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Ethnomedicinal Studies of *Euphorbia hirta* L. (Family: Euphorbiaceae): Traditional Uses, Phytochemistry and Pharmacological Potential

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Abstract

Euphorbia hirta L. (Euphorbiaceae), commonly known as asthma weed, garden spurge or dudhi, is a ubiquitous small annual plant that grows widely in the tropical and subtropical regions of the world. Though it is frequently considered as a weed, this species has an ethnobotanical interest and has been used in various traditional medicines to treat respiratory, digestive, skin, and genital tract infections, as well as to address other health issues. For example, asthma, bronchitis, cough, diarrhea, dysentery, parasitic infections, jaundice, dermatitis, conjunctivitis, and abortion were among the reported uses of *Euphorbia hirta*. The plant parts usually used for this purpose included leaves, whole plant, roots, and latex, which were employed in the form of decoctions, poultices, infusions, and other preparations. Flavonoids, tannins, phenolics, triterpenoids, and phytosterols were among phytochemicals reported in *Euphorbia hirta*. At the same time, the pharmacological properties of this plant species were also confirmed by several researchers, who found that it might be useful as an antibacterial and antifungal, anti-inflammatory, antidiarrheal, antioxidant, antiasthmatic, antimalarial, antidiabetic agent, among other purposes. Moreover, there were reports on the use of *Euphorbia hirta* for the treatment of dengue fever in the Philippines, whereas in other regions, it was used to address respiratory and gastrointestinal tract infections, among other conditions. Nevertheless, it is necessary to note that the use of this plant species has not been proved to be safe, and the application of *Euphorbia hirta* latex and extracts might cause numerous adverse effects. In this regard, this review aims to present the botanical and ethnobotanical aspects, phytochemistry, pharmacology, and toxicity of *Euphorbia hirta*, as well as summarize the collected findings in the form of tables and diagrams for the ease of access to the information.

***Key words*:** *Euphorbia hirta*, Euphorbiaceae, Ethnomedicine, medicinal plants, Traditional medicine, Phytochemistry, Pharmacology, Asthma weed

Medicinal plants have been an essential component of traditional health systems since time immemorial. Even today in developing countries people rely on local resources for the management of their ailments due to their availability, cultural relevance, and traditional knowledge. Ethnomedicine provides insights into the uses, parts used, preparations, and applications of various species, which can serve as a basis for pharmacological and phytochemical studies. Among the wide range of medicinal flora, *Euphorbia hirta* L. stands out as one of the most widely used traditional medicinal plants, particularly in tropical and subtropical regions. It is a small, annual herb that occurs abundantly in disturbed habitats, roadsides, grasslands, agricultural fields and wastelands. Different parts of the plant, particularly the leaves, stems, roots and latex, have been traditionally employed in various systems of medicine. Its ethnomedicinal importance is largely attributed to its diverse therapeutic applications, including the management of gastrointestinal disorders, respiratory ailments, skin problems, inflammation, fever and infections. Commonly known as asthma weed or garden spurge, this herbaceous plant has a long history of use in traditional systems of medicine for the treatment of a variety of ailments. Different parts of the plant, especially the leaves and aerial portions, have traditionally been used in preparations intended to manage respiratory disorders, gastrointestinal disturbances, skin problems, inflammation, fever, and various infections [1]. Its widespread ethnomedicinal use is largely attributed to the presence of diverse bioactive constituents, including flavonoids, phenolic compounds, terpenoids, tannins, alkaloids, and other secondary metabolites. These phytochemicals are believed to contribute to the plant's reported pharmacological properties, such as antimicrobial, antioxidant, anti-inflammatory, antidiarrhoeal, analgesic and bronchodilatory activities [2]. Consequently, *Euphorbia hirta* has attracted considerable scientific interest as a potential source of therapeutically valuable natural compounds. This species

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belongs to the family Euphorbiaceae and genus Euphorbia. According to Plants of the World Online, *Euphorbia hirta* is a species that is accepted in the taxonomical sense as a 'tropical American' plant, but it is pantropical nowadays [3]. This species was traditionally used to manage respiratory ailments and, therefore, it is locally called the asthma plant or asthma weed. Additionally, it was used folklorically to treat diarrhoea, dysentery, intestinal parasites, bronchitis, cough, jaundice, skin disease, earache, and scorpion sting [4-6].

