

ECLIPTA ALBA (BHRINGRAJ): A PROMISING HEPATOPROTECTIVE AND HAIR GROWTH STIMULATING HERB.

ISHA KUMARI, HEMLATA KAURAV, GITIKA CHAUDHARY*

Shuddhi Ayurveda, Jeena Sikho Lifecare Pvt. Ltd. Zirakpur, Punjab, India. Email: shuddhi.research@jeenasikho.co.in

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ABSTRACT

Plants are the primary source of food, shelter, and various remedial approaches. They are being in use for treating various kinds of human ailments across the world since the ancient times. One of such important plants is *Eclipta alba hassk* (*Asteraceae*) which is commonly known as Bhringraj and false daisy. This plant is known for its extra-ordinary therapeutic properties. It is one of most widely used plant in traditional systems of medicines such as Ayurvedic, Unani, Sidha, homeopathy, Chinese, and folk. Each part of this medicinal plant contains many important phytochemical constituents such as coumestans, triterpenes, flavonoids, steroids, polypeptides, and saponins. It is majorly used for enhancing the growth, strength, and blackening of hair. It is used as the main ingredient in many hair oils. It significantly treats problems related to hair such as hair fall, dandruff, premature greying, and baldness. *E. alba* exhibits many other important biological properties such as anticancer, anti-bacterial, anti-viral, anti-stress, and immunomodulatory. Thus, this medicinal plant is playing a vital role in the medical field and cosmetic industry. The present review is a summary of phytomedicinal importance of *E. alba* in Ayurveda as well as folk medicine system.

Keywords: Bhringraj, Rasapanchak, Coumestans, Saponin, Hepatoprotective.

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INTRODUCTION

Nature is the primary source of numerous medicines for thousands of years [1,2]. Among plants, medicinal plants are of great significance. Medicinal plants are those plants whose one or more than one part possess substances which are medically important and are used for the synthesis of new drugs [3,4]. Kingdom plantae is considered as the treasure house of many important drugs. It has been a culture of using medicinal plants [5]. Initially most of the medicinal preparations were obtained from the plants only either in the simpler form or in the complex form [6]. Drugs derived from plants are named as herbal drugs, botanical drugs, botanicals, phytomedicines, traditional medicines, herbal medicines, traditional Chinese medicines (TCMs), traditional herbal medicinal products, natural health products, or plant food supplements. These phytomedicines have advantages over synthetic drugs such as they are easily available, less expensive, safe, and efficient and have negligible side effects [7-10]. Even most of the modern drugs are derived from the natural sources like plants. As per the data resources, quarter of the medicines used in the present times in industrialized countries has been derived from tropical plants directly or indirectly [11-13]. Medicinal plants have a very rich history of their utilization to treat variety of diseases. The practice of using plants to treat diseases and get relief from physical sufferings is as old as the origin of mankind [14,15]. As per the estimated reports of the WHO, in developed nations around 80% of the total population rely majorly on the phytomedicines for maintaining their health and fulfilling basic requirements [16-19]. India comes under the category of world biodiversity centers which is blessed with the rich medicinal plant history having more than 45,000 diverse species of plants; therefore, it is considered as Botanical garden of the world [20,21]. Indian medicinal plants are used in many traditional systems of medicine such as Ayurveda, Siddha, Unani Folk system, and as well as allopathy [22]. Ayurveda is the most ancient traditional medicine system. There are almost 600 medicinal plants and their formulations are being in use in Ayurvedic practices for the treatment of several diseases [23]. In U.K. around 25% of population use phytomedicines in their day-to-day routine. Phytomedicines are used in each and every corner of the world. Medicinal herbs are used for the healing purpose by African

