Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2025; 14(3): 388-395
Received: 25-04-2025
Accepted: 29-05-2025

Aditi Sharma
Department of Biotechnology, Faculty of Science, Kalinga University, Raipur, Chhattisgarh, India

Megha Chaturvedi
Department of Biotechnology, Faculty of Science, Kalinga University, Raipur, Chhattisgarh, India

Abhijeeta Nandha
Assistant Professor, Department of Biotechnology, Faculty of Science, Kalinga University, Raipur, Chhattisgarh, India

Corresponding Author:
Abhijeeta Nandha
Assistant Professor, Department of Biotechnology, Faculty of Science, Kalinga University, Raipur, Chhattisgarh, India

Euphorbia hirta Linn. (Asthma plant): A comprehensive review on its phytochemical constitutes & pharmacological properties

Aditi Sharma, Megha Chaturvedi and Abhijeeta Nandha

DOI: https://www.doi.org/10.22271/phyto.2025.v14.i3e.15392

Abstract
Euphorbia hirta Linn is a widely recognized medicinal herb utilized in traditional medicine systems for treating respiratory ailments, gastrointestinal disorders, skin conditions, and wounds. This review consolidates current ethnomedicinal knowledge and recent pharmacological evidence related to the plant. Phytochemical screening has identified several active compounds, including flavonoids, tannins, saponins, alkaloids, and phenolics, contributing to its reported therapeutic activities. Experimental studies have demonstrated a range of pharmacological effects, such as antimicrobial, anti-inflammatory, antioxidant, antidiabetic, anticancer, wound-healing properties. Despite promising preclinical results, comprehensive clinical trials are lacking, and toxicological profiles remain underexplored, thereby limiting clinical application. Standardization of plant extracts and mechanistic elucidation of bioactive compounds are crucial for advancing its therapeutic credibility. Future directions include pharmacokinetic assessments, in-depth toxicology, and formulation of standardized extracts. *Euphorbia hirta* holds significant promise for novel drug discovery, particularly in addressing infectious and chronic diseases. Integrating ethnopharmacological knowledge with modern biomedical research could lead to the development of effective and affordable plant-based medicines for global health challenges.

Keywords: *Euphorbia hirta* Linn., Pharmaphytochemistry, pharmacological, biological activities, bioactive compounds

Introduction
In traditional medicine, medicinal plants are recognised as the primary source of drug therapy. It is a substitute for Western medicine and has a close connection to indigenous cultures' religious beliefs and customs. Anxiety, depression, arthritis, high blood pressure, hormonal imbalances, insomnia, migraines, skin issues, and other ailments can all be treated with the thousands of Ayurvedic and home remedies that India has to offer. Secondary metabolites are physiologically active biochemical compounds that are responsible for a plant's medicinal properties. The capacity of plants to produce secondary metabolites, which are found in their leaves, fruits, buds, stems, flowers, bark, roots, and other plant parts, is nearly infinite [Sudha *et al*., 2023] [52]. The World Health Organisation estimates that approximately 80% of people in developing nations still rely on plant-based traditional medicines for both prevention and treatment. It has been demonstrated that traditional medicine, also known as folk medicine, is less expensive, clinically effective, and has comparatively fewer side effects than contemporary medications.

In addition to being vital for plant survival, secondary metabolites produced by plants are also critical for growth, development, reproduction, and plant protection [Tran *et al*., 2020] [55]. Among all the plants in the world, there is on medicinal weed which is abundantly found in Asia continent majorly in monsoon season named *Euphorbia Hirta Linn.* and in this review many of its advantages and specific features are highlighted or described. The plant *Euphorbia hirta* is used in traditional medicine to treat a number of illnesses, including genitourinary infections, colic, cough, and asthma. Also referred to as the Queensland asthma weed or the Australian asthma herb, this plant, which is a member of the Euphorbiaceae family, is not harmful in normal dosages. It is frequently used in South Africa to treat asthma, one of the most prevalent respiratory conditions. [Ekpo and Pretorius, 2007] [13]. The herb *Euphorbia hirta Linn.* is highly popular among traditional medicine practitioners.

