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Review Article

PHYTOCHEMICAL AND PHARMACOLOGICAL REVIEW OF ECBOLIUM VIRIDE (FORSSK.) MERRILL: A PROMISING MEDICINAL PLANT

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ABSTRACT:
Ecbolium viride (Forssk.) Merrill, a member of the Acanthaceae family, is a medicinal plant traditionally used in Ayurveda and Siddha systems for treating a variety of ailments including fever, jaundice, asthma, inflammation, rheumatism and liver disorders. This review highlights its taxonomy, morphology, phytochemistry and pharmacological activities. Phytochemical analysis reveals the presence of flavonoids (orientin, isoorientin, vitexin, isovitexin), ecbolin A and B, alkaloids, glycosides, and phenolic compounds. Extracts from different parts of the plant-especially roots, leaves, and flowers—have shown significant antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, antidiabetic, cytotoxic, and larvicidal effects. Despite its rich ethnomedicinal background and promising bioactivity, comprehensive pharmacological studies, toxicity assessments, and clinical trials remain limited. Ecbolium viride holds great potential as a source of natural drugs and offers valuable opportunities for future pharmaceutical development.

Keywords: Ecbolium viride, Phytochemistry, Pharmacological activities, Antioxidant, Hepatoprotective, Antimicrobial

INTRODUCTION

Medicinal plants remain a trusted source of affordable, safe, and accessible remedies worldwide. In Sudan and other developing countries, traditional herbal medicine plays a key role in healthcare, making it important to study local plants for their potential to treat serious illnesses [1-2]. In traditional healing practices, plants are valued as essential sources of natural compounds that support and maintain human health. They have played a vital role in promoting well-being across generations [3]. It's no wonder that more than 80% of the world's population still relies on traditional plant-based treatments for their health needs [4].

Plants are incredibly rich in natural chemicals, especially secondary metabolites, which offer a wide range of healing and therapeutic effects[5]. These properties make them especially valuable to fields like pharmaceuticals. Today, there's a growing global interest in natural medicine, largely because plant-based remedies are often seen as safer, more effective, and more culturally familiar than synthetic drugs with fewer side effects [6].

Ecbolium viride (Forsk) Merrill. Syn: Ecbolium linneanum Kurz (Acanthaceae) is a low ornamental shrub found in northeast India. In folk medicine, aqueous extract of dried roots of the plant are used for treating jaundice, rheumatism and menorrhagia, Phytochemical screening has shown the presence of alkaloids, carbohydrates, glycosides, tannins and saponins. The roots of E. viride have been reported to have anthelmintic, antioxidant, anti-inflammatory, anti-hepatotoxicity, antiplasmodial, antitrypanosomal antimalarial activity. Methanolic extract from aerial parts of the plant exhibited antibacterial activity [7].

Geographical distribution of E.viride

India, Africa, Sri Lanka, Malaya, Nepal. In India, it has been distributed across Andhra Pradesh, Kerala, Tamil Nadu and Karnataka [8].

Taxonomical Characters:

