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PHARMACOLOGICAL SIGNIFICANCE OF MEDICINAL HERB *ECLIPTA ALBA* L. - A REVIEW

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ABSTRACT: Though conventional medicines are slow in action, they represent safety in contrast to the synthetics that are regarded as somewhat unsafe to human and environment. The uses of many traditional herbs in the treatment of many diseases, which are usually free from side effects, are economical and also easily accessible to humans. Plants have formed the basis of sophisticated traditional medicine systems that have been in existence for hundreds of years and continue to provide mankind with new remedies. The use of synthetic chemical compounds has led to a decline in the use of plants in contemporary medicine. However, synthetic medicine can cause side effects, and as a result, people are more constructive to use natural compounds obtained from plants. *Eclipta alba* (L.) is a herbaceous plant which has been employed as traditional medicine especially in tropical and subtropical regions. *E. alba* is a widely applied traditional medicine and functional food, has been extensively explored for its bioactivities. The plant contains a broad array of active principles which includes coumestans, alkaloids, flavonoids, glycosides, polyacetylenes, and triterpenoids. The leaves contain stigmasterol, a-terthienylmethanol, wedelolactone, demethylwedelolactone, and demethylwedelolactone-7- glucoside. Some of the important pharmacological activities are antihepatotoxic, analgesic, antioxidant, antibacterial, antidiabetic, *etc*. This review article describes the phytochemical and pharmacological properties of *Eclipta alba*.

INTRODUCTION: Plants are important sources of medicine since ages and are used in traditional medicine due to their therapeutic potential. Studies on medicinal plants have led to the discovery of novel drug candidates used against diverse diseases. Natural phytocompounds are commonly used for the prevention and treatment of various diseases.

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The therapeutic value of herbal medicinal plants has shown that the therapeutic effect can is due to a specific chemical or compound in the herb or due to complex synergistic interaction of various constituents of the plant, which makes a single plant versatile for treatment of various diseases. *Eclipta alba* has an important role in the traditional Ayurvedic, Siddha and Unani systems of medicine. *Eclipta alba* (Linn.) Hassk of family *Asteraceae* is also known as *Eclipta prostrata* (Linn.) and is commonly known as "Bhringarajah" (Sanskrit), "Bhamgra" (Hindi), "Kadiggagaraga" (Kannada) which is one of the ten auspicious herbs that constitute the group dasapuspam. In many parts of India and Southwestern US it is grown commercially as a medicinal crop [1].

E. alba has been promoted as a potent hepatoprotective agent and is official in Indian Herbal Pharmacopoeia and The Ayurvedic Pharmacopoeia of India [2]. *Eclipta alba* occurs throughout the whole of India. It is widely distributed throughout India, China, Thailand, and Brazil. It is common in waste places, marshy lands, hedges and roadsides particularly in the more tropical parts of the country. It is also found in more eastern counties including Indonesia, Sri Lanka, Philippines, Nepal, and Malaysia where it grows well in moist clay ground-bunds, paddy fields, water courses, tanks, both in the plains and hilly regions.

Eclipta alba is an erect or prostrate, much branched, roughly hairy, annual herb. Root is taproot; stem is herbaceous, branched, nodes brown in color and presence of white trichomes and cylindrical. Leaves are sessile to sub-sessile, opposite, 2.2-8.5 cm long, and 1.2-2.3 cm wide usually oblong, lanceolate, sub-acute or acute, with apprised hair on both surfaces. The inflorescence is a heterogamous head with campanulate involucre of bracts, bracts biseriate, and the outer broader; receptacle flat with slender plumose palea. Ray florets are pistillate; disc florets are bisexual; Pappus is very minute, corolla of the pistillate flower is ligulate and two-lipped and those of bisexual flowers is tubular with five lobes; stamens five epipetalous, syngenesious; ovary inferior, unilocular. Achenes of ray florets triquetrous, warted and those of disc are compressed [3]. The phytochemical and pharmacological properties of *Eclipta alba* are discussed in the review article.

Phytochemistry: The plant contains a broad array of active principles which includes coumestans, alkaloids, flavonoids, glycosides, polyacetylenes, and triterpenoids. The leaves contain stigmasterol, a-terthienylmethanol, wedelolactone, dimethyl-wedelolactone, and demethylwedelolactone-7-glucoside [4]. The aerial parts of the plant contain a phytosterol, β-amyrin in the n-hexane extract and luteolin-7-glucoside, β- glucoside of phytosterol, a glucoside of a triterpenic acid and wedelolactone in the polar solvent extract, roots contain polyacetylene substituted thiophenes.

Six new triterpene glycosides, eclalbosaponins I-VI were isolated, and structures were characterized as echinocystic acid glycosides, and those of V-VI were reported to be sulphated saponins[5]. Taraxastane triterpene glycosides, named eclalbasaponins VII-X were isolated, along with four oleanane glycosides eclalbasaponins I-VI. Based on spectral data, the structures of eclalbasaponins VII-X were characterized as 3β, 20β, 16β and 3β, 20β, 28β trihydroxytaraxastane glycosides, and their sulphated saponins[6].

Two oleanane-type glycosides eclalbasaponin II, eclalbasaponin I and steroid, stigmasterol were isolated from an n-hexane extract of the stem bark of *E. prostrate* [7]. Among eight bioactive steroidal alkaloids isolated based on Bioassay-guided fractionation of the methanol extract of *E. alba* by three yeast strains, six alkaloids of which are reported for the first time from nature[8]. The major alkaloid was identified as (20*S*)(25*S*)-22,26-imino-cholesta- 5,22(*N*)-dien-3*β*-ol (verazine, 3), while the new alkaloids were identified as 20-*epi*-3-dihydroxy-3-oxo-5, 6- dihydro-4, 5-dehydroverazine (1), ecliptalbine [(20*R*)-20-pyridyl-cholesta-5-ene-3*β*,23-diol] (4), (20*R*)-4*β*-hydroxyverazine (5), 4*β*- hydroxyverazine (6), (20R)- 25 *β*-hydroxy-verazine (7), and 25*β*-hydroxyverazine (8).

The potential bioactive components of *E. alba* leaves using Gas Chromatography-Mass Spectrometry analysis determined [9]. The identification of phytochemical compounds was based on their retention time (RT), molecular formula, molecular weight (MW), chemical structure and concentration (peak area %). GC-MS chromatogram of leaves of *E. alba* analysis showed the presence of eight different compounds namely Tridecanol, 2-ethyl-2-methyl, 1-Heptatriacotanol, c-Sitosterol, Oleic acid, eicosyl ester, 9,19-Cyclocholestan-3-ol-7- one,4a-dimethly-[20R], 10-Octadecenoic acid, methyl ester, 1,2 Benzene-dicarboxylic acid, butyl octy ester, Dodecanoic acid, 10 methyl and methyl ester.

