

A COMPREHENSIVE REVIEW ON PHARMACOLOGICAL POTENTIALS EXPLORATION OF TRAGIA INVOLUCRATA

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Abstract - Ethanomedicinal plants have been used as medicine for different ailments since ancient times. *Tragia involucrata* (Family:Euphorbiaceae) is a medicinal plant widely used in Sri Lankan and Indian traditional medicine. This genus is used for several medicinal uses such as cancer diarrhea, constipation, scorpion bite, rheumatism, whooping cough and diabetes this is important constituents of ayurvedic and siddha medicine. Alkaloids, phenols, terpenoids and tannin are present in the *Tragia involucrata*. *Tragia involucrata* has been important properties such as antibacterial activity, antifungal activity, anti-inflammatory activity, antioxidant activity, antinociceptive activity, antiparasitic activity, diuretic activity, antitumor activity, hepatoprotective activity, *Tragia involucrata* make qualify as a potent candidate to be developed into a phytomedicine to be utilized as both a preventive and as a therapeutic agents.

Keywords - *Tragia involucrata*, phytochemicals, medicinal uses, pharmacological activities.

I.INTRODUCTION

Traditional medicinal plants have been used medicinally since ancient times to treat various ailments. Even today, medicinal plants play an important role in global health. The use of traditional, complementary and alternative medicine, mainly using plant material for these formulations, is widespread in both developing and developed countries [1]. Because of this widespread use of medicinal plants, WHO has recommended initiation of research to identify and classify new herbal products from traditionally known plants and develop new effective therapeutic agents, especially in areas lacking modern medicine, such as chronic disease [2]. *Tragia involucrata* (Family:Euphorbiaceae) is a herbal medicinal plant that has been used for centuries in Sri Lankan traditional medicine and ayurvedic medicine [3]. This plant is chiefly found and used in South Asian countries like Sri Lanka, India and Bangladesh. *Tragia involucrata* is a weed, so spread easily and survives harsh weather conditions. Even though this plant has been used for thousands of years, currently the public is not aware of its medicinal properties and its being destroyed on a large scale, especially in Sri Lanka, because it causes severe stinging when touched [4]. Different parts of the plant such as leaves, root, stems, and whole plant are used either singly or in combination for medicinal purposes. Phytochemical investigation has revealed the presence of bioactive constituents like flavanoids, alkaloids, tannins, saponin, phenolic compounds, glycosides and steroids, which are responsible for its wide range of pharmacological action. Pharmacological studies have demonstrated that *Tragia involucrata* possesses multiple biological activities, [5].

II. AIM

The main aim of this review is to provide a comprehensive and systemic overview of the pharmacological potential of *Tragia involucrata*, a medicinal plant widely used in traditional system of medicine. This review intends to compile and analyse the available scientific literature regarding its phytochemical composition, ethnomedicinal uses.

III. OBJECTIVES

To collect and compile scientific information regarding the traditional and ethnomedicinal uses of *Tragia involucrata* reported in various traditional systems of medicines.

To review the botanical description, distribution, and ecological characteristics of *Tragia involucrata* to provide basic knowledge about the plants.

To summarize the phytochemical constituents and bioactive compounds present in different parts of the plant including leaves, roots, stems, and whole plant extracts.

To analyse and discuss the pharmacological activities of *Tragia involucrata* in scientific studies, such as antimicrobial, anti-inflammatory, anti-diabetic, diuretic, and other biological activities.

To highlight the therapeutic potential of *Tragia involucrata* as a natural source for drug discovery and herbal medicinal development.

IV. PLANT PROFILE :



4.1 Scientific Classification :

Kingdom : Plantae

Subkingdom : Tracheobionta

Division : Eudicots

Class : Rosids

Order : Malpighiales

Family : Euphorbiaceae

Genus : *Tragia involucrata*

Species : *T. involucrata* L.

4.2 Synonyms :

Tamil	: Kanchori, Senthatti
Sanskrit	: Dahanika
Hindi	: Bichhu
English	: Stinging nettle (Indian Stinging Nettles)

4.3 Common uses

4.3.1. Diuretic Activity- The plant is traditionally used as diuretic to increase urine output. It helps in the treatment of urinary disorders such as dysuria and urinary tract infections.