It is used as a decoction or infusion to treat a wide range of conditions, such as intestinal parasites, peptic ulcers, heartburn, vomiting, amoebic dysentery, asthma, bronchitis, hay fever, laryngeal spasms, emphysema, coughs, colds, kidney stones, menstrual issues, sterility, and

venereal diseases. Additionally, the plant is used as an antiseptic to treat wounds, sores, and conjunctivitis, as well as to treat fungal afflictions, measles, Guineaworm, warts, scabies, tinea, thrush, aphthae, and other affections of the skin and mucous membranes. The plant is well known for its ability to relieve severe headaches, toothaches, rheumatism, colic, and pregnancy-related pains. It is used to treat snakebite and scorpion sting pain and as an antidote. It's common practice to apply latex to help remove thorns from the skin [Rajeh *et al*., 2010] [42]. Central America is the native home of the plant species *Euphorbia hirta Linn*. It is found in many tropical and temperate regions of Africa, Australia, Asia, and India, making it a cosmopolitan species. It thrives in dry, humid environments between sea level and 2200 meters above sea level. It typically grows in lowlands, gardens, paddy fields, and waste areas by roadsides. Habitat: Native to tropical and subtropical regions, this erect or procumbent annual herb grows in parts of Africa, Southeast Asia, and South Asia. Roadsides, gardens, farmlands, and pastures are among the disturbed areas where it is frequently found. It frequently grows well in areas with disturbed soil, like fields used for agriculture or close to populated areas. Waste Areas: Because *Euphorbia hirta Linn.* can adapt to poor soil conditions, it also grows in urban areas, along railway tracks, and in waste lands [Tripathi *et al*., 2021] [57].

Current pharmacological studies have recently demonstrated that E. hirta and its active ingredients have a wide range of pharmacological actions, including anti-inflammatory, antifungal, antibacterial, antidiarrheal, sedative, anxiolytic, analgesic, antipyretic, antioxidant, antiasthmatic, antitumor, antimalarial, larvicidal, diuretic, and electrolyte-boosting properties, among others. [Huang *et al*., 2012] [19] Numerous other Euphorbia species are employed in traditional medicine. When broken, all species of Euphorbia release a milky juice that is used as an ingredient in arrow poisons and is more or less poisonous. Antibacterial, anthelmintic, antiasthmatic, sedative, antispasmodic, antifertility, antifungal, and antimalarial qualities are all possessed by E. hirta. [Kumar *et al*., 2010] [26].

Physiological Characteristics

Height: 15-50 cm high.

Stem: Densely clothed with yellow hairs; branches often 4-angled.

Leaves: Opposite, 1.3-3.8 cm long and 0.6-1.6 cm wide, obliquely elliptic, apex acute, base usually unequal-sided, margins serrulate or dentate, hairy, dark green above and pale beneath.

Flowers: Numerous, less than 1.3 mm long, crowded in small, globose, greenish-yellow axillary cymes**.**

Fruits: Capsules minute, 1.25 mm in diameter, trigonous, appressed hairy.

Seeds: Angular, 0.8 mm long, light reddish-brown. [Naidu, V.S.G.R. 2012].

Common Name: Asthma Plant (English), Dudh ghas (In Hindi) [Ghosh *et al*., 2019] [15].

A B

Photo 1: View of *Euphorbia Hirta Linn.* a) View of *Euphorbia Hirta Linn.* in bunches b) leaves, stem, flowers, fruits & seeds of *E. Hirta*

Traditional Uses

The plant is used to treat a number of conditions, including respiratory diseases (cough, cold, asthma, bronchitis, hay fever, emphysema), gastrointestinal disorders (diarrhoea, dysentery, intestinal parasitosis, bowel complaints, digestive problems), genital gonorrhoea, urinary tract disorders (diuretic, kidney stones), ocular conditions (conjunctivitis, corneal ulcer), skin and mucous membrane issues (guinea worm, scabies, tinea, trush, aphtha), and tumours. It is used as ear drops and to treat wounds, boils, and cuts in South India. The plant's latex is frequently applied to cuts and warts to stop the spread of infections. The leaves are chewed with palm kernels to restore virility, and a leaf decoction causes milk to flow. It works well for ulcers as well. Additionally, the plant is consumed as a vegetable. [Uddin *et al*., 2019] [58].