Antimicrobial: Researchers have documented the antimicrobial properties of *E. alba* extracts against bacterial and fungal pathogens. The antibacterial effect of *E. alba* methanol extract on five human pathogenic bacteria *viz*., *Salmonella paratyphi*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella oxylata* and antifungal effect on *Aspergillus niger*, *A. flavus*, *Candida*

albicans, *Penicillium citrinum* were studied [10] by disc diffusion method at different concentrations. The minimum inhibitory concentration of the methanolic extract of *E. alba* at 250 µg/ml was comparable with standard drug tetracycline and streptomycin at 100 µg/ml.

Anti-leptospiral property of *E. alba* was studied [11]. Leptospirosis is a globally important disease affecting humans and affects a wide range of animals including mammals, birds, amphibians, and reptiles. The solvent extracts of *E. alba* were tested by tube dilution technique and micro dilution technique against various serogroups of *Leptospira.* The aqueous and methanol extract of *E. alba* at a concentration of 50 and 100 µg/mL showed significant anti-leptospiral activity, especially on species *L. icterohaemorrhagiae*, *L. canicola*, *L. pamona*, *L. javnanica,* and *L. hardjo*. The concentration of 50 µg/mL showed 100% inhibition against species *L. icterohaemorrhagiae*, *L. canicola,* and *L. pamona*.

E. prostrata was evaluated for antifungal activity against anthrophilic and zoophilic *Trichophyton* and *Microsporum* species, under *in-vitro* conditions [12]. Fungal infections of skin and nails are the most widespread mycoses. Some of the common infections include *Tinea pedis*, *T. unguium*, *T. cruris*, *T. capitis* and *T. corporis*. Antifungal activity assay was conducted by the disc diffusion method. The petroleum ether extract was active against the test fungi at the tested concentration of 50 mg mL^{-1}. Maximum inhibition zone was recorded against *T. rubrum* (20.66 mm) followed by *Microsporum* spp. The MIC was 0.15 mg mL^{-1} against all the test fungi. TLC analysis of petroleum ether extract revealed the presence of six clear bands between R_f value 0.38-0.95. Interestingly in bio-autography, none of the individual bands exhibited inhibitory activity against any of the test pathogens, resulting in loss of antifungal activity of the petroleum ether extract during TLC separation, suggesting the synergistic action of the compounds.

Methanol and ethyl acetate extract of *E. alba* was studied for its *in-vitro* antibacterial ability against six bacterial pathogens, *Staphylococcus aureus, Salmonella typhimurium*, *Escherichia coli*, *Staphylococcus epidermidis*, *Shigella flexneri*, and *Pseudomonas aeruginosa*. Methanol extract and ethyl acetate extract showed antimicrobial activity against all six bacterial pathogens. Wedelolactone exhibited significant antibacterial activity against the six tested bacterial pathogens. *S. epidermidis* and *S. aureus* were found to be highly sensitive. The compound recorded the highest zone of inhibition against *S. epidermidis*, followed by *S. typhimurium*, *S. aureus*, *E. coli*, *P. aeruginosa* and *S. flexneri* [13].

Ethanolic extract of *E. prostrata* leaves recorded significant antibacterial activity against *Escherichia coli, Klebsiella pneumoniae, Shigella dysenteriae*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Bacillus subtilis* and *Staphylococcus aureus* [14]. Ethyl acetate extract recorded medium activity and no significant results were recorded in both hexane and aqueous extracts as measured by the zone of inhibition and minimum inhibitory concentration methods. The ethanol extract was highly effective against *S. typhi* even at 25 µl/mL concentration followed by ethyl acetate extract at 35 µl/mL concentration. The ethanol extract was fractionated by silica gel G 60-120 mesh column chromatography. The last three of 8 fractions of the ethanol extract had significant activity against *S. typhi*.

Antiviral: Coumestans belong to flavonoids category of phytoestrogens. Members of this family have been reported to possess diverse pharmacological properties such as anti-hemorrhagic, antiproteolytic and antiphospho-lipase activities. Wedelolactone, the naturally occurring active ingredient of herbal medicine derived from *E. prostrata* and *Wedelia calendulacea*, has been extensively used in South American native medicine as snake anti-venom [15] (Mors *et al.*, 1989). The hepatitis C virus (HCV) NS5B is essential for viral RNA replication. Kaushik-Basu *et al*., [16] identified a new class of HCV NS5B inhibitors belonging to the coumestan family of phytoestrogens.

Diuretic, Hypotensive, and Hypocholesterolemic Activity: Clinical studies in humans have established the hepatoprotective potential of *E. alba* with no side effects. Rangineni *et al*., [17] elucidated the therapeutic impact of *E. alba* on mild hypertensives. Consumption of six capsules

(500 mg each per day) before each meal among 60 mildly hypertensive human male in the age group of 40–55 years for a period of 60 days resulted in reduction in mean arterial pressure (15%), total cholesterol (17%), low-density lipoprotein fraction (24%), triglycerides (14%), very-low-density lipoprotein fraction (14%), plasma lipid peroxides (18%) and a remarkable increase in urine volume (34%), urine sodium (24%), serum vitamin C (17%), and serum tocopherols (23%) in comparison to control group which received placebo capsules for a period of 60 days and helps in alleviating oxidative stress-induced complications in hypertensives.

The antihypertensive effect of *E. alba* was assessed by observing the degree of lowering of BP in the hypertensive rats by Jena *et al*., [18] Hypertension was induced in rats by feeding them a fructose diet for 15 days. A significant rise in systolic blood pressure, diastolic blood pressure, mean arterial pressure and heart rate was noticed on the 16th day of fructose diet. There was no significant change in body weight. Administration of ethanolic extract of *E. alba* continuously for 21 days to the hypertensive rats recorded a decrease in systolic, diastolic, mean arterial pressure and heart rate in a dose-dependent manner which was highly significant with 200 and 400 mg/kg doses, on day 7 post-dosing. Except for reduction of heart rate, all the effects of ethanolic extract of *E. alba* were parallel to that of the standard drug quinapril.