population [24]. In Africa, traditional medicines are being in use since 4000 years. These medicines served as the primary health-care system in the absence of modern medicines [25,26]. More than 1000 species of plants are mentioned in the compendium of *Materia Medica* which is an ancient encyclopedia of TCM [27]. In China, medicinal plants are being in therapeutic use in dietary therapy for numerous years and thus maintaining the health [28,29]. As per the reported data, 60 out of 104 global drugs that are used for last 37 years have been derived from the TCM plants [30]. In countries like West Africa modern drugs are not affordable by many people thus people rely on phytomedicines for cure and heal purpose [31]. About 85% of Swazis and Nigerians use traditional medicine as a health-care system [32,33]. Approximately 27% of South African population uses traditional medicines as its main health care system. *Eclipta alba* (L.) (Fig. 1) is one of most well-known and valuable medicinal plants in India. It is commonly named as false daisy and Bhringaraj and Karisilakanni. Genus *Eclipta* originated from the Greek word "Deficient" which means absence of the bristles and awns on the fruits [34,35]. *E. alba* (L.) belongs to the family *Asteraceae*. This medicinal plant has rich ethnomedicinal history. *E. alba* and its therapeutic value has also been mentioned in classical text "Bhavaprakash" [36]. In Ayurveda, it is named as "bhringoraja", in Unani system; it is named as "bhangra" whereas in Siddha it is named as "karissalaankanni" [37]. *E. alba* is categorized into three categories on the basis of the color of the flowers/fruits which are white-flowering, the yellow-flowering, and the black-fruited. Each type is found in marshes, rivers, and lakes or on the foothills of the Himalayas in India [33]. This medicinal plant is mostly used in tropical and sub-tropical regions as a traditional medicine. It is also utilized as a functional food [38]. It is a very famous hepatoprotective drug and popularly called as "King of hair" [39]. The extracts of this medicinal herb are used as preventive measure or as an anti-venom against snakebite. It is used to treat issues related to gastro-intestinal tract, respiratory issues, to heal cut and wounds, inflammation, and many more diseases [40-44]. Wedelolactone, demethylwedelolactone, desmethyl-Wedelolactone, furanocoumarins, oleanane and taraxastane glycosides, and 7glucoside are the primary coumestan derivatives present in *E. alba* [45,46]. Ecliptal, β -amyrin, luteolin-7-O-glucoside, hentriacontanol, heptacosanol, stigmaterol are other principle phytochemical constituents of *E. alba*. Each part of this

medicinal plant is important from medicinal point of view. *E. alba* is associated with therapeutic properties such as anticancer, antileprotic, analgesic, antioxidant, antimyotoxic, anti-hemorrhagic, antihepatotoxic, antiviral, antibacterial, spasmogenic, hypotensive, and ovicidal. *E. alba* is known as "King of hair" because it exhibits properties which enhance the growth and blackening of hair [47,48]. It is used externally to treat eczema and in athlete foot [49]. It is also used as a treatment of epilepsy [50]. Vernacular names and Taxonomy of *E. alba* are shown in Tables 1 and 2.

BOTANICAL DESCRIPTION OF *E. ALBA* (BHRINGRAJ)

E. alba (L.) is an annual multibranched herbaceous plant that reaches up to the height of 30–50cm. The form of this plant may be erect or prostrate. The plant is covered with hair of white color. The hair is present on both the surfaces of leaves. The stem is of red color. There is presence of simple, sessile, and lanceolate leaves which are of length 4–10 cm, breadth 0.8–2 cm, and tallness 90 cm with slender. The leaves



Fig. 1: *Eclipta alba* (Bhringraj)

Table 1: Vernacular names of *Eclipta alba* (Bhringraj) [51]

English	False daisy
Sanskrit	Bhrungaraj, Kesharaj, Markava, Kesharanjana, Kesharaj
Hindi	Bhangara, Bhangarayya
Punjabi	Bhangara, dodhak, Babri
Marathi	Maka
Gujarat	Bhangaro
Bengali	Kesuriya, Kesuti
Tamil	Kaikeshi
Telugu	Galagara, Gunta, Galijaeru
Malyalam	Cajenneam,Kanni
Konkani	Mako, Kajalamavu
Asamese	Kehraj
Arabic	Kadim-ul-bint, Radim-el-bint

Table 2: Taxonomy of *Eclipta alba* (Bhringraj) [52]

Kingdom	Plantae
Subkingdom	Viridaeplantae
Infrakingdom	Streptophyta
Division	Tracheophyta
Subdivision	Spermatophytina
Infradivision	Angiospermae
Class	Magnoliopsida
Superorder	Asteranae
Order	Asterales
Family	Asteraceae
Genus	<i>Eclipta</i>
Species	<i>alba</i>
Common name	False Lily, Bhringraj

are present in opposite manner which are attached to the stem without the presence of petiole. At the lower nodes rooting is present. The floral heads are solitary and white whose diameter is 6–8 mm. Flowers are narrowly winged. The plant has well developed root system. Grey cylindrical roots are present there. The plant is covered with flowers throughout the year. The fruiting period of *E. alba* is from September to October [53-55].

