

A Comprehensive Review of Antioxidant Activity of Bhringraj (*Eclipta alba*): An Indian Ancient Herb

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Abstract

Eclipta alba, commonly known as Bhringraj, is an herb widely utilized in traditional Indian medicine (Ayurveda) for its diverse therapeutic properties, particularly in promoting hair growth, enhancing liver function, and improving overall health. Among its numerous biological activities, the plant's antioxidant potential has garnered significant interest in modern phytochemistry. Oxidative stress, caused by an imbalance between reactive oxygen species (ROS) and the body's antioxidant defenses, is a key contributor to the pathogenesis of various chronic diseases, including cancer, cardiovascular diseases, neurodegenerative disorders, and aging. Antioxidants, which neutralize these harmful free radicals, are crucial in mitigating oxidative damage and maintaining cellular health. This review provides a comprehensive analysis of the antioxidant activity of Bhringraj (*Eclipta alba*), summarizing the plant's chemical constituents, its mechanisms of action, and the scientific evidence supporting its therapeutic potential. The plant contains a variety of bioactive compounds, including alkaloids, flavonoids, terpenoids, and coumarins, all of which contribute to its protective properties.

Keywords: Antioxidant, Bhringraj, ayurvedic medicine, traditional medicine, *Eclipta alba*

INTRODUCTION

Bhringraj, or *Eclipta alba*, has long been hailed as an important herb in traditional Indian medicine, specifically within the ancient Ayurvedic system (Figure 1). Known for its diverse therapeutic uses, Bhringraj is also gaining recognition in modern phytochemistry for its medicinal properties, particularly its antioxidant activity. Antioxidants are molecules that neutralize harmful free radicals in the body, and Bhringraj's antioxidant potential is of significant interest for health promotion and disease prevention [1].

Eclipta alba (Bhringraj) has been an integral part of traditional Indian medicine, primarily used in Ayurvedic practices for its therapeutic properties. Over time, modern research has validated many of these ancient claims, particularly regarding the plant's antioxidant properties. Oxidative stress, the imbalance between reactive oxygen species (ROS) and the body's natural antioxidant defense systems,

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has been implicated in a wide range of diseases, such as cancer, cardiovascular diseases, neurodegenerative disorders, diabetes, and aging. The need for effective antioxidants has led to a growing interest in natural compounds with antioxidant activity, with Bhringraj emerging as a promising candidate [2, 3].

This review explores the antioxidant activity of Bhringraj, focusing on its bioactive compounds, mechanisms of action, and the scientific evidence supporting its medicinal potential.

While its benefits in Ayurvedic medicine have been well established, the plant's modern pharmacological applications – especially in

antioxidant therapy—are still under investigation. Understanding the scientific basis of Bhringraj's antioxidant properties is key to harnessing its full potential in modern medicine.



Figure 1. Bhringraj.

OXIDATIVE STRESS AND ANTIOXIDANTS

Damage to cellular structures, proteins, lipids, and DNA results from oxidative stress, a state in which the body's capacity to neutralize reactive oxygen species (ROS) with antioxidants is out of balance. This damage is a contributing factor to various chronic conditions like cardiovascular diseases, diabetes, cancer, neurodegenerative disorders (e.g., Alzheimer's and Parkinson's), and even aging [4].

Antioxidants counteract oxidative stress by scavenging ROS, preventing harmful effects. Natural antioxidants, such as those found in plant-based products, are of increasing interest due to their availability, safety, and efficacy. As such, Bhringraj, with its rich phytochemical composition, is an exciting candidate for the exploration of antioxidant mechanisms.

Objective of the Review

The aim of this review is to provide a comprehensive analysis of the antioxidant properties of Bhringraj (*Eclipta alba*), summarizing the scientific research on its bioactive compounds, biological activities, and therapeutic potential. Through an in-depth examination of traditional and contemporary studies, this article will highlight the molecular mechanisms by which Bhringraj exerts its antioxidant effects.