Pharmaphytochemistry

Various plants contain numerous biological elements that are highly active, plants can help humanity address important issues, such as health. Numerous phytochemicals are present in the plant, such as reducing sugars, alkaloids, terpenoids, flavonoids, tannins, steroids, fats, proteins, gums, oils, mucilage, saponins, glycosides, cardiac glycosides, coumarins, anthraquinones, and phenolic compounds. [Khursheed *et al*., 2019] [24].

Using both qualitative and quantitative analysis, phytochemical profiling is a crucial procedure for locating bioactive substances in plant extracts. To stop heat-sensitive compounds from degrading, the process starts with the collection of plant material and ends with drying in a shaded area. Depending on the solubility of the target phytochemicals, the dried material is then ground into a fine powder and extracted using methanol, ethanol, chloroform, acetone, or water. For accurate identification, the information gleaned from chromatograms and spectra is contrasted with reference standards. Understanding the therapeutic potential of plants like *Euphorbia hirta Linn.* requires thorough phytochemical profiling, which helps identify the main bioactive components that give them their therapeutic qualities.

Table 1: List of Derivatives of *E. hirta*

Phytochemicals	Derivatives	Reference
Flaonoids	Quercetin, Quercitrin, Quercitol, Rutin, Myricitrin, Leucocyanidin, Leucocyanidol, Cyanidin 3,5-diglucoside, Pelargonium 3,5-diglucoside, Camphol, Quercetin-Rhamoside, Chlorophenolic acid, Xanthorhamnin, 3',4'-Dimethoxyquercetin, Hirtacoumaroflavonoside Hirtaflavonoside-B, Rhamnetin, Pinocembrin and Isorhamnetin, kaempferol, Epicatechin 3-gallate, Afzelin, Epicatechin 3-gallate	Yan *et al*., 2011 [62]; Sheliya *et al*., 2015 [46]; Subbiah & V 2007 [51]; Wu *et al*., 2012 [61]; Singh & Kumar 2013 [49]; Perumal *et al*., 2017 [39]; Liu *et al*., 2007 [28]; Perumal *et al*., 2017 [39]
Terpenoids	α-Amyrin, β-Amyrin, Friedelin, Taraxerol, Taraxerone, 11α,12α-oxidotaraxerol, Cycloartenol, 24-methylene-cycloartenol, 12-deoxyp horbol-13-phenylacetate-20-acetate, Ingenol triacetate, Tinyatoxin, 2-beta,16-alpha,19-trihydroxy-ent-kaurane, taxerol ingenol triacetate, Diterpenoids-oxidotaraxerol, Tinyatoxin, Resiniferonol, diterpenoids (2β,16-α,19-trihydroxy, 2β,16α-dihydroxy, 16α,19-dihydroxy)	Yan *et al*.,2011 [62]; Hazimi *et al*., 2008 [3]; Baslas and Agarwal, 1980 [8]; Shih *et al*., 2012 [47]; Yan *et al*., 20113 [62]
Sterols	β-Sitosterol, Campesterol, Cholesterol, Stigmasterol	Huang *et al*., 2012 [19]
Tannins	Euphorbins A, B, C, E, 2,4,6-tri-O-galloyl-β-D-glucose, 1,2,3,4,6-penta-O-galloyl-β-D-glucose, 5-O-caffeoylquinic acid (neochlorogenic acid), 3,4-di-O-galloylquinic acid, Benzyl gallate, Terchebin, Geranin 2,3-di-o methylellagic acid 7-o-rutinoside, 3,3,4-tri-o- methyl 4-o-Rutinosyl ellagic acid	Yan *et al*., 2011 [62]; Tripathi *et al*., 2021 [57]; Srivastava *et al*., 2024 [50]
Acids	Ellagic acid, Gallic acid, Tannic acid, Maleic acid, Tartaric acid	Yan *et al*., 2011 [62]
Alkaloids	Cyclobarbital, Mephobarbital	Chouhan *et al*., 2020
Mineral Content	Ca: 1.1%, P: 0.3%, Fe: 0.03%, Mg: 0.5%, Mn: 0.01%, Zn: 0.01%, Cu: 0.002%	Yan *et al*., 2011 [62]
Essential Oil, Volatile Oils (Major/Minor)	Major-3,7,11,15-Tetramethyl-2-hexadecen-1-ol,6,10,14-Trimethyl-2 pentadecanone, Hexadecanol, Phytol, n-Hexadecanoic acid Minor- 2-Butoxyethanol, Tetradecane, Phthalic acid, Butyl tetradecyl ester, Oleic acid, 13-Heptadecyn-1-ol, 2-methyl-1-hexadecanol, 1,2-Benzene dicarboxylic acid, Diiso-octylester	Ogunlesi *et al*.,2009 [33]; Ogunlesi *et al*., 2009 [33]
Phenols	Galloylquinic acid, Chebulic acids and Brevifolincarboxylic acid, Caffeic acid, Ferulic acid and Gallic acid, O-coumaric acid, Hydroxyl cinnamic acid, Protocatechuic acid, ellagic acid	Chen *et al*., 1991 [11]; Yang *et al*., 2020 [63]; Perumal *et al*., 2017 [39]; Subbiah & V 2007 [51]; Abdelkhalek *et al*., 2018 [1]; Tripathi *et al*., 2021 [57]