According to the survey, the leaf and whole herb are commonly used in the form of an infusion or decoction. Occasionally, the latex was applied topically [7]. In the recent ethnobotanical survey conducted among the Tripuri people of Assam, India, *Euphorbia hirta* was found to be utilized for the treatment of asthma, dysentery, jaundice, and stomach disorder. This suggests that the traditional knowledge of this species is well maintained among indigenous people to this day. Therefore, the purpose of this review is to highlight the ethnobotanical relevance of *Euphorbia hirta*, primarily focusing on its traditional uses, botanical description, phytochemistry, pharmacological potential, safety concerns, and scope for further research.

Botanical description

Taxonomic classification

Table 1 Taxonomic classification of *Euphorbia hirta* [3]

Taxonomic category		Classification
Kingdom	:	Plantae
Division	:	Phanerogames
Class	:	Dicotyledonae
Sub Class	:	Monochlamydeae
Series	:	Unisexuales
Family	:	Euphorbiaceae
Genus	:	Euphorbia
Species	:	*Euphorbia hirta*

The currently accepted botanical name is *Euphorbia hirta* L. The species was first published by Linnaeus in *Species Plantarum* in 1753. *Chamaesyce hirta* (L.) Millsp. is listed as a taxonomic synonym.

Morphological characteristics

Euphorbia hirta is typically an herbaceous plant that is usually small and grows as an annual herb. This plant is characterized by having hairy stems that are often branched, with the plants either being prostrate, ascending, or erect. The leaves and stems are also covered with white or yellow latex. The leaves are opposite, ovate or oblong, with fine teeth along the margins, and a reddish or purple spot at the center. These plants have flowers that are borne in dense clusters which define the inflorescence of Euphorbia. The flowers are small, and the fruits are three-lobed capsules that contain the seeds. The following features are useful for identifying the plant species, which are shown in (Fig 1) below: hairy plants, opposite leaves with red-purple spots, and densely clustered axillary inflorescence.



Fig 1 Photo of *Euphorbia hirta*

Ethnomedicinal importance

The ethnomedicinal importance of *E. hirta* is attributed to the use of various parts of the plant for the treatment of different ailments. Kumar *et al*. [7] for example, report that traditionally, the species has been used to treat gastrointestinal disorders, cough, intestinal parasites, dysentery, jaundice, conjunctivitis, skin problems among other illnesses. Further, Huang *et al*. [8] in their ethnopharmacological survey report that whole parts of the plant have been used in Chinese medicine as well as other regions to manage ailments including fever, diuresis, itching and lactation.

Table 2 Major ethnomedicinal applications reported for *Euphorbia hirta* [5], [7-8]

Plant part	Traditional preparation / use	Reported condition
Whole plant	Decoction / infusion	Fever and general ailments
Leaves	Infusion / decoction	Diarrhoea and dysentery
Leaves	Infusion / decoction	Asthma and respiratory disorders
Leaves	Traditional preparations	Jaundice
Leaves	External preparations	Skin disorders and itching
Aerial parts	Decoction	Gastrointestinal disorders
Root	Decoction	Selected traditional reproductive / lactation applications
Stem sap / latex	External application	Certain eye and skin conditions
Whole plant	Traditional preparation	Intestinal parasitosis
Leaves / flowers	Infusion / decoction	Asthma and digestive disorders