Botanical Overview of *Eclipta alba* (Bhringraj) Taxonomy and Nomenclature

Eclipta alba, another name for Bhringraj, belongs to the broad family of flowering plants called the Asteraceae. The plant is known by several names across various cultures. In Ayurveda, it is often called "Bhringraj" or "Kesha raj" (king of hair) due to its reputed ability to enhance hair growth and health. Other common names for *Eclipta alba* include False Daisy, Bhringaraj, and Kayam. Its scientific classification is as follows [5]:

Kingdom

- *Plantae Phylum:* Angiosperms.
- *Class:* Eudicots.
- *Order:* Asterales.
- *Family:* Asteraceae.
- *Genus:* *Eclipta*.
- *Species:* *Eclipta alba*.

MORPHOLOGICAL DESCRIPTION

Eclipta alba is a small herbaceous plant with simple, lanceolate leaves that are about 2–4 cm in length. The plant, which grows between 30 and 60 cm tall, has tiny yellow blooms with a clear yellow center that are white with occasional purple undertones. The plant's roots are fibrous and branched, typically growing in moist environments, and it often thrives in tropical and subtropical climates.

The plant grows prolifically in areas with high humidity, particularly in India, Southeast Asia, and tropical regions worldwide. It is found in fields, roadsides, and as a common weed in many agricultural areas [6, 7].

Habitat and Distribution

Bhringraj is native to India but can be found in many parts of Asia, including China, Sri Lanka, and Southeast Asia. It grows well in moist, fertile soil, often near water sources, such as ponds or wetlands. Because of its capacity to adapt to different climatic conditions, the species is widely distributed and is often seen in tropical and subtropical areas.

Traditional Uses of *Eclipta alba* (Bhringraj)

Bhringraj has been used for thousands of years in traditional medicine systems, particularly Ayurveda, where it is considered a “Ramayana” or rejuvenating herb. The plant has been valued for its wide range of health benefits, including its ability to improve liver function, enhance hair growth, and promote longevity.

Ayurvedic Medicine

In Ayurveda, Bhringraj is considered a powerful herb for rejuvenation and health maintenance. It is said to balance the Pitta dosha and is used for promoting liver detoxification, improving hair growth, and enhancing skin health. Some of the primary Ayurvedic uses of Bhringraj include,

- **Hair Health:** Bhringraj is traditionally used as an herbal oil for treating hair loss, dandruff, and premature greying. It is thought to strengthen hair roots, stimulate hair follicles, and encourage the growth of thick, healthy hair.
- **Liver Function:** Bhringraj is used as a hepatoprotective agent, aiding in the detoxification of the liver and supporting its function. It is thought to support bile secretion, improve digestion, and alleviate symptoms of liver diseases, such as jaundice and hepatitis.
- **Skin Health:** The plant works well for dermatitis, acne, and eczema because of its antibacterial and anti-inflammatory qualities.

Other Ethnomedicinal Uses

Beyond Ayurvedic traditions, Bhringraj has also been used in other ancient medical systems. In Traditional Chinese Medicine (TCM), it is employed for its liver-cleansing properties. In folk medicine across Southeast Asia, Bhringraj is used to treat conditions, such as diarrhea, fever, and as a general tonic to boost vitality. Its use as a hair tonic in India is especially widespread, with the plant being an essential ingredient in many natural hair care formulations.

Chemical Constituents of *Eclipta alba*

One of the reasons Bhringraj is valued in herbal medicine is the presence of various bioactive compounds that contribute to its therapeutic effects. These compounds possess significant antioxidant, anti-inflammatory, and hepatoprotective properties.

PHYTOCHEMICALS AND BIOACTIVE COMPOUNDS

Bhringraj contains several bioactive compounds, including:

- **Alkaloids:** Compounds, such as *Ecliptalbine* are present in Bhringraj. Plants having therapeutic qualities must include alkaloids, flavonoids, terpenoids, and tannins. Flavonoids, including Wedelolactone, can regulate cellular oxidative stress and have potent anti-inflammatory and

antioxidant qualities. Terpenoids shield cellular structures and lessen oxidative damage. Both tannins and saponins contribute to the plant's anti-inflammatory and antioxidant activities, while saponins increase the bioavailability of other bioactive components. Coumarins, such as Scopoletin in Bhoringraj, have anticancer and antioxidant qualities.