Biological potential of phytochemistry

Antibacterial/Antifungal Activity

Both methanolic and ethanolic extracts of *Euphorbia hirta* have demonstrated strong antibacterial activity against a range of Gram-positive and Gram-negative bacteria, such as *Bacillus subtilis, Pseudomonas aeruginosa, Escherichia coli*, and *Staphylococcus aureus*. According to a study, the methanolic extract demonstrated a strong antibacterial potential against Shigella dysenteriae, with a minimum inhibitory concentration (MIC) of 0.78 mg/mL. Flavonoids, tannins, and phenolic acids are thought to be responsible for the plant's antimicrobial properties. These compounds work by rupturing the bacterial cell membrane, preventing the synthesis of proteins, and obstructing the replication of nucleic acids. The saponification process was used to test the extracts' inhibitory effects on uropathogens using a variety of solvents, including ethanol, methanol, acetone, and chloroform Among the tested microorganisms, *Pseudomonas aeruginosa* and *Staphylococcus epidermidis* were found to be the most susceptible, whereas *Serratia marcescens*, *Enterobacter cloacae*, *Citrobacter koseri*, and *Citrobacter freundii* were the least inhibited by most of the *E. hirta* extracts [Parul Sharma, 2024] [45] [Ansari *et al*., 2016]. Additionally, *Euphorbia hirta* has demonstrated antifungal activity against a variety of fungal pathogens. Research has indicated that the plant's extracts are effective against fungi like *Aspergillus niger*, *Candida albicans*, and *Trichophyton rubrum*. [Asha *et al*., 2014] [27] Saponins, tannins, and terpenoids—all of which have been demonstrated to damage fungal cell membranes and impede their growth—are thought to be responsible for *Euphorbia hirta* antifungal properties [Ghosh *et al*., 2019] [15].

Antioxidant Activity

Total antioxidant and total ferric reducing power computation, as well as assays for free radical scavenging activity using ABTS, DPPH, and hydroxyl radical scavenging assays, the aqueous extract of *Euphorbia hirta Linn.* demonstrated both antioxidant effect and free radical scavenging activity. It demonstrated the highest levels of antioxidants and free radical scavenging. DPPH and hydroxyl showed a scavenging effect of free radicals of 68.80 ± 5.21 and 73.36 ± 5.21%, respectively [Patidar *et al*., 2024] [37]. And the antioxidant activity *of Euphorbia hirta* leaves, stems, roots, and flowers. Using the DPPH assay, samples of *Euphorbia hirta* leaves, stems, flowers, and roots were examined for total phenolic content, flavonoid content, and *in vitro* antioxidant activity. The cyanoferrate method was used to determine the reducing power. The cyanoferrate method was used to measure the reducing power and DPPH assay. According to the findings, the leaf extract had the highest DPPH scavenging activity at 72%. The flowers, roots, and stems had scavenging activity values of 52, 48, and 44%, respectively. 75% was the typical amount of butylated hydroxytoluene (BHT). BHT, leaves, flowers, roots, and stems had IC50 values of 0.803, 0.972, 0.989, 1.358, and 0.794 mg/ml, respectively, hence these results suggested that *Euphorbia hirta* exhibited strong antioxidant activity and can serve as a new antioxidant agent using various *in vitro* anti-oxidant tests [Basma *et al*., 2011] [9].

