

FROM TRADITION TO THERAPEUTICS: A COMPREHENSIVE REVIEW OF *ECLIPTA ALBA* AND ITS BIOACTIVE POTENTIAL

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ABSTRACT

Eclipta alba (L.) commonly known as bhiringraj as well as false daisy, is a species of plant in the family Asteraceae. It is a small branched annual herbaceous plant with a long history of traditional medicines uses in many countries especially in tropical and subtropical regions. It is widely dispersed throughout India, Brazil, Thailand, and China. Vernacular names of the plant include bhangaara (Hindi), maakaa (Marathi), bhangaro (Gujarati), kesuriya (Bengali), galagara (Telugu). The principal constituents of *Eclipta alba* are coumestan derivatives like Wedololactone, Apigenin, Oleanolic acid, Sitosterol, etc. This review comprehensively compiles existing knowledge on the botanical characteristics, traditional uses, phytochemistry, and pharmacological activities of *E. alba*. The herb has been known for its curative properties and has been utilized as anticancer, analgesic, antibacterial, anti-inflammatory, antihyperglycemic, antioxidant, immunomodulatory properties, etc. Also, it is a well-documented herb traditionally used in various traditional healing systems such as Ayurveda, Unani, Siddha, and Traditional Chinese medicine. It has been used ethnomedicinally to treat liver disorders, skin infections, respiratory ailments, and promote hair growth. Extracts and metabolites from this plant have been known to possess pharmacological properties. This contribution provides a comprehensive review on ethnomedicinal uses, chemical composition, and the pharmacological profile as medicinal plant. *Eclipta alba* has been traditionally used in Ayurveda, Unani, and Traditional Chinese medicine. The review further discusses recent developments and Applications including advances in phytochemical research, regulatory and commercialization efforts. Overall, this review reaffirms *E. alba* as a promising herb with considerable therapeutic potential and encourages continued pharmacological and phytochemical exploration.

KEYWORDS: Eclipta alba, Anti-microbial activity, Phytochemistry, Ethnomedicine, Pharmacological activity.

INTRODUCTION

E. alba (L.) Hassk., also popularly known as Bhringraj, the king of hair, is an herbaceous species classified under the Asteraceae family, which is one of the largest families of flowering plants.^[1] Native to tropical and subtropical regions, *E. alba* has garnered significant attention for its extensive medicinal properties, making it a vital component in traditional systems of medicine.^[2] Throughout India, it commonly grows as a natural weed, in Himalayas arises to 1800 m, commonly found in regions of upper northern plains, in grazing lands, Chota Nagpur roadsides and in territories of Orissa and Bihar, Punjab, Western India, South India.^[3] The plant has a bitter, hot, sharp, dry taste and is used in Ayurveda (a primary health care system of India), for the treatment of vitiated conditions of kapha and vata.^[4] Indian Materia Medica includes about 2000 drugs of natural origin of which approximately 400 are mineral and animal origin while the rest are of origin Ayurveda, Siddha, and Unani systems 600 vegetable 700 herbs for medicinal use.^[5] World Health Organization (1980) has also recommended the evaluation of the effectiveness of plants in conditions where there is lack of safe synthetic drugs. This plant has several therapeutic uses like oil is a famous hair tonic for maintaining dark hair and reversing baldness. It is often translated as 'king of the hair'.^[6] It is decocted in coconut oil and as this is a 'Cooling' oil it is used externally for 'hot' and inflammatory head problems such as headaches, sinusitis, and ear infections. The herb is also beneficial for heat problems.^[7] This plant is known to have various pharmacological properties and is traditionally used in treatment of epilepsy.^[8] There are three kinds of *Eclipta Alba* the white- flowering, the yellow-flowering, and the black-fruited, but all three grow throughout India by marshes, rivers, and lakes or on the foothills of the Himalayas.^[9] This plant is well documented and several in vitro and in vivo studies describe its antiaging agent and anti- hepatotoxic properties. The present study was carried out to test the antibacterial efficacy of the aerial parts extracts of *Eclipta alba* with reference to bacterial spp.^[10]

Plant Profile

Synonyms: Bhringraj, False daisy, Bhringraj.