GEOGRAPHICAL DISTRIBUTION OF *E. ALBA* (BHRINGRAJ)

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 [56-60].

PHYTOCHEMISTRY OF *E. ALBA* (BHRINGRAJ)

E. alba (Bhringraj) contains wide range of diverse phytochemical constituents which include coumestans, alkaloids, flavonoids, glycosides, polyacetylenes, and triterpenoids, phenolic acids, saponins, sterol, sesquiterpene lactones, proteins, amino acids, carbohydrates, and many more [61-65]. Some major phytochemicals are shown in (Fig. 2).

Coumestans

Coumestans are the main active phytochemical constituents of *E. alba* which are the derivatives of coumarin. Wedelolactone, demethylwedelolactone, demethylwedelolactone-7-glucoside, isodemethylewedelolactone, and strychnolactone are the main coumestans present in the whole plant especially in the leaves. These are believed to be associated with anti-cancer properties [66-70].

Alkaloids

The major alkaloids present in *E. alba* leaves are (20S)-22,26-imino-cholesta-5,22(N)-dien-3 β -ol (verazine, 3). Other novel alkaloids reported are 20-epi-3-dehydroxy-3-oxo-5,6-dihydro-4,5-dehydroverazine (1), ecliptalbine [(20R)-20-pyridyl-cholesta-5-ene-3 β ,23-diol] (4), (20R)-4 β -hydroxyverazine (5), 4 β -hydroxyverazine (6), (20R)-25 β -hydroxyverazine (7), 25 β hydroxyverazine and (8), Ecliptalbine (4). While methanolic extract of the plant contains alkaloids such as verazine, 20-epi3-dehydroxy-3-oxo-5, 6-dihydro-4, 5- dehydroverazine ecliptalbine, (20R)-4s-hydroxyverazine, 4shydroxyverazine, (20R) 25s-hydroxyverazine, and 25shydroxyverazine. Some other reported alkaloids are ecliptine, nicotine, verazine, and dehydroverazine ecliptalbine [71].

Saponin

Saponins are mainly associated with the cytotoxic activity. Eclalbatin, alpha-amyrin, ursolic acid, and oleanolic are novel triterpene saponin which has been isolated from the whole plant of *E. alba* [72-74]. Eclalbatin, dasyscyphin C is present in the roots which are associated with the properties such as anticancer, antiviral, and antioxidant activity [75].

Sterols

Stigmasterol, daucoesterol, stigmasterol-3-O-glucoside, phytosterol, and β -glucoside of phytosterol are the major sterols present in *E. alba* seed [76,77]. Stigmasterol is an important sterol which is involved in the process of synthesis of major reproductive hormones like progesterone, androgens, estrogens, and corticoids [78].

Flavonoids

Apigenin, luteolin and luteolin-7-glucoside, and orobol are the main flavonoids present in *E. alba*. Apigenin and luteolin are associated with the anti-cancer properties [64].

Triterpenoids and their glycosides

Eclalbasaponins VII–X (taraxastane triterpene glycosides), eclalbasaponins I–VI (oleanane triterpene glycosides), eclalbasaponins