Anti-inflammatory Activity

In the carrageenan-induced oedema test in rats (an acute inflammatory process), the aqueous extract of *Euphorbia hirta* demonstrated notable and dose-dependent anti-inflammatory effects starting at a dose of 100 mg/kg [Lanhers *et al*., 1991] [27]. *Euphorbia hirta* aerial parts and its primary triterpene constituents' anti-inflammatory properties. In the model of phorbol acetate-induced ear inflammation in mice, the extract and chemicals demonstrated significant anti-inflammatory effects and decreased inflammatory hyperalgia in a dose-dependent manner, according to the results [Vazquez *et al*., 1991] [60]. Using lipopolysaccharide (LPS)-activated macrophage cells (RAW264.7) as a well-established

inflammation model, the anti-inflammatory properties of the *Euphorbia hirta* extract and its active ingredients were investigated. The enzyme-linked immunosorbent assay (ELISA) was used to simultaneously monitor the change in the levels of PGE2, TNFa, and IL-6. The findings demonstrated that the ethanol extract of *Euphorbia hirta* and its constituent beta-amyrin had a noteworthy anti-inflammatory effect and could potentially be used as a novel selective NO inhibitor by blocking the majority of iNOS protein functions and NO induction for the treatment of arthritis inflammation [Shih *et al*., 2010] [48].

Antidiabetic Activity

Alloxan causes diabetes by destroying the pancreatic beta cells that produce insulin. Alloxan is selectively toxic to pancreatic beta cells, causing cell necrosis, according to *in vitro* research. Beta cells are rapidly destroyed by the cytotoxic action of alloxan, which is mediated by reactive oxygen species and a massive increase in cytosolic calcium concentration. According to experimental research, ethanolic extracts from *Euphorbia hirta Linn* significantly reduced blood glucose levels in rats with diabetes induced by alloxan. It was discovered that the mechanism was independent of insulin. The process through which plant extracts have been suggested to prevent intestinal glucose absorption, prevent hepatic glucose synthesis, or correct insulin resistance. It also proves the traditional claim with regard to *Euphorbia hirta Linn* for its anti-diabetic activity [Uppal *et al*., 2012] [59]. A study shows in normal control mice, body weight increased slightly from 27.3±1.93 g to 28.59±1.11 g over 21 days. Diabetic control mice lost weight from 30.37±1.25 g to 27.2±2.43 g, indicating diabetes-induced wasting. Petroleum ether extract (250 mg/kg) reduced weight from 32.44±0.4 g to 29.91±0.91 g, and at 500 mg/kg from 30.34±2.32 g to 27.75±2.02 g, showing mild protection. Ethanolic extract (250 mg/kg) dropped from 28.67±2.4 g to 27.09±2.41 g, and 500 mg/kg from 27.41±2.29 g to 25.46±4.51 g, suggesting limited efficacy. Glibenclamide (10 mg/kg) significantly increased weight from 26.27±1.80 g to 30.46±1.91 g (*p<0.01), reflecting strong anti-diabetic action. Overall, *Euphorbia hirta* extracts provided partial protection against diabetic weight loss but were less effective than Glibenclamide [Rashmi *et al*., 2010] [43].