Antioxidant: Oxidative stress, including ultraviolet (UV) irradiation-induced skin damage, is involved in numerous diseases. The antioxidative assay demonstrated that the water extract of *E. prostrata* (WEP) has potent activity against reactive oxidative stress (ROS) and has rich polyphenol content that includes chlorogenic acid as a major component, as determined by RP-HPLC [19]. Similar results produced in HaCaT human keratinocytes and mouse fibroblasts 3T3 cells against UVB-induced cytotoxicity indicate that water extract of *E. prostrate* can prevent epidermally (HaCaT) and dermal (3T3) cells against UV-induced cytotoxicity. This study demonstrates that water extract of *E. prostrata* (WEP) has a potent effect in scavenging 1,1-diphenyl-2-picrylhydrazyl (DPPH), superoxide radicals, and chelating ferrous ion, exhibiting IC_{50} values of 0.23 mg/mL, 0.48 mg/mL, and 1.25 mg/mL, respectively. WEP absorbs both UVA and UVB irradiation, and furthermore, the extract shows a dose-dependent response in the protection of HaCaT and 3T3 cells against UVB-induced cytotoxicity, which may result from a synergistic effect between chlorogenic acid and other active components present in WEP.

E. prostrata has been used as a traditional medicinal plant to prevent lipidemia and atherosclerosis in Asia. Kim *et al*., [20] elucidated the biological basis for hypolipidemic and antioxidant activities of *E. prostrata*. Rats were fed experimental diets supplemented with 0 mg (control), 25 mg (E25), 50 mg (E50), or 100 mg (E100) of a freeze-dried butanol fraction of *E. prostrata* per kilogram of diet for 6 weeks. Serum triacylglycerol and total cholesterol levels in rats fed *E. prostrata* at 50, and 100 mg/kg diet were lower by 9.8% to 19.0% and 10.7% to 13.4%, respectively, as compared with the untreated control group. *E. prostrate* significantly decreased serum LDL-cholesterol levels by 10 to 13.0% in the E50 and E100 groups. In contrast, HDL-cholesterol levels were significantly increased (13-19%) in these groups compared with the control group. Atherogenic indices were also decreased by 10% to 31% in all groups supplemented with *E. prostrata*.

E. alba methanol extract (82%) showed potent antioxidant activity at a concentration of 100 µg/ml when compared to the standard ascorbic acid in DPPH free radical scavenging assay [10]. IC_{50} DPPH free radical scavenging effect of extract was compared with standard antioxidant ascorbic acid value was found 75 µg/ml for the extract and 45 µg /ml for ascorbic acid and the methanol extracts had good activity and IC_{50} value was found to be 55 µg/ml and 30 µg/ml in ABTS assay [11]. Hexane, ethyl acetate, ethanol and water extract at various concentrations (50, 100, 250 and 500 in µg/mL) showed antioxidant activities in a concentration-dependent manner. However, ethanol extract at the concentration of 500 µg/mL showed 77% antioxidant activity, very close to that of 500 µg/mL of reference compound (α-tocopherol; 80%)[14].

Anti-Cancer Potential: The structural identity of saponin, extracted and purified from *E. prostrata*

was established as dayscyphin C by spectroscopic analysis. The anticancer-cytotoxic activities of isolated dasyscyphin C, from *E. prostrata* leaves were tested under *in-vitro* conditions in HeLa (Human cervical carcinoma) cells. The dayscyphin C at 50 µg/ml showed 52% cytotoxic activity in HeLa cells at 48 hours with the IC_{50} value of 50 µg/ml. 5-Fluorouracil (5-FU) a positive control showed 57% cell death with the IC_{50} value of 36 µg/ml. The percentage of HeLa cell death was 53% in dasyscyphin C. The isolated saponins were not toxic to Vero cells and concluded that the saponins dayscyphin C have significant anticancer-cytotoxic activity on HeLa cells under *in-vitro* conditions [21].

Liu *et al*., [22] observed that *t*he antitumor activity of single compounds extracted from *E. prostrata* was not reported. The authors tried to extract and separate active components from *E. prostrata*. Furthermore, the inhibitory effects of various fractions and single compounds of *E. prostrata* on hepatoma cell smmc-7721 were tested to assess their anti-tumor activity. Based on spectroscopic analyses including MS, ^{1}H and ^{13}C NMR, four compounds from the aerial parts of *E. prostrata*, wedelolactone (I), eclalbasaponin I (II), luteolin (III) and luteolin-7-*O*-glucoside (IV) were identified. Antitumor activities of crude extracts, four fractions, and the isolated compounds were assessed using hepatoma cell smmc-7721 as an *in-vitro* assay system. The 30% ethanol fraction and eclalbasaponin I dose-dependently inhibited the proliferation of hepatoma cell SMMC-7721 with IC_{50} values of 74.23 and 111.17 µg/ml respectively, more strongly compared with 5-fluorouracil positive control group with the IC_{50} value of 195.31 µg/ml.

Chaudhary *et al*., [23] studied the effect of *E. alba* as multi-drug resistant (MDR) reversal agent using multidrug-resistant hepatocellular carcinoma cell line (DR-HepG2). The expression level of *MDR1* gene which is often associated with MDR in cancer encoding P-glycoprotein (P-gp) a 170 kDa trans-membrane protein level was analyzed by RT-PCR and western blotting. It was found that EAE (10 and 20 μg/ml) could significantly inhibit cell proliferation in DR-HepG2 whereas DOX (0.5 μg/ml) could not because of the enhancement effect of MDR1/Pgp. In the present investigation, the hydroalcoholic extract of *E. alba* was showed cytotoxicity on DR-HepG2 cells alone and with DOX more efficiently. The results of the present study demonstrate that EAE is a novel, selective, and highly potent modulator of P-gp-mediated MDR in human HepG2 cells.

Wedelolactone, a coumestan isolated in 1956, is one of the active polyphenolic compounds in extracts of *E. prostrate* [24]. Benes *et al*., [25] researched that wedelolactone inhibited growth and induced apoptosis in MDA-MB-231 breast cancer cells. The growth inhibitory and proapoptotic effects of wedelolactone did not result from deregulation of NFκB but were more likely attributable to its ability to bind dsDNA, inhibit topoisomerase IIα and block DNA synthesis and elucidated that wedelolactone can act as growth suppressor independently of NFκB and androgen receptors. Wedelolactone was shown to inhibit androgen receptor activity in prostate cancer cells at a concentration of 0.2 µM [26].