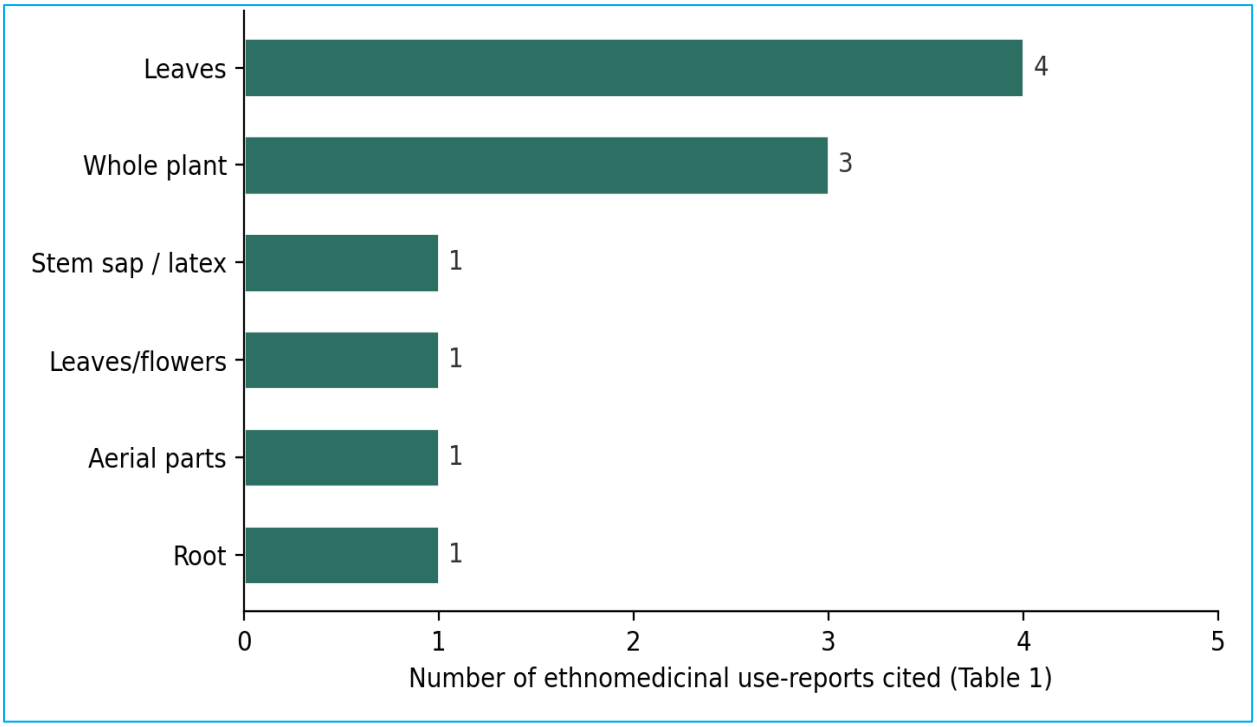


Fig 2 Plant parts most frequently cited in traditional preparations of *Euphorbia hirta*

These uses should be understood as ethnomedicinal reports rather than established clinical treatments.

Traditional use in respiratory disorders

Herbal medicines from *Adhatoda vasica* are among the most common ethnomedicinal claims for the plant. The leaves of the plant have been used traditionally to manage asthma, bronchitis, cough, cold, hay fever, and other related respiratory infections [4]. The plant species is commonly associated with asthma management, hence the names asthma weed and asthma plant. However, the ethnobotanical evidence does not suffice clinical trials, although pharmacological experiments have shown some positive results. For instance, the plant extracts showed "relaxation of isolated bronchial smooth muscles and reduction of respiratory rate in experimental animals" [6]. Nonetheless, more randomized and controlled trials are needed to confirm these findings before the herb can be recommended for the management of respiratory illnesses. Besides Al-Snafi [6], Kumar *et al*. [7] conducted an ethnomedicinal survey of the Tripuri tribe of Northeast India, where they also reported that the locals use the leaves and flowers of *E. hirta* to prepare a decoction for the management of asthma.

