

Evaluating the Antioxidant and Anticataract Effects of *Eclipta alba*: A Potential Herbal Alternative for Cataract Management

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ABSTRACT

Cataract remains a leading cause of blindness worldwide, predominantly affecting the aging population. Although surgical intervention is effective, it remains costly and inaccessible in many developing regions, underscoring the need for alternative preventive strategies. The present study investigated the antioxidant and anticataract potential of *Eclipta alba* (L.) Hassk, a medicinal plant widely used in Ayurveda for its Chakshushya (eye-protective) properties. Hydroalcoholic extract of *Eclipta alba* was prepared by Soxhlet extraction and subjected to preliminary phytochemical screening, which confirmed the presence of phenolics, flavonoids, tannins, and ascorbic acid. In vitro anticataract activity was evaluated using D-galactose-induced cataract models in rat lenses. The degree of lens opacity was graded and compared with standard Vitamin E treatment. The extract demonstrated a dose-dependent protective effect against galactose-induced opacity, with higher concentrations showing greater restoration of lens transparency. Antioxidant activity was further validated using the DPPH free radical scavenging assay, where the extract exhibited significant radical neutralization comparable to standard ascorbic acid. These findings suggest that *Eclipta alba* extract, owing to its strong antioxidant potential, may delay cataract progression and serve as a natural therapeutic agent. Further in vivo studies and clinical validations are warranted to establish its pharmacological relevance and safety for ophthalmic use.

Keywords: Cataract, *Eclipta alba*, Antioxidant, D-galactose, Lens opacity, Herbal therapeutics

I. INTRODUCTION

A cataract is a clouding or opacification of the eye's normally clear lens or its capsule, which is a translucent membrane that surrounds the lens and

prevents light from passing through it to the retina.

(1) Although it primarily affects the elderly, this crippling illness can also affect newborns, adults, and older persons. It can vary in severity and be bilateral. Early on, the illness process advances gradually without having a major impact on day-to-day activities. However, the cataract will gradually evolve, becoming totally opaque to light and hindering with daily activities, particularly during the fourth or fifth decade. (2) One of the leading causes of blindness in the globe is cataracts. Refractive glasses are the sole treatment option available at an early stage. Surgery is a very effective alternative if cataracts become severe enough to interfere with daily activities (3).

It has been believed that cataract is caused by aberrant protein aggregation in the lens. For humans to see clearly, an external image must be focused onto the retina of the eye by the lens. The lens orchestrates the interactions of highly concentrated structural proteins, known as the crystallin family, to preserve clarity. Each of the many subunits that make up lens crystallins has certain functional characteristics. On size exclusion chromatography (SEC), polymeric α -crystallin, dimeric or tetrameric β -crystallin, and monomeric γ -crystallin exhibit an increasing order of elution.

The existence of post-translational alterations of crystallin proteins is another factor contributing to changes in the aged lens's elution profile. Lens crystallins may experience structural alterations linked to environmental stress because our eyes are constantly exposed to the outside world. Because lens fiber cells lack turnover mechanisms, or a way to repair damaged proteins, post-translational alterations build up over the course of a person's lifetime. (4)

Cataracts are the second most common eye condition, accounting for 8 million disability-

adjusted life years (DALYs), after near vision loss (9.8 million), according to the 2017 Global Burden of condition (GBD) research (6). Between 1990 and 2019, the number of DALYs caused by cataracts rose by 91.2% worldwide. Age, female sex, and worse socioeconomic level were all linked to a larger cataract burden, according to a prior study (5).

Although synthetic lenses can be used to repair vision loss caused by cataracts, cataract surgery is an expensive process. Many cataract sufferers in developing nations are unable to have their vision restored because of a lack of medical resources or financial considerations. Finding a safe substance that can lower the incidence of cataracts or postpone their start is therefore a crucial first step in the development of novel cataract treatments. Numerous substances have been assessed for their possible ability to prevent cataract development, with an emphasis on plant-based active ingredients. A wealth of frequently structurally complex substances with intriguing biological roles can be found in phytoconstituents. They have long been a significant source of pharmacologically active substances, either by themselves or through their derivatives. (6)

Because of its Chakshushya qualities, Bhringaraja (*Eclipta alba* (L.) Hassk), a member of the Asteraceae family, is utilized in many Kalpas to treat eye conditions. It is also used extensively in Ayurveda to treat liver disease, anemia, eye conditions, and hair issues. It possesses antiviral, antifungal, antibacterial, analgesic, immunomodulatory, neuroprotective, and antihepatotoxic qualities. It contains a variety of chemical components, such as flavonoids, alkaloids, and coumarins. It is used to treat a variety of eye conditions because of these qualities. Similar to other body parts, the eye is also composed of Panchamahabhutas. Along with other herbs, *Eclipta alba* (L.) Hassk can be used in a variety of formulations with suitable concentrations and in a variety of disorders with ocular signs (7).

