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Synthesis of Silver Nanoparticles Using Dichloromethane Extract of Chrysanthemum cinerariaefolium and Its Bioactivity

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ABSTRACT

Common methods of synthesizing metallic nanoparticles are chemical and physical. However, they are expensive and use toxic chemicals. Green synthesis is less costly and safer, hence a potential alternative. Silver nanoparticles (Ag NPs) were synthesized using dichloromethane extract of Chrysanthemum cinerariaefolium, and colour change from pale green to dark brown was observed. Scanning electron microscopy (SEM) images were faceted, and others formed clusters. Transmission electron microscopy (TEM) images were spherical with an average size of 22.8± 17.5 nm. EDX analysis showed the nanoparticles had percentage abundance of 67.26%. Fourier-transform infrared spectroscopy (FTIR) analysis showed absorption bands at 3489.59 cm-1, 3217.80 cm-1, 2384.74 cm-1, 1633.05 cm-1, 1405.08 cm-1, 1109.32 cm-1, and 505.93 cm-1. The UV-Vis analysis showed surface plasmon resonance (SPR) peak at 434 nm. The nanoparticles were more active on P. aeruginosa with an MIC of 15 μg/ml while the cytotoxicity assay showed Ag NPs had an MIC of 33.33 μg/ml, and hence, were noncytotoxic against Vero cells.

KEYWORDS

Bioassay, Characterization, Cytotoxicity, Nanoparticles, Synthesis

INTRODUCTION

Bacteria are the oldest form of life on earth. They are responsible for a variety of infections affecting humans, animals and plants (Reta et al., 2019). In a study done in South China, bacteria was the leading causative agent of food borne illness with 44.93% followed by poisonous plants at 33.33% (Li et al.,

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2018). The emergence of resistant bacterial strains to various convectional drugs has necessitated a search for alternative antibacterial drugs. The use of silver in treatment of various infections dates back to ancient civilizations. In recent years, this material in form of nanoparticles has found its way back with diverse applications (Aritonang et al., 2019).

Nanoparticles are molecules that have a size ranging from approximately 1-100 nm and in one dimension. Due to their small sizes, the nanomaterials/nanoparticles possess novel physiochemical and biological properties, leading to their widespread application in various areas such as health, electronics, space industries, drug-gene delivery, energy science, optoelectronics, and catalysis (Nikam et al., 2014). They are classified as organic nanoparticles, (fullerenes), inorganic nanoparticles (magnetic and noble metal nanoparticles) and semiconductor nanoparticles (e.g. titanium oxide and zinc oxide). Inorganic metal nanoparticles (Gold and silver) have gained more attention due to superior properties and functional versatility (Devi et al., 2020).

The immense antibacterial properties of silver nanoparticles (Ag NPs) and toxicity to cells have made these molecules find great demand in comparison to other nanoparticles in the medical field (Vance et al., 2015). As a result, Ag NPs have been used in production of wound dressing agents, food packaging materials, incorporation into water purification system, coating of medical devices, antiseptics in health care delivery, personal healthcare products, and textile coatings (Tran and Le, 2013; Li *et al.,* 2013; Thakare and Ramteke, 2017; von Goetz et al., 2013). The anticancer properties of silver nanoparticles are associated with the anti-angiogenic and anti-proliferative properties of these molecules (Rani et al., 2009).

Silver nanoparticles can be synthesized using chemical, photochemical, and physical methods. However, these methods are expensive and environmentally unfriendly (Hemlata, et al 2020). Plant-based synthesis of nanoparticles provides an alternative to the aforementioned methods due to cost-effectiveness and eco-friendliness(Gengan, et al 2013). This is because plants possess phytochemicals which act as reducing and stabilization agents in the synthesis of the nanoparticles. These phytochemicals are; flavanoids, alkaloids, terpenoids, steroids, tannins, and phenols among others (Swarnalatha et al., 2013). Plants are also widely available, provide simple, and one-step method that does not require culturing or purification (Reda et al., 2019). Some of the studies displaying use of plant extracts in the synthesis of silver nanoparticles include synthesis of Ag NPs using *Ananas comosus* (pineapple juice)(Ahmad and Sharma, 2012) and biogenic synthesis of Silver Nanoparticles using *Phyllanthus emblica* fruit extract (Masum et al., 2019).

Although silver nanoparticles have been successfully synthesized using plant extracts (Femi-Adepoju et al., 2019), a search for nanoparticles with precise biological, physical, and chemical features is still at the cutting edge of nanoscience research. To the best of our knowledge, synthesis of Ag NPs using *Chrysanthemum cinerariaefolium* (pyrethrum) has not been done, hence in the current study, silver nanoparticles were synthesized using dichloromethane extract of *C. cinerariaefolium.* The dichloromethane extract was chosen following prior laboratory analysis, which showed that the extract contained phytochemicals such as tannins, flavonoids and phenols which have been shown to act as stabilizers and reductants in the synthesis of silver nanoparticles (Swarnalatha et al., 2013).

The nanoparticles were also characterized using Scanning Electron Microscopy/Energy Dispersive X-Ray (SEM/EDX), Transmission Electron Microscopy (TEM), Fourier-transform Infrared Spectroscopy (FTIR), and UV–visible Spectroscopy (UV-vis). Phytochemical analysis of the crude extract was also carried out. Antibacterial activity of the nanoