Review of the phytochemical and pharmacological activities of Euphorbia hirta Linn.

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ABSTRACT

The use of plant extract to cure diseases has been the traditional way used in many parts of the world. The synthetic drugs used now are more prone to cause side effects than curing the disease. Hence, the use of plant extract has now emerged due to their effective action against the disease without causing any side effects. The plants belonging to the family called Euphorbia are widely used in medicine for its wide medicinal properties. The plant Euphorbia hirta has properties like anti-bacterial, anti-diarrheal, anti-allergic, diuretic, anti-oxidant, anti-tumor, anti-diabetic, anxiolytic and sedative activity. This review contains the detailed information about all the properties of E. hirta.

INTRODUCTION

Euphorbia hirta, belongs to genus Euphorbia, and family Euphorbiaceae. It is widely used as an important medicinal plant and used for the treatment of various diseases like gastrointestinal disorders including intestinal parasites, diarrhea, peptic ulcers, heartburn, vomiting, and amoebic dysentery, inflammations of the skin and mucous membranes like warts, scabies, tinea, thrush, aphthae, fungal affections, and measles and respiratory system disorders like asthma, bronchitis, hay fever, laryngeal spasms, emphysema, coughs, and cold.¹² The plant is commonly found in China, India, Philippines, Australia, Africa, and Malaysia. According to the epidemiological survey, the increasing lifestyle in human causes more serious health issues like kidney and hepatic issues, which can be cured by the use of plant and weed extract.³

BOTANICAL DESCRIPTION

E. hirta is a plant that grows up to 80 cm in height with slender and erect stem. It is a broad leaf with hairy stem with leaves that are oblong, elliptical, opposite arrangement. It has a faint toothed margin with small flowers. The plant is usually found in grasslands, pathways, roadsides, and in areas rich in water. The fruits are yellow in color with 1-2 mm in diameter that has wrinkled seeds along the four sides with hairy capsules.²

PHYTOCHEMISTRY

E. hirta is composed of flavonoids, terpenoids, phenols, essential oil, and other compounds. Flavonoids include quercetin, quercitrin, quercitol, and its derivatives.⁴ Terpenoids include triterpenes: α-amyrin, β-amyrin, friedelin, taraxerol, and its derivatives.⁵ Tannins include the dimer rich hydrolysable dehydro-ellagitannins-euphorbins A, B, C, E, and terchebin, the monomeric hydrolysable tannins-geraniin.⁶ Other compounds include ellagic, gallic, tannic, maleic and tartaric acid.⁷ Various other compounds present in the plant contain saponins, amino acids, alkaloids and minerals.⁸ The ethyl acetate extract of the plant contain afforded quercetin, dihydroxy quercetin, and two new prenylated flavonoids known as hirtacoumarinflavonoside and hirtaflavonoside-B characterized as 7-O-(p-coumaroyl)-5,7,4′-trihydroxy-6-(3,3-dimethyl allyl)-flavonol-3-O-β-d-glucopyranosyl-(2″→1″)-O-α-l-rhamnopyranoside and 5, 7, 3′, 4′-trihydroxy-6-(3, 3-dimethyl allyl)-8-(iso-butenyl)-flavonol-3-C-β-d-glucopyranoside, respectively. All compounds extracted from the plant exhibited dose dependent inhibition of α-glucosidase. It was reported that 5,7,4′-trihydroxylavone structure is imperative for the inhibitory activity. The rich flavonoids contents increase the potency and p-coumaroyl substitution at C-7 further enriched the α-glucosidase inhibition.⁹ A Study conducted by Yvette Fofie reported that the leaf and stem extract of E. hirta contained mineral salts, bioactive secondary metabolites and various other trace elements which can be used as a therapeutic drug against diabetes mellitus.¹⁰ Table 1 shows the different beneficial effects of different extracts of E. hirta.