Kingdom: Plantae
Phylum: Magnoliophyta
Class: Magnoliopsida
Order: Lamiales

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Family: Acanthaceae
Genus: Ecbolium
Species: Ecbolium viride (Forssk).
Alston Common name: Green Shrimp plant Synonym: Ecbolium linneanum.
Vernacular names
English: Blue fox Tail Nail Dye
Telugu: Nakka toka
Tamil: Nilambari
Hindi: Udajat
Malayalam: Karinkurinji
Kannada: Kappu bobbali (kappu karni)
Sanskrit: Sahacharah
Bengali: Neel Kantha
Plant Description:
Woody under shrubs. Leaves opposite, 3-4 x 2-2.5 cm, sessile, ovate, acute, base truncate, puberulous. Flowers in dense terminal spikes; bracts shortly aristate, broadly ovate, minutely dentate, shortly acuminate, 2 x 1.5 cm. Calyx 5-partite, connate below; lobes linear. Corolla tube very long and slender, bluish-green; limb 2-lipped, the upper lip narrow, shortly 2-fid, the lower 3-lobed with broad pendent lobes. Stamens 2, attached near the top of the tube; anthers 2 celled, parallel. Fruit an ovoid compressed capsule narrowed into a solid stalk; seeds on curved retinacula[9].
Chemical constituents
Nair AG et al., prepared the ethanolic extracts of shade-dried leaves, flowers, and roots of Ecbolium linneanum. The extracts showed a significant presence of four C-glycosyl flavones: orientin, vitexin, isoorientin, and isovitexin. These flavones were present in a characteristic ratio of 5:5:1:1. All parts of the plant were notably rich in these glycoflavones. Remarkably, the extracts lacked free aglycones and O-glycosides, which is uncommon among Acanthaceae species[10].
Venkataraman R, et al., reported the isolation of a furofuran-type unsymmetrical lignan, Ecbolin A, from the chloroform extract of the root of Ecbolium viride [11].
Ezhilmuthu RP et al., identified a novel hetero-furanoid compound, named 4-methoxy-5-[4-(4-methoxy-1,3-benzodioxol-5-yl) perhydro-1H,3H-furo[3,4-c] furan-1-yl]-1,3-benzodioxole, in the ethyl acetate extract of Ecbolium viride roots [12].
Lalitha KG et al., reported the isolation of a new flavone glycoside, identified as luteolin 7-O-(2"-sinapoyl) glucoside, from the ethyl acetate extract of the root[13].
Choudhury D et al., conducted GC-MS analysis of the ethanolic leaf extract and reported the presence of several potential compounds, including (R)-4-(1',1'-dimethylethyl)-1,3,2-dioxathiolane-2-one, neophytadiene, 3,5-dioxohexanoic acid, 3-chloromethylfuran, the methyl ester of 9,12,15-octadecatrienoic acid (Z, Z, Z), and 1-(cyclohexan-1-yl) but-3-ene[14].
Cecilia, K.F et al., isolated an active compound, Ecbolin A — a furofuran-type lignan — from the ethyl acetate extract of the roots[15].
Cecilia KF et al., fractionated the ethyl acetate root extract using column chromatography, which yielded 12 fractions. Fractions 6 and 7 were selected for crystallization and further analysis. Ecbolin B was isolated from fraction 6, while Ecbolin A was obtained from fraction 7 [16].
Ankush Pal et al., reported that among all extracts tested from Ecbolium viride, the methanol extract contained the highest total phenolics at 16.82 mg GAE/g. The aqueous extract showed the greatest flavonoid content, measuring 6.39 mg QE/g. Interestingly, both the methanol and aqueous extracts had the highest alkaloid levels, each at 7.45%. In contrast, extracts prepared with petroleum ether and chloroform contained significantly lower amounts of these key phytochemicals [17].
Pharmacological Activities
Antioxidant Activity
Babu VL et al., investigated the antioxidant effects of methanolic extract of E. viride root in carbon tetrachloride induced oxidative stress in albino Wister rats. The extracts were administered through oral route at two doses of 200 and 400mg/kg for 7 days. The extract significantly lowered TBARS levels and enhanced the activities of antioxidant enzymes like SOD, CAT, and GPx, conforming its antioxidant activity [18].
Antimicrobial activity
Cecilia KF et al., reported antibacterial activity of the E. viride plant. Hexane, ethyl acetate and methanol extraction of roots showed antimicrobial activity against nineteen bacteria and twelve fungal species. Disc diffusion method is used to measure bacterial growth and MIC was determined using broth dilution method. The ethyl acetate extract showed highest degree of antibacterial activity than other solvent extracts. The ethyl acetate showed highest antibacterial activity of MIC- 0.039mg/ml against Staphylococcus aureus and it was compared

with ciproflaxicin while the highest antifungal activity of MIC- 0.025mg/ml against Malassezia pachydermatis it was compared with fluconazole [19].

Cecilia KF et al., reported the antimicrobial activity of the ecbolin-A isolated from ethyl acetate fraction of E.viride roots. Using the microbroth dilution method, its antibacterial activity was evaluated against 12 fungal and 19 bacterial strains. The chemical showed strong antibacterial activity and moderate antifungal effects. These findings suggest that Ecbolin A could be a promising new antibiotic, especially for treating infections that are resistant to multiple drugs. [20]

Rudhra.S et al., reported the antimicrobial activity of E. viridae plant. Ethanol, methanol and acetone extraction of leaves shows important antibacterial activity against Gram positive and Gram-negative pathogenic bacteria. Disc diffusion method is used to measure the bacterial growth and it is compared with Ampicillin. The ethanol extract showed the highest antibacterial activity at 200(µg\mL) with inhibitory zone of 20.3±0.27mm against Staphylococcus aureus followed by inhibitory zone of 19.3±0.26 mm against Escherichia coli and inhibitory zone of 16.56±0.3mm against klebsiella pneumonia [21].

Siraj MA, et al., investigated the antibacterial activity of ethanolic extract of E. linneanum against Gram positive and Gram-negetive pathogenic bacteria. Disc diffusion method is used to measure the bacterial growth and it is compared with Mecillinam. The highest zone of inhibition was found against Shigella sonnei (14 mm) at 500µg/disc and showed a moderate activity against E. coli, E. facealis and S. agalectiae. This suggests that extract has antibacterial activity [22].