4.3.2 Wound healing- Leaves and root extracts are applied to cuts, wounds, and ulcers. The plant possesses antibacterial and anti-inflammatory properties that promote faster wound healing.

4.3.3 Anti-inflammatory Activity- Extracts of the plant help in reducing inflammation, swelling, and pain and are used in conditions like arthritis and inflammatory disorders.

4.3.4 Antimicrobial Activity- The plant shows antibacterial and antifungal properties, which help in controlling infections caused by microorganisms.

4.3.5 Antidiabetic Activity- Some studies indicate that the plant extracts can help lower blood glucose levels, suggesting its potential use in managing diabetes.

4.3.6 Treatment of skin diseases- Traditionally used to treat eczema, itching, scabies, and other skin infections.

4.3.7 Respiratory Disorders- It is used in traditional medicine for asthma, cough, and breathing difficulties.

4.3.8 Antioxidant Activity- The plant contains phytochemicals that act as antioxidants, helping protect the body from oxidative stress.

4.3.9 Digestive Problems- It is sometimes used to treat stomach disorders, intestinal worms, and digestive problems.

Other uses- It is used in traditional medicine for treating scorpion stings, abdominal issues (constipation, diarrhea), and even in treating leprosy.

V. MORPHOLOGY CHARACTERS:

5.1 Flowers:

5.1.1 Unisexual

5.1.2 Actinomorphic (radically symmetrical)

5.1.3 Male flower : These are found in the upper part of the spike, measuring about 1.5 mm across; they feature spoon-shaped bracts, 3 spreading tepals and 3 stamens with almost sessile anthers.

5.1.4 Female flower : These are found in the lower part of the spike, measuring about 3 mm across, they have 6 ovate-lanceolate sepals that enlarge significantly to enclose the fruits.

Female flowers have a 3-lobed, hispid ovary and 3 spreading styles.

5.1.5 Active compounds : It contains phytoconstituents such as alkaloids, flavonoids, and tragacanthic acid.

5.1.6 Flowering period : Often throughout the year, with peak flowering in February – March, June or July – December, depending on the region.

5.6.7 Colour type : Pale yellow to greenish.



5.2 Stem:

5.2.1 Habit : It is a perennial herb with slender, elongated and twining or straggling stem that acts as a climber or trailer, often found in thickets and wastelands

5.2.2 Texture : The stems are densely hispid – pubescent, meaning they are covered in long , rough, stiff hairs.

5.2.3 Stinging hair system : A key feature is the presence of scattered, stinging hair (trichomes) throughout the stem , which causes itching and irritation upon contact.

5.2.4 Internal anatomy : The stem like the leaves, is equipped with glandular capitate trichomes (featuring biserial stalks and club-shaped, secretory bodies) and non-glandular, long, pointed unicellular trichomes.



5.3 Leaves

It leaves covered in stinging, hispid hair that causes skin irritation Size

Generally 6 – 10 cm long and 3 – 5.5 cm wide, though they can range from 2.5 – 12.5 cm long.

Texture : densely hispid – pubescent on both sides.

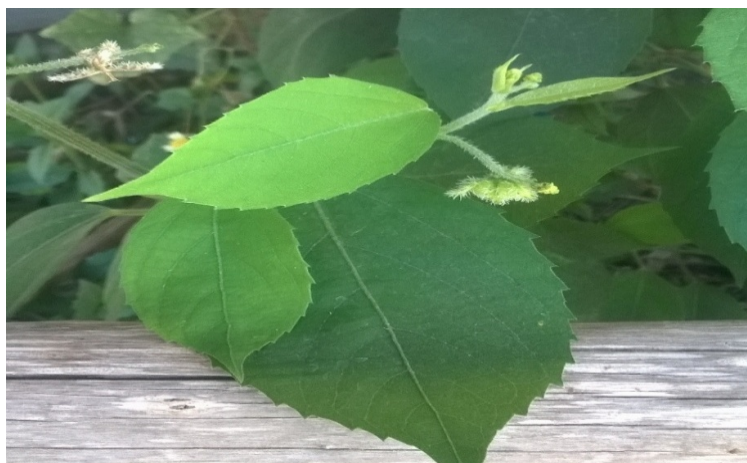
Colour : green, often with stinging, clear hairs.