Antimalarial and Larvicidal Activity

An. stephensi larval and pupal mortality was noted following treatment with a methanol extract of *Euphorbia hirta* leaf extract. It shows the mortality of An. stephensi larvae and pupae (I to IV instars) following treatment with E.hirta at varying concentrations (75 to 375 ppm). Mortality at the first instar larvae was 40.8% when E. hirta leaf extract was treated at 75 ppm, but it rose to 81.6% when E. hirta leaf extract was treated at 375 ppm.First study shows the larval and pupal toxicity effect of *Euphorbia hirta* on different stages of *Anopheles stephensi* (malarial vector). The percentage of larval and pupal mortality progressively increased with concentrations ranging from 75 ppm to 375 ppm. In the 1st instar, mortality increased from 40.8±0.7% (75 ppm) to 81.6±1.8% (375 ppm). In the 2nd instar, it rose from 36.0±1.4% to 77.2±0.7%, in the 3rd instar from 31.2±1.1% to 71.6±1.1%, in the 4th instar from 27.2±1.7% to 68.6±0.7%, and in the pupa from 22.6±1.3% to 55.2±0.7%. The LC_{50} values from the 1st instar to the pupa were 137.40, 172.65, 217.81, 269.37, and 332.39 ppm, respectively, while the LC_{90} values were 470.69, 531.43, 590.77, 685.60, and 779.80 ppm, respectively. All the chi-square (χ^2) values (0.05*, 0.21*, 0.45*, 0.23*, 0.13*) were significant at the $P< 0.05$ level [Panneerselvam *et al*., 2012]. Second study presents the larvicidal activity of *Euphorbia hirta* leaf extract against Yellow Fever mosquito larvae across various concentrations. Ten larvae were exposed per treatment group. In the control group (0% concentration), no larval mortality was observed across all three trials (T_1, T_2, T_3), resulting in a mean mortality of 0.00% with a standard deviation of 0.00. At 25% concentration, mortality rates were recorded as 70%, 70%, and 100%, yielding a mean mortality of 83.3% with a standard deviation of 15.28. Complete larval mortality (100%) was consistently observed at 50%, 75%, and 100% concentrations across all trials, with a mean mortality of 100% and no variation (standard deviation = 0.00). These findings indicate that *Euphorbia hirta* leaf extract exhibits potent and concentration-dependent larvicidal activity, achieving complete lethality at concentrations of 50% and higher, highlighting its potential as an effective natural larvicide [Bayon *et al*., 2023] [10].

Wound healing Activity

A study presents that the ethanolic extract of *Euphorbia hirta* significantly promoted burn wound healing in rats. In the test group, wound closure was 16.60±2.09% (day 4), 32.26±2.92% (day 8), 64.29±3.25% (day 12), and 88.00±2.86% (day 16), all significantly higher than the control group values. Although slightly less effective than the standard treatment, *Euphorbia hirta* extract showed considerable enhancement in wound closure, especially evident by day 12 and day 16 ($p<0.001$). Collectively, these findings suggest that *Euphorbia hirta* possesses potent larvicidal properties and significant wound healing potential, supporting its use in mosquito control and therapeutic applications [Jaiprakash *et al*., 2006] [21]. The wound healing process encompasses overlapping yet distinct phases, including granulation, collagenation, collagen maturation, and scar maturation. Phytochemical analysis identified the presence of flavonoids, alkaloids, and phenolic compounds in *Euphorbia hirta* extract, known for their potent antioxidant, antibacterial, and antimicrobial activities. The role of antioxidant enzymes such as catalase and superoxide dismutase in neutralizing reactive oxygen species highlights the importance of oxidative stress modulation in wound repair. The enhanced antioxidant enzyme activity observed in granuloma tissues likely contributed to the accelerated healing. Thus, the wound healing efficacy of *Euphorbia hirta* may be attributed to its bioactive constituents, particularly alkaloids, tannins, and flavonoids, which synergistically promote tissue regeneration and mitigate oxidative damage. [Jain *et al*., 2020] [20].

Antidiarrheal Activity

In normal rats, the aqueous leaf extract of *Euphorbia hirta* dramatically and dose-dependently reduced gastrointestinal motility, and in mice, it lessened the impact of castor oil-induced diarrhoea [Hore *et al*., 2006] [18]. Mice were used to test the *Euphorbia hirta* herb decoction's antidiarrheal properties. In models of diarrhoea brought on by castor oil, arachidonic acid, and prostaglandin E2, it showed activity. At a dosage of 50 mg/kg, quercitrin, a flavonoid that was separated from this crude medication, helped prevent mice's diarrhoea caused by castor oil and prostaglandin E2 [Galvez *et al*., 1993] [14]. *Euphorbia hirta* water extract demonstrated antibacterial, antitetanic, antidiarrheal, and antiamoebic

qualities. Entamoeba histolytica growth was inhibited by the polyphenolic extract of E. hirta at a minimum active concentration of less than 10 mg/ml [Tona *et al*., 2000] [54].

