: Ethnobotany, Bioactive Compounds, and Biomedical Relevance

G. Sumithra[1], M. Navaneetha Krishnan*[2], S. Nandhini[2], P.V. Agalya Gayathri[2], B. Yuvan Karthik[3], G. Subitcha Jabakani[3]

[1]*Lecturer, Department of Pharmacognosy, KMCH College of Pharmacy, Coimbatore, Tamil Nadu, India.*
[2]*Research Scholar, Department of Pharmacognosy, College of Pharmacy, Madurai Medical College, Madurai, Tamil Nadu, India.*
[3]*Research Scholar, Department of Pharmaceutical Chemistry, College of Pharmacy, Madurai Medical College, Madurai, Tamil Nadu, India.*

*Author for Correspondence: M. Navaneetha Krishnan
Email: navee3136@gmail.com

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Abstract

Eclipta prostrata (L.) L., also referred to as *Eclipta alba*, is a common medicinal herb that is a member of the Asteraceae family. It is well known for its ability to heal respiratory, skin, and liver illnesses as well as to encourage hair growth. It has long been prized in many ethnomedical systems. The current understanding of *E. prostrata*'s botanical description, ethnomedical applications, phytochemical makeup, and range of pharmacological activity is compiled in this paper. The plant has a wide range of bioactive substances, including as alkaloids (ecliptine), triterpenoid saponins (eclalbasaponins), flavonoids (e.g., luteolin), phenolic compounds, and coumestans (e.g., wedelolactone). Its powerful anti-inflammatory, antioxidant, antidiabetic, hepatoprotective, anticancer, antiobesity, osteogenic, neuroprotective, immunomodulatory, antiulcer, and antibacterial qualities have been emphasized in recent research. Certain phytoconstituents are thought to be responsible for the therapeutic benefits via working via ERK/STAT1, AMPK/PGC-1α, NF-κB, and METTL3-mediated RNA methylation. The review supports the plant's incorporation into contemporary pharmaceutical formulations and highlights its promising role in evidence-based therapy.

Keywords: Eclipta prostrata, Eclipta alba, Wedelolactone, Coumestans, Ethnopharmacology, Phytochemistry, Traditional medicine, Herbal therapeutics.

INTRODUCTION

The little herb genus *Eclipta prostrata* Hassk belongs to the family Asteraceae, which is also commonly referred to *as Eclipta alba* (L.), *Eclipta erecta* (L.), *Verbesina alba* (L.), *Verbesina prostrata* (L.), *Wedelia psammophila Poepp,* etc. The plant develops in humid wastelands throughout India, ascending upward to an altitude of 2000m. It is a white-flowering plant with multiple branches that can grow straight or prostrate.[1]

The Eclipta prostrata has been reported to demonstrate anti-inflammatory, antioxidant, antidiabetics, hepatoprotective, antitumour, antifibrotic, antimicrobial, antiobesity, osteogenetic, antialzheimer's, immunomodulatory, hair growth, antivenom, antiulcer, etc.[2,3]

Vernacular Names[4]
English: False Daisy, Trailing Eclipta
Arabic: Kadim-ul-bint, Radim-el-bint
Assamese: Kehraj
Bengali: Kesuriya, Kesuti
Gujarati: Bhangaro
Hindi: Bhangra, Bhringaraj, Bhangru
Kannada: Garagadasappu, Garugalu, Bhringaraja
Konkani: Mako
Malayalam: Kannunni, Kayyonni, Kayunni Marathi: Maka
Punjab: Bhangra
Sanskrit: Bhringaraj, Kesharaj, Kesharanjana
Tamil: Karisalankanni, Kaikesi, Kaiyantakarai
Telugu: Galagara, Gunta-galagara
Urdu: Bhangra

Taxonomical Classification
Kingdom: Plantae-Plants
Subkingdom: Tracheobionta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Asteridea
Order: Asterales
Family: Asteraceae Bercht
Genus: *Eclipta*
Species :*prostrata*

Distribution [1]
It is a herbaceous annual, a weed of moist places found throughout India, ascending up to 1700m.

Description [5-7]
Leaves: Strigose, appressed hairs on both surfaces, oblong, lanceolate, sub-entire, acute to sub-acute, sessile to sub-sessile, and measure 2.0 to 6.2 cm in length and 1.5 to 1.9 cm in width.
Stem: It is hairy and may reach up to 30-40cm long as a yearly plant with multiple branching and occasionally roots at nodes. Its stem is flat or cylindrical, rough with repressed white hairs, and features prominent, occasionally brownish, greenish nodes.
Flower: A short or non-existent peduncle (stalk) surrounds the tiny, radiating heads of flowers, which can be seen separately or in clusters. The flower buds are tiny, their diameters can vary between 4 to 6 m.
Seed: Its seeds are tiny, ovoid, black, and vary in size between 1-2mm. Their outermost layers are smooth and firm to the touch.
Fruits: Brown, cuneate, one-seeded, narrow-winged, and covered with warty exudates, the achene-like cypsela lacks a pappus.
Roots: Numerous secondary branches arise from the primary root, which is well-developed, up to 7mm thick, cylindrical, and grey.