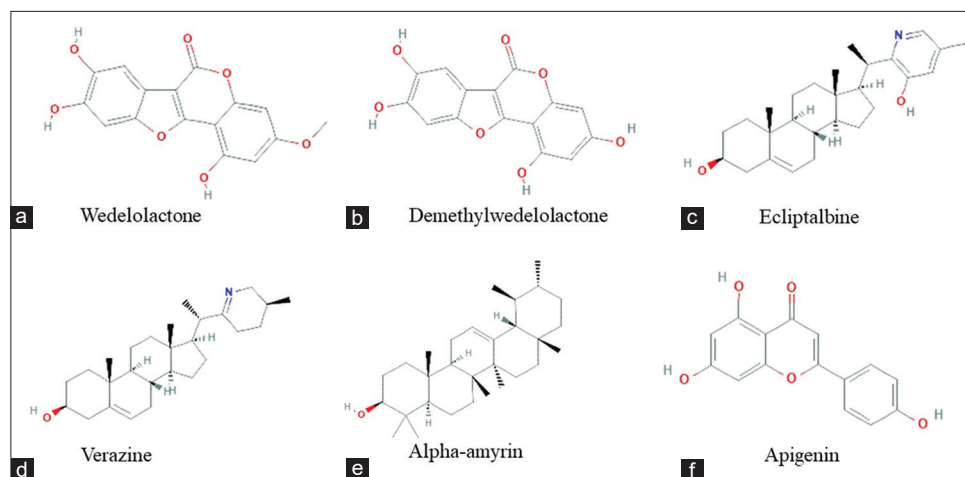


Fig. 2: (a-f) Chemical structures of some of phytochemicals of *Eclipta alba*

I-VI (triterpene glycosides), ecliptasaponins C and D (triterpenoid glucosides), eclalbatin, α -amyrin, β -amyrin, oleanolic acid, ursolic acid (triterpenoids), wedelic acid are the main terpenoids, and their glycosides present in *E. alba*. Oleanolic acid, eclalbatin, and α -amyrin, are present in the whole plant [79-82].

Phenolic acid

Protocatechuic acid and 4-hydroxy benzoic acid are the phenolic acid extracted from the *E. alba*. Sesquiterpene lactones *E. alba* consists of 5-hydroxymethyl-(2,2':5',2'')-terthienyl tiglate, 5-hydroxymethyl-(2,2':5',2'')-terthienyl agelate, 5-hydroxymethyl-(2,2':5',2'')-terthienyl acetate as its main Sesquiterpene lactone content.

Polypeptides

The main polypeptides present in *E. alba* are cystine, glutamic acid, phenyl alanine, tyrosine and methionine.

Volatile oil

Heptadecane, 6,10,14-trimethyl-2-pentadecanone, n-hexadecanoic acid, pentadecane, eudesma-4(14),11-diene, phytol, octadec-9-enoic acid, 1,2-benzenedicarboxylic acid diisooctyl ester, (Z,Z)-9,12-octadecadienoic acid, (Z)-7,11-dimethyl-3-methylene-1,6,10-dodecatriene, (Z,Z,Z)-nt [83].

TRADITIONAL AND MODERN VIEW OF *E. ALBA* (BHRINGRAJA)

Ayurvedic view

E. alba is called as Bhringaraja in Ayurveda. It is one of the most valuable plants in Ayurveda. This magical herb is associated with many biological properties which are being used in many Ayurvedic practices for the treatment of various human ailments. It significantly works on Pitta dosha (Fire and water component of the body) and Vatta dosha (air and space components of the body). It acts as a rasayana. The extract obtained from the leaves is used as liver tonic, rejuvenative and beneficial for hair, eyes, edema, and phlegm [84]. It is mentioned in Dhanvantari Nighantu, Raj Nighantu, Kaiyyadev Nighantu for its use in pandu, shotha and kamala [85-87]. Rasapanchak of *E. alba* (Bhringaraja) as per Ayurveda is shown in Table 3.

Table 3: Rasapanchak of *Eclipta alba* (Bhringaraja) as per Ayurveda [88]

Sanskrit/English	Sanskrit/English
Virya/Potency	Ushna/Hot
Vipak/Metabolic property	Kattu/Pungent
Guna/Physical property	Laghu/Light, Ruksha/Rough
Guna/Taste	Kattu/Pungent, Tikat/Bitter

Properties and uses of *E. alba* (Bhringaraja) [89,90]

Sansthanic Karm-wahaya

It is topically used in cuts, wounds, and inflammation/swelling. It reduces headache when its oil is applied on head. It is used as eye/ear drop to reduce pain. It is also used in elephantiasis. It is very good for hair as it helps in growth, strengthening and blackening of hair. It is used in hair disorders such as premature greying, dandruff, hair fall, and baldness.

Abhyantar-nadi sansthan

It is used as pain killer.

Netra

It is beneficial for eyes.

Pachansansthan

It improves digestion and enhances appetite. It is good for liver. It helps in digestion of "ama" which means toxins and undigested food. It also acts as an anthelmintic. It is used in conditions such as anorexia, hepatomegaly, splenomegaly, jaundice, piles, and abdominal pain.

Rakatwahasnsthan/Twacha

It helps in blood augmentation. It used in treating anemia. It induces sweating and helps to fight against skin disorders. It used in treatment of leprosy, psoriasis, eczema, and urticaria.