Antiviral Activity

The MT4 human T lymphocyte cell line was used to study the antiretroviral properties of Euphorbia hirta extracts *in vitro*. The MTT cell proliferation assay was used to assess the extracts' cytotoxicities. Following that, measurements of the aqueous extract's direct effects on the reverse transcriptase (RT) activity of HIV-1, HIV-2, and SIV (mac251) showed that all three viruses' RT activity was dose-dependently inhibited. Additional research compared the activities of the 50% methanolic and aqueous extracts to determine *Euphorbia hirta* HIV-1 inhibitory potency. Compared to the aqueous extract, the 50% methanolic extract demonstrated a stronger antiretroviral effect. [Gyuris *et al*., 2009] [17].

Anxiolytic Activity

In chronically stressed rats exposed to two distinct stressors—forced swim stress (FSS) and chronic immobilisation stresses (CIS)—the anxiolytic potential of *Euphorbia hirta* hydroalcoholic extract was assessed. The open field test (OFT) and the elevated plus maze (EPM) were used to measure anxiety. Antagonists of the GABAA receptor-benzodiazepine receptor-Cl_channel complex with E. hirta were co-administered in order to assess anxiety in the EPM and comprehend the mechanism behind the anxiolytic action of this medication. The results unequivocally show *Euphorbia hirta* anxiolytic potential, especially in cases of anxiety brought on by CIS. The GABAA receptor-benzodiazepine receptor-Cl channel complex may mediate, at least partially, *Euphorbia hirta* actions [Anuradha *et al*., 2008] [5].

Anti-tumor Activity

Swiss albino mice were used to test the aerial portion of *Euphorbia hirta* antitumor activity against the EL-4 cell line (S.C.). EF-treated tumor-bearing mice showed a marked increase in mean survival time and decrease in solid tumour mass [Patil *et al*., 2011] [38]. A study reveals that the quercetin and aqueous and methanolic extracts from *Euphorbia hirta* for their mutagenic and antimutagenic properties. The mutagenicity of 2-aminoanthracene in S. typhimurium TA98 in the presence of S-9 metabolic activation was demonstrated by the aqueous extract (100 g/ml) and methanolic extract (10 and 100 g/ml). In both the presence and absence of S-9 metabolic activation in S. typhimurium TA98, quercetin was shown to be mutagenic and to exhibit no antimutagenic activity. The results suggest that *Euphorbia hirta* methanolic and aqueous extracts may have anti-carcinogenic properties.

Anticancer Activity

In the presence of S-9 metabolic activating enzymes, the methanol extract at 10 and 100 µg/ml and the aqueous extract of the entire *Euphorbia hirta* plant at 100 µg/ml demonstrated potent anti-mutagenic activity against the mutagenicity of 2-aminoanthracene.

Salmonella typhimurium TA98 was used to test the antimutagenic properties of aqueous and methanolic extract [Loh *et al*., 2009] [29]. The *Euphorbia hirta* plant's *in vitro* anticancer activity against HepG2 cells, which cause liver cancer, was investigated. Plant extract administration demonstrated a notable reduction in cell proliferation and successfully triggered apoptosis in HepG2 cells. Plant extract efficiently suppressed cell proliferation and induced apoptosis in liver cancer HepG2 cells, according to an *in vitro* study of plants [Kalaivani *et al*., 2024] [23].

Anti-allergic Activity

Significant anti-anaphylactic activity was discovered in the ethanolic extract of *Euphorbia hirta* prevented mice's active paw anaphylaxis and rats' passive cutaneous anaphylaxis (PCA). When anti-DNP-HAS activated rat peritoneal mast cells released TNF-α and IL-6, E.hirta was found to have a suppressive effect. The present study's results clearly support the traditional use of E. hirta as a herbal remedy to treat Type I allergic disorders [Youssouf *et al*., 2007] [64].