Hepatoprotective

Babu, V. L et al., assessed the hepatoprotective effects of E.viride extracts in albino wister rats subjected to paracetomol- induced liver toxicity. Pretreatment with the extract reduced the levels of SGPT, SGOT, ALP, total bilirubin, triglycerides and increasing the level of total proteins with the 200 and 400 mg/kg suggesting its potential in mitigating hepatic damage [23].

AJ, S et al., investigated the hepatoprotective role of aqueous extract of E.viride whole plant in Thioacetamide induced liver cirrhosis in albino rats. Rats received intraperitoneal injections of TAA (200 mg/kg) thrice weekly for eight weeks. Concurrently 250mg/kg was administered three time a week for eight weeks. The aqueous extract exhibited significant hepatoprotective effects, as evidenced by improved liver histology and biochemical parameters [24].

Cheedella HK et al., Explored the hepatoprotective and antioxidant effects of ethanolic extract from the roots of E.viride against paracetamol-induced hepatotoxicity in Albino Wistar rats. Rats received Paracetamol to induce hepatotoxicity, followed by treatment with ethanolic extract of E. viride roots was suspended in 0.5% CMC and administered orally (p.o., post-esophagus) at doses of 100, 200, and 400 mg/kg body weight. The treatment began 24 hours after paracetamol administration and continued for a total duration of 7 days. The antioxidant activity of the extract was evaluated using various in vitro methods, including DPPH radical scavenging, nitric oxide (NO) radical scavenging, superoxide radical scavenging, hydrogen peroxide (H_2O_2) scavenging, hydroxyl radical scavenging, and lipid peroxidation inhibition assays. Liver samples were subjected to histopathological examination. The observed tissue changes were compared with those of the respective control group [25]

Malarvizhi P et al., reported the membrane stabilizing potential against acetaminophen-induced hepatotoxicity in animal models. Pretreatment with E. viride extract significantly reduced elevated liver enzymes (ALT, AST, ALP), suggesting protective effects on liver cell membranes. Histopathological analysis supported the biochemical findings, showing reduced liver damage in treated groups compared to the toxic control. The extract demonstrated antioxidant activity, suggesting its role in mitigating oxidative stress associated with acetaminophen toxicity. Overall, E. viride exhibited promising hepatoprotective and membrane-stabilizing properties, making it a potential remedy for managing drug-induced liver damage [26].

Malarvizhi P et al., reported the hepatoprotective activity of E.viride by using albino wister rats by heamatological and biochemical parameters.Ethanolic and aqueous extracts were administered orally at doses of 200 and 400mg/kg for the period of 14 days. The protective effects of ethanolic and aqueous leaf extracts of Ecbolium viride (Forsk.) Alston against liver damage caused by an overdose of acetaminophen (APAP). When APAP was given orally at a dose of 2 g/kg, it led to increased lipid peroxidation and a significant reduction in the body's natural antioxidant defenses, including enzymes like superoxide dismutase, catalase, glutathione peroxidase, glutathione-S-transferase, and reduced glutathione levels [27].

Priyadharshni SP et al., investigated the protective effects of ethyl acetate and methanol extracts of E.viride stems against paracetomol- induced toxicity in albino wister rats. Rats were induced with hepatotoxicity using paracetomol after induction ethyl acetate and methanol extracts was administered orally at doses of 200 and 400mg/kg for the period of 10 days. The results indicated that the methanolic extract of E. viride stem and ethyl acetate extract provided notable protection against liver damage in the experimental hepatotoxicity model [28].

Antidiabetic activity

Nallapaty S et al., explored the antidiabetic activity of Ecbolium linneanum leaf extracts using invitro assays like α-amylase and antioxidant activity using assay, H2O2 assay, and FRAP assay. GC-MS and HR-LCMS analyses identified 28 phytoconstituents, such as flavonoids and phenolics, contributing to the observed

bioactivities. Computer simulations further confirmed that these compounds bind well to α-amylase, and drug-likeness profiling showed they meet important safety and effectiveness criteria. Overall, the research suggests that E. linneanum could be a promising natural source for developing supportive treatments for diabetes [29].

Nallapaty, S et al., evaluated the Antidiabetic effect of petroleum ether, ethyl acetate and methanolic extracts of E.linneanum leaves in Streptozotocin- induced diabetic rats. The extracts were administered through oral route at two doses of 100 and 200mg/ kg /day for 14 days. Blood glucose levels were measured at 0,30, 60, and 120 minutes post administration. The ethyl acetate and methanolic extracts at 100 and 200 mg/kg, petroleum ether extract at 200mg/kg increased blood glucose levels at 30 minutes. This increase was followed by a decrease in blood glucose up to 120 minutes. Both ethyl acetate and methanolic extracts at the tested concentrations showed a significant decrease in blood glucose levels. These results indicated the potential hypoglycemic effects of the extracts over the observed period [30].

