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Unlocking nature's pharmacy: *Euphorbia hirta* (L.) as a potent defense against *Escherichia coli* and *Klebsiella pneumoniae* infections in Tanzania

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Abstract

Background

Urinary tract infections (UTIs) are among the most common bacterial infections, primarily caused by *Escherichia coli* and *Klebsiella pneumoniae*, both of which have mostly developed resistance to various antibiotics. The Maasai and Meru communities in Tanzania have traditionally used *Euphorbia hirta* to combat resistant pathogens, particularly those causing UTIs.

Purpose

This study aimed to evaluate the antimicrobial compounds of aqueous extracts and the antibacterial compounds in methanolic extracts of *E. hirta*. We specifically focused on the antibacterial activity of aqueous and methanolic extracts against *E. coli* and *K. pneumoniae* strains, which are significant contributors to UTIs.

Study design

In March 2024, we randomly collected *E. hirta* plant parts from the Kikwe and Kisongo wards in the Arusha region of Tanzania. The samples were washed with distilled water and shade-dried for three weeks to prevent the degradation of bioactive compounds. After drying, the samples were powdered using a laboratory grinder and stored in sterile nylon bags.

Methods

We conducted qualitative and quantitative analyses to assess the presence of various phytochemicals, including alkaloids, saponins, coumarins, terpenoids, quinones, flavonoids, and glycosides, in the aqueous and methanolic extracts of *E. hirta*. To identify specific phytochemical

compounds in these extracts, we used gas chromatography-mass spectrometry (GC–MS) and disc diffusion assays to test their antibacterial activity against *E. coli* and *K. pneumoniae.*

Results

The GC–MS analysis identified sixteen potential bioactive compounds with antibiotic properties, including dodecanal, trans-Farnesol, phytol, 13-tetradecynoic acid, methyl ester, cis-5,8,11,14,17-Eicosapentaenoic acid, 2(4*H*)-Benzofuranone, 5,6,7,7a-tetrahydro-4,4,7a-trimethyl-, (*R*)-, paromomycin, decanoic acid, methyl ester, azelaic acid, undecanoic acid, 10-methyl-, methyl ester, palmitoleic acid, 9,12,15-Octadecatrienoic acid (*Z,Z,Z*), 7-Hydroxy-3-(1,1-dimethylprop-2-enyl) coumarins, linoleyl methyl ketone, and 8,11,14-Eicosatrienoic acid, methyl ester (*Z,Z,Z*). When tested at a concentration of 1 g/mL, all extracts demonstrated significant antibacterial activity. The methanolic extract exhibited the highest performance, with a minimum inhibition zone of 12.0 ± 2.35 mm, followed by the aqueous cold extract at 9.25 ± 1.75 mm, and the aqueous boiled extract at 8.0 ± 1.35 mm.

Conclusion

The traditional methods employed by the Maasai and Meru communities for preparing herbal medicine from *E. hirta,* such as boiling and soaking in cold water, seemed to be effective in treating UTIs. Organic solvent extraction using methanol generally showed superior antibacterial activity compared to aqueous extraction. However, soaking in cold water produced extracts with higher inhibitory activity against *E. coli,* while boiling was more effective against *K. pneumoniae*. This study validates the local practices of *E. hirta* preparation, suggesting that water-based extracts could be both effective and safe for treating certain bacterial strains responsible for UTIs in the Arusha region.