Family: Asteraceae

Table 1: Taxonomical Classification.

Kingdom	Plantae
Division	Angiosperms
Phylum	Angiospermae
Class	Dicotyledonae
Subclass	Asteridae
Order	Asterales
Family	Asteraceae
Genus	<i>Eclipta</i>
Species	Alba

Table 2: Vernacular Names.

Language	Name
Marathi	Maka
Hindi	Bhangra, Bhangraya
Gujarati	Bhangaro
Bengali	Kesuriya
Punjabi	Bhangra
Kannada	Garagada soppu, Garga
Telugu	Kayanthakara, Kaikeshi
Malayalam	Jala Bhangara, Tekaraju
Arabic	Kadimulabit

This plant is known for its small size, typically growing between 30 and 60 The cm in height. It produces white to purple flowers arranged in spherical clusters, characteristic of its family. Its fruits are achenes, which disperse through the wind. Although several species exist within the genus *Eclipta*, *E. alba* is the most commonly used for its medicinal properties.^[11]

Geographical Distribution

It is found as a weed in tropical and subtropical regions of the world such as South America, Asia, and Africa at an altitude of up to 2000 m. It is found throughout India, China, Thailand, and Brazil, Taiwan, Indonesia, Japan, the Philippines, Bangladesh, and United States. In India, it is mainly found in states Assam, Bihar, Uttar Pradesh, and Manipur.^[12] In India, it is typically found in moist, well-drained soils, fields, growing in riverbanks, open areas, and distributed soils. It has an adaptive ability to grow in diverse climatic conditions and can be found at altitudes ranging from sea level to 1500 m. It can also be discovered in other eastern nations such as Sri Lanka, Indonesia, Nepal, Malaysia, and the Philippines where the growth is good in damp ground- bunds, clay, water courses, paddy fields, and tanks in both hilly areas and plains.^[13]

Ethnomedical Relevance of *E. Alba*

The ethnomedicinal relevance of *E. alba* is vast, as it is used to promote hair health, often referred to as the “**King of Hair**” because of its reputed ability to stimulate hair growth and prevent hair loss and it has been utilized for centuries in various traditional healing systems, most notably in Ayurveda. In Ayurvedic medicine, *E. alba* is known as *Bhringraj*. Apart from these, the plant has been used in folk medicine for the treatment of respiratory issues, digestive disorders, diabetes, and skin diseases such as eczema and psoriasis.^[14]

Beyond its use for hair health, *E. alba* is regarded as a potent liver tonic in Ayurveda. The plant is believed to detoxify the liver and aid in liver regeneration by supporting liver cell repair and reducing the effects of toxins on liver function. It is used to treat liver ailments such as jaundice, hepatitis, and liver cirrhosis. It is used as a tonic and diuretic in hepatic and spleen enlargement. It is also used in catarrhal jaundice and for skin diseases. The alcoholic extract of the plant has shown antiviral activity against Ranikhet disease virus.^[15]

It is used as a general tonic for debility. Externally it is used for inflammation minor cuts and burns and the fresh leaf juice is considered very effective in stopping bleeding. The water extract of *Eclipta prostrata* (whole plant) exhibited the most potent inhibitory activity against HIV-1 integrase (HIV 1 IN).^[16]