Petiole : long, slender and hairy.

Special character : leaves possess (stinging) hairs containing irritant compounds which cause itching and burning sensations on contact.

The stinging nature helps protect the plant from herbivores.

Leaves are rich in bioactive phytoconstituents like flavonoids, tannins, alkaloids, and phenolic compounds, which have medicinal value.



5.4 Roots:

5.4.1 Physical appearance :

The roots are generally tough and wiry , consistent with a hardy, trailing or scrambling perennial.

The roots are brown in colour and are known for being fibrous and woody as they mature, according to traditional medicinal descriptions.

5.4.2 Root utilisation :

The roots are explicitly mentioned in traditional, Siddha and Ayurvedic systems as a key part used, particularly for their diaphoretic and alternative properties.

5.4.3 .Pharmacological relevance :

The root extract is known to possess significant anti-inflammatory and analgesic activities.



5.5 Seeds:

Shape : The seeds of *Tragia involucrata* are subglobose or globose

Size : Approximately 4 mm in diameter.

Colour : Greyish – brown with slight mottling.

Quantity : They are contained within a 3-lobed hispid (covered with stiff hairs) capsule, typically containing 3 seeds.

Seed coat : The seed coat (testa) is hard, thick and smooth, offering mechanical protection.

Roots are woody, cylindrical, branched, and tough in nature.

Roots possess medicinal importance and are often used in traditional systems of medicine [11].



VI. DISTRIBUTION

6.1 Regional Distribution:

Primarily found throughout India and Sri Lanka. It is also present in Bangladesh, Myanmar, and parts of China.

6.2 Habitat :

It grows in tropical and subtropical regions, specifically in dryland weeds, scrubs, waste grounds, and along roadsides.

6.3 Distribution in India :

It is widely distributed across the country, with reported occurrences in Kerala, Tamil Nadu, Odisha, Assam, Meghalaya.

VII. ECOLOGY AND HABITAT

7.1 Stinging mechanism:

The plant is covered with trichomes (stinging hairs) containing needle-shaped crystals of calcium oxalate. These act as hypodermic syringes, releasing toxins (like Shellsol) upon contact, causing severe pain, inflammation and itching.

7.2 Grown condition:

Thrives in moist and shaded environments.

7.3 Flowering and fruiting:

Flower and fruits are found throughout the year. By it is most commonly observed from July to December.

7.4 Ecology role:

Serves as a larval host plant for certain butterflies, including the angelled castor (*Ariadne ariadne*) and common (*Aniandne merione*)[12]

VIII. PHYTOCONSTITUENTS

Tragia involucrata (Indian stinging needle) contains a rich profile of bioactive compounds present in plant tissues. In the whole plant of *Tragia involucrata*, the following have been reported. Carbohydrates: Present in appreciable amount, serves as primary energy sources.

8.1 Protein : Occurs in small quantities – important for metabolic activities.

8.2 Lipid : Found in significant amounts; acts as a structural and energy reserve molecules

8.3 Starch : presents as storage polysaccharides.

These biochemical components form the basic nutritional and metabolic framework of the plant.

8.4 Alkaloids : Nitrogen containing organic bases. Known for antimicrobial and pharmacological activities.

8.5 Flavonoids : Polyphenolic compounds with antioxidants; contribute to defence mechanism.

8.6 Saponins : Glucosides that produce foam; reported possess antimicrobial action.

8.7 Tannins : Astrigents polyphenols important for wound healing and antimicrobial effects.[13]

IX. EXTRACTION METHODS

Extraction methods for *Tragia involucrata* commonly target bioactive compounds as flavonoids, alkaloids, and terpenoids, utilizing solvents like methanol, ethanol, ethyl acetate, and hexane for both leaves and roots. The most common approach involves drying the plant material, powdering it, and using maceration or soxhlet extraction to produce concentrated extract, typically for pharmacological studies related to inflammation, pain, and infection.