Extraction Methods

To isolate these beneficial compounds, several extraction methods are employed (Figure 2).

- *Ethanol Extraction:* Alcoholic solvents like ethanol are commonly used to extract flavonoids, alkaloids, and other bioactive compounds from Bhoringraj.
- *Water Extraction:* Water-based extracts are also utilized, especially for therapeutic formulations, due to the plant's solubility in aqueous solutions.
- *Cold Pressing:* For hair oils and topical applications, cold pressing is used to extract essential oils from the leaves and flowers of Bhoringraj.



Figure 2. Extraction of Bhoringraj.

MECHANISMS OF ANTIOXIDANT ACTIVITY

Bhoringraj's antioxidant activity is multifaceted, involving various mechanisms that prevent oxidative stress and reduce the damage caused by free radicals.

Free Radical Scavenging

The bioactive compounds in Bhoringraj act as free radical scavengers, neutralizing harmful ROS in the body. Flavonoids and coumarins are effective in scavenging ROS like superoxide anion and hydroxyl radicals, which are known to cause cellular damage and contribute to diseases like cancer and aging [8].

Enzyme Modulation

Bhoringraj has been shown to influence antioxidant enzymes in the body. Protecting cells from oxidative damage requires the action of enzymes, such as SOD, CAT, and GRX.

Bhoringraj stimulates the activity of these enzymes, enhancing the body's natural defense mechanisms against oxidative stress.

Inhibition of Lipid Peroxidation

The process of lipid deterioration known as "lipid peroxidation" can lead to the production of toxic substances that can injure cell membranes.

Bhoringraj's antioxidants inhibit lipid peroxidation, thereby protecting cellular membranes from oxidative damage [9].

GENE EXPRESSION REGULATION

Some studies suggest that Bhoringraj's bioactive compounds can regulate the expression of genes involved in oxidative stress response, such as Nrf2 (nuclear factor erythroid 2-related factor 2), which plays a crucial role in cellular protection against oxidative stress. By activating Nrf2, Bhoringraj may enhance the body's capacity to combat free radical-induced damage.

Health Benefits Associated with Antioxidant Activity of Bhoringraj (*Eclipta alba*)

Bhoringraj (*Eclipta alba*) is renowned for its wide range of therapeutic benefits in traditional medicine, especially in Ayurveda, where it is used for rejuvenation, liver health, and hair restoration. The plant's antioxidant activity is one of the primary mechanisms by which it exerts its beneficial effects, helping to combat oxidative stress that contributes to a variety of diseases. Here, we explore in detail the health benefits of Bhoringraj, specifically related to its antioxidant properties, which have been supported by both traditional use and modern scientific research.

Hepatoprotective Benefits

One of the most well-known uses of Bhoringraj in traditional medicine is its hepatoprotective (liver-protecting) effects. The liver is a crucial organ in detoxification, and it is highly susceptible to damage caused by oxidative stress and toxic substances. The antioxidant activity of Bhoringraj plays a pivotal role in mitigating this damage and protecting liver cells from oxidative injury [10].

MECHANISMS OF LIVER PROTECTION

- **Reduction in ROS Generation:** Studies have shown that Bhoringraj can reduce the accumulation of reactive oxygen species (ROS) in liver cells. By scavenging free radicals, Bhoringraj prevents oxidative damage to liver cells and hepatocytes. Bhoringraj increases the activity of liver antioxidant enzymes, such as GRX, SOD, and CAT, which prevent liver damage, lessen oxidative stress, and neutralize dangerous free radicals (Figure 3).
- **Inhibition of Lipid Peroxidation:** One of the consequences of oxidative stress is lipid peroxidation, which leads to the formation of harmful malondialdehyde (MDA), a marker of oxidative damage. Bhoringraj inhibits lipid peroxidation, thus protecting liver cell membranes and maintaining cellular function [11].
- **Regeneration of Liver Cells:** Bhoringraj has been shown to stimulate the regeneration of liver tissue, aiding in the recovery of liver function after injury or exposure to toxic substances like alcohol, chemical toxins, and viruses. Its efficacy in preventing cirrhosis and hepatitis has been demonstrated by studies.