Phytochemical Constituents Reported from *Eclipta alba*

E. alba (L.) Hassk., widely referred to as *Bhringraj*, is renowned for its diverse bioactive compounds that contribute to its wide array of pharmacological activities. It contains wide range of active principles which includes coumestans, alkaloids, flavonoids, glycosides, triterpenoids. The leaves contain stigmaterol, wedelolactone, β terthienylmethanol, demethylwedelolactone and demethylwedelolactone-7-glucoside. The roots give hentriacontanol and heptacosanol. This plant has been found to contain and nicotinic acid and nicotine. Four oleanane Glycosides-Eclalbasaponins 1-6 and three Taraxastane Triterpene glycosides-Eclalbasaponins 7-10 were identified.^[17-18]

Table 3: Parts containing chemical constituents of *Eclipta alba*^[19]

Sr. No	Parts	Chemical Constituents
1	Leaves	Wedelolactone [1.6%], Desmethylwedelolactone, Desmethylwedelolactone 7-glucoside, stigmasterol]
2	Roots	Hentriacontanol, Heptacosanol & Stigmasterol, Ecliptal, Eclalbatin.
3	Stems	Wedelolactone, ^[22] wedelic acid, L-terthienyl methanol, luteolin. ^[23]
4	Seeds	Sterols, ^[24] Ecliptalbina (alkaloid)
5	Aerial parts	β -amyrin & Luteolin-7-0-glucoside, Apigenin, Cinnaroside, Sulphur compounds, Eclalbasaponins I-VI
6	Whole plant	Resin, Ecliptine, Reducing sugar, Nicotine, Stigmasterol, Triterpene saponin, Eclalbatin, Ursolic acid, Oleanolic acid

Table 4: Reported Phytochemical compounds in *Eclipta alba* plant^[20]

Extract	Isolated compounds	Title of work	Author	Journal
Methanolic extract of leaf	Oleic acid, Octadecenoic acid, Dodecanoic acid	Phytochemical analysis of leaf extract of <i>Eclipta alba</i> by GC-MS method	Anand. D et. al. 2014	International Journal of Pharmacognosy and Phytochemical Research. ^[25]
Methanolic extract of the root	Silane, Acetamide, L Alanine, c-Sitosterol, Tridecanol	Phytochemical Analysis of root extract of <i>Eclipta alba</i> by GC-MS method	K. Satheesh Naik et. al. 2017	International Journal of Pharmaceutical Sciences Review and Research. ^[26]
Methanolic extract of whole plant	Triterpenoids	Isolation and Characterization of Triterpenoids from methanolic extract of medicinal plant: <i>Eclipta alba</i>	G.V.R. Sharma et. al. 2011	International Journal of Pharmacy and Technology. ^[27]
Methanolic extract of whole plant	Six new oleanane triterpene glycosides named eclalbasaponins I- VI	Oleanane glycosides from <i>Eclipta alba</i>	Shoji Yahara et. al. 1994	Chemical and Pharmaceutical Bulletin. ^[28]
Methanolic extract of whole plant	Ecalbatin a triterpene, saponin	Ecalbatin, A triterpene Saponin from <i>Eclipta alba</i>	R.K. Upadhyay et. al. 2001	Journal of Asian Natural Products Research. ^[29]

Phytochemical Screening of *Eclipta Alba*^[21]**Table 5: Test for Screening.**

Sr. No.	Test	Procedure	Observation
Phytosterols			
1	Libermann-Burchard Test	Test 10 mg of extract was dissolved in 1ml of chloroform, 1 ml of acetic anhydride was added following the addition of 2ml of concentrated sulphuric acid.	The presence of steroids is shown by developing reddish- violet colour.
2	Salkowski Test	1 ml of concentrated sulphuric acid was added to 10 mg of extract dissolved in 1 ml of chloroform.	A reddish-blue colour exhibited by chloroform layer and green fluorescence by the acid layer suggested the presence of steroids
Alkaloids			
1	Dragendroff's test	5 ml of distilled water should be added to the sample extract. A few ml of hydrochloric acid and a few drops of Dragendroff's reagent should then be added.	The presence of alkaloids is shown by the orange-red precipitate that formed in the test tube.
2	Mayer's test	Mayer's reagents should be added in a few drops to the sample extract.	Alkaloids are present when a white or light-yellow precipitate forms in the test tube.
3	Wagner's test	Add a few ml of hydrochloric acid and a few drops of Wagner's reagent to the sample extract.	Alkaloids are present because of the yellow-brown precipitate that formed in the test tube.
4	Hager's test	The Hager's reagents should be added in a few drops to the sample extract.	The presence of alkaloids is shown by the test tube's yellow precipitation.