The role of *E. alba* extracts as an anti-cancer agent was studied by Chaudhary *et al*. [27] The extract was able to inhibit the proliferation of liver (HepG2), Kidney (A498) and brain (C6 glioma) cell lines in a dose-dependent manner, as observed by MTT assay and phase contrast study. The expression level of NF-kB was analyzed by western blotting and RT PCR. Gelatin zymography was done for gelatinase matrix metalloproteinases (MMP-2 and 9) analysis. *E. alba* hydroalcoholic extract (EAE) inhibited the cell proliferation in dose-dependent manner in HepG2, A498 and C6 glioma cell lines with an IC50 of 22 ± 2.9, 25 ± 3.6 and 50 ± 8.7 µg/ml, respectively. The expression of MMP-2 and MMP-9 was down-regulated with EAE treatment. DNA damage was observed following 72 h of extract treatment, leading to apoptosis. Additionally, the expression level of NF-kB was evaluated with western blotting and RT-PCR and was found to be down-regulated/inactivated.

Cerebroprotective Properties: Mansoorali *et al*., [1] evaluated cerebroprotective and antioxidant effect of hydroalcoholic extract of *E. alba* against global cerebral ischemia in adult Wistar albino rats, induced by occluding bilateral common carotid arteries (BCCA) for 30 min, followed by 4 h reperfusion. Quercetin (20 mg/kg, i.p.) was used as the reference compound. Animals sacrificed by

decapitation, brain removed and various biochemical estimations, cerebral edema, assessment of cerebral infarct size, and histopathological examinations showed that BCCA caused significant depletion in superoxide dismutase, glutathione peroxidase, reduced glutathione, catalase, glutathione-s-transferase, glutathione reductase and significant increase in malondialdehyde in the brain. Pre-treatment with hydroalcoholic extract of *E. alba* (250 and 500 mg/kg/day, p.o.) for 10 days significantly reversed the levels of biochemical parameters and significantly reduced the edema and cerebral infarct size as compared to the ischemic control group. *E. alba* at higher dose markedly reduced the ischemia-induced neuronal loss of the brain.

Shaikh *et al*. [28] studied the anticonvulsant activity of methanol extract of *E. alba* (10-200 mg/kg) using pentylenetetrazole and picrotoxin-induced seizure models. Delay in the onset of seizure was observed at all evaluated doses of methanol extract of *E. alba* and diazepam (2 mg/kg). A significant difference in the emergence of seizers was observed at 50 mg/kg of methanol extract of *E. alba* concerning control; the effect was not equivalent to that of diazepam. Delay in onsets of seizures was observed at 100 and 200 mg/kg, showing saturation of pharmacological activity at 50 mg/kg. Diazepam at the dose of 2 mg/kg and methanol extract of *E. alba* at the dose of 50, 100, and 200 mg/kg exhibited 100% protection from the death of animals. In the PIC-induced seizure model, the % protection by the 100 mg/kg dose of MEEA was 66%, which was equivalent to that of diazepam (66%).

Hepatoprotective: *Eclipta alba* is a highly reputed plant in the ayurvedic system of medicine for the treatment of liver damage [29, 30]. Based on *in-vitro* studies, coumestan, wedelolactone and desmethyl-wedelolactone have been identified as active components responsible for antihepatotoxic activity on primary cultured rat hepatocytes against CCl_4, galactosamine and phalloidin induced cytotoxicity [4, 31]. Singh *et al*., [32] elucidated that the fraction Ea ll containing coumestan wedelolactone and desmethyl-wedelolactone as the major constituents is responsible for the *in-vivo* hepatoprotective activity of *E. alba* that supports the earlier *in-vitro* finding.

Male Wistar rats were orally fed with boric acid at a dose regimen of 350 mg/kg body weight for 30 days, followed by oral administration of a hydroalcoholic extract of *E. alba* at a dose regimen of 500 mg/kg body weight orally for 60 days. Signs of toxicity as early as 15 days such as, liver damage, nephropathy and total damage to the testis were observed in boric acid treated group which aggravated on 30 days. A significant increase in oxidative stress in all the vital organs was observed.

Following the plant extract treatment, a complete reversal in reproductive toxicity was observed. The hormonal levels *viz*., testosterone, estrogen, and FSH returned to normal range, 60 days of plant extract treatment. Significant reversal comparable to the control groups was observed in oxidative stress in the vital tissues. The fertility of the rats was found to be restored [33].

In the course of screening antifibrotic activity of natural products employing HSC-T6, a rat hepatic stellate cell line as an *in-vitro* assay system, Lee *et al*., [34] observed the methanolic extract of aerial parts of *E. prostrata* significantly inhibited the proliferation of HSCs (51% of the control at 100 mg/ml). Activity-guided fractionation led to the isolation of five oleanane-type triterpenoids, echinocystic acid (1), eclalbasaponin II (2), eclalbasaponin V (3), eclalbasaponin I (4) and eclalbasaponin III (5), which are all echinocystic acid derivatives. Among the five echinocystic acid derivatives isolated, echinocystic acid (1) and eclalbasaponin II (2) significantly inhibited the proliferation of HSCs in the dose- and time-dependent manner.

Hepatoprotective activity of *E. alba* against paracetamol-induced hepatocellular damage in mice was studied by Tabassum and Agrawal[35]. Serum alanine aminotransferase levels were significantly higher in animals receiving paracetamol and reduced significantly in groups which received paracetamol and EA. The values returned to normal in animals of the group receiving 250 mg/100 g of EA along with paracetamol. Liv-52, which was used for comparative evaluation, produced a highly significant fall in the enzyme levels, alanine aminotransferase.

Histopathological studies revealed centrizonal and focal necrosis and ballooning in livers of mice challenged with paracetamol. But only mild ballooning with sinusoidal dilatation and binucleate cells was observed in the group treated with EA (100 mg/100 g per day) while binucleate cells spread throughout the liver sections and slight fatty changes were observed at the dose of 250 mg/100g/day of EA. EA (100 and 250 mg/100gm/day) was found to reduce serum ALT levels in a dose-dependent manner (18% and 31% fall, respectively) and with the latter dose the values returned to normal levels.