Anti-Venom Activity

The terpenes and plant extracts that have antivenomous qualities. In this case, *Euphorbia hirta* whole plant extracts exhibit superior activity against N. naja. The study's conclusion demonstrates that plants have strong anti-venom properties and may offer a different strategy to block venom toxins in snakebite cases [Sylvia A *et al*.,2024].

Anti-hemorrhoidal Activity

Rutin and its semi-synthetic derivative, which were isolated from *Euphorbia hirta*, were used to treat the rectoanal cell line for five days in order to produce anti-hemorrhoidal activity. The authors of this study proved that these substances have strong anti-hemorrhoidal properties [Kori *et al*., 2020] [23].

Table 2: Mechanisms of bioactive compounds isolated from *E. hirta*.

Activities	Mechanisms	References
Anticancer	Cytotoxicity against a human cancer cell line, colon carcinoma (HCT 116) and non-small cell lung adenocarcinoma	Wu Yi *et al*., 2012 [61]; Ragasa *et al*., 2013 [41]; Yang *et al*., 2019 [63];
Antimicrobial	Against *Pseudomonas aeruginosa* and *Staphylococcus aureus*	Aquil *et al*., 1999 [6]; Ragasa *et al*.,2013 [41]; Wu Yi *et al*., 2012 [61]; Singh *et al*.,2013 [49]
Antimalarial	Proliferation inhibition of *Plasmodium falciparum*	Aleksandrov *et al*., 2019 [2]; Gopi *et al*., 2016 [16]
Anti-viral	High binding affinity against protease Mpro, RNA-dependent RNA polymerase RdRp of SARS-CoV-2	Parmar *et al*., 2022 [36]; Meda *et al*., 2023 [31]; Tayone *et al*.,2020
Anti-inflammatory	Inhibition effects on TPA-induced inflammation in ear to the mice	Subbiah *et al*., 2007 [51]; Martínez *et al*., 1999 [30]; Shih *et al*., 2010 [48];
Anti-diabetes	Pancreatic β cells MIN6-protective effect	Trinh *et al*., 2014 [56]; Sheliya *et al*., 2015 [46] Quetin-Leclercq *et al*., 2018 [46]

Conclusion

The ethnopharmacologically significant medicinal plant *Euphorbia hirta Linn* is used extensively in traditional medical systems to treat skin infections, gastrointestinal issues, bronchitis, and asthma. Flavonoids, tannins, saponins, alkaloids, and phenolic compounds are found in its phytochemical profile and are in charge of its wide range of biological activities, which include antimicrobial, anti-

inflammatory, antioxidant, antidiabetic, and anticancer effects. Although many of its traditional uses have been validated by experimental studies, there is still a significant lack of clinical data to support widespread therapeutic applications. Additionally, the plant shows promise as a source of new bioactive compounds for the creation of pharmaceuticals. To validate its effectiveness, dosage safety, and therapeutic value, more thorough pharmacological research, toxicological analyses, and clinical trials are required. Overall, Euphorbia hirta holds great promise in the development of cost-effective, plant-based treatments for various human diseases, making it a valuable subject for continued scientific exploration and drug discovery research.

Future Prospects

Future pharmacological and therapeutic research on *Euphorbia hirta Linn* has a lot of promise. Standardised preclinical and clinical studies are vital to determine its safety profile, pharmacokinetics, and pharmacodynamics, even in the face of widespread traditional use and early scientific validation of its biological activities. Subsequent investigations ought to concentrate on the structural clarification and isolation of new bioactive substances through sophisticated chromatographic and spectroscopic methods, succeeded by mechanistic analyses to comprehend their molecular targets and modes of action. *Euphorbia hirta* may prove to be a useful ingredient in the creation of herbal remedies to treat chronic inflammatory diseases and antibiotic resistance due to its extensive antimicrobial and anti-inflammatory properties. Human safety depends on toxicological evaluations, especially long-term and reproductive toxicity studies. Its pharmacological network and interactions within biological systems may also be better understood by combining genomic, proteomic, and metabolomic approaches. *Euphorbia hirta* plant's transition from traditional medicine to evidence-based clinical application can be facilitated by partnerships between ethnobotanists, pharmacologists, and the pharmaceutical industry.

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