Protein and Amino Acid			
1	Ninhydrin Test	Extract solution was treated with ninhydrin (Tri-keto hydrindene hydrate) at the pH range of 4-8.	The presence of protein and amino acid is shown by the presence of purple colour.
2	Biuret's test	Add a few drops of copper sulfate solution and a few drops of aqueous sodium solution (1-2) to the heated sample extract.	The presence of proteins is shown by the test tube turning red.
3	Million's test	Add a few milliliters of water and a few drops (5-6) of the million's test solution (reagent) to the sample extract before heating it.	It reveals the presence of proteins by turning the white precipitation red.
Tannin			
1	Ferric chloride test	Add a few drops of ferric chloride aqueous solution to the sample extract before adding hydrochloric acid.	bluish-black colour disappears and indicates the presence of tannins.
2	Lead Acetate test	Add a few drops of lead acetate aqueous solution to the sample extract.	The presence of tannins is shown by the test tube's appearance of yellow colour precipitation.
Triterpenes			
1	Lieberman-Burchard's test	Add a few ml of chloroform, 2 ml of acetic anhydride, and a few drops of sulfuric acid to the extract.	The presence of triterpenes is shown by the purple colour that appears at the junction.
Carbohydrates			
1	Fehling's test	Equal parts of the Fehling A and Fehling B solution should be added to the sample extract, which should then be allowed to boil for a few minutes.	The test tube's appearance as brick red indicates the presence of carbohydrates.
2	Benedict's test	Benedict solution should be added to the sample extract before allowing it to boil for a short while.	The presence of carbohydrates is shown by the formation of coloured precipitate in the test tube.
3	Molisch's test	A few drops (2-3) of 20% alcohol alpha naphthol should be added to the sample extract in the test tube. This will add 2ml of concentrated sulphuric acid through the test tube's sidewall.	A red-violet ring that appears at the junction in the test tube denotes the presence of carbohydrates.
Flavonoids			
1	Shinoda test	A little piece of magnesium ribbon and a few drops of diluted hydrochloric acid should be added to the sample extract before it is boiled for a short period of time.	The presence of flavonoids is indicated by the test tube's colour of purple or reddish pink.
Resin		Add a few ml of the acetic anhydride solution to the sample extract, boil it, and then let it cool. Add 0.05ml of sulfuric acid to this.	Add a few ml of the acetic anhydride solution to the sample extract, boil it, and then let it cool. Add 0.05ml of sulfuric acid to this.
Saponins		Add a few drops of aqueous sodium bicarbonate solution to the sample extract and shake vigorously for a while.	The presence of saponins is indicated by the appearance of honeycomb foam.
Fixed oil test		The sample extract is taken, added to the filter paper, and allowed to dry for a day (or for 24 hours), at the usual room temperature.	The presence of fixed oils is indicated by the emergence of a translucent mark on the filter paper.
Glycosides		Add a few milliliters of water and sodium hydroxide aqueous solution to the sample extract.	The presence of glycosides is shown by the test tube turning yellow.

Traditional and Ethnomedical Use of *Eclipta alba*

E. alba widely referred to as Bhringraj, has been widely utilized in traditional medicine systems across various cultures for centuries. This herb is predominantly used in Ayurvedic and Unani to treat a broad spectrum of ailments.^[22]

Therapeutic uses include

- *Eclipta alba* is an herb used in traditional medicine for a variety of diseases.
- To darken and thicken hair.
- For the common cold and cough.
- Coughing, asthma, diabetes, stomach difficulties, inflammatory illnesses, and skin ailments are some of its traditional and therapeutic uses.
- Anaemia treatment.
- As a liver tonic.