Gastrointestinal and antidiarrhoeal uses

Gastrointestinal indications represent another category of *E. hirta* traditional use. The plant has been used for the treatment of diarrhoea, dysentery, intestinal parasites, indigestion, stomach ache and related conditions [8-10]. Quercitrin and other flavonoids have drawn special attention since they have been reported to possess antidiarrhoeal properties which may contribute to the therapeutic effect of different *E. hirta* preparations [11]. However, considering that the phytochemical composition of the species may vary depending on the part of the plant, its geographical origin, time of harvest and extracting solvents, the therapeutic efficacy of various preparations may differ as well. However, considering that the phytochemical composition of the species may vary depending on the part of the plant, its geographical origin, time of harvest and extracting solvents, the therapeutic efficacy of various preparations may differ as well.

Traditional applications in skin and eye disorders

In addition to the described properties, traditional healers attribute various other curative effects to *E. hirta*. Thus, leaf preparations are used in the local treatment of swellings, abscesses, and skin irritations, and the latex or juice obtained from the stem is traditionally used in the treatment of some eye diseases [9]. However, it is necessary to use caution when using this plant since the latex of euphorbias often contains biologically active substances and can cause irritation. As stated in the article, the latex of euphorbias is described as acrid and irritating to the skin and contains a set of different diterpenoids and terpenoids. Consequently, it is not possible to use traditional medicine preparations containing this component without any restrictions since they may be harmful to health.

Ethnomedicinal use in indigenous communities

I think that ethnobotanical research is most interesting because such studies document traditional knowledge directly from the sources. For instance, there was a survey conducted among the members of the indigenous community in Pangasinan, Philippines, to find out the local folklore beliefs about the plant *E. hirta* growing there, called tawa-tawa. The results were obtained from 82 respondents from 3 communities, where the use reports, fidelity levels and corrected major-use agreements were made, and a similar non-intervention ethnobotanical study used pictorial assessment of traditional plant use in selected communities to document the folk taxonomy of useful plants from the region [12]. Moreover, an ethnomedicinal survey in the Tribal communities of the Northeast India recorded the use of *E. hirta* for asthma, dysentery, jaundice, and stomach problems. Thus, it can be concluded that the ethnobotanical research has wide application in understanding the importance of different species for various indigenous groups worldwide.

Phytochemical constituents

The medicinal value of *Euphorbia hirta* has prompted extensive phytochemical studies and reports on the plant's secondary metabolites. The phytochemical constituents isolated from *Euphorbia hirta* include flavonoids, tannins, polyphenols,

triterpenoids, phytosterols, alkanes, and other secondary metabolites. Among the many phytochemicals that have been identified, Kumar *et al*. [7] isolated afzelin, quercitrin, myricitrin, rutin, quercetin, gallic acid, protocatechuic acid, euphorbin derivatives, β-amyrin, 24-methylenecycloartenol and β-sitosterol from *Euphorbia hirta*. Ghosh *et al*. [5] also reported flavonoids, steroids, tannins, alkaloids, and polyphenolic compounds as some of the secondary metabolites present in the plant. On the other hand, Al-Snafi [6] identified reducing sugars, terpenoids, saponins, coumarins, and cardiac glycosides among the phytochemical constituents of *Euphorbia hirta*.

Table 3 Important phytochemical groups reported in *Euphorbia hirta* [5-7]

Phytochemical group	Examples / reported constituents
Flavonoids	Quercetin, quercitrin, rutin, myricitrin, afzelin
Phenolic compounds	Gallic acid, protocatechuic acid
Tannins	Hydrolysable / polyphenolic tannins
Triterpenoids	β-amyrin and related compounds
Phytosterols	β-sitosterol
Steroidal compounds	Various reported sterol derivatives
Alkanes	Heptacosane, n-nonacosane
Other compounds	Choline, shikimic acid and related constituents

