Antimicrobial Applications of Green Synthesized Bimetallic Nanoparticles from *Ocimum basilicum*

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Abstract

Antibiotic resistance is an important and emerging alarm for public health that requires the development of new potential antibacterial strategies. In recent years, nanoscale materials have emerged as an alternative way to fight pathogens. Many researchers have shown great interest in nanoparticles (NPs) using noble metals, such as silver, gold, and platinum, even though numerous nanomaterials have shown toxicity. To overcome the problem of toxicity, nanotechnology merged with green chemistry to synthesize nature-friendly nanoparticles from plants. Here, we describe the synthesis of NPs using silver (AgNPs) and platinum (PtNPs) alone or in combination (AgPtNPs) in the presence of *Ocimum basilicum* (*O. basilicum*) leaf extract. *O. basilicum* is a well-known medicinal plant with antibacterial compounds. A preliminary chemical–physical characterization of the extract was conducted. The size, shape, and elemental analysis were carried out using UV–visible spectroscopy, dynamic light scattering (DLS), and zeta potential. Transmission electron microscopy (TEM) confirmed polydisperse NPs with spherical shape. The size of the particles was approximately 59 nm, confirmed by DLS analysis, and the polydisperse index was 0.159. Fourier transform infrared (FTIR) demonstrated an effective and selective capping of the phytoconstituents on the NPs. The cytotoxic activities of AgNPs, PtNPs, and AgPtNPs were assessed on different epithelial cell models using the 3-[4.5-dimethylthiazol-2-yl]-2.5-diphenyltetrazolium bromide (MTT) cell proliferation assay. They discovered low toxicity, with a cell viability of 80%. The antibacterial potential of the NPs was evaluated against *Escherichia coli* (*E. coli*), *Enterococcus faecalis* (*E. faecalis*), *Klebsiella pneumonia* (*K. pneumoniae*), and *Staphylococcus aureus* (*S. aureus*) strains. Minimum inhibitory concentration (MIC) assays showed AgPtNP activity till the least concentration of NPs (3.15–1.56 µg/mL) against ATCC, MS, and MDR *E. coli, E. faecalis,* and *S. aureus* and the Kirby–Bauer method showed that AgPtNPs gave a zone of inhibition for Gram-positive and Gram-negative bacteria in a range of 9–25 mm. In addition, we obtained AgPtNP synergistic activity in combination with vancomycin or ampicillin antibiotics. Taken together, these results indicate that bimetallic nanoparticles, synthesized from *O. basilicum* leaf extract, could represent a natural, eco-friendly, cheap, and safe method to produce alternative antibacterial strategies with low cytotoxicity.

References

[1] Abdelsattar, A.S.; Hakim, T.A.; Rezk, N.; Farouk, W.M.; Hassan, Y.Y.; Gouda, S.M.; El-Shibiny, A. Green Synthesis of Silver Nanoparticles Using Ocimum basilicum L. and Hibiscus Sabdariffa L. Extracts and Their Antibacterial Activity in Combination with Phage ZCSE6 and Sensing Properties. J. Inorg. Organomet. Polym. 2022, 32, 1951–1965.

Figures

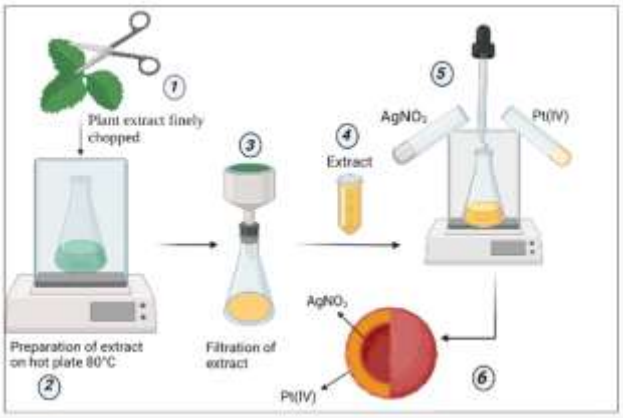

Figure 1. Schematic representation of synthesis of AgPtNPs from *O. basilicum*. (1) Fresh leaves of *O. basilicum* were chopped finely (2) Then, the finely chopped leaves were used for the preparation of the exact on a hot plate at 80 °C (3) The prepared extract was then filtered through a Whatman filter paper No.1 (4) This extract was used for the preparation of the bimetallic NPs (5) At 80 °C, and under continuous shaking conditions in the presence of two noble metals, namely Silver nitrate and Potassium tetrachloroplatinate (II), synthesis of the NPs was carried out (6). The hypothesis was that the NPs formed would possess an inner core of silver and an outer cover of platinum.