Ethnomedicinal Uses
Liver disorders, worm infestations, edema, anemia, asthma, cough, headache, heart diseases, senility, peptic ulcers, hepatitis B virus.

Fig 1: *Eclipta prostrata* leaves

Fig 2: *Eclipta prostrata* flower

Phytochemistry [8-11]

Various bioactive phytoconstituents, such as glycosides, triterpenoids, alkaloids, flavonoids, coumestans, and polyacetylenes, are found in *Eclipta prostrata*. Wedelolactone, demethylwedelolactone, β-terthienylmethanol, and stigmasterol are especially abundant in the leaves. Long-chain alcohols like hentriacontanol and heptacosanol are produced from the roots. Luteolin-7-O-glucoside, triterpenic acid glucosides, phytosterols, β-glucoside phytosterols, and β-amyrin have all been found in the plant's aerial portions, particularly in n-hexane extracts. Several organic solvents are also frequently used to extract wedelolactone. Furthermore, following hydrolysis, polypeptides that were separated from *Eclipta prostrata* produce amino acids like glutamic acid, phenylalanine, cystine, tyrosine, and methionine. The plant also includes alkaloids, such as nicotine and nicotinic acid, which add to its wide range of pharmacological effects.

Coumestan

Desmethylwedelolactone and Wedelolactone are the two main coumestans discovered in *Eclipta prostrata*, and they are primarily present in the plant's aerial sections. These compounds are considered to be key components of the plant's hepatoprotective and anti-cancer properties and are found in significant quantities, with concentrations ranging from 0.5% to 0.55% of the plant's dry weight.

Terpenoids and their glycosides

Many terpenoid glycosides have been found in *Eclipta prostrata*, such as oleanane-type glycosides (eclalbasaponins I–VI) and taraxastane-type saponins (eclalbasaponins VII–X), which are classified as derivatives of trihydroxytaraxastane and echinocystic acid. Interestingly, sulfated saponins are eclalbasaponins V and VI. Furthermore, stigmasterol has been separated from the stem bark's n-hexane extract.

Alkaloids

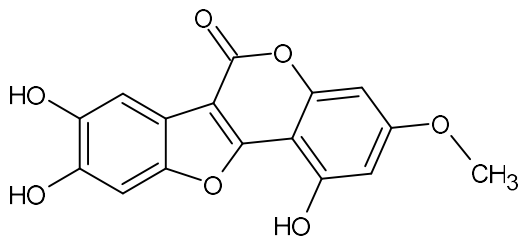
According to recent research, *Eclipta prostrata* contains the alkaloid ecliptine. Eight bioactive steroidal alkaloids were isolated by the use of yeast strains (1353, 1138, and 1140) in the bioassay-guided fractionation of its methanolic extract. Key chemicals include a variety of hydroxyverazine derivatives, a new alkaloid called ecliptalbine [(20R)-20-pyridyl-cholesta-5-ene-3β,23-diol], and (20S)(25S)-22,26-imino-cholesta-5,22-dien-3β-ol. The pharmacological activity of ecliptalbine is similar to that of verazine.

Volatile oils

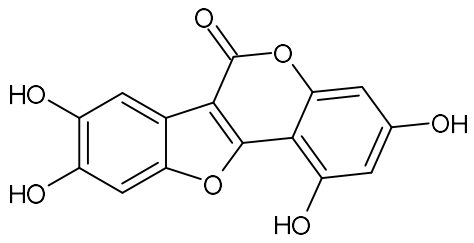
The mass spectrum library (NIST 05.L) was used to identify the 55 chemicals that made up the majority (91.7%) of the volatiles. During this analysis, the following primary compounds were discovered: (Z, Z, Z) -1,5,9,9-tetramethyl-1,4,7-cycloundekatriene (2,07%), (Z) -7,11-dimethyl-3-methylene-1,6,10-dodecatriene (2.08%), (Z, Z)-9,12-octadecadienoic acid (2.36%), 1,2-benzenedicarboxylic acid diisoctyl ester (2.74%), octadec9-enoic acid (3.35%), phytol (3.77%), eudesma-4 (14), 11-diene (5.86%), pentadecane (8.68%), n-hexadecanoic acid (8.98%), 6,10,14-trimethyl-2-pentadecanone (12.80%), and heptadecane (14.78%).