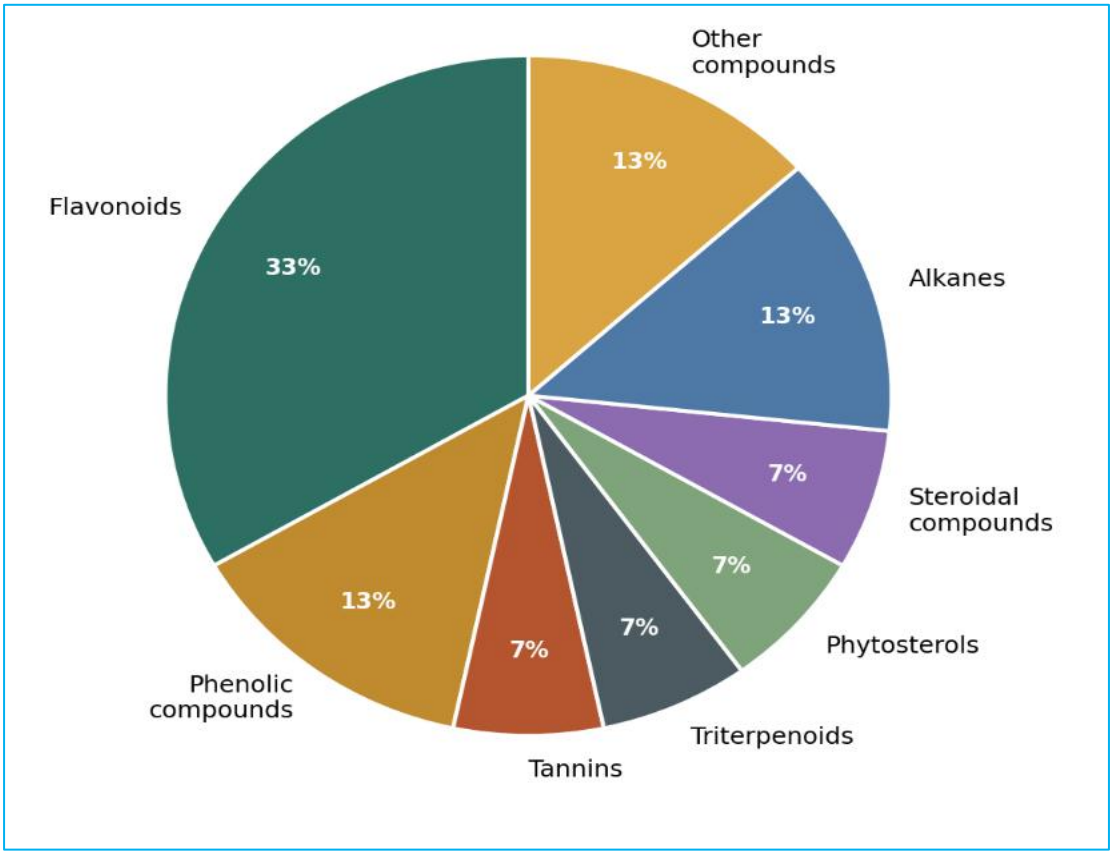


Fig 3 Relative representation of phytochemical groups reported for *Euphorbia hirta*

The presence of these compounds may partly explain the antioxidant, antimicrobial and anti-inflammatory activities reported in experimental studies.