Thirumalai *et al*., [36] studied the potential restorative effect on CCl_4 induced hepatotoxicity in male albino rates by aqueous leaf extract. Hepatic damage in serum was assessed by biochemical markers such as aspartate transaminase, alanine transaminase, and alkaline phosphatase. The oxidative stress in hepatic tissue was evaluated by measuring levels of thiobarbituric acid reactive substance, hydroperoxides, activity levels of enzymes *viz*., superoxide dismutase, catalase, glutathione peroxidase, and glutathione-s-transferase. CCl_4 and olive oil mixture induced oxidation stress was indicated by elevated levels of thiobarbituric acid reactive substance and hydroperoxides and increased levels of serum aspartate transaminase, alanine transaminase, and alkaline phosphatase. The depleted activity levels of antioxidant enzymes such as superoxide dismutase, catalase, glutathione peroxidase, and glutathione-s-transferase were found in CCl_4 induced animals. The aqueous *E. alba* leaf extract restored the effects of CCl_4 and returned the later levels of the biochemical markers near to normal levels.

Saxena *et al*., studied the hepatoprotective potential of *E. alba*., [37] through assessing the biochemical parameters viz., superoxide dismutase, glutathione reductase, lipid peroxide, catalase, glutathione peroxide, ascorbic acid, and α-tocopherol. The ethyl acetate fraction of *E. alba* improves both enzymatic and nonenzymatic antioxidant status in rat liver. Oral administration of the *E. alba* significantly decreased levels of lipid peroxide and elevated the activity of antioxidant enzymes superoxide dismutase, catalase, glutathione peroxide, and glutathione reductase as well as endogenous levels of ascorbic acid and α-tocopherol. *E. alba* has shown a protective effect on experimental liver damage in rats and mice and also used for the treatment of liver cirrhosis and infective hepatitis by reducing centrilobular necrosis, hydropic degeneration and fatty change of the hepatic parenchymal cells.

Hepatoprotective activity of methanolic extract and subfractions of leaves and the chloroform extract and subfractions of roots of *E. alba* was carried out using carbon tetrachloride- induced liver damage and lysosomal enzymes level in wistar albino rats. The methanolic extract of leaves and the chloroform extract of roots of *E. alba* showed significant activities and respectively causing 73% and 48% reduction of a lysosomal enzyme. The triterpenoid eclabasaponin fraction from the methanolic extract of leaves produced significant (79%) and the alkaloidal fraction (61%) reduction of carbon tetrachloride induced an increase in a lysosomal enzyme in the blood.

Coumestan fraction and triterpenoidal saponin fraction from the chloroform extract of roots produced very significant (76%) and (52%) respectively reduction of carbon tetrachloride induced an increase in lysosomal enzyme levels in blood[38].

E. alba is a well-known plant of medicinal importance and reported for hepatoprotective activity, but the active principle responsible for its hepatoprotective activity *in-vivo* was not known. The *in vivo* hepatoprotective activity of active fraction from the ethanolic extract of *E. alba* leaves was studied by Singh *et al*. [32] The previously reported alcoholic extract of *E. alba* fresh leaves for its hepatoprotective activity was fractionated into three parts to identify the most potent bioactive fraction chemically. The hepatoprotective potential of the fraction prepared from extract was studied in-*vivo* in rats and mice against carbon tetrachloride-induced hepatotoxicity. The hepatoprotective activity was determined by their effects on parameters like hexobarbitone sleep time, zoxazolamine paralysis time, bromosulphaline clearance, serum transaminases, and serum bilirubin. Fraction EaII (10-80 mg/kg, p.o.) containing coumestan wedelolactone and desmethyl-wedelolactone as major components

with apigenin, luteolin, 4-hydroxybenzoic acid, and protocatechuic acid as minor constituents exhibited maximum hepato-protective activity and are the active fraction for the hepatoprotective activity of *E. alba* leaves.

Immunomodulatory Activities: Jayathirtha and Mishra [39] by employing carbon clearance, antibody titer and cyclophosphamide immune-suppression parameters analyzed preliminary immuno-modulatory activities of methanol extracts of *E. alba* whole plant (1.6% wedelolactone) at five dose levels (dose-response relationship) ranging from 100 to 500 mg/kg body weight. The phagocytic index and antibody titer increased significantly, and the F ratios of the phagocytic index and WBC count were also significant. Regression analysis showed linearity in patterns of the dose-response relationship, greatest in the case of the phagocytic index, moderate in the WBC count and lowest in the antibody titer, indicating the promise preliminarily as immunomodulatory candidates, and provide scope for further detailed investigation.

Antidepressant: Swati *et al.,* [40] evaluated the antidepressant activity of *E. alba* leaf extract (EALE) in rats employing tail suspension test (TST) and forced swim test (FST). *E. alba* leaf extract produced significant antidepressant-like effect at a dose of 200 and 400 mg/kg administered for 7 and 14 consecutive days as indicated by a reduction in immobility times of rat in TST and FST. The efficacy of *E. alba* leaf extract at 200 mg/kg was found to be comparable to that of Fluoxetine and Imipramine at doses of 20 mg/kg & 15 mg/kg indicating *E. alba* leaf extract possesses significant antidepressant activity compared to that of both Fluoxetine and Imipramine.

Anti-inflammatory and Analgesic Activity: The traditional use of *E. prostrata* in the treatment of inflammatory diseases was substantiated by Arunachalam *et al.,* [41] by oral administration of *E. prostrata* leaves methanolic extract at a concentration of 100 and 200 $mgkg^{-1}$ to investigate anti-inflammatory activity in carrageenin and egg white induced hind paw edema in rats. Significant dose-dependent anti-inflammatory activity in carrageenin and egg white induced hind paw edema in rats was observed at 100 and 200 $mgkg^{-1}$ concentration. Anti-inflammatory activity of the tested extract was comparable with that of the standard drug indomethacin (10 $mgkg^{-1}$) and cyproheptadine (8 $mgkg^{-1}$).

Antinociceptive, anti-inflammatory and bronchodilator activities of hydro-alcoholic extracts of five Brazilian medicinal plants including *E. alba*, containing coumarin one of their active principles were studied by Leal *et al.* [42] The antinociceptive effects of all hydro-alcoholic extracts in mice were reported to be similar. All the hydro-alcoholic extracts showed bronchodilator activity. Antinociceptive, anti-inflammatory, and bronchodilator activities of these plants observed in this preliminary study justify their traditional use in the treatment of respiratory tract diseases.

The identification and characterization of wedelolactone, one of active ingredient of *E. alba*, a natural compound that inhibits lipopolysaccharide-induced caspase-11 expression in cultured cells by inhibiting NF-κB-mediated transcription was described by Kobori *et al.* [43] A key regulator of pro-inflammatory cytokine IL-1β maturation and pathological apoptosis is Caspase-11. Under normal condition, Caspase-11 is not expressed in most tissues, but highly inducible upon pathological stimulation such as in the presence of lipopolysaccharide (LPS). Kobori *et al.* demonstrated that wedelolactone is an inhibitor of IKK, a kinase critical for activation of NF-κB by mediating phosphorylation and degradation of IκBα.