Saponins

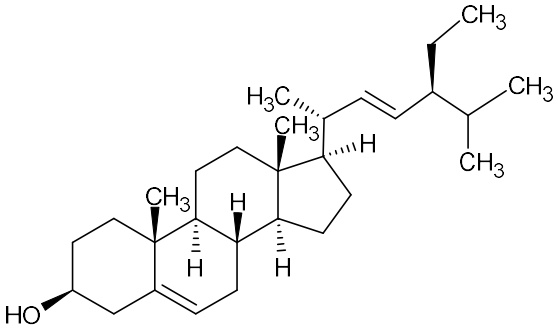
New triterpene saponins, including ursolic acid, eclalbatin, alpha-amyrin, and oleanolic acid, were identified in *Eclipta prostrata*. Based on spectral and chemical data, 3-O beta-D-glucopyranosyl-3-beta-hydroxy-olean-12-en-28-oic acid and 28-O-beta-D-arabinopyranoside have been identified as the constituents of eclalbatin.



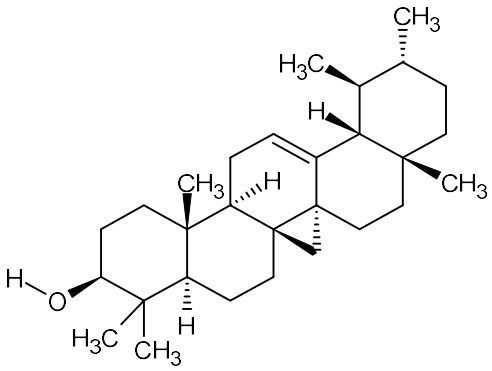
WEDELOLACTONE



DEMETHYLWEDELOLACTONE



STIGMASTEROL



ALPHA AMYRIN

Pharmacological Activities

Anti-inflammatory

Eclipta prostrata reduced epidermal/dermal thickness, immune cell infiltration, and skin barrier function to alleviate atopic dermatitis (AD) in mice produced through HDM and HaCaT cells triggered by TNF-α/IFN-γ. According to Western blot, qRT-PCR, ELISA, and histology, EP inhibited ERK/STAT1 phosphorylation, reduced Th1/Th2/Th17 cytokines, and blocked NF-κB translocation.As a whole, EP reduced skin irritation caused by allergies by restoring the skin's protective layer and balancing the immune system. These findings imply that EP might be used therapeutically as an anti-atopic agent.[12]

Antioxidant

Extracts from *Eclipta prostrata* showed high antioxidant activity in the Folin-Ciocalteu and DPPH tests. The highest level of activity and phenolic content (493.2 mg GAE/g) were found in the EP07 fraction. At 20 mg/mL, crude ethanolic extract reduced protein oxidation caused by $H2O_2/Cu2^+$ by up to 63.23%. The main components of EP07 were flavonoids, which supported the compound's potential as a dietary supplement and antioxidant.[13]

Antidiabetes

Eclipta prostrata callus cultures subjected to multispectral lights had the highest phenolic (57.8 mg/g) and flavonoid (11.1 mg/g) content and the highest growth (11.2 g/L) under red light. This also increased the accumulation of significant compounds such as eclalbatin (5.00 mg/g) and wedelolactone (32.54 mg/g). The greatest adverse effect was caused by yellow light (4.87 g/L). Under blue light, stigmasterol levels were their most significant (0.22 mg/g). So, antidiabetic activities of calli extracts were found elevated in red light compared to the control.[14]

Hepatoprotective

Eclipta prostrata yielded 12 recognized compounds and a novel bithiophene, 5-(but-3-en-1-yn-1-yl)-5′-(methoxymethyl)-2,2′-bithiophene (1). Compounds 11–13 showed the strongest hepatoprotective effects (38.68–48.54% HepG2 viability) at 100 μM. In comparison with terthiophenes, bithiophenes exhibited greater biological activity. [15]

Antitumour

A variety of cancer cell lines, including human colorectal carcinoma (HCT-116), human prostate cancer (PC-3), Michigan Cancer Foundation-breast cancer (MCF-7), and renal cell carcinoma (RCC-45), were used to

investigate the extract's anti-cancer activity. We have also used the methyl thiazoldiphenyltetrazolium bromide (MTT) test, clonogenic (colony formation), and migration assays to examine the effects on normal human embryonic lung fibroblast cells (WI-38). Methanolic extract of *Eclipta prostrata* revealed considerable ($p < 0.005$) anticancer efficacy against HCT-116 cells with low damage to WI-38 cells. Its specificity for HCT-116 was further confirmed by clonogenic and migratory experiments. [16]

Antifibrotic

Through apoptosis (↓Bcl-2, ↑Bax), collagen I and α-SMA downregulation, and viability reduction, wedelolactone prevented LX-2 hepatic stellate cell activation. Potential as an anti-fibrotic drug is suggested by the upregulation of p-ERK and p-JNK and the suppression of NF-κB signaling.[17]