ANTI-BACTERIAL ACTIVITY

The anti-bacterial activity of E. hirta was discovered and proven by using the methanol extract which showed the property against dysentery causing Shigella species in the Vero cell line.¹¹ The non-cytotoxic concentration of the plant extract was examined for anti-bacterial activity against the various doses of the pathogen. The extracts were thus proved to be non-cytotoxic and effective anti-bacterial agents.¹² The anti-microbial activity was tested using the nystatin and the methanol extract obtained from the leaves of E. hirta and examined on Candida albicans. The results obtained were favouring.¹² It was reported that anti-microbial activity was attributed to tannins, flavonoids, alkaloids, glycosides, proteins, sterols, and saponins. The crude ethanolic extract of E. hirta exhibited anti-bacterial activity against the growth of Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, and Bacillus subtilis.¹³ When compared to the anti-bacterial activity of the plant extract between the gram positive and gram negative bacteria the results were exhibited more promisingly in gram positive bacteria.¹⁴ The plant is found to be rich with caffeic acid and epicatechin 3-gallic acid, which are found to be anti-bacterial in nature. This is the reason for the plant to be traditionally used in Malaysia for the treatment of gastrointestinal and respiratory ailments caused by nosocomial infectious agents. The plant extract also expressed inhibitory action against P. aeruginosa cells.¹⁵ The flavonoids extracted from the roots of
the plant expressed activity against C. albicans, Proteus mirabilis and S. aureus. Mir et al. conducted study on dengue patients whose platelet count was extremely low and after treatment with the plant extract it was found that 70% patients showed improvement in platelet count, fever and flu-like symptoms.

**ANTI-DIARRHEAL ACTIVITY**

The aqueous extract obtained from the leaves of E. hirta exhibited excellent effect by decreasing the gastrointestinal motility in normal rats and effect of castor oil-induced diarrhea in mice. The anti-diarrheal activity was shown by Quercitin, a flavonoid extracted from the plant in crude form. This quercitin acts by increasing the colonic fluid absorption showing anti-diarrheal activity in the presence of secretagogue compounds.

**ANTI-ALLERGIC ACTIVITY**

The ethanolic extract of E. hirta showed effective anti-anaphylactic activity. E. hirta by inhibits the passive cutaneous anaphylaxis in rat and active-paw and anaphylaxis in mice. The extracts of E. hirta showed suppressive effects on the release of tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) from anti-DNP-HAS activated rat peritoneal mast cells. Thus, it is reported that E. hirta is traditionally used as an herbal drug against Type I allergic disorders. It was also found that the aqueous extract of the plant inhibited the stimulation of prostaglandin E2 from activated rabbit synovial fluid cells, HIG-82 cells up to a large extent. Bioactive compounds possessing anti-inflammatory activity was reported to be highly concentrated in the aqueous extract of the plant.

**DIURETIC ACTIVITY**

The ethanolic and aqueous leaf extracts of E. hirta showed diuresis in rats. It was observed that the extract increased urine output and electrolytes. Various experiments reported that the active components in the water extract of E. hirta leaf had similar property of diuretic just like acetazolamide thus proving the diuretic activity of E. hirta.

**ANTI-OXIDANT ACTIVITY**

The methanolic extract of the plant expressed similar anti-oxidant activity as that of green and black tea. The phenolic acids extracted from the aqueous leaf solution showed the anti-oxidant activity. Ferric reducing antioxidant power (FRAP) and 1,1-Diphenyl-2-picryl-hydrazyl (DPPH) assays were conducted to ascertain the efficacy of phenolic extracts. The phenolic acid from E. hirta displayed enhanced, free radical scavenging activity, and exhibited protection against oxidative damage to protein. Lipid peroxides, hydroperoxides and both enzymatic and non-enzymatic anti-oxidants express the anti-oxidant potential of the leaf extract.

**ANTI-TUMOR ACTIVITY**

The anti-tumor activity of the E. hirta extract was studied on EL-4 cell lines in Swiss Albino mice. Significant in cell tumor mass was observed after treating it with the plant extract. The methanol extract of the leaves of E. hirta showed anti-proliferative activity on Hep-2 cells from human epithelium of the larynx. It was also evaluated that the methanolic extract and quercetin exhibited mutagenic and anti-mutagenic activity.

