Green synthesis, antimicrobial and cytotoxic effects of silver nanoparticles mediated by *Eucalyptus camaldulensis* leaf extract

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Abstract

Silver nanoparticles synthesized using green methods have been reported to have potential biomedical applications for controlling pathogenic microbes. This cost-effective method provides an alternative to traditional physical and chemical methods. In the present study, silver nanoparticles (AgNPs) were synthesized using the *Eucalyptus camaldulensis* extract as a reducing agent. A change in color was noticed while the synthesis process, and the AgNPs were characterized using UV-Vis spectrometry. The antibacterial potential of plant extracts and AgNPs was tested against common human pathogens such as gram-positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) and gram-negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*) by using the disk diffusion agar method. The results of the antibacterial assays indicated that AgNPs were effective against pathogenic bacteria.

Introduction

Nanotechnology is a rapidly developing field in materials science that has the potential; to improve human health (1) The chemical and physical methods used for synthesis are expensive and environmentally harmful. As a result, green synthesis has been proposed as a cost-effective and eco-friendly alternative to prevent unfavorable situations(2).In the field of nanotechnology, silver nanoparticles (AgNPs) possess exceptional properties and are widely regarded as the most important metal element(3). Silver ions are highly toxic to a broad range of microorganisms(4). Ag NPs attach easily to cell walls, leading to cellular respiration and permeability effects that cause cell death. AgNPs can also enter cells to interact with biomolecules such as DNA and protein(3). *Eucalyptus camaldulensis* is an important medicinal plant from the Myrtaceae family. It is used to treat bacterial infections of the respiratory and urinary tracts and sore throat(5). Studies have shown that the extract obtained from the leaves of Eucalyptus camaldulensis possesses antimicrobial properties(6–8). In this study, AgNPs were synthesized using *E. camaldulensis* extract. The biogenic AgNPs were characterized using UV-Vis Spectroscopy. In addition, the antibacterial activity of both the plant extract and AgNPs was tested against common human pathogens, including gram-positive bacteria such as *Staphylococcus aureus* and *Bacillus subtilis*, and gram-negative bacteria such as *Escherichia coli* and *Pseudomonas aeruginosa*, using the disk diffusion agar method.

Methodology

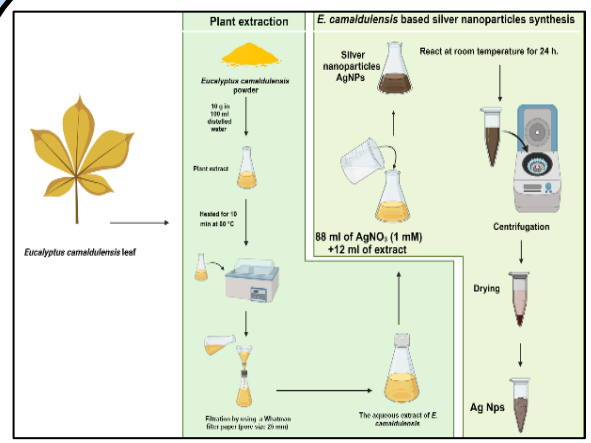

Figure 1: Fabrication of AgNPs using plant extract.

Preparation of the *E. camaldulensis* Extract:, 10 grams of dry leaf sample was mixed with 100 mL of highly purified water. The mixture was then heated at 80 °C for 10 minutes. Finally, the solution was filtered through a Whatman filter paper No. 1, with a pore size of 125 mm

Synthesis of AgNPs from *E. vcamaldulensis* extract a mixture was prepared by combining 88 mL of 1mM silver nitrate solution with 12 mL of *E. camaldulensis* extract. The reaction was allowed to take place at room temperature for 24 hours. During this time, there was a noticeable change in color, from yellow at the start to dark brown as the reaction progressed. The fabrication process of AgNPs is shown in Figure 1.

Results

Characterization of AgNPs

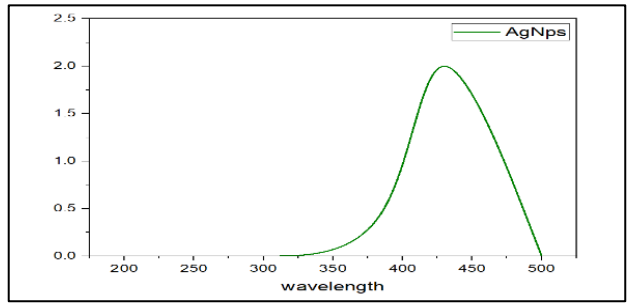

Figure 2: The UV-vis spectrum analysis reveals that AgNPs demonstrate a peak absorbance at 420 nm.

Antimicrobial activity

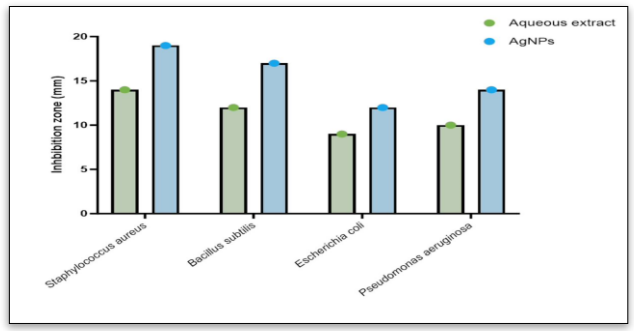

Figure 3: Four replicates of the aqueous extract of Eucalyptus camaldulensis and 1mg/ml AgNPs were tested for their antibacterial activity against microorganisms.

Conclusion

Silver nanoparticles were successfully synthesized using *Eucalyptus camaldolensis* extract. This approach is environmentally friendly and cost-effective. The plant extract acts as a reducing agent and provides stability to the nanoparticles produced by coating them. The addition of plant extracts to the $AgNO_3$ solution caused a color change from yellow to dark brown. The synthesized silver nanoparticles showed an absorption peak at 420 nm. On the other hand, the aqueous extract *of E. camaldulensis* leaves demonstrated noticeable antibacterial potential. AgNPs indicated noticeable high activity against *S.aureus* and *B.subtilis*. However, lower activity was noticed against *E. coli* and *P.aeruginosa*. Therefore, the activity of AgNPs is bacterial species dependent. A recommendation for improved screening is to test more pathogenic bacteria.

Acknowledgment

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