Traditional uses include**Ayurvedic medicine**

In Ayurvedic medicine, *E. alba* is regarded as a powerful herb with multiple health benefits. It is most commonly referred to as “Bhringraj,” a name derived from the Sanskrit word Bhringa, meaning “bee,” which refers to the plant’s attractiveness to bees, and Raj, meaning “king,” symbolizing its revered status in traditional medicine. *E. alba* is highly valued in Ayurveda for promoting hair growth. The plant is believed to strengthen hair follicles, reduce hair fall, and stimulate hair regrowth. The oil extracted from its leaves is commonly used in hair care formulations to treat conditions like dandruff and premature graying. Ayurvedic texts describe the use of the plant in treating disorders associated with the liver’s ability to detoxify the body, restore bile secretion, and prevent liver damage.^[23]

Unani medicine

In Unani medicine, *E. alba* is known as “Karisma” and is used for its medicinal benefits, particularly in treating liver and hair related issues. Similar to Ayurvedic practices, *E. alba* is utilized in Unani medicine for hair care. The Unani practitioners also use *E. alba* as a remedy for digestive disorders, particularly those involving excessive bile production, such as gastritis and indigestion. The Unani system places significant emphasis on balancing the four humors of the body: Blood, phlegm, yellow bile, and black bile. *E. alba* is believed to have a cooling effect and is commonly used to treat conditions related to excess heat or bile, such as inflammation, jaundice, and fever.^[24]

Traditional Chinese medicine

In TCM, *E. alba* is called “Mo Han Lian” and is used primarily for its effects on the liver and kidneys. The plant is utilized to treat various ailments, such as liver disorders, jaundice, and vertigo. It is also employed in managing kidney weakness, urinary tract infections, and dizziness linked to liver dysfunction. It is considered a cooling herb that detoxifies the liver and promotes the flow of vital energy, or Qi. The herb is also used to nourish the liver and kidneys, which are thought to be critical organs in maintaining vitality, energy, and longevity in TCM. Typically, the plant is prepared as a decoction or powdered form, and it is occasionally combined with other herbs to boost its therapeutic benefits.^[25]

Ethnomedical uses in other regions

- *E. alba* has been utilized in traditional medicine across different regions of Southeast Asia, Africa, and South America to address a variety of health conditions.
- In Sri Lanka and India, it is used for hair growth and to treat alopecia.
- In parts of West Africa, *E. alba* is used to treat malaria, fever, and jaundice.
- The plant's use extends to the treatment of skin diseases in several African and Asian communities.^[26]

Contemporary ethnopharmacology

The contemporary use of *E. alba* is supported by a growing body of ethnopharmacological research that validates many of the traditional claims associated with the plant.

In India, the juice of *E. alba* is often used as a natural remedy for hair care and skin health, aligning with its traditional use in Ayurvedic practices.

Modern studies have confirmed its hepatoprotective, anti-inflammatory, and antioxidant properties, which validate its widespread use in treating liver disorders, inflammation, and oxidative stress-related conditions.^[27]

Pharmacological Studies

C. N. S. Activity

Studies indicated that the aqueous extract of *Eclipta alba* and its hydrolyzed fraction at a dose of 300 mg/kg and 300 mg/kg, respectively showed no tropic activity in rats.^[28]