Figure 3. Health Benefits of Bhoringraj.

Scientific Studies Supporting Hepatoprotection

A study by demonstrated that Bhoringraj extract protected rats from carbon tetrachloride (CCl₄)-induced liver toxicity by restoring the activity of liver enzymes and antioxidant markers.

Another study by reported that Bhoringraj reduced serum bilirubin levels, a marker for liver function, in patients with jaundice, confirming its effectiveness in liver disease management.

Thus, the antioxidant activity of Bhoringraj is essential in protecting the liver from oxidative damage, reducing inflammation, and promoting liver regeneration.

Cultivation of Bhoringraj (*Eclipta alba*)

Bhoringraj (*Eclipta alba*) is a versatile and hardy herb, known for its medicinal properties, particularly its use in Ayurveda for hair care, liver health, and overall rejuvenation. Cultivating Bhoringraj can be done with minimal resources (Figure 4), as the plant grows in a variety of environments ranging from wetlands to dry areas. Below is a detailed guide on the cultivation of Bhoringraj, including the ideal environmental conditions, propagation methods, soil requirements, and care needed to successfully grow the plant.



Figure 4. Cultivation of Bhoringraj.

Ideal Growing Conditions for Bhoringraj

Bhoringraj is a tropical and subtropical herb that thrives in a range of climates. Understanding the plant's environmental preferences is key to successful cultivation.

Climate

Temperature

Although Bhoringraj grows best in warm, humid conditions with temperatures between 25 and 35°C (77 and 95°F), it is not suited for temperate regions with frigid winters since it is susceptible to frost. It favors rainfall that is between 1,200 and 2,500 mm per year, which is moderate to high.

However, it can also tolerate dry conditions during brief periods, though it thrives with regular water.

Humidity

Bhringraj prefers high humid environments, which is typical of tropical regions, though it can also grow in semi-arid conditions.

Light

Bhringraj requires full sun to grow optimally, making it ideal for areas with abundant sunlight. Although it can withstand some shade, the plant's ability to grow and produce may be limited.

Soil Requirements

Bhringraj is relatively undemanding when it comes to soil types, but certain characteristics improve growth and yield.

Soil Type

- *Soil Texture:* The plant grows best in well-drained, loamy soils. It can tolerate clayey soils but prefers sandy loam or a slightly acidic to neutral pH range (pH 6.0 to 7.5) [12].
- *Soil Fertility:* While Bhringraj can thrive in less fertile soils, it benefits from rich, organic matter. Fertilizing with compost or well-rotted manure can boost growth and yield.
- *Water Retention:* The soil should have good water retention without becoming waterlogged, as standing water can damage the roots. A loose, well-aerated soil is ideal to support root development and ensure adequate drainage [13].

pH Range

Bhringraj grows well on soil that is slightly acidic to neutral (pH 6.0 to 7.5); alkaline soil needs sulfur or organic matter as a supplement. Vegetative propagation is the best method for ensuring healthy development, however seeds can also be used.

SEED PROPAGATION

- *Seed Collection:* Bhringraj produces small, brown seeds, which are generally harvested once the flowers are fully mature. The plant flowers in the late rainy season, and the seeds are typically ready for collection in late autumn or early winter [14].
- *Sowing Time:* The best time to sow Bhringraj seeds is during the beginning of the rainy season (monsoon), which ensures that the plant receives adequate moisture for germination.

Sowing Procedure

Loosen the soil, remove weeds, and evenly distribute the seeds to create a Bhringraj seedbed. Apply a thin layer of mulch or dirt. After seeding, lightly water encourage germination. Under ideal circumstances, germination takes 7–14 days, so keep the soil damp but not soggy [15, 16].

Vegetative Propagation (Cuttings)

- *Selecting Cuttings:* Select robust, non-flowering stems that are 10–15 cm long and have several nodes where leaves appear from mature Bhringraj plants.
- *Preparation:* Trim the cuttings to ensure they are free from any diseases or pests.
- *Rooting:* To propagate by cuttings, place the cut ends in water or directly in a soil bed rich in organic matter. You can use rooting hormone to improve the chances of successful rooting.
- *Transplanting:* Cuttings can be moved into the field or containers for additional growth after two to three weeks of development [17].

