Antifungal Potential of *Phyllanthus niruri* -Derived Nanoparticles: A Novel Therapeutic Approach

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ABSTRACT

The increasing prevalence of fungal infections and the emergence of antifungal resistance underscore the urgent need for novel and effective antifungal agents. This study investigates the antifungal potential of nanoparticles synthesized from *Phyllanthus niruri*, a plant renowned for its medicinal properties. The research encompasses the green synthesis, detailed characterization, and evaluation of these nanoparticles against a range of pathogenic fungi. Antifungal efficacy is assessed through in vitro assays, including disc diffusion and the determination of minimum inhibitory concentration (MIC), alongside mechanisms of fungal inhibition such as cell wall and membrane disruption. Results demonstrate that nanoparticles derived from *Phyllanthus niruri* exhibit significant antifungal activity, attributed to their distinctive physicochemical properties and the plant's bioactive compounds. These findings suggest that *Phyllanthus niruri*-derived nanoparticles present a promising natural alternative for antifungal therapy, potentially addressing the limitations of conventional antifungal agents. Future research should aim to optimize the synthesis process, elucidate the molecular interactions with fungal cells, and assess the safety and efficacy of these nanoparticles in clinical settings. This study highlights the potential of plant-based nanoparticles in developing innovative antifungal treatments.

Fungal infections have become a significant global health concern, exacerbated by the rising incidence of antifungal resistance. Conventional antifungal agents often exhibit limited efficacy and adverse side effects, necessitating the development of new therapeutic strategies. *Phyllanthus niruri*, commonly known as the stonebreaker, is a medicinal plant traditionally used in various cultures for its antimicrobial properties. The plant's rich phytochemical composition makes it a promising candidate for the synthesis of nanoparticles with potential antifungal applications. Nanoparticles have garnered attention in recent years due to their unique physicochemical properties, including high surface area-to-volume ratio and enhanced reactivity, which can be tailored for specific biomedical applications. This study aims to synthesize nanoparticles from *Phyllanthus niruri* using a green synthesis approach, characterize their properties, and evaluate their antifungal activity against various pathogenic fungi.

Design/Other information

Green Synthesis of Nanoparticles

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Characterization of Nanoparticles (UV-Vis Spectroscopy, FTIR, XRD, TEM)

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Evaluation of Antifungal Activity (Disc Diffusion Assay, Minimum Inhibitory Concentration Determination)

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Results

The green synthesis of nanoparticles from *Phyllanthus niruri* was successfully achieved, with UV-Vis spectroscopy confirming the formation of nanoparticles. Characterization results revealed that the nanoparticles were well-defined, with FTIR identifying key bioactive compounds from the plant incorporated into the nanoparticles. XRD analysis indicated a crystalline structure, and TEM imaging showed nanoparticles with an average size of 10-50 nm.

The antifungal assays demonstrated significant activity of the nanoparticles against all tested fungal strains. The disc diffusion assay revealed clear zones of inhibition, indicating the nanoparticles' effectiveness. The MIC values ranged from 10-50 µg/mL, varying with different fungal species. Mechanistic studies suggested that the nanoparticles disrupted the fungal cell wall and membrane, leading to cell death.

Conclusions

This study highlights the potential of nanoparticles synthesized from *Phyllanthus niruri* as effective antifungal agents. The significant antifungal activity observed can be attributed to the unique physicochemical properties of the nanoparticles and the bioactive compounds from the plant. These findings suggest that *Phyllanthus niruri*-derived nanoparticles present a promising natural alternative for antifungal therapy, potentially addressing the limitations of conventional antifungal agents. Future research should focus on optimizing the synthesis process, elucidating molecular interactions with fungal cells, and assessing the safety and efficacy of these nanoparticles in clinical settings. The development of plant-based nanoparticles represents an innovative approach to combating fungal infections.

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