Hair growth & Alopecia

- *Eclipta alba* is used in hair oil preparations since it promotes hair growth and maintains hair black. 10% w/v of *Eclipta alba* was a main ingredient in the preparation of herbal formulation for hair growth.
- The described study attempted to assess the effect of petroleum ether and ethanol extracts of *E. alba* Hassk. on encouraging hair development in albino rats. Alopecia is a dermatological disorder with psychosocial implications on patients with hair loss. *Eclipta alba* is a well-known Ayurvedic herb for hair growth.^[29]
- Petroleum ether extract (PEE) along with other solvent fractions of *E. alba* was topically applied on the backs of nude mice. Prominent follicular hypertrophy was observed after the treatment with PEE. In the basal epidermal and matrix cells, follicular keratinocytes number was increased. These changes support *E. alba* use in the growth of hair.
- A polyherbal formulation containing *E. alba*, *Hibiscus rosa-sinensis*, and *Nardostachys jatamansi* exhibited excellent hair growth activity in Wistar albino rats. Hair growth initiation time and time required for complete hair growth were significantly reduced. Treatment with the formulation resulted in greater number of hair follicles in the anagenic phase.^[30]

Hepatoprotective effect

- *Eclipta alba* significantly counteracted CCl₄-induced inhibition of the hepatic microsomal drug metabolizing enzymes. The loss of hepatic lysosomal acid phosphatase and alkaline phosphatase by CCl₄ was significantly restored by *Eclipta alba*. The study shows that hepatoprotective activity of *Eclipta alba* is by regulating the levels of hepatic microsomal drug metabolizing enzymes.^[31]

- The experimental study conducted by Naik et al., on albino rat models treated with high fatty diet to investigate the hepatoprotective activity of *E. alba* (Bhringraja) demonstrated that phytochemical constituents such as, Wedelolactone, demethylwedelolactone, and saponins are associated with hepatoprotectivity. It was found that these phytochemicals significantly reduced the fat deposition, mononuclear infiltration, and necrotic foci. Regeneration of hepatocytes in the liver was also stimulated by these phytochemical constituents.
- Indulekha and Jeyaraj performed an investigative study on animal models to find out the hepatoprotective nature of *E. alba*. Models were induced with hepatotoxicity by paracetamol. Study revealed that *E. alba* has potent hepatoprotective activity.^[32]

Hypolipidemic effect

The activity of alcoholic extract of *E. alba* was assessed by studying the lipid profiles of serum, liver and heart of the control and drug-treated animals. Serum triacyl glyceride and total cholesterol levels were significantly lower in the E50 and E100 groups and low-density lipoprotein-cholesterol levels were significantly reduced in the same groups when compared with the untreated control group.^[33]

Analgesic activity

Mahesh Sawant et al worked on an experimental study that was conducted to determine the analgesic activity of the total ethanol extract of *Eclipta alba*, as well as the isolated alkaloids of *Eclipta alba*, in albino mice using standard experimental models such as the tail clip method, the tail flick method, and the acetic acid-induced writhing response. The results of this study reveal that both the ethanol extract and the whole alkaloids had good analgesic activity in all of the different analgesia models employed. In all models evaluated, the total alkaloidal percentage was the most effective.^[34]

Antihyperglycemic effect

Eclipta alba as an ingredient in polyherbal formulation Pan-five were scientifically and clinically proved to possess antidiabetic and diuretic activity by acting upon pancreas by restoration and regeneration of pancreatic β -cell activity. The oral administration of leaf suspension of *E. alba* for 2 months resulted in significant decrease in blood glucose, glycosylated hemoglobin HbA1c, a decrease in the activities of glucose-6 phosphatase and fructose 1,6-bisphosphatase, and an increase in the activity of liver hexokinase was demonstrated.^[35]

Antioxidant properties

The antioxidant effects of *Eclipta prostrata* was reported when 50mg/kg and 100mg/kg dose were fed orally into Charles River Sprague-Dawley CD rats which reduced serum hydroxyl radical (nmol/mg protein per minute) and serum lipid peroxide (nmol/mg protein) levels compared to untreated group. 100mg/kg dose significantly reduced Carbonyl content of oxidatively modified proteins.^[36]

