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Green synthesis of silver nanoparticles using plants from Myrtaceae family and characterization of their antibacterial activity

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ABSTRACT

Silver nanoparticles (AgNPs) were synthesized using ethanolic leaf extracts from Myrtaceae family including *Callistemon lanceolatus*, *Decaspermum parviflorum*, *Eucalyptus citriodora*, *Melaleuca cajuputi*, *Rhodomyrtus tomentosa*, *Syzygiupam campanulatum*, and *Xanthostemon chrysanthus*. AgNPs were verified by UV–visible spectroscopy, TEM, EDS, zeta potential, and FTIR. Surface plasmon resonance bands of AgNPs occurred in the wavelength range of 417–462 nm. AgNPs morphology was spherical and ranged in size from 5 to 55 nm. Zeta potential of AgNPs were −36.49 to −22.25 mV. FTIR results showed the binding properties of constituents responsible for capping and stabilizing the nanoparticles. MIC and MBC of AgNPs against *Enterococcus faecalis*, *Staphylococcus aureus*, *Acinetobacter baumannii*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* ranged between 7.8–62.5 and 62.5–125 μg/ml, respectively.

1. Introduction

In recent years, AgNPs have been considered as a viable alternative for the production of new generation of antimicrobial agents. Various techniques including chemical and physical methods have been developed to synthesize AgNPs. These methods require noxious reducing and stabilizing agents which increase the environmental toxicity or hazardous wastes [1]. Therefore, it needs to find an alternative strategy for the development of AgNPs. Biosynthetic approaches using bacteria, fungi, and plants [2–4] as reducing and capping agents have been reported. However, utilization of plants for the green synthesis is advantageous over other resources since it does not require the maintenance of cell cultures, inexpensive, and could be scaled up for large-scale synthesis. In addition, plants have been explored in the synthesis of AgNPs due to well-known bioactive potential, especially for their antimicrobial activity. Plants belong to Myrtaceae have been employed for AgNPs synthesis, for instance, *Eucalyptus globules* and *Syzygium cumini* [5,6]. We earlier synthesized nanoparticles using acetone extract of *Rhodomyrtus tomentosa* leaf as a reducing agent. As we found that synthesis of nanoparticles using the extract could enhance antibacterial activity against *S. aureus* and *E. coli* [7,8], this present work extended previous findings and claimed to be the first to report, AgNPs synthesized using ethanolic leaf extracts from a number of selected important plant species according to ethnobotanical data. Extended antibiotic spectrum of AgNPs against a wide range of both Gram positive and Gram negative bacteria were tested.

2. Materials and methods

2.1. Synthesis of AgNPs

Dried leaves of plants were extracted with 95% [9]. For AgNPs synthesis, the mixture was prepared by adding silver nitrate (169.87 mg/ml) solution sterile distilled water containing the extracts (50 mg/ml). The mixture was incubated at 28 °C for 16 h on rotator shaker at 150 rpm in the dark.

2.2. Characterization of AgNPs

AgNPs were then tested using ultraviolet–visible spectroscopy in the range 300–800 nm. The functional groups were studied using fourier transform infrared and transmission electron microscopy was performed to study the shape and size of the AgNPs. Zeta potential was measured using zeta PALS-zeta potential analyzer by dynamic light scattering method. Elemental composition of AgNPs was analyzed by an energy dispersive analysis of X-ray spectroscopy coupled to the scanning electron microscope.

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2.3. Antibacterial activities of AgNPs

Minimum inhibitory concentration and minimum bactericidal concentration were determined following Clinical and Laboratory Standardization Institute guideline [10].