9.1 Common extraction methods:

9.1.1 Maceration (Cold Extraction)

9.1.2 Soxhlet Extraction (Hot Extraction)

9.1.3 Hydroalcoholic Extraction

9.1.4 Accelerated solvent Extraction

9.2 Specific Solvent Application:

9.2.1 Methanol: Used to extract to a wide range of polar components, including flavonoids, tannins, alkaloids.

9.2.2 Ethyl Acetate: Often used to isolate bioactive compounds like quercetin, rutin, and phytosterols.

9.2.3 n-Hexane: Utilized to remove chlorophyll and extract non polar lipids and triterpenoids.

9.2.4 Petroleum Ether/Chloroform: Used for defatting the plant material and extracting alkaloids [14].

9.3 *Tragia involucrata* leaf extracts:

The fresh leaves of *Tragia involucrata* were washed with distilled water and shade dried at room temperature. The dried leaves were milled using a mixer and shived. The powdered sample of 50g was successively extracted with solvents of increasing polarity: Petroleum ether (TI-P), Ethyl Acetate (TI-EA), Chloroform (TI-C) And water (TI-A) by soxhlet method. The extracts are then concentrated under reduced pressure using a rotary evaporator and stored in a desiccator for further analysis. It shown the extracts of *Tragia involucrata* possess potent amylase enzyme inhibitory activity. The preliminary phytochemical screening reveals the presence of various phytoconstituents mainly steroids, terpenoids, phenols, and carbohydrates [15].

9.4 *Tragia involucrata* root extracts:

The roots of *Tragia involucrata* were collected, washed thoroughly with distilled water, and shade-dried at room temperature. The dried plant materials were then powdered using a mechanical grinder. The powdered root material was subjected to successive solvent extraction using solvents of increasing polarity such as petroleum ether, acetone, and distilled water. For each extraction, an appropriate amount of powdered material was soaked in the solvents and kept for sufficient time with occasional shaking to ensure proper extraction of phytoconstituents. After extraction, the mixtures were filtered using Whatman filter paper to remove plant debris. The filtrates obtained from each solvent were concentrated using evaporation to obtain crude extracts. The dried extracts were then stored in airtight containers at low temperature until further analysis. These extracts were later used to evaluate antibacterial activity and phytochemical constituents [16].

9.5 Steps for Extraction Process:

9.5.1. Preparation: Collect leaves/roots, wash, shade-dry, and grind into a fine powder.

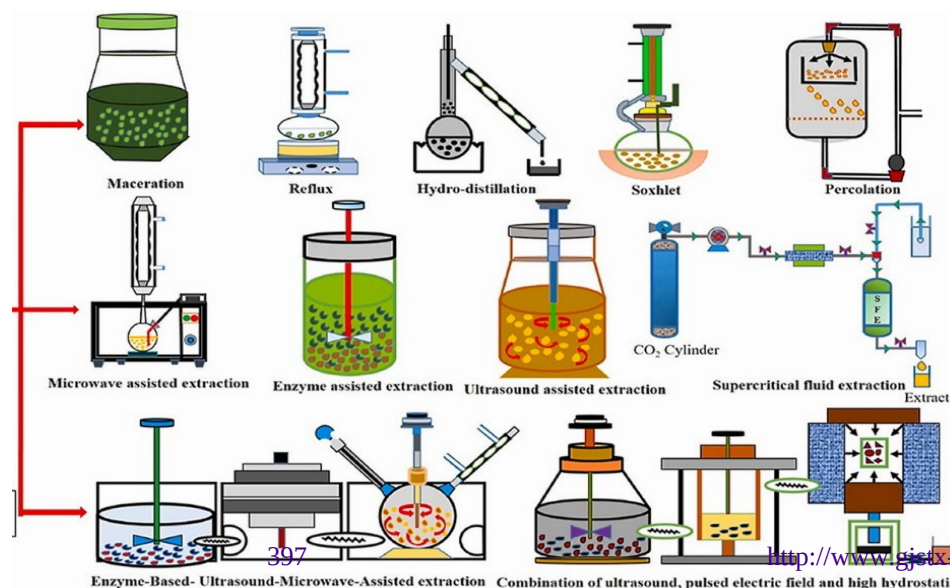
9.5.2 Extraction: Perform maceration (e.g., 100g powder in 400 ml solvents for 7 days) or Soxhlet extraction.