Antioxidant activity of *Eclipta alba* was determined by FRAP, radical scavenging activity, reducing activity, and DPPH assay. The antioxidant capacity was increased by increasing the concentration of the extracts. The antioxidant activity of the hexane, ethyl acetate, ethanol and water extracts of *E. alba* was determined by ferric thiocyanate.^[37]

Anti-inflammatory activity

E. alba is used for its anti-inflammatory effects, which are crucial in the management of arthritis, asthma, and inflammatory bowel disease. The plant's anti-inflammatory action is due to the flavonoids such as luteolin and apigenin, both of which are known to inhibit the pro-inflammatory cytokines production and reduce the activity of key inflammatory mediators like NF- κ B and cyclooxygenase-2.^[38]

The methanolic extract administered by the oral route at a concentration of 100 and 200 mg/kg-1 showed the significant dose dependent anti-inflammatory activity in carrageenan and egg white induced hind paw oedema in rats. The findings show that *Eclipta alba* extract has a powerful anti-inflammatory impact and therapeutic efficacy in animal models when compared to Indomethacin.^[39]

Anticancer activity

Juice obtained from *E. alba* was shown to inhibit the migration of HCC-S102 (hepatocellular carcinoma) cells. In various human cancer cell lines of different tissue origins (liver, lung, and breast), the juice inhibited migration of all the cell lines with IC50 values ranging from 31–70 μ g/mL. Thus, the plant has potential for preventing cancer metastasis. The model systems used for the study were Human liver cancer cell line (HepG2), C6 glioma and A498 cell lines. It was found that hydroalcoholic extract of this plant caused inhibition of cell proliferation.^[40]

Coumestans are also known to act as phytoestrogens. In many countries it is used as diet which acts as chemo preventive agent in breast and prostate cancer. Dasyscyphin-C (saponins) a new isolated compound from *Eclipta alba* reported to have anticancer-cytotoxic activity. The extract increased the life span of Ehrlich Ascites Carcinoma (EAC) treated mice and restored the haematological parameters as compared with the EAC bearing mice. Thus, study revealed that the methanolic extract of *Eclipta alba* showed anticancer activity in the tested animal models.^[41]

Antimicrobial effect

Antibacterial

Ethanol and ethyl acetate extracts of leaves of the plant have been found to be active against *E. coli*, *K. pneumoniae*, *Shigella dysenteriae*, *Salmonella typhi*, *P. aeruginosa*, *Bacillus subtilis*, and *S. aureus* with Minimum Inhibitory Concentrations (MIC) ranging from 4.5 to 90 μ L/mL. It has been observed that the compounds obtained from *E. alba* showed good activity against Staphylococcus epidermidis and Salmonella typhimurium. According to the findings, the isolated saponin from *E. alba* disrupts the bacterial cell membrane, resulting in the loss of bacterial cell viability.

Antifungal

The in vitro antifungal activity of *E. alba* extract was investigated against *Candida tropicalis*, *Rhodotorula glutinis* and *Candida albicans*. The active compound 25-beta hydroxyverazine showed good activity against *Candida albicans*.

Antimalarial

The anti-malarial activity of *Eclipta alba* leaves extract was evaluated against *Plasmodium berghei* ANKA strain in mice.^[42]

Neuropharmacological effects

The plant is used to improve memory and cognitive function, and this has been supported by modern studies that show enhanced memory retention and learning abilities in animal models after administration of *E. alba* extracts. The

aqueous extract and the hydrolyzed fraction exhibited gastro protective effect and normalized the white blood cell count in the milk induced leukocytosis challenge model.^[43]

Antidiabetic activity

Leaf suspension of *Eclipta alba* (2 & 4g/kg) orally in alloxan induced diabetic rats resulted in reduction in blood glucose level, glycosylated hemoglobin. *Eclipta alba* as an ingredient in polyherbal formulation Pan-five were scientifically and clinically proved to possess Antidiabetic and diuretic activity by acting upon pancreas by restoration and regeneration of pancreatic β -cell activity.^[44-45]

