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Green Synthesis, Characterization, and Antimicrobial Activity of Silver Nanoparticles from Brown Algae *Padina Commersonii*

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Abstract

Nanotechnology, which operates at the nanoscale (1-100 nm), is advancing due to the unique properties of materials exhibited at this scale, particularly increased surface area. Silver nanoparticles (AgNPs) are highly valued for their conductivity, stability, and therapeutic potential. Green synthesis offers an eco-friendly approach to nanoparticle production by utilizing biological compounds, including those found in marine algae like *Padina commersonii*, an edible brown algae species from the Hikkaduwa coast of Sri Lanka. The study's objective was to biosynthesize AgNPs using *Padina commersonii*, characterize the nanoparticles, and evaluate their antimicrobial activity. AgNPs were synthesized by combining crude methanol extract of the algae with silver nitrate. Characterization was conducted through various techniques, including UV-Vis spectroscopy, Dynamic Light Scattering (DLS), Zeta potential analysis, Scanning Electron Microscopy (SEM), Energy Dispersive X-ray (EDX) analysis, X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), and Raman spectroscopy. The colour shift from pale yellow to reddish-brown within 48 hours confirmed nanoparticle formation. UV-Vis spectrophotometry revealed a peak at 424 nm, indicating the presence of AgNPs. DLS analysis determined an average size of 73.19 nm, with a zeta potential of -21.5 mV, signifying stability. SEM images showed spherical nanoparticles with smooth surfaces, while EDX analysis confirmed 19.5% silver content by weight. XRD analysis indicated a face-centered cubic structure, and FTIR and Raman spectra identified proteins, phenolic compounds, and amines as capping agents. The synthesized AgNPs demonstrated significant antimicrobial effects against *Staphylococcus aureus* (12.77±0.58 mm), *Escherichia coli* (15.27±0.58 mm), *Aspergillus niger* (18.10±0.15 mm), and *Candida albicans* (17.43±0.57 mm), outperforming the crude extract of *Padina commersonii*. The antimicrobial potential of silver nanoparticles synthesized using *Padina commersonii* against bacterial strains *Staphylococcus aureus* (12.77±0.58 mm), *Escherichia coli* (15.27±0.58 mm), and fungal strains *Aspergillus niger* (18.10±0.15 mm) and Candida albicans (17.43±0.57 mm) was greater than that of the crude extract of *Padina commersonii* (*S. aureus* = 11.17±0.29 mm, *E. coli*=10.50±0.50mm, *A. niger*=12.66±0.10mm, *C. albicans*=15.66±0.10mm) These findings suggest that AgNPs synthesized through green methods offer a promising strategy for treating bacterial and fungal infections.

Keywords: *Silver nanoparticles, Padina commersonii, Antimicrobial, Green synthesis, Characterization*