9.5.3 Filtration: Filter the mixture through Whatman NO.1 filter paper.

9.5.4 Concentration: Use a rotary evaporator (e.g., Bibby RE200) to evaporate the solvent at a temperature below its boiling point, resulting in a viscous extract.

9.5.5 Storage: Store the concentrated extract in an airtight container at 4°C [17].

Tragia Involucrata



X. PHARMACOLOGICAL ACTIVITIES

10.1 Anti-inflammatory Activity:

Extract from the root, and whole plant of *Tragia involucrata* were tested to investigate the anti-inflammatory effects. Experiments were performed on healthy Wistar rats in vivo using carrageenan induced paw oedema and cotton pellet granuloma methods. Various solvent extracts such as aquomethanol, petroleum ether and chloroform were used. All extracts at tested doses showed positive results both orally and intraperitoneally. The active compound is shellsol has shown positive results for anti-inflammatory activity and that *Tragia involucrata* mediates antibacterial and anti-inflammatory activity via shellsol[18].

10.1.1 Carrageen-induced paw oedema model (acute inflammation): Ethanolic and metanolic extracts showed significant reduction in paw oedema in rats. The effects were comparable to standard drug like indomethacin.

10.1.2 Cotton pellet-induced granuloma model (chronic inflammation): Extracts significantly reduced granuloma formation. Indicates inhibition of fibroblast proliferation and collagen formation.

10.1.3 Formalin-induced inflammation model: Evaluate anti-inflammatory activity of drugs and plant extracts in laboratory animals, mainly rats or mice [19].

10.2 Antibacterial Activity:

Phytochemical studies of *Tragia involucrata* leaf and root extracts have revealed the presence of alkaloids, phenolic compounds, flavonoids, steroids, tannins, and terpenoids, which are classes of secondary metabolites known to contribute to antimicrobial effects in plants. *Tragia involucrata* have been evaluated for their ability to inhibit bacterial growth and their antibacterial properties[20].

Petroleum ether, chloroform and acetone extracts of *Tragia involucrata* are effectively inhibiting the growth *E. coli*. Among these, methanolic and ethanolic extracts show stronger antibacterial activity due to better extraction of bioactive compounds. Specific bioactive compounds have been isolated from *Tragia involucrata* and tested individually for antibacterial effects. Compounds such as shellsol and vinyl hexylether showed broad antibacterial activity against bacteria, including *Staphylococcus aureus*, *Proteus vulgaris* and *Escherichia coli*[21].

10.3 Antifungal Activity:

Tragia involucrata has significant antifungal activity. The growth of *Alternaria solani*, *Rhizopus stolonifera*, *Tilletia indica* and *Aspergillus niger* inhibited by extracts of *Tragia involucrata*. However, *Chaetomium globosum* and *Mucor indicus* are resistant. The extract from the root also exhibited antifungal activity. In vitro cultures of *Malassezia furfur* and *Trichophyton rubrum* are inhibited by root extracts prepared from *Tragia involucrata*.

10.3.1 In vitro antifungal activity of crude extracts:

Leaf extract: methanolic and other solvent-based leaf extracts of *Tragia involucrata* have demonstrated inhibitory activity against a range of pathogenic fungi in agar-based assays, including *Aspergillus niger*, *Rhizopus stolonifera*, *Alternaria solani* and *Tilletia indica*. In comparative screening of stinging plants, leaf extracts of *Tragia involucrata* showed zones of inhibition against multiple fungi, albeit with variable potency depending on the test.

10.3.2 Antifungal action of different plant parts:

Root Extracts: Ethyl acetate and other solvent extracts from the roots also exhibited activity. Studies report that *Tragia involucrata* root extracts were effective against skin-associated fungi such as *Malassezia furfur* and *Trichophyton rubrum*, with inhibition comparable to antifungal controls like ketoconazole.

10.3.3 Nanoparticle-Enhanced Antifungal Activity: Green Synthesis Approaches: ZnO nanoparticles synthesised using *Tragia involucrata* leaf extracts showed antifungal effects against *Aspergillus niger* and *Aspergillus flavus*, indicating that plant-mediated nanomaterials can retain and possibly enhance antifungal bioactivity.