Swasansansthan

It has mucolytic property. It is used in cough and cold conditions.

Mootrawahasnsthan

It has diuretic properties. It is used as a cure in burning micturition.

Prajnansansthan

It has aphrodisiac property.

Satmikaran

It enhances body strength.

Tapkram

Due to its sweat inducing and ama pachna property it acts as an antipyretic agent.

Some Ayurvedic formulations of *E. alba* (Bhringaraja) [91-94]

Bhringaraja is used in many Ayurvedic formulations. For example,

Bhringraja taila is used for Khalitya (Hair fall or loss of hair). Another formulation of yakrit plihantak churna is used as an hepatoprotective. An important Ayurvedic cosmetological formulation of *E. alba* along with *Vitex negundo*, *Sphaeranthus indicus* and *Carum copticum* is used as a rejuvenator in the treatment of Kayakalpa.

Folk view

E. alba (Bhringraja) is an important medicinal herb with rich history of its utilization in various folk systems around the world. It is used to treat numerous diseases. For instance, in Thailand, people use *E. alba* leaves against skin related problems and hair fall. They use stem to treat tuberculosis, asthma and as a blood tonic while *E. alba* roots exhibit antibacterial properties [95]. In Egypt, people administer plant juice to blacken the hair and beard [96]. In Philippines, people use this plant for hemoptysis and hematemesis. It is used in tea for treating sprains, furuncle and dermatitis. Dried for the herb is also use against dysentery and hematuria urine [97]. It is used as an emetic and purgative agent and in the treatment of cuts and wounds. People also use it in the treatment of jaundice in Eastern Nepal [98,99]. In many areas of India, leaf extract along with cow milk is used against the weakness of vision whereas leaves are also used to reduce wrinkles and heal wounds, palpitation, pimples, premature greying of hair, gingivitis, and alopecia. Whole plant is consumed in treating diarrhea and dysentery, fever, general weakness, jaundice, liver related problems, loss of appetite, and edema, whereas root extract is used against hemorrhoids [100]. In Himachal Pradesh India, people use leaf decoction of *E. alba* against headache. The extract obtained from the leaves is used against head lice, cold, and asthma [101]. *E. alba* is a common remedy for the upper respiratory infections and eye/ear infections in children. Bhringraj oil is used all over the India for good hair [102]. In Punjab, Pakistan leaves, roots, and flowers of *E. alba* are prescribed by herbal healers as a cure for liver disorders, hepatic, and spleen ailments. Leaves are used to enhance the digestion and appetite. The whole plant is used as hair tonic, whereas leaves are used to treat athlete's foot disease [103,104]. In Bahawalnagar District, Punjab, Pakistan, people use to chew *E. alba* leaves to improve their eye health and they treat hypertension using the extract of this plant [105]. In Bahawalpur, Pakistan, this plant is used as a blood purifier and hair tonic. It is also used against leprosy, itching, earache, jaundice, fevers and bleeding disorder, toothache and gum complaints, nausea, and vomiting [106]. In Odisha, India, leaves are used as an antibacterial agent [107]. The juice of *E. alba* is useful for the expulsion of worms in infants. Manipuri tribes use stem decoction of this plant against liver enlargement while use extracts of leaves in cough and fever. Toto tribe of India uses it as an antidote against scorpion sting. Some communities of Odisha use it as remedy for itching, conjunctivitis and other eye problems. Tribal Societies of Anaikatty Hills, Tamil Nadu, consumes this plant against antifertility, antidote to snake bite, fever, and headache. It is used against toothache, headache, gland swelling, and elephantiasis by people of Sagar tribes, Madhya Pradesh. Asthma, bronchitis, and leukoderma are treated by consumption this plant by tribal Societies of Saurashtra, Gujarat [108]. In Chandauli District of Uttar Pradesh, people use leaves of *E. alba* against dandruff along with seeds of *Foeniculum vulgare* [109]. In Javadhu Hills Tamil Nadu, *E. alba* leaves are used for treating diabetes [110]. Gujjars of Rajaji Tiger Reserve, Uttarakhand, treat liver problems with the leaves of this plant [111]. In some areas of Tamil Nadu, people use the paste made up of leaves of *E. alba* to prevent dandruff and to enhance the hair growth [112]. In some villages of Dakshin Dinajpur District, West Bengal, people use leaf and seed of this plant to treat problems related to stomach and liver, inflammation, digestion, and use it as a hair tonic [113]. In West Nimar district, Madhya Pradesh, people use oil extracted from the seeds of *E. alba* to enhance the hair growth [114]. In areas around the Dandeli Wild Life Sanctuary, people treat warts and leprosy by applying the *E. alba* leaf juice [115]. People of Warangal district of Andhra Pradesh, use this plant to avoid hair fall and provide strength to hair and to increase the appetite [116]. The people of Nandurbar tribe of Maharashtra use this plant as a remedy for menorrhagia [117]. The tribal people of Peth and Trimbakeshwar of Nashik District, Maharashtra, the leaves of *E. alba* are used for treating the injuries caused by mud [118]. In Chennai,