Pharmacological activities

Although the present analysis deals primarily with ethnomedicine, pharmacological evidence also plays a critical role, as it provides a reliable basis for assessing the mechanism of action for various reported applications. In particular, the reviewed literature on *E. hirta* indicates that this plant species exhibits a variety of therapeutic properties, including but not limited to Anti-infective (antibacterial and antifungal) efficacy, antidiarrhoeic effects, Anti-inflammatory potential, Free radical scavenging ability, antiasthmatic / respiratory properties, Antimalarial (antiplasmodial) efficacy, Antipyretic and analgesic activity, Anxiolytic and sedative potential, antiamoebic effects, antidiabetic properties, Wound-healing capacity, Selected antiviral and antitumour / cytotoxic effects. Therefore, Kumar *et al*. [7] concluded that there is a large repertoire of reported biological activities for *E. hirta*, involving diverse classes of bioactive compounds with considerable structural variability. Similarly, Huang *et al*. [8] provided a comprehensive overview of the antibacterial, anti-inflammatory, antioxidant, sedative and antiallergic activities of this medicinal plant. In turn, Al-Snafi [6] elaborated on the antidiabetic, antiviral, angiotensin-converting-enzyme inhibitory, and antidipsogenic effects, while Khursheed *et al*. [13] highlighted the extensive phytochemical and pharmacological research on *E. hirta*, including potential implications for the treatment of SARS-CoV-2 infections.

Table 4 Selected pharmacological activities reported for *E. hirta* extracts, with representative preparations and sources

Activity	Representative extract / model	Key Source(s)
Antibacterial / antifungal	Methanolic leaf extract, in vitro assays	Kumar *et al*. [7], Kausar *et al*. [14]
Antioxidant	Methanolic extract, DPPH / phenolic assays	Ghosh *et al*. [5], Basma *et al*. [14]
Anti-inflammatory	Aqueous extract, carrageenan-induced models	Al-Snafi [6], Kumar *et al*. [7]
Antidiarrhoeal	Quercitrin-rich fractions	Kumar *et al*. [7]
Antiasthmatic / respiratory	Whole-plant decoction	Kumar *et al*. [7], Tripathi *et al*. [10]
Antidiabetic	Ethanolic / ethyl acetate extract	Al-Snafi [6], Tripathi *et al*. [10]
Antimalarial / antiplasmodial	Ethanolic whole-plant extract	Al-Snafi [6]
Sedative / anxiolytic / analgesic	Aqueous extract, behavioural models	Huang *et al*. [8], Al-Snafi [6]
Wound healing	Aerial-part extract, excision wound models	Al-Snafi [6]
Antiviral	Whole-plant extract (in vitro)	Al-Snafi [6]