**ANTI-APOPTOTIC ACTIVITY**

In the studies conducted by Kwan et al. it was revealed that E. hirta showed significant inhibition of the survival of breast cancer cell lines MCF-7 cells and the half inhibitory concentration (IC50) values were 25.26 µg/mL at 24 h. Microscopic studies conducted expressed that E. hirta treated cells showed remarkable morphological characteristics of apoptosis. E. hirta extract also expressed an ignorable influence on the lactate dehydrogenase leakage. The flow cytometry study confirmed that E. hirta extract induced apoptosis in MCF-7 cells. E. hirta also induced DNA fragmentation in MCF-7 cells. Above all, E. hirta treatment resulted in the accumulation of cells at the S and G/M phases and apoptosis.

**ANTI-DIABETIC ACTIVITY**

Ethanolic and ethyl acetate extracts of E. hirta were used to examine the anti-diabetic activity. Using the α-glucosidase inhibitor method the extract was assayed in vitro. A significant reduction in the blood glucose level was observed in streptozotocin induced diabetic mice on treatment with ethanolic extract of leaf, flower and stem of the plant. Subramanian et al. treated the experimental diabetic rats with the leaf extract of E. hirta and found the anti-diabetic property of the extract.

**ANXIOLYTIC AND SEDATIVE ACTIVITY**

The hydroalcoholic extract of E. hirta was used to examine anxiolytic property of the plant in chronically stressed rats. To evaluate the mechanism for the anxiolytic action of the drug, antagonists of the GABAA receptor-benzodiazepine receptor-Cl channel complex with E. hirta were used together, showed marked anti-anxiety activity in chronic immobilization stress.

**ANTI-VENOM ACTIVITY**

It is reported that the methanolic extract of E. hirta inhibited the venom enzymes under the in vitro conditions, thereby reducing the ration of edema in the mice. The evidences were collected by the histopathological analysis of the vital organs. The content of phenolic compound was also found to be quite elevated and the plant was found to be highly rich with the contents of ellagic acid, quinic acid and gallic acid. These compounds well known for their ability to inhibit venom proteases.

**IMMUNOSTIMULATORY ACTIVITY**

Pratheepa and Sukumaran worked with the leaf extract of E. hirta with the objective of studying its immunostimulatory activity. The study was conducted on a medicated fish which was infected with Aeromonas hydrophila pathogen. It was reported by them that the count of red blood cells and white blood cells gradually increased with the higher dose concentration of the plant leaf extract. The leaf extract was also able to induce immune response of antibodies. The extract also helped in the elimination of pathogens from the kidney and blood of the fish. Thus, their work suggested that E. hirta possessed immunostimulatory activity by stimulating both specific and non-specific immunity at elevated concentrations.

**WOUND HEALING ACTIVITY**

Studies conducted by Upadhyay et al. reveals that the methanol extract of the E. hirta possess wound healing activity as it showed potentially high anti-microbial activity against Escherichia coli and Klebsiella pneumoniae along with the fibroblast proliferating activity. In their study, they concluded that the wound healing activity and collagen production in wounded tissues is governed by the Smad-mediated proteins. The terpenes extracted from the stems, roots and leaves of E. hirta showed anti-microbial activity and are commonly used for wound healing and for the treatment of boils.