3. Results and discussion

AgNPs were synthesized using leaf extracts from Myrtaceae. The color change in the reaction mixture turned from light yellow to dark brown. It has been demonstrated that phytochemical con-

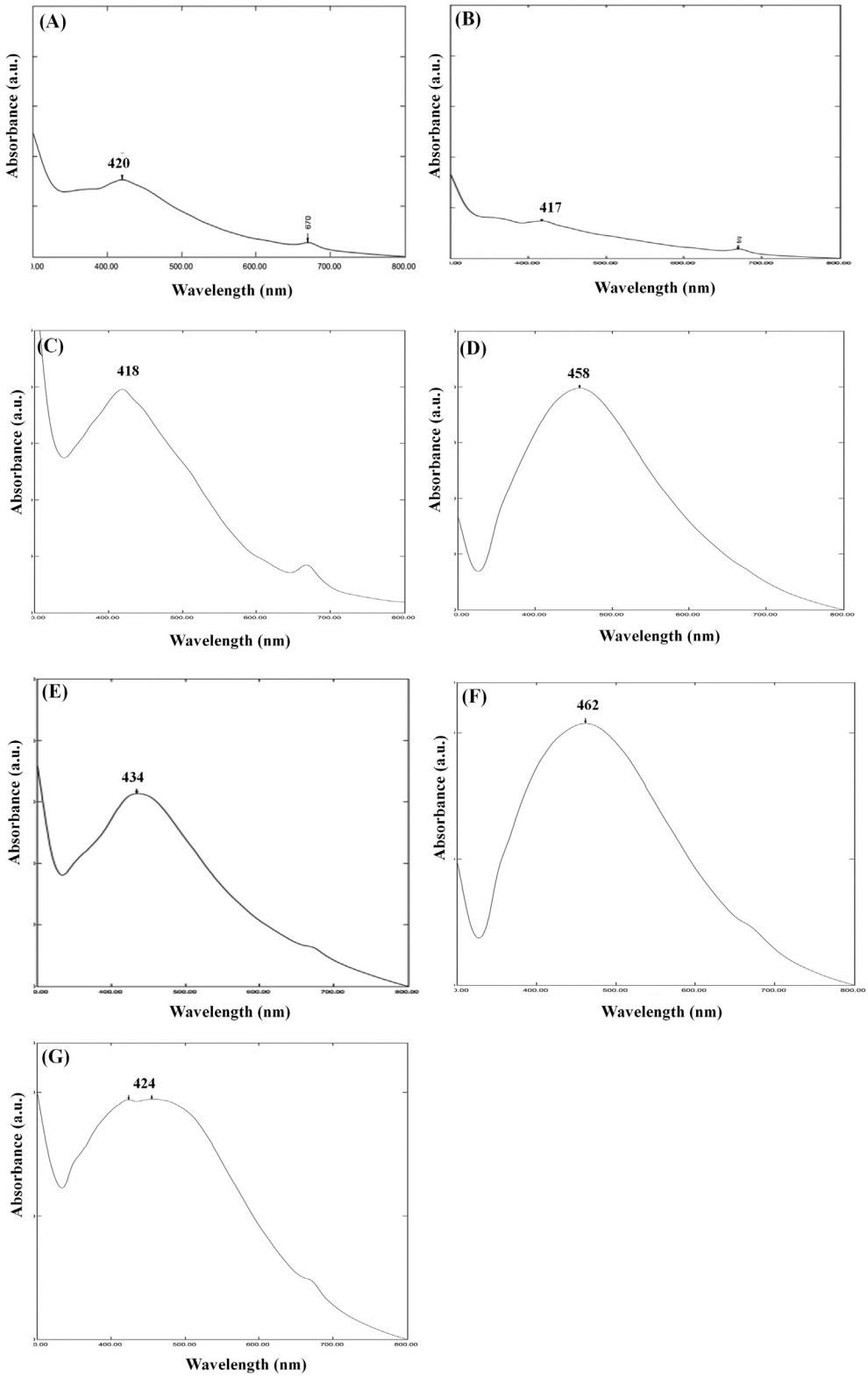

Fig. 1. SPR spectra of AgNPs synthesized using (A) Callistemon lanceolatus, (B) Decaspermum parviflorum, (C) Eucalyptus citriodora, (D) Melaleuca cajuputi, (E) Rhodomyrtus tomentosa, (F) Syzygium campanulatum, and (G) Xanthostemon chrysanthus.