Hair Growth and Alopecia: Roy *et al.,* [2] validated the ethnomedical use of *E. alba* for hair loss treatment and thus confirmed that the petroleum ether extract (5%) treatment is at par with Minoxidil (2%) treatment in revitalizing the growth of hair in male rats. Topical application with the petroleum ether extract of *E. alba* reduced the time required for hair growth initiation and was comparable to standard (minoxidil 2%) solution. Similar to minoxidil treated group, the quality of hair in petroleum ether extract treated group was superior as the hairs were soft and silky. Among ethanol and petroleum ether extract treatment, the petroleum ether extract treatment caused premature switching of hair follicles from resting telogenic phase to active anagenic phase. The treatment also helped to retain anagenic hair follicles. Thus, %

hair follicle population in the anagenic phase exhibited marked improvement over ethanol extract treated and control group animals.

E. alba has been traditionally used to check hair loss, stimulate hair growth and has been reported in the various poly-herbal formulation for hair growth promotion. Datta *et al*., [44] studied the methanolic extract of *E. alba* with potential for hair growth promoting activity in pigmented C57/BL6 mice and recorded a comparable degree of growth induction with standard (Minoxidil). The methanol extract of *E. alba* promoted hair growth in dose-related manner by inducing growth in resting phase hair follicles. Mice treated with 3.2 mg/15 cm^2 of methanol extract showed better efficacy as compared to lower doses supported by immune-histochemical studies.

Nervine Tonic: *E. alba* has been used as a nervine tonic in the Indian system of medicine [45]. Neuropharmacological profile of *E. alba* was investigated by Thakur and Mengi [46] by studying the aqueous, hydroalcoholic extract (dose of 150 and 300 mg/kg, p.o.) and hydrolyzed fraction (30 mg/kg, p.o.) for sedative, muscle-relaxant, anxiolytic, nootropic and anti-stress activities in rats. Nootropic activity was observed of the aqueous extract (300 mg/kg, p.o.) and its hydrolyzed fraction (30 mg/kg, p.o.). Protection against cold restraint induced gastric ulcer formation and white blood cell count in the milk induced leukocytosis challenge model was normalized by aqueous extract and the hydrolyzed fraction. However, the hydroalcoholic extract established a considerable effect only in the milk induced leukocytosis challenge model.

Anti Snake Venom Properties: Neutralization of lethal and myotoxic activities of South American rattlesnake (*Crotalus durissus terrificus*) venom by extracts and constituents of the plant *E. prostrate* in Brazil was studied by Mors *et al*. [24] *In-vitro* studies showed that ethanolic extracts of the aerial parts of *E. prostrata* neutralized the lethal activity of the venom of South American rattlesnake when mixed *in-vitro* before i.p. Injection into adult Swiss mice. Up to four lethal doses of venom were neutralized by ethanolic extract corresponding to 1.8 mg of dry extract. Three lethal doses of venom were neutralized by wedelolactone (0 .54 mg/ animal), sitosterol (2.3 mg/animal) and stigmasterol (2.3 mg/animal). The release of creatine kinase from isolated rat muscles exposed to the crude venom was inhibited by aqueous extract of the plant. Among two protocols used in *in-vivo* studies, venom pre-incubated with the extract prior to injection into mice, protection was recorded against the myotoxic effects of the venom.

E. prostrata and its constituent wedelolactone are investigated to possess anti-myotoxic and anti-hemorrhagic against the crotalid venoms responsible for snakebites in Brazil [47]. The *in-vitro* myotoxicity of the crotalid venoms and mycotoxins (bothropstoxin, bothropasin, and crotoxin) was neutralized by simultaneous exposure of the muscles to *Eclipta prostrata* aqueous extract or wedelolactone. The *in-vivo* myotoxicity of venoms and mycotoxins was neutralized by their pre-incubation with the *Eclipta prostrata* aqueous extract or wedelolactone. Intravenous administration of the plant extract or wedelolactone attenuated the increase in plasma creatine kinase activity induced by subsequent intramuscular injections of the crotalid venoms or the mycotoxins. *Eclipta prostrata* aqueous extract and wedelolactone inhibited the hemorrhagic effect of *Bothrops jararaca* venom, as well as the phospholipase A2 activity of crotoxin and the proteolytic activity of *B. jararaca* venom.

Among several organic and inorganic compounds present in snake venom, one of the principal toxic components are phospholipases A_2 (PLA_2s). A wide variety of pharmacological activities, such as neurotoxicity, myotoxicity, cardiotoxicity, anticoagulant, hemorrhagic, and edema-inducing effects are displayed by PLA_2s. PLA_2 inhibition is of immense pharmacological and therapeutic research interest as these enzymes are involved in several inflammatory diseases [48]. Production of secondary wedelolactone metabolites, which are coumestan compounds with activity against basic PLA_2s was enhanced in *E. alba* by genetically engineered using *Agrobacterium rhizogenes* LB9402. This mutant strain was found to reduce the phospholipase A_2 activities and myotoxic and neurotoxic effects of the *C. d. terrificus* and *B. jararacussu* snake venom [15, 49]. Analogs of wedelolactone molecules were able to antagonize the release of creatine kinase induced by *B.*

jararacussu venom at concentrations as low as 30 μM [50, 51].

Anti-Diabetic: The antihyperglycemic effect of *E. alba* was evaluated by Ananthi *et al*., [52] by studying the activities of glucose-6-phosphatase and fructose 1,6-bisphosphatase in alloxan-diabetic rats by oral administration of *E. alba* leaf extract of 2 and 4 g/kg body weight) for 2 months. A significant reduction in blood glucose level (from 372 to 117), glycosylated hemoglobin HbA_1c, followed by a decrease in the activities of glucose-6 phosphatase and fructose1,6-bisphosphatase, and an increase in the activity of liver hexokinase was recorded. Based on *in-vitro* α-amylase, α-glucosidase enzyme studies, antidiabetic activity of *E. alba* was investigated. Methanolic extract of *E. alba* showed inhibition of α-amylase and α-glucosidase enzymes that are responsible for the breakdown of oligosaccharides into monosaccharides [53].