The extract from *Eclipta alba* (L.) Hassk exhibits significant levels of ascorbic acid, flavonoids, tannins, and phenolics. *Eclipta alba* (L.) Hassk's hydroalcoholic extract demonstrated strong antioxidant properties in a dose-dependent manner and efficiently scavenged free radicals at all doses. The extract from *Eclipta alba* (L.) Hassk has strong antioxidant qualities. (8).

II. MATERIALS AND METHODS

2.1. PLANT DESCRIPTION

Throughout India, *Eclipta alba* (L.) Hassk, a member of the Asteraceae family, is a common weed that can grow up to 1800 meters in the Himalayas. It can also be found in pasture lands, roadsides in Chota Nagpur, all districts of Bihar and Orissa, Punjab, Western India, and South India. In the Eastern herbal medicine and holistic health systems of Ayurveda and Unani, the plant *Eclipta alba* Hassk plays a significant role (9).

2.2. TRADITIONAL USES

Acidity, Alopecia, Asthma, Body pain, Bronchitis, Burns, Constipation, Diarrhea, High blood pressure, Weakness of vision, Jaundice, Liver enlargement, Loss of appetite, Oedema, Palpitation, Pimples, Premature graying of hair, Skin diseases, Spleen enlargement, Anti-bacterial, Anti-oxidant, Anti-cancer, etc⁽¹⁰⁻¹⁵⁾

2.3. COLLECTION, IDENTIFICATION, AND AUTHENTICATION

The leaves of *Eclipta alba* (L.) were collected from Malappuram district in January 2025. About 10.44kg of leaves were collected. The plant material was authenticated by Mr. Rojimon P. Thomas, Professor & HOD, Department of Botany, CMS College, Kottayam, based on microcharacters and by direct comparison with the herbarium specimens available at the herbarium of the Botany Department. The specimen was deposited in the college herbarium for future reference.

2.4. EXTRACTION

The initial stage in separating the desired natural products from the basic ingredients is extraction. According to the extraction principle, extraction techniques include pressing, sublimation, solvent extraction, and distillation. The approach that is most frequently employed is solvent extraction. The following steps are involved in the extraction of natural products: the solvent enters the solid matrix, the solute penetrates the matrix, dissolves in the solvent, diffuses out of the solid matrix, and the extracted solutes are gathered. The extraction process will be facilitated by any element that increases the diffusivity and solubility in the aforementioned processes. The extraction efficiency will be influenced by the solvent's characteristics, the raw materials' particle size, the solvent-to-solid ratio, the extraction temperature, and the extraction time. ⁽¹⁶⁻¹⁹⁾

2.5. SOXHLET EXTRACTION

The sample is put in a thimble or porous bag within the Soxhlet apparatus chamber. The

extraction solvent is the alcohol in the round-bottom flask, and the heated vapor condenses in the condenser. Contact is used to extract the crude sample from the thimble after the condensed extractant drips into it. The liquid contents of the chamber syphon into the RB flask when the liquid level in the chamber reaches the top of the syphon tube. This is a continuous 36-cycle process. The percentage yield was determined by practical yield / theoretical yield x 100

2.6. PHYTOCHEMICAL SCREENING

Preliminary phytochemical screening using standard procedures described by Harborne and Kujur et al. was performed on HIE to ascertain the presence of phytochemicals.

2.7. DRUGS AND CHEMICALS

DPPH reagent, ethanol, sample, ascorbic acid, Optional buffer, UV-Visible spectrophotometer, D-galactose, Vitamin E, Sodium CMC.

2.8. IN VITRO STUDY

2.8.1 CATARACT STUDY IN RAT LENS

For a PhD study at the college, the rat lenses were obtained from animals that had been previously euthanized. A Falcon plastic culture plate (24-well) with 2 milliliters of Dulbecco's Modified Eagle's media supplemented with streptomycin and penicillin was used to hold each isolated lens. For two hours, crystalline lenses were incubated at 37°C with 90% moisture, 95% air, and 5% CO₂ gas. For the next in vitro group, only transparent lenses were utilized; damaged lenses that formed artificial opacities were thrown away. Incubated for 24 hours after grouping.

Degree of opacity is graded as follows: Clear lens with no vacuole scored 0, Clear lens with less than 3 vacuoles scored 1, Clear lens with more than 3 vacuoles scored 2, Vacuoles covering

the entire surface of the lens scored 3, Partial lens opacity scored 4, Total lens opacity scored 5.

2.8.2 EFFECT OF D-GALACTOSE-INDUCED CATARACT IN HEEA

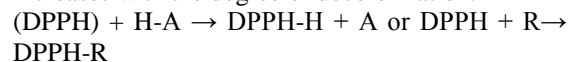
(Hydro alcoholic Extract of Eclipta alba)

The lenses were divided into 7 groups. Normal group treated with DMEM (Dulbecco's Modified Eagle Medium) solution, vehicle group treated with DMEM and DMSO 0.5ml/Induced group treated with 30Mm D-galactose.

Only three treatment groups, along with D-galactose in a concentration 30Mm and plant extract concentrations of 25µg, 50µg, and 100µg. In the standard group, Vitamin E is 50µg.

