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Facile coconut inflorescence sap mediated synthesis of silver nanoparticles and its diverse antimicrobial and cytotoxic properties

M.K. Rajesh[a,*,1], K.S. Muralikrishna[a,1], Swapna S. Nair[b], B. Krishna Kumar[c], T.M. Subrahmanya[d], K.P. Sonu[e], K. Subaharan[f], H. Sweta[g], T.S. Keshava Prasad[g], Neeli Chandran[b], Indrani Karunasagar[c], K.B. Hebbar[a], Anitha Karun[a]

[a] ICAR-Central Plantation Crops Research Institute, Kasaragod 671 124, Kerala, India
[b] Central University of Kerala, Kasaragod 671 316, Kerala, India
[c] Nitte University Center for Science Education & Research, Nitte (Deemed to be University), Mangaluru 575 018, Karnataka, India
[d] Graduate Institute of Applied Science and Technology Department, National Taiwan University of Science and Technology, Taipei 106 07, Taiwan
[e] Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru 560 064, Karnataka, India
[f] ICAR-National Bureau of Agricultural Insect Resources, Bengaluru 560 064, Karnataka, India
[g] Center for Systems Biology and Molecular Medicine, Yenepoya Research Centre, Mangaluru 575 018, Karnataka, India

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ABSTRACT

Green synthesis of nanoparticles (NPs) involves the use of diverse extracts of biological origin as substrates to synthesize NPs and can overcome the hazards associated with chemical methods. Coconut inflorescence sap, which is unfermented phloem sap obtained by tapping of coconut inflorescence, is a rich source of sugars and secondary metabolites. In this study, coconut inflorescence sap was used to synthesize silver NPs (AgNPs). We have initially undertaken metabolomic profiling of coconut inflorescence sap from West Coast Tall cultivar to delineate its individual components. It was found to comprise of 64% secondary metabolites, 9% sugars, 12% lipids/fats and 9% peptides in positive mode, whereas in the negative mode, it was 33, 20, 9 and 11%, respectively. The concentration of silver nitrate, inflorescence sap and incubation temperature for the synthesis of AgNPs were optimized. Incubating the reaction mixture at 40 °C was found to enhance AgNP synthesis. The AgNPs synthesized were characterized using UV–visible (UV-Vis) spectrophotometry, X-Ray Diffraction (XRD), Fourier Transform Infrared spectroscopy (FTIR) and Transmission Electron Microscopy (TEM). The particles were crystalline in nature and the bulk of the particles were spherical with smooth (thin) shell and poly-dispersed with a diameter ranging from 10 nm to 30 nm. Antimicrobial property of AgNPs was tested in tissue culture of arecanut (*Areca catechu* L.) where bacterial contamination (*Bacillus pumilus*) was a frequent occurrence. A significant reduction in the contamination was observed when plantlets were treated with aqueous solutions of AgNPs. Notably, treatment with AgNPs did not affect the growth and development of the arecanut plantlets. Antimicrobial properties of AgNPs synthesized from inflorescence sap were also evaluated in human pathogenic bacteria viz., *Escherichia coli* ATCC 25922; *Salmonella* Typhimurium ATCC 14028 and *Vibrio parahaemolyticus* AQ4037. The antibacterial action was confirmed by determining the production of reactive oxygen species (ROS) and protein leakage studies. Cytotoxicity of AgNPs was quantified in HeLa cells. The viability (%) of HeLa cells declined significantly at 10 mg L^{-1} concentration of AgNP and complete mortality was observed at a concentration of 60 mg L^{-1}. The study concludes that unfermented inflorescence sap, with above neutral pH, serves as an excellent reducing agent to synthesize AgNPs from Ag+.

1. Introduction

In the recent years, syntheses of various nanoparticles (NPs), which range in size from 1 to 100 nm, have incited enhanced interest in the field of nanosciences as these NPs possess unique catalytic, optical, electronic, biological and magnetic properties. These NPs find a repertoire of applications in different domains such as biosensors, electronics, catalysts, wastewater treatment, cosmetics, drug delivery,

* Corresponding author.
E-mail address: rajesh.mk@icar.gov.in (R. M.K.).
[1] Both authors contributed equally to this manuscript.

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