people use whole plant as a liver tonic. Leaf juice along with honey is used to treat cough and watery nose in children. Furthermore, the leaves juice is used for hair growth [119]. In Karnataka, this plant is used as an antidote for scorpion bite while the paste made up of this plant is used to blacken and strengthen the hair [120]. In Chittagong Hill Tracts, Bangladesh, people use paste made up of stem, and leaves of *E. alba* against skin problems [121]. In Koikuri, Dinajpur, this plant is used to heal wounds and as a remedy for skin diseases [122]. In West Singhbhum districts of Jharkhand, people eat *E. alba* leaves used as a leafy vegetable as a cure to anemia [123]. The plant is administered as nasal or eye drop to get relief from pain and chronic headache in Bayelsa state of Nigeria [124].

Modern view

In the modern era people are showing great interest in herbal medicines because these have several advantages over the modern synthetic drugs. The demand of herbal drugs in the market is increasing rapidly due to which the chances of their adulteration/contamination have also increased [125,126]. There are several factors which promote the degradation of the herbal products such as misidentification of species or plant parts, intentional adulteration, and contamination. Due to all these factors the quality and safety of herbal drugs is in question [127]. There are reported cases of misidentification of herbal plants that might happen due to similarities of morphology of the plants and sometimes due to conflict in the common as well scientific names of the plants. This is one of the primary reasons that lead to the degrading of the herbal products [128]. Another major factor of degradation of herbal products is intentional adulteration which is done in many ways such as by inducing either orthodox drugs or by substituting products of inferior quality or by introducing foreign particles or contaminants like sand, metals, soil etc. The main purpose behind intentional adulteration is to derive maximum profit [129-131]. Most commonly used contaminants in herbal products are heavy metals like mercury, arsenic, and lead, cadmium, copper and thallium. Other contaminants used are pesticides, microbes, and mycotoxins [132-138]. The most common forms of herbal drugs available in the market are powders, capsules, and extracts. Adulterants are often induced before processing stage or during the processing of herbal drugs. Proper quality analysis standardization at these stages are required to avoid health risks [139-141]. Standardization of herbal drugs confirms the accurate quantity, quality and associated therapeutic properties with dosage [142]. Techniques like standard DNA barcode have proved to be important in detecting species misidentification [143].

PHARMACOLOGICAL AND THERAPEUTIC USES OF *E. ALBA* (BHRINGRAJA)

E. alba (Bhringraja) has variety of phytochemical constituents present in it which exhibit various therapeutic properties. Some of its reported therapeutic uses are summarized below.

Hepatoprotectivity

Singh *et al.* conducted a study on rats and mice models in which lung injury was induced artificially by carbon tetrachloride. It was found that alcoholic extract of *E. alba* (Bhringraja) exhibit hepatoprotective activity at a dosage of 62.5–500.0 mg/kg p.o. Extract restored all the changes induced by carbon tetrachloride [144]. 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 [145]. This activity was also investigated by Ahirwar and Saxena, on albino rat models. Models were artificially induced with hepatotoxicity by carbon tetrachloride. It was found that isolated fraction of *E. alba* had significant hepatoprotective potential at dosage of 200 mg/kg body weight. The protein levels were

restored after the treatment with *E. alba* extract. [146]. This activity was also supported by a comparative study conducted by Kumar *et al.*, on albino rat models. In this study paracetamol was used to induce hepatotoxicity in the models. Alcoholic and aqueous extracts were comparatively investigated. It was found that alcoholic extract of *E. alba* has more potent hepatoprotective activity [147]. Indhuleka 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 [148].