Verma P et al., evaluated the antihyperglycemic activity of E.viride hydroalcoholic leaf extract in streptozotocin-induced diabetic rats. The extract significantly reduced the fasting blood glucose levels. It also corrected lipid abnormalities (decreased total cholesterol, triglycerides, and LDL; increased HDL; reduced VLDL) and improved the antioxidant enzyme activities, including catalase and superoxide dismutase (SOD). It also decreased lipid peroxidation (LPO), indicating reduced oxidative stress compared to the diabetic control group. Histopathological analysis showed regeneration of pancreatic β-cells. These results suggest that the extract possesses antihyperglycemic Properties[31].

Anti-dengue potential

Reegan AD et al., investigated antiviral activity against Aedes aegypti L. The ecbolin A and ecbolin B, compounds isolated from ethyl acetate extract of roots of E.viride . Ecbolin B showed strong larvicidal activity with an LC_{50} of 0.70 ppm and LC_{90} of 1.42 ppm, while ecbolin A was less effective. At sub-lethal doses, ecbolin B caused significant developmental disruptions like larva–pupa intermediates, malformed adults, and reduced adult emergence. Histological studies showed midgut epithelial damage, including disruption of columnar cells and the peritrophic membrane. The study concludes that ecbolin B has potential as a botanical larvicide for dengue vector control [32].

Larvicidal activity

Cecilia, K F et al., assessed the larvicidal and pupicidal activities of ecbolin-A and ecbolin-B isolated from roots of from ethyl acetate fraction of E.viride against Culex quinquefasciatus. LC50 and LC90 values of Ecbolin A are 7.22 and 12.75ppm respectively LC50 and LC90 values for ecbolin-B are 1.36and 2.41ppm respectively which is comparable to Azadirachtin. Ecbolin B showed complete (100%) larvicidal and pupicidal activity against Culex quinquefasciatus within 24 hours when tested at concentrations of 5 and 10 ppm. These findings suggest that Ecbolin B shows strong potential as an effective natural agent for controlling Culex quinquefasciatus mosquitoes by targeting both their larvae and pupae [33].

Anti-inflammatory Potetial

Lalitha KG et al., evaluated the anti-inflamatory effect of ethyl acetate fraction of E.viride root using the cotton pellet-induced granuloma and carrageenan-induced paw edema model in male albino wister rats, employing different doses of the extract (100,200 and 400mg/kg). Their results showed significant inhibition of granuloma tissue formation and reduction in paw swelling, confirming the extract's efficacy in inflammation [34].

Cytotoxic

Akter R et al., screened various Bangladeshi medicinal plant extracts, including Ecbolium viride, for cytotoxic activity using two normal cell lines, namely mouse fibroblast (NIH3T3, ATCC CRL-1658) and healthy monkey kidney cells (VERO, ATCC CCL-81), as well as four human cancer cell lines, including gastric (AGS, ATCC CRL-1739), colon (HT-29, ATCC HTB-38), non-estrogen-dependent breast (MDA-MB-231, ATCC HTB-26), and estrogen-dependent breast (MCF-7, ATCC HTB-22). E. viride showed selective cytotoxicity only against both of the breast cancer cell lines namely MCF-7 and MDA-MB-23. The IC_{50} values for MCF-7 cell line was 0.06 and for MDA-MB-23 was 1.4mg/ml [35].

Antidiarrheal activity

Siraj MA et al., investigated the antidiarrheal and antibacterial activities of the 95% ethanolic extract of E.viride against castor oil induced diarrhea in swiss albino mice. . The extracts were administered through oral route at two doses of 250 and 500mg/kg for 7 days using luperamide. As standard. The extract significantly delayed the onset of diarrhea, reduced the frequency of defecation. The ethanolic leaf extract of Ecbolium linneanum was found to significantly reduce the onset of diarrhea in mice, and its effectiveness increased with higher doses. These results suggest that extract possess antidiarrheal activity [36].

Analgesic Activity

Siraj MA et al., reported analgesic activity of 95% ethanolic extract of E.viride against acetic Acid induced writhing method in swiss albino mice. The extract demonstrated significant, dose-dependent pain relief, comparable to standard drug diclofenac sodium, conforming ethanolic extract efficacy in analgesic activity [37].

Conclusion

Ecbolium viride (Forssk.) Merrill stands out as a valuable medicinal plant with a broad range of therapeutic applications. Its rich phytochemical composition and well-documented pharmacological activities lend strong support to its traditional use in herbal medicine. However, to fully understand and harness its potential, further studies are essential. Future research should focus on isolating specific active compounds, exploring their mechanisms of action, and validating their efficacy through clinical trials. Such efforts could pave the way for the development of effective plant-based pharmaceuticals derived from this remarkable species.

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