Toxicity Studied

In studies conducted by the alcoholic extract of *E. Alba* shows no signs of toxicity in rats and mice and the minimum lethal dose was found to be greater than 2.0g/kg when given orally and intra-peritoneally in mice.^[46]

Clinical Studies

There have been clinical studies conducted that prove the effectiveness of *E. alba* therapy in jaundice in children. The herbal drug Tefroli, containing extracts of the plant in combination with others, when administered to the patient of viral hepatitis, produced improvement and good results. *Eclipta alba* thus offers remarkable preventative and curative potential ongoing clinical investigation of *Eclipta alba* is health promoting qualities.^[47]

Recent Developments and Applications

E. alba (L.) Hassk., commonly known as Bhringraj, continues to garner significant attention in both traditional medicine and modern scientific research. Over the past few years, substantial advancements have been made regarding the phytochemistry, pharmacology, and potential applications of this versatile plant. These developments are providing insights into the mechanisms behind its therapeutic properties and opening new avenues for its application in the healthcare and cosmetic industries.

Advances in phytochemical research

- Recent studies have introduced innovative extraction techniques, such as supercritical fluid extraction and microwave-assisted extraction, to enhance the yield and purity of bioactive compounds from the plant.
- These modern extraction techniques have the potential to enhance the quality and efficacy of plant-based therapeutic formulations.
- Recent studies have focused on identifying and characterizing the active phytochemical constituents of *E. alba*. The primary bioactive compounds in *E. alba* include wedelolactone, luteolin, apigenin, flavonoids, alkaloids, and saponins, which contribute to its hepatoprotective, anti-inflammatory, and antimicrobial properties.
- In addition, molecular docking studies have been used to understand the mechanisms of action of active compounds such as wedelolactone, which interact with enzymes involved in liver detoxification pathways.^[48]

Regulatory and commercialization efforts

In countries like India and China, where the plant has been used for centuries, *E. alba* is gaining acceptance in the form of herbal supplements and cosmetics. However, global regulatory bodies, including the U.S. Food and Drug Administration and the European Medicines Agency, are still in the process of reviewing the plant's safety profile for

broader use in pharmaceutical products. The medicinal and cosmetic uses of *E. alba* gain recognition; regulatory bodies have begun to assess the safety and efficacy of products containing this herb.^[49]

Pharmaceutical companies are increasingly investing in the commercialization of *E. alba* extracts for liver protection and hair growth applications. As research continues to uncover the plant's therapeutic potential, it is expected that *E. alba* will find a more prominent place in the global market for herbal medicines and cosmetics.^[50]

Future Prospective

Finally, further investigation of the plant can open the door to modern medicine by isolating new bioactive molecules that will be useful for the investigation of various pharmacological activities against incurable human diseases and will save the world from economic and environmental losses.^[51]

CONCLUSION

Eclipta alba is a tiny branching annual herbaceous folk medicinal plant with important anti-disease qualities. It has a wide range of chemical constituents. Can be found in different parts of the plant. The pharmacological profile exhibits it to be for its good anti-microbial activity, anti-oxidant activity, anti-inflammatory activity, antitumor activity, neuroprotective activities, hepatoprotective activity, hypolipidemic activity, etc. Even though the world has so many medicines to treat each ailment, they all have certain side effects that are quite dangerous to one's health. However, because these components are organic, metabolites extracted from *Eclipta alba* used to treat various diseases have no negative effects. Clinical studies have been conducted on various pharmacological activities such as anti-bacterial, anti-depressive hypoglycemic, hepatotoxicity, and so on. This plant also has a better ability to suppress the growth of bacteria and fungi. As research on *E. alba* progresses, it shows promise in becoming a significant contributor to the development of natural therapeutic agents and cosmetics, further reinforcing its role in both traditional and contemporary healthcare systems.

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