Hair growth

Begum *et al.* conducted a study on nude mice to evaluate the hair growth promoting activity of *E. alba*. 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 [42]. Another study conducted by Begum *et al.*, supported the use of *E. alba* for hair growth. The study was conducted on nude mice models which were genetically suffering from hair loss due to abnormal keratinization. It was revealed from the study that topical application of methanolic extract of *E. alba* had significant impact on the hair growth of mice models. It was observed that hair follicle number had increased after the treatment which shows that *E. alba* is a brilliant hair growth promoter [149].

Anti-cancer

An *in vitro* study was conducted by Chaudhary *et al.*, to evaluate the anti-cancer potential of *E. alba*. 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 [150].

Antibacterial

An *in vitro* study conducted by Gurrupu and Mamidala, on *Escherichia coli*, *Pseudomonas aeruginosa*, *Shigella boydii*, *Staphylococcus aureus*, and *Streptococcus faecalis* demonstrated that *E. alba* can be used as a good antimicrobial agent. It was found that alkaloids extracted from *E. alba* has inhibitory against these bacterial strains [151]. Karthikumar *et al.* evaluated the anti-bacterial and anti-oxidant potential of *E. alba* on bacterail species *E. coli*, *Klebsiella pneumoniae*, *Shigella dysenteriae*, *Salmonella typhi*, *P. aeruginosa*, *Bacillus subtilis*, and *S. aureus*. Ethanol and ethyl acetate extracts were found to be significant antibacterial agents. Ferric thiocyanate method was employed for the evaluation of anti-oxidant potential. Hexane, ethyl acetate, ethanol, and water extract showed anti-oxidant activity at various concentrations (50, 100, 250, and 500 in µg/mL) while aqueous extract showed significantly less activity than the other extracts [152].

Anti-viral

A study conducted by Manvar *et al.*, against Hepatitis C virus (HCV) showed that *E. alba* extract had significant inhibitory actions against RNA dependent RNA polymerase activity of HCV replicas *in vitro* whereas it caused inhibition of HCV replication in cell-culture system which showed its anti-viral potential [153].

Memory enhancer

Banji *et al.* examined the memory enhancing activity of *E. alba*. The suspension of *E. alba* extract in distilled water was administered to rat models. They evaluated the transfer latency of models on an elevated plus maze. The study revealed that *E. alba* is associated with memory enhancing activities [154].

Immunomodulatory

Syed *et al.* evaluated the immunomodulatory behavior of *E. alba* in an *in-vitro* study. It was found that coumestans such as Wedelolactone and demethylwedelolactone had inhibitory actions against trypsin which supports its use as an immunomodulatory agent [155].

Anti-stress

Chanu *et al.* studied anti-stress property of *E. alba* in Labeo calbasu fingerlings in stress was induced by acid. It was observed that ethanolic extract of the plant exhibited anti-stress activity by restoring the levels of stress hormones – serum cortisol, glucose, alanine amino transferase, aspartate amino transferase – and enzymes – lactate dehydrogenase, malate dehydrogenase, ATPase, superoxide dismutase, and catalase which showed its anti-stress activity [156].

CONCLUSION

E. alba (Bhringraj) is a wonder herb which is most commonly used in traditional systems of medicine for treating numerous human ailments. It is widely used for its extra-ordinary property of enhancing the hair growth and provides strength to hair. It possesses wide range of phytochemical constituents such as coumestans, saponins, and alkaloids which exhibit significant biological properties such as hepatoprotectivity, antibacterial, anti-viral, anti-stress, and immunomodulatory. It is used in almost each culture and tribe of the world. It is also used as leafy vegetable in some cultures. In Ayurveda, it is used against diseases such as elephantiasis, anorexia, leprosy, eczema, psoriasis, jaundice, piles, cough, col, and splenomegaly. This small medicinal herb with multiple therapeutic applications can be a promising and reliable source of new drugs in future.

AUTHOR CONTRIBUTION

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors.

Dr. Gitika Chaudhary drafted the article and contributed in writing Ayurvedic view of the article. Dr. Hemlata Kaurav contributed in drafting and writing pharmacological portion of plant.

Isha Kumari contributed in data collection and writing the paper.

CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

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