Planting and Spacing

Whether you are growing Bhringraj from seed or cuttings, proper planting and spacing are essential to maximize plant growth and yield.

Spacing

- *Seed Sowing:* Bhringraj may be cultivated on raised beds or containers in small areas, and seeds

should be spaced 30 cm apart in rows to allow for enough air circulation and development.

- *Transplanting*: To get the best root system and leaf development without crowding, plant seedlings or rooted cuttings 30 to 45 cm apart.
- *Seeds*: Plant seeds at a shallow depth of about 0.5 to 1 cm. Cover lightly with soil or mulch.
- *Cuttings*: Insert cuttings into the soil at a depth of about 3–5 cm, ensuring at least one or two nodes are underground to promote root development.

Irrigation and Watering

Bhingraj is a water-loving plant but is also drought-tolerant once established.

Watering Requirements

- *During Germination*: Keep the soil consistently wet, but refrain from waterlogging throughout the germination phase, to guarantee the effective establishment of seedlings [18].
- *After Establishment*: To avoid root rot, bhringraj plants need to be watered often, particularly during dry spells. Water when the topsoil feels dry to the touch to prevent over-irrigation and to guarantee proper drainage.
- *Rainwater*: Additional watering is essential during the dry season in arid places, while it may not be necessary for growing in areas with regular rainfall.

Fertilization and Soil Enrichment

Bhingraj is not particularly demanding in terms of soil nutrients but benefits from periodic fertilization, especially in poor or depleted soils.

Organic Fertilizers

- *Compost*: Apply well-rotted compost or manure to the soil at the start of the growing season to enhance soil fertility.
- *Green Manure*: Incorporate green manure crops (e.g., legumes) to enrich the soil with nitrogen.
- *Bone Meal*: For better root development, the addition of bone meal can improve phosphorus availability to the plant [19–21].

CHEMICAL FERTILIZERS

Bhingraj can be supplemented with balanced fertilizers (e.g., NPK) during the early growth phase. Nitrogen promotes lush leaf growth, while potassium and phosphorus help in flower and root development.

Micronutrients

Bhingraj may also benefit from trace elements like zinc, iron, and manganese, which can be provided through micronutrient fertilizers.

Fungal Diseases

Maintaining adequate air circulation and refraining from overhead watering in high-humidity settings are essential for lowering the danger of fungal infections [3, 22, 23].

Harvesting and Post-Harvest Management Harvesting Time

- *Leaves and Stems*: Bhingraj can be harvested multiple times throughout the year. Three to four months after planting, the plant is usually ready for harvesting its leaves and stems. Harvest the leaves before flowering to maximize the concentration of active compounds.
- *Flowers and Seeds*: The flowers appear in the late rainy season (August to October in tropical climates) and can be harvested when they are mature to collect seeds.

Harvesting Techniques

Manual Harvesting

Use sharp pruning shears or knives to cut the stems and leaves, ensuring minimal damage to the plant. For seeds, collect the mature seed heads by hand [24].

CONCLUSIONS

Bhringraj (*Eclipta alba*) is a potent herb with significant antioxidant properties that have been explored in traditional medicine, particularly in Ayurveda. The plant, which is abundant in bioactive substances, such as terpenoids, alkaloids, and flavonoids, efficiently combats free radicals, lowers oxidative stress, and protects cells from damage. Its antioxidant activity is key in combating age-related diseases, including neurodegenerative, cardiovascular, liver, and skin diseases.

Bhringraj exhibits several mechanisms of action, such as free radical scavenging, enhancing antioxidant enzyme activity, and inhibiting lipid peroxidation. These properties not only protect the body from oxidative damage but also help in managing inflammation, making it a potential remedy for various chronic conditions. In addition, Bhringraj has hepatoprotective, neuroprotective, and cardioprotective effects, which highlight its overall therapeutic value.

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