Non-Toxic: Fine dry *E. alba* powder consumed in the form of capsules 3 g/day) is diuretic, hypotensive and hypocholesterolemic and helps in alleviating oxidative stress-induced complications in hypertensives. Clinical studies in humans have established *E. alba* as hepatoprotective with no side effects [17]. Biochemical and histological changes in the liver associated with acute oral toxicity (LD_{50}) of aqueous extract of *E. alba* was investigated in female Swiss albino mice. Treatment groups were administered aqueous leaf extract of *E. alba* orally at different doses of 500 mg, 1750 mg, 2000 mg, 2500 mg and 3000 mg/ kg/b.wt. for seven consecutive days. The LD50 was found to be 2316 mg/kg /body weight in female mice. Serum SGPT, total protein and albumin increased in treated group 2000 mg/ kg/b.wt. and 3000 mg/ kg/b.wt. as compared to the control.

Alkaline phosphatase level significantly decreased in the treated group 2000 mg/kg/b.wt. and 3000 mg/kg/b.wt. Histopathological changes were observed at the dose of 2000 mg, 2500 mg, and 3000 mg group. Oral administration of aqueous leaf extract of *E. alba* had detrimental effects on biochemical parameters and induced Histopathological alterations in liver of female Swiss albino mice at doses higher than 2000 mg/kg/day indicating that its indiscriminate use should be avoided [54].

The acute oral toxicity, dermal irritation and eye irritation of aqueous extract of *E. alba* dried leaves in Sprague Dawley rats and New Zealand white rabbits were conducted by Udayashankar *et al.* [55] The toxicity studies were carried out based on OECD guidelines. The highest dose administered at 2000 mg/kg body weight did not produce mortality or changes in general behavior of the test animals indicating the safety of the oral administration of aqueous *E. alba* extract in Sprague Dawley rats. The *E. alba* fine powder applied to the intact left flank of female rabbit did not elicit any skin reactions at the application site of the animal at any of the observation time points and hence 'Non-Irritant' to the rabbit skin. The acute eye irritation study on Newzealand white rabbits did not cause corneal opacity, iris, and conjunctivae in any of the treated animals and did not cause staining of the treated eye and is termed as 'not irritating' to the rabbit eyes/eye mucosa. The same low level or absence of acute toxicity was reported for ethanolic extracts of freshly harvested leaves of *E. alba* in mice [56].

Animal Diseases: Researchers have validated the use of phytotherapy containing *E. alba* coumestans at a dose of 120 ppm as a therapeutic or prophylactic agent against avian coccidiosis. The chicken broilers were individually infected with 2×10^4 oocysts of *Eimeria tenella* when they were 14 days old and were monitored weekly to evaluate zootechnical parameters. The group treated with coumestans from *E. alba* presented an average weight gain and food conversion ratio higher than the negative control group and similar to the mean value of the positive control group. Coumestan-treated groups showed a significant decrease in the oocyst counting since the 21st day of life and displayed a reduced number of macroscopic lesions [57].

Aqueous leaf extract of *E. alba* administered as feed supplement at 0, 0.01, 0.1 or 1% levels fed for 1-3 weeks enhanced most of the non-specific immune parameters tested; humoral (lysozyme, antiprotease and complement) and cellular (myeloperoxidase content, production of reactive oxygen and nitrogen species) responses and disease resistance against *Aeromonas hydrophila* bacteria in tilapia, *Oreochromis mossambicus* [58]. When challenged with *A. hydrophila* after 1, 2 or 3 weeks

of feeding, the percentage mortality was significantly reduced in the treated fish. The highest dose of 1% gave better protection than the other doses with the relative percentage survival values of 64, 75 and 32 after feeding for 1, 2 and 3 weeks respectively.

The highest lysozyme activity was observed in the group fed with 1% aqueous extract-supplemented feed for 2 weeks. Dietary intake of *E. alba* aqueous extract had significantly increased the serum antiprotease activity after 2 or 3 weeks of feeding. Leucocyte myeloperoxidase activity was increased significantly in fish fed with diets supplemented with different levels of aqueous extract for 1 week. The larvicidal activity of synthesized silver nanoparticles (AgNPs) utilizing aqueous extract from *E. prostrata* was investigated against fourth instar larvae of filariasis vector, *Culex quinquefasciatus* and malaria vector, *Anopheles subpictus* [59]. The worms were exposed to varying concentrations of aqueous extract of synthesized AgNPs for 24 h. The maximum efficacy was observed in crude aqueous and synthesized AgNPs against *C. quinquefasciatus* and *A. subpictus* respectively.

TABLE 1: BENEFICIAL EFFECTS OF *E. ALBA*

S. no.	Extract/compound	Effect	Reference
1	Hydro-alcoholic extract	Multidrug resistance reversal potential	Chaudhary *et al*., (2013).
2	Water; 30, 60 and 90% ethanol extract	Anti-tumor activity	Liu *et al*., (2012).
3	Methanol extract	Anticancer-cytotoxic activity	Khanna and Kannabiran, (2009)
4	Methanol extract	Anti-leptospiral, antioxidant	Chandan *et al*., (2012)
5	Methanol extract	Antimicrobial and antioxidant activity	Prabu *et al*., (2011)
6	Water extract	The potent effect in scavenging DPPH, superoxide radicals, and chelating ferrous ion	Chan *et al*., (2014)
7	Dried *E. alba* leaf powder in the encapsulated form	Diuretic, hypotensive, and hypocholesterolemic and helps in the alleviating oxidative stress-induced complications in hypertensives	Rangineni *et al*., (2007)
8	Hydro-alcoholic extract	Cerebro-protective effect against the global model of cerebral ischemia induced oxidative stress in rats	Mansoor alias *et al*., (2012)
9	Aqueous extract	Anti-dermatophytic activity against human infective *Trichophyton* and *Microsporum* spp.	Nagabhushan *et al*., (2013)
10	Aqueous extract	Larvicidal activity of synthesized silver nanoparticles against filariasis and malaria vectors	Rajakumar and Rahuman, (2011)
11	Freeze dried butanol fraction	Reduces serum lipid levels and improves antioxidant activities in CD rats	Kim *et al.*, (2008)
12	80% Methanol extract	Anti-proliferative activity of triterpenoids on hepatic stellate cells	Lee *et al*., (2008)
13	Aqueous extract	Restorative effect of *E. alba* in CCl_4 induced hepatotoxicity in male albino rats	Thirumalai *et al*., (2011).
14	Methanol extract	Effect on acute seizure models: a $GABA_A$-mediated effect	Shaikh *et al*., (2013).
15	Hydro-alcoholic extract	The reversal in reproductive toxicity in Boric Acid-induced male reproductive toxicity in male Wistar rats	Nair *et al*., (2012).
16	50% Ethanol	Found to protect the mice from hepato-toxic action of paracetamol	Tabassum and Agrawal, (2004)
17	90% ethanol extract	Anti-depressant	Swati *et al.*, (2013)
18	Aqueous extract	Enhances the non-specific immune responses and disease resistance of fish *Oreochromis mossambicus* against Disease caused by *Aeromonas hydrophila*	Christybapita *et al*., (2007)
19	Methanol and ethyl acetate extract	Ethyl acetate fraction, wedelolactone showed enhanced anti-microbial activity. *Staphylococcus epidermidis, Staphylococcus aureus*, and *Salmonella typhimurium* were most susceptible	Dalal *et al*., (2010)
20	Ethanol, ethyl acetate, hexane, and aqueous extract	Ethanol extract effective against *Salmonella typhi* at 25 µl/mL followed by ethyl acetate extract at 35 µl/mL concentration. The last three of 8 fractions - ethanol extract by silica gel G	Karthikumar *et al*., (2007)