Antimicrobial

Zinc acetate and leaf extract from *Eclipta prostrata* were used to green-synthesize ZnO quantum dots. TEM revealed hexagon-shaped, spherical, 6 nm wurtzite particles. Strong antibacterial activity against *E. coli* was demonstrated by ZnO QDs, indicating their potential to be employed in both clinical and commercial applications.[18]

Antiobesity

By increasing thermogenesis and promoting glucose and lipid metabolism in mice fed a high-fat diet, the chemical T-CA produced from *Eclipta prostrata* exhibits anti-obesity benefits. It enhances mitochondrial biogenesis, fatty acid oxidation, and LD-mitochondria coupling by upregulating Plin5 and activating the AMPK/PGC-1α pathway, which in turn improves metabolic health. It shows high efficacy towards anti-obesity activities. [19]

Osteogenetic

Alizarin red S (ARS) staining and alkaline phosphatase (ALP) staining were used to determine osteoblastogenesis from BMSC. Quantitative real-time PCR and Western blot were used. The characteristics of m6A methylation were established by RNA sequencing analysis. METTL3 was knocked down steadily with lentiviral-based shRNA.ALP activity, ossification, and m6A levels in BMSCs were elevated after 9 days of MHL treatment, and METTL3/14 (but not WTAP) was upregulated. MHL-induced osteogenesis and the expression of Osterix, Osteocalcin, and m6A-modified genes such as HIF-1α, VEGF-A, and RASSF1 were all decreased by METTL3 knockdown. These effects were connected to the HIF-1α, PI3K/Akt, and Hippo pathways by RNA-seq and KEGG analysis. METTL3 was likewise elevated by wedelolactone.[20]

Antialzheimer

In rats, *E. prostrata* administration (50–100 mg/kg diet) for 6 weeks raised serum SOD activity, decreased MAO-B activity and serum superoxide levels, and increased brain acetylcholine and acetylcholine esterase activity. These findings point to possible neuroprotective and anti-oxidative advantages that are pertinent to the prevention of dementia.[21]

Immunomodulatory

E. prostrata and *C. asiatica* methanol extracts (100–500 mg/kg) had immunomodulatory effects, which were dose-dependent. The strongest linearity was in the phagocytic response, markedly elevated WBC count, antibody titer, and phagocytic index. Additionally, *E. prostrata* and *C. asiatica* increased the WBC count and phagocytic index, exhibiting comparable dose-response patterns. In the end, *E.prostata* shows greater potential.[22]

Hair growth activity

Microneedle treatment (MTS) and *Eclipta prostrata* extract, particularly when combined, significantly improved hair density, thickness, and scalp quality in a 10-week study of office workers experiencing hair loss. Along with fewer scalp problems and hairline recession, the MTS-Eclipta group displayed the most noticeable improvements. High levels of pleasure and increased confidence were expressed by the participants through the application of *E.prostrata* extract. It has high potential for hair growth.[23]

Anti-venom

Strong dose-dependent anti-proteolytic and anti-hemorrhagic activity against MPV (Malayan pit viper) venom was demonstrated by the ethyl acetate extract of *Eclipta prostrata* (47% wedelolactone); however, it only exhibited partial anti-PLA2 activity and offered no defense against venom lethality.[24]

Antiulcer

Using a variety of polymers, including HPMC E5, HPMC E15, sodium alginate, and PVA, the extract of *Eclipta Prostrata* leaves was created as films using the solvent casting process. SSG as a super disintegrant, honey as a sweetener, and propylene glycol as a plasticizer were used in the creation of the films. The thickness, folding durability, weight fluctuation, elongation, surface pH, moisture uptake, moisture loss, disintegration, and in vitro drug release study of the films were also assessed. Every film has a pleasing look and feel. The quickest disintegration was seen in F3 and F5 (27–32 sec). Drug release was highest in F3 (83.57% in 4 min). Stability testing showed that F3 and F5 were both stable, non-tacky, and efficient.[25]

CONCLUSION

Eclipta prostrata, often known as *E. alba*, is a pharmacologically diverse herb that has a broad profile of bioactive components that are involved in a variety of biological processes. It is beneficial in treating inflammation, oxidative stress, metabolic disorders, liver dysfunction, immunological dysregulation, neurodegeneration, and even hair loss because of its rich phytochemical makeup, which includes flavonoids, alkaloids, terpenoids, saponins, and coumestans. Growing amounts of scientific evidence support the plant's traditional use, highlighting its use in integrative medicine and modern medication development. More thorough research, including as clinical trials, toxicological evaluations, and standardization of active ingredients, is necessary to prove its safety and effectiveness for therapeutic usage. Molecular docking studies and nanoformulations should be investigated in future studies to clarify the mechanisms of action and enhance the bioavailability of important phytoconstituents.

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