2.8.3 DPPH (2,2-DIPHENYL-1-PICRYLHYDRAZYL) FREE RADICAL SCAVENGING ASSAY

The DPPH test technique is based on the stable free radical DPPH. The odd-electron free radical DPPH has a maximum absorption wavelength of 517 nm, or purple. The stable free radical is reduced to the DPPH-H when antioxidants react with DPPH, and it is paired off when a hydrogen donor is present (for example, an antioxidant that scavenges free radicals). The absorbances from the DPPH are lowered as a result. Radiation to the DPPH-H form causes decolorization (yellow) based on the number of electrons absorbed. The ability to decrease increases with the degree of decolorization.



(Purple) (Yellow)

III. RESULTS AND DISCUSSION

3.1 IN VITRO STUDY

3.1.2. CATARACT STUDY IN RAT LENS

After incubating the lens for 24 hours, the different group lenses were analyzed through a wire mesh to determine the transparency of lens.

Fig 1: Morphological and photographic evaluation of different cataract treatment groups

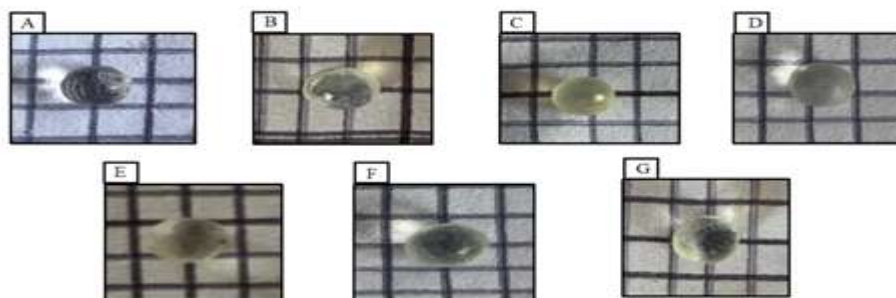


Table 10: Grading of opacity

SAMPLE	GRADING OF OPACITY
A) Normal Group	0
B) Vehicle Group	+
C) Inducing Group	+++
D) Test 1	+++
E) Test 2	++
F) Test 3	+
G) Standard Group	+

3.1.3 DPPH RADICAL SCAVENGING ACTIVITY

Fig. 5. DPPH radical scavenging assay

DPPH SCAVENGING ASSAY

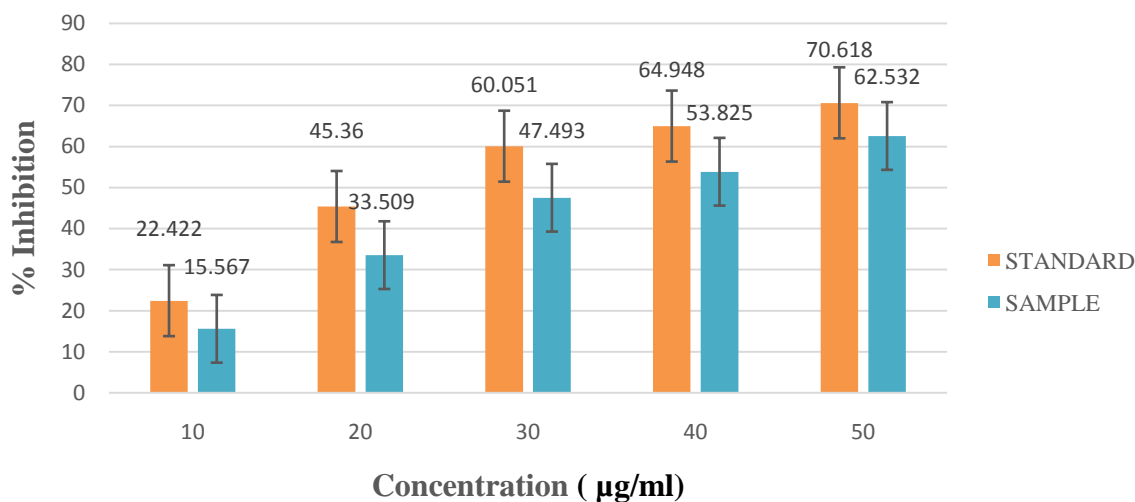


Fig 2:DPPH radical scavenging assay

This result showed that the plant extract contains antioxidants when compared with the standard. As the concentration increases % the percentage inhibition increases.

IV. CONCLUSION

The hydroalcoholic extract of Eclipta alba exerted potent anticataract activity by reducing lens opacity and demonstrating strong free radical

scavenging effects. The phytochemicals present in the extract play a key role in mitigating oxidative stress, which is a central mechanism in cataractogenesis. Considering the socioeconomic impact of cataract and limited accessibility to surgical treatment in developing regions, Eclipta alba offers a promising phytotherapeutic alternative for delaying cataract onset and progression. Future research, including in vivo validation and clinical

evaluation, is essential to establish its therapeutic efficacy and safety for ocular use.

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