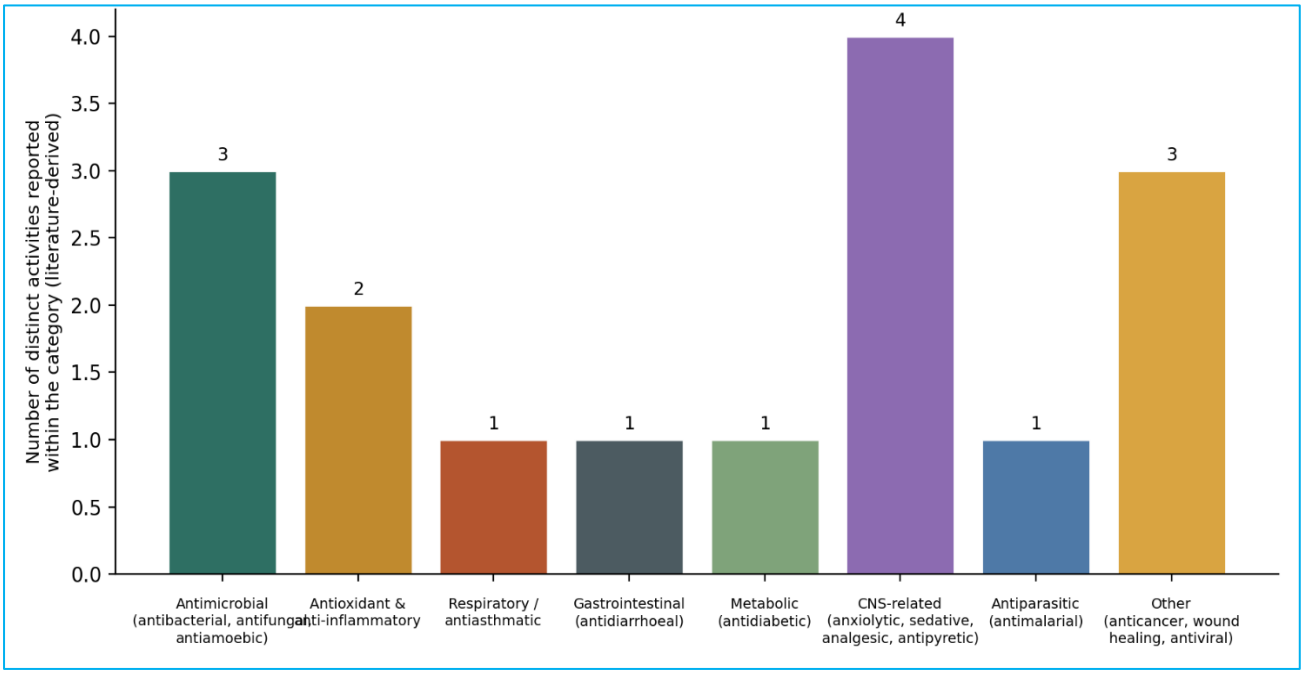


Fig 4 Pharmacological activity categories reported for *Euphorbia hirta*

Antimicrobial potential

The antimicrobial potential of *E. hirta* has been demonstrated using various extracts and models. For instance, methanolic extracts of the leaves have displayed antibacterial and antifungal properties in vitro [9], [15]. The presence of phenolics, flavonoids and tannins may contribute to its antimicrobial potential by disrupting microbial membranes, inhibiting enzyme activities and interfering with other cellular processes. However, antimicrobial potential in vitro does not necessarily imply efficacy in vivo. Further studies are needed to evaluate standardized extracts, define minimum inhibitory concentrations, establish mechanisms of action and assess antimicrobial activity against pathogens of clinical relevance.

Antioxidant and anti-inflammatory potential

Phenolic and flavoniod components have been found to contribute to *E. hirta's* antioxidant potential. It has been reported by Basma *et al*. [14] that free-radical scavenging activity together with total phenolic content in methanolic extracts could be potentially responsible for the herb's ability to manage inflammation and oxidative stress. It is also reported that extracts had significant anti-inflammatory activity. Kumar *et al*. [7] concluded that anti-inflammatory effects contributed to the plant's ethanolic and aqueous extracts' ability to manage diverse inflammatory diseases, including edema and respiratory and gastrointestinal tract ulcers.

Safety and toxicological considerations

The medicinal use of *E. hirta* always has to consider certain side effects and safety mechanisms. Mostly, the species of Euphorbia contain latex, which can be dangerous for the human body, cause irritation, or have a notable physiological effect. In addition, several experimental toxicological studies showed that the safety of these preparations depends on multiple factors: the part of the plant used for preparation, a solvent, and a dose. For example, one of the studies revealed that methanolic extracts of flowers and roots of *E. hirta* demonstrated varying levels of toxicity in experimental animals [16-17]. Therefore, it is unsafe to use the traditional dosage of these preparations, especially for vulnerable groups of people like pregnant women and children and in the case of prolonged use.

The reviewed literature highlights evidence on the ethnomedicinal significance of *E. hirta*. The species has been reported as ethnomedically used traditionally to manage a range of diseases including respiratory and gastrointestinal tract infections [18]. The prevalence of asthma, diarrhoea, dysentery, and skin diseases reported in diverse communities and countries from Northeast India to the Philippines indicates the plant's ethnomedical importance (Table 2, Fig 2).

One of the strengths of the research on ethnomedicine is that it helps generate hypotheses for pharmacological investigations. For instance, reports on the traditional use of *E.*

hirta led to phytochemical studies revealing the presence of flavonoids, phenolics, tannins, triterpenoids, and phytosterols (Table 3, Fig 3). Consequently, pharmacological trials have demonstrated antimicrobial, antioxidant, anti-inflammatory, antidiarrhoeal, antidiabetic, and other activities of *E. hirta* (Table 4, Fig 4). These findings partly explain the traditional therapeutic claims for the species.