**ANTI-INFLAMMATORY ACTIVITY**

Ahmad et al. worked with the plant extract whose traditional use for the treatment of a variety of diseases drove their interest to check for the anti-inflammatory effect of it. They initiated the study with the aim...
Table 1 Shows the several of activities of *Euphorbia hirta*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Action</th>
<th>Study done by</th>
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<tbody>
<tr>
<td>Anti-bacterial activity</td>
<td>Plant extracts were used to check the anti-bacterial activity in Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, and Bacillus subtilis and the results showed reduced growth of these bacteria.</td>
<td>Vijaya et al., 1995; Jackson et al., 2009; Suresh et al., 2008; Ogbulie et al., 2007; Nelofar et al., 2006</td>
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<td>Anti-diarrheal activity</td>
<td>The flavonoid called quercitin present in the leaves extract showed anti-diarrheal activity by increasing the colonic fluid absorption in the presence of secretagogue compounds.</td>
<td>Galvez et al., 1993; Hore et al., 2006</td>
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<td>Anti-allergic activity</td>
<td>The ethanolic extract of <em>E. hirta</em> showed suppressive effects on the release of TNF-a and IL-6 from anti-DNP-HAS activated rat peritoneal mast cells thus acting as an anti-allergic agent.</td>
<td>Youssouf et al., 2007</td>
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<tr>
<td>Diuretic activity</td>
<td>The ethanolic extract when given to rat showed increased urine output thus enhancing the diuresis.</td>
<td>Johnson et al., 1999</td>
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<tr>
<td>Anti-oxidant activity</td>
<td>DPPH assays proved the activity of <em>E. hirta</em> extract acting against oxidative damage to protein.</td>
<td>Sharma and Prasad, 2008</td>
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<tr>
<td>Anti-tumor activity</td>
<td>The methanol extract of the leaves of <em>E. hirta</em> showed anti-proliferative activity on Hep-2 cells from human epithelium of the larynx thus proving its anti-tumor activity.</td>
<td>Sandeep and Chandrakant, 2011</td>
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<tr>
<td>Anti-diabetic activity</td>
<td>Reduction in blood glucose level was observed in streptozotocin induced diabetic mice on treatment with ethanolic extract of leaf, flower and stem of the plant.</td>
<td>Widharna et al., 2010</td>
</tr>
<tr>
<td>Anxiolytic and sedative activity</td>
<td>The antagonists of the GABAA receptor-benzodiazepine receptor-Cl channel complex with <em>E. hirta</em> were used together, and anxiety in the EPM showed marked anti-anxiety activity in chronic immobilization stress.</td>
<td>Anuradha et al., 2008</td>
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</table>

Toxicity Studies

*E. hirta* is widely used as ethnomedicine due to its various benefits. Thus, the need of toxicity, check arose in the mind of various researchers and Yuet Ping et al., went ahead with it. The conducted the study for evaluation of acute and subchronic toxicity on Sprague Dawley rats. The extract dose did not express any signs of acute toxicity or mortality on any of the rats. Long term oral administration of the plant extract showed no variation in the food or water consumption, body weight, biochemical and haematological parameters etc. therefore, the team concluded that the plant extract does not possess acute or sub-chronic toxicity.

Conclusion

In this review of *E. hirta*, a summary of its phytochemistry, anti-bacterial activity, anti-diarrheal activity, anti-allergic activity, diuretic activity, anti-oxidant activity, anti-tumor activity, anti-diabetic activity, anxiolytic and sedative activity were discussed in detail. Details furnished in this review will further help in exploring more about other properties associated with it.

Conflicts of Interest

No funding source and there is no conflict of interest.
ABBREVIATION USED

DPPH: 1,1-Diphenyl-2-picryl-hydrazyl; FRAP: Ferric Reducing Antioxidant Potential; IC₅₀: Inhibitory Concentration; IL-6: Interleukin-6; TNF-α: Tumor Necrosis Factor-Alpha.

REFERENCES


PICTORIAL ABSTRACT

Euphorbia hirta

SUMMARY

- Euphorbia hirta has been recognized as the medicinally essential phytoconstituents.
- These phytoconstituents have immense potential of this plant in the treat-ment of numerous diseases.

ABOUT AUTHOR

Dr. A. Vijaya Anand: Associate Professor and Head, Department of Human Genetics and Molecular Biology, Bharathiar University, Coimbatore, Tamil Nadu, India. He has published multiple scientific articles in international journals. He is currently engaged in the field of phytopharmacology, neurogenetics, medical genetics and clinical biochemistry.