		60-120 mesh column chromatography -significant activity against *S. typhi*	
21	Ethanolic extract	The decrease in systolic, diastolic, mean arterial pressure and heart rate in a dose-dependent manner which was highly significant with 200 and 400 mg/kg doses, on day 7 post-dosing	Jena *et al*., (2013).
22	Wedelolactone	The growth inhibitory and pro-apoptotic effects of wedelolactone did not result from deregulation of NFκB but were more likely attributable to its ability to bind dsDNA, inhibit topoisomerase IIα and block DNA synthesis - wedelolactone can act as growth suppressor independently of NFκB and androgen receptors	Lin *et al*., (2007).
23	Hydro-alcoholic extract	Inhibit the proliferation of liver (HepG2), Kidney (A498) and brain (C6 glioma) cell lines in a dose-dependent manner HepG2, A498 and C6 glioma cell lines with an IC_{50} of 22 ±2.9, 25 ±3.6 and 50±8.7µg/ml, respectively	Chaudhary *et al*. (2011).
24	Methanol and chloroform extract	The methanolic extract of leaves and the chloroform extract of roots - 73% and 48% reduction of a lysosomal enzyme. The triterpenoid eclabasaponin fraction from the methanolic extract of leaves produced significant (79%) and the alkaloidal fraction (61%) reduction of carbon tetra chloride induced an increase in a lysosomal enzyme in the blood. Coumestan fraction and triterpenoidal saponin fraction from the chloroform extract of roots produced very significant (76%) and (52%) respectively reduction of carbon tetrachloride induced an increase in lysosomal enzyme levels in the blood	Lal *et al*., (2010)
25	Ethyl acetate fraction	Oral administration of the *E. alba* significantly decreased levels of lipid peroxide and elevated the activity of antioxidant enzymes superoxide dismutase, catalase, glutathione peroxide, and glutathione reductase as well as endogenous levels of ascorbic acid and α-tocopherol	Saxena *et al*., (1993)
26	Ethanol extract	Fraction EaII (10-80 mg/kg, p.o.) containing wedelolactone and desmethyl-wedelolactone as major components with apigenin, luteolin, 4-hydroxybenzoic acid, and protocatechuic acid as minor constituents exhibited maximum hepatoprotective activity	Singh *et al*., (2001).
27	Methanol extracts	The phagocytic index and antibody titer increased significantly, and the F ratios of the phagocytic index and WBC count were also significant. Regression analysis showed linearity in patterns of the dose-response relationship, greatest in the case of the phagocytic index, moderate in the WBC count and lowest in the antibody titer, indicating the promise preliminarily as immunomodulatory candidates	Jayathirtha and Mishra (2004)
28	Methanolic extract	Significant dose-dependent anti-inflammatory activity in carrageenin and egg white induced hind paw edema in rats was observed at 100 and 200 $mgkg^{-1}$ concentration. Anti-inflammatory activity of the tested extract was comparable with that of the standard drug indomethacin (10 $mgkg^{-1}$) and cyproheptadine (8 $mgkg^{-1}$)	Arunachalam *et al.*, (2009)
29	Petroleum ether extracts (5%)	Topical application with the petroleum ether extract of *E. alba* reduced the time required for hair growth initiation and was comparable to standard (minoxidil 2%) solution	Roy *et al*., (2008)
30	The aqueous, hydroalcoholic extract	Nootropic activity was observed of the aqueous extract (300 mg/kg, p.o.) and its hydrolyzed fraction (30 mg/kg, p.o.). Protection against cold restraint induced gastric ulcer formation and white blood cell count in the milk induced leukocytosis challenge model was normalized by aqueous extract and the hydrolyzed fraction	Thakur and Mengi (2005)
31	Methanolic extract	Promoted hair growth in dose-related manner by inducing growth in resting phase hair follicles	Datta *et al*., (2009)

32	Ethanolic extracts	*In-vitro* studies showed that ethanolic extracts of the aerial parts of *E. prostrata* neutralized the lethal activity of the venom of South American rattlesnake when mixed *in-vitro* before i.p. injection into adult Swiss mice	Mors *et al*., (1989)
33	Dry leaf powder	A significant reduction in blood glucose level (from 372 to 117), glycosylated hemoglobin HbA_1c, followed by the decrease in the activities of glucose-6 phosphatase and fructose1,6-bisphosphatase, and an increase in the activity of liver hexokinase was recorded	Ananthi *et al*., (2003)
34	Ethyl acetate fraction from methanolic extract of *E. alba* aerial parts	Coumestan-treated groups showed a significant decrease in the oocyst counting since the 21st day of life and displayed a reduced number of macroscopic lesions	Michels *et al*., (2011).

CONCLUSION: *Eclipta alba* is an important medicinal plant in the traditional system of medicine. Several of these ethnomedicinal properties have been validated by *in-vitro* cell-based as well as animal experiments. These studies have given several leads to the antimicrobial, diuretic, hypotensive, and hypocholesterolemic activity, antioxidant, anti-cancer potential, cerebral-protective properties, hepato-protective, immune-modulatory activities, anti-depressant, anti-inflammatory, and analgesic activity potential. Further several bioactive phytochemicals have been identified. The lead bioactive molecules could be further developed as drug molecules by generating data on pharmaceutical and clinical trials.

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