However, the evidence on the pharmacological potentials of *E. hirta* is limited by the fact that many studies used crude extracts, cell cultures, laboratory-grown microorganisms, and animal models for experimentation [19-20]. Besides, most of the trials aimed at establishing the antiasthmatic, antimalarial, antidiarrhoeal, and antitussive properties of the species reported conflicting results. Moreover, the traditional efficacy claims of *E. hirta* in treating skin ulcers, dengue, and malaria should be viewed with caution since they lack sufficient scientific evidence [21-22]. Therefore, future research on the pharmacological actions of *E. hirta* should involve multidisciplinary and collaborative trials using pharmacognosy, phytochemistry, ethnobotanical surveys, molecular biology, pharmacology, and toxicology approaches.

Research gaps and future prospects

Future studies on *E. hirta* would be aimed at addressing the following research goals:

1. Conducting ethnobotanical surveys among the tribal and rural populations of different parts of the country to document their traditional knowledge about the plant.
2. Carrying out quantitative ethnobotanical studies including calculation of Use Value (UV), Informant Consensus Factor (ICF) and Fidelity Level (FL).
3. Pharmacognostic standardization of different parts of the plant.
4. Using DNA barcoding for authentication of the species.
5. Phytochemical screening by using modern techniques like HPLC, LC-MS/MS and GC-MS.
6. Isolation of major bioactive compounds present in different fractions of the plant.
7. Exploring the mechanism of action of the plant extract which helps to understand its anti-diarrhoeal, anti-inflammatory and antimicrobial activity.
8. Standardization of traditional formulations and dosage.
9. Carrying out acute, subacute and chronic toxicity studies.
10. Conducting well-designed clinical trials for evaluating the traditional claims that have been proved active in preclincal studies.
11. Conservation of indigenous knowledge.
12. Phytochemical variation – geographical study.

Table 5 Summary of priority research gaps by domain

Research domain	Priority gap
Ethnobotany	Systematic, community-based documentation across Indian tribal and rural regions
Quantitative ethnobotany	Application of Use Value, Informant Consensus Factor and Fidelity Level indices
Pharmacognosy	Standardization of leaf, root and whole-plant material
Molecular identification	DNA barcoding to confirm species identity across populations
Phytochemistry	Profiling via HPLC, LC-MS/MS and GC-MS across geographic sources
Pharmacology	Mechanistic studies for antidiarrhoeal, anti-inflammatory and antimicrobial effects
Toxicology	Acute, subacute and chronic toxicity studies by plant part and extract type
Clinical research	Controlled trials where preclinical evidence is sufficiently strong

CONCLUSION

Euphorbia hirta L. (Euphorbiaceae) is a medicinal plant with a wide range of traditional uses. However, most of these claims lack clinical trials and reliable data on pharmacological properties. This review aims to present and discuss available information on the botanical, phytochemical and pharmacological properties of *Euphorbia hirta* and provide directions for future research. The species has been reported to possess a variety of pharmacological activities. The most prominent effects include anti-inflammatory and antimicrobial activity, along with anti-ulcer and antispasmodic properties. A number of phytochemicals have been reported from the plant, including flavonoids, polyphenolics, tannins, triterpenes and phytosterols. Despite its pharmacological potential, *Euphorbia hirta* is not devoid of adverse effects, particularly when using crude latex or over-concentrated extracts. While many of the reported properties of *Euphorbia hirta* were found to have a basis in experimental studies, most traditional applications have not undergone thorough scientific evaluation. Particular caution should be exercised when extrapolating traditional claims to specific population groups, as different populations may use different plant parts and preparations. *Euphorbia hirta* appears to be a valuable object of pharmacological research due to the potential synergy between traditional claims and scientific data. Better understanding of the mechanisms and applications of the species' phytochemistry may help realize its therapeutic potential.

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