10.3.4 Implicated In Activity: The phytochemical makeup of *Tragia involucrata* includes flavonoids, phenolics, terpenoids and other secondary metabolites known for antimicrobial action. These compounds are believed to contribute to antifungal effects[22].

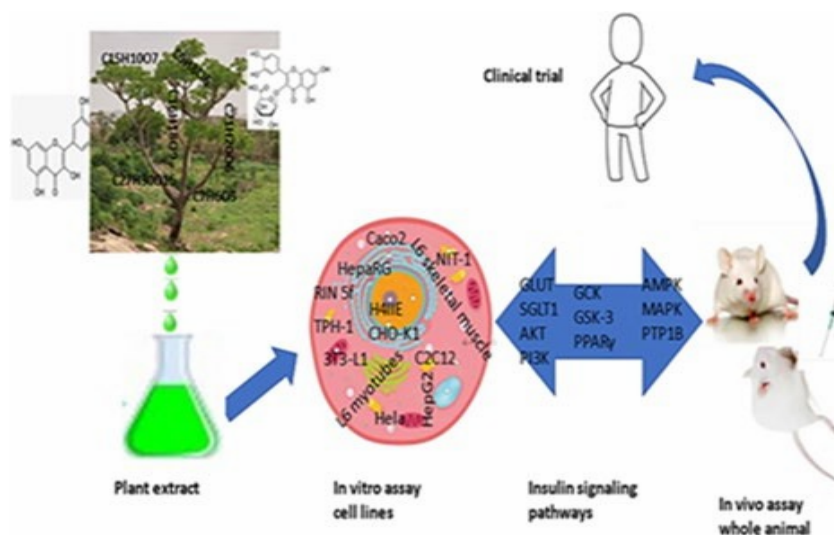


10.4 Antidiabetic Activity:

Tragia involucrata has been used for diabetes in traditional medicine practice for centuries in South Asian countries. In Sri Lankan traditional medicine, a decoction prepared from the whole plant of *Tragia involucrata* is used for diabetes mellitus. Traditional medicine rarely uses a plant to make a decoction; hence, it depicts the effectiveness of *Tragia involucrata* in treating diabetes mellitus. Several studies have been performed to investigate the antidiabetic activity of *Tragia involucrata*; both *in vitro* and *in vivo* are discussed. *In vivo* studies were carried out using diabetic-induced rats. The mice were stimulated with alloxan, which mimics type 1 diabetes mellitus and streptozotocin and a high-fat diet and low-dose streptozotocin were used to mimic diabetes mellitus [23].

Tragia involucrata extracts showed potent antidiabetic activity in both types because the effect of insulin triglyceride metabolism causes hyperlipidemia secondarily. The hypolipidaemic activity was also investigated during the same antidiabetic study. *Tragia involucrata* extracts normalised the value of the lipid profile, which shows that *Tragia involucrata* has insulin-replicating action. An *in vitro* and diabetic study was carried out with leaf extract of *Tragia involucrata* using α -amylase inhibition assay. The extract exerted effective α -amylase enzyme inhibitory activity. α -amylase is a protein enzyme hydrolyses the alpha bonds of large, alpha-linked polysaccharides such as starch and glycogen to yield glucose and maltose.

By inhibiting the α -amylase enzyme, the breakdown of polysaccharides is inhibited, thereby inhibiting the digestion of starch and glycogen and inhibiting the release of glucose into blood. It is a popular strategy for treating disorders of carbohydrate intake such as diabetes and obesity. To add to the benefits of TI in diabetes, due to its antibacterial activities, *Tragia involucrata* has shown potent activity against pathogens that cause diabetic foot ulcers and urinary tract infections, which are common complications of diabetes mellitus [24].



10.5 Diuretic Activity:

In Ayurveda and traditional Sri Lankan medicine, *Tragia involucrata* is used in dysuria and other conditions related to the urinary tract. *Tragia involucrata*'s diuretic activity scientifically validates its traditional medicinal use in urinary disorders such as dysuria and urinary tract problems. Studies evaluated its extracts because traditional systems report that the plant is used for conditions related to urine flow and kidney function, suggesting possible natural diuretic potential. Experimental research using animal models is conducted to measure urine output and electrolyte excretion and confirm whether the plant truly produced diuresis. Such investigation also help determine which extracts (aqueous, petroleum, ether, chloroform, etc.) show the strongest activity, since aqueous root and whole plant decoction were found to be most potent[25].

Therefore, the diuretic activity has been evaluated using various extracts from the root and a decoction prepared from the whole plant. Experiments were performed using healthy Wistar rats. The results showed that the activity of aqueous root extract and whole plant decoction was very potent as a diuretic, and other extracts such as petroleum ether and chloroform extracts had mild activities. Diuretic activity of *Tagia involucrata* is evaluated using the Lipschitz methods in rats. Animals are divided into control, standard (furosemide) and test groups and placed in metabolic cages for urine collection. Urine volume and electrolyte levels are measured over 5-24 hours and the diuretic index is calculated. Increased urine output and electrolyte excretion compared to control confirm diuretic activity [26].

10.6 Hepatoprotective Activity:

Tragia involucrata is well known medicinal plant used in traditional systems like a Ayurveda and Siddha for treating liver disorders, inflammation and metabolic diseases. Recent pharmacological studies have validated its hepatoprotective (liver-protecting) activity. Hepatoprotective efficacy of *Tragia involucrata* has been confirmed in experimental trials in rats. The root extracts of *Tragia involucrata* exhibited dose-dependant hepatoprotective activity in rat models. The capability of compounds from *Tragia involucrata* to protect hepatocytes is interesting for further studies and the identification and mechanism of action of the lead compound. Hepatoprotective activity is usually evaluated using an animal model where liver damage is induced by carbon tetrachloride (CCl₄), paracetamol, ethanol. These toxic agents cause liver injury by generating free radicals and damaging hepatocyte membranes.

The purpose of using *Tragia involucrata* in hepatoprotective activity studies is to evaluate its ability to protect liver cells from toxin-induced damage. The plants contain flavonoids, phenolic compounds, and other phytochemicals known for their antioxidant effect that can reduce oxidant stress in hepatic tissue. It is also investigated for anti-inflammatory properties that may prevent liver injury and support regeneration of hepatocytes. Experimental studies assess its ability to normalise elevated liver enzymes and improve histological liver structure. Such research helps validate its traditional medicinal use and explore its potential as a natural hepatoprotective agent [27].

10.7 Antinociceptive Activity:

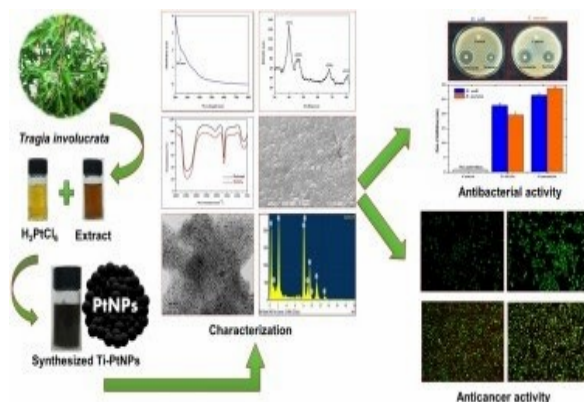
Antinociceptive activity is the ability of a substance to reduce or block pain sensation by inhibiting pain signals in the nervous system. It indicates the analgesic potential of a drug or plant extracts against painful stimuli. *Tragia involucrata* is traditionally used in herbal medicine for antinociceptive (pain relieving) activity because traditional medicines use it for treating pain and inflammatory actions. Experimental studies show that plant extracts produce both peripheral and central analgesic effects, demonstrated using acetic acid writhing and tail-flick models in mice. The analgesic activity of *Tragia involucrata* was investigated *in vivo* using acetic acid-induced writhing and radiant thermal analgesimeter methods [28]. *Tragia involucrata* extract shows antinociceptive activity in the acetic acid writhing test by significantly reducing abdominal constriction in mice, indicating inhibition of peripheral pain mediators such as prostaglandins. This model is widely used to screen plant extracts for analgesic potential. *Tragia involucrata* extracts are assessed for antinociceptive activity using the hot plate test, which evaluated response to thermal pain in experimental animals. An increase in reaction latency (paw licking or jumping) after treatment indicates analgesic effects. This suggests the extracts may act through central pain-modulating mechanisms similar to standard drugs. Methanolic and ethyl acetate extracts significantly reduced writhing response and increase tail-lick latency, indicating inhibition of nociceptive pathways. The antinociceptive action is thought to be related to inhibition of cyclooxygenase or lipoxygenase pathways of arachidonic acid metabolism, reducing inflammatory pain mediators. The plants are rich in flavonoids, phenols and terpenoids, compounds known for anti-inflammatory effects that contribute to analgesic activity. Because of these pharmacological properties of *Tragia involucrata* is considered a promising natural source for developing safe analgesic agents [29].

10.8 Anti-Tumour Activity:

Tragia involucrata is a medicinal plant reported to possess potential antitumour activity due to its rich phytochemical composition, including flavonoids, alkaloids, tannins, phenolic compounds and terpenoids. These bioactive compounds are known to inhibit cancer cell growth through multiple biological mechanisms. Some experimental investigation using *in-vitro* cell line models have shown that plant extracts can reduce the viability of cancer cells in a dose-dependent manner. This activity is believed to be associated with phenolic compounds that modulate signalling pathways involved in inflammation, angiogenesis and tumour growth. The antitumour activity was analysed by using trypan blue exclusion assay, gas chromatography-mass spectrometry analysis, liquid chromatography-mass chromatography analysis, and a DLA-induced solid tumour model.

The trypan blue exclusion assay is a simple method used to assess antitumour activity by determining cancer cell viability. It is based on membrane integrity, where viable cells excluded the dye while non viable cells absorb it and appear blue. When tumour cells are treated with a plant extract, reduced numbers of unstained cells indicated cytotoxic effects. An increase in stained (dead) cells suggests effective antitumour potential. Thus, the assay helps screen compounds for their ability to inhibit cancer cell growth or survival [30].

Gas chromatography-mass spectrometry (GC-MS) is used in antitumour studies to identify and characterise bioactive compounds present in plant extracts or drug samples. It separates chemical constituents by gas chromatography and detects Liquid chromatography-mass spectrometry (LC-MS) is used to identify and characterise bioactive compounds in *Tragia involucrata* extracts responsible for antitumour activity. LC separates phytochemicals such as flavonoids, alkaloids, and phenolic compounds based on polarity. MS detects their molecular weight and structural fragments. LC-MS supports the discovery of potential anticancer constituents from *Tragia involucrata* [31].



10.9 Alzheimers Disease Therapy:

Alzheimer's disease therapy constitutes a combination of pharmacological and nonpharmacological interventions designed to manage symptoms, improve quality of life, and in newer approaches, slow disease progression by targeting underlying pathology. The aim is to enhance cognitive function and manage behavioral changes. *Tragia involucrata* is widely investigated because it contains multiple bioactive classes known to influence neurodegenerative pathways. Gas chromatography-Mass chromatography of leaf extracts identified 43 active compounds, including fatty acids, sterols, and terpenoid derivatives. Major chemical groups reported across extracts include terpenoids, phenols, and flavonoids. These compound classes are widely recognized in neuropharmacology for antioxidant, anti-inflammatory, and anti-amyloid action relevant to Alzheimer's pathology. Flavonoids are extensively studied for Alzheimer's therapy because they scavenge free radicals, inhibit amyloid aggregation, protect synapses, and improve cognition. Plants with multitarget pharmacology are attractive in Alzheimer's research because the disease involves multipurpose medicinal plants. These pharmacological properties provide a scientific basis for considering this plant as a promising candidate for multi-targeting neuroprotective drug development [32].

XI. CONCLUSION

Tragia involucrata is an important medicinal plant with long history of use in traditional systems of medicine particularly in Ayurveda and folk practices across India. The present review highlights that various parts of the plant especially the roots, leaves, whole plant extracts, exhibit a wide range of medicinal and pharmacological activities, including anti-inflammatory, analgesic, antioxidant, antidiabetic, antimicrobial, hepatoprotective, antinociceptive, Alzheimer's disease therapy. *Tragia involucrata* represents a valuable source of bioactive compounds and hold strong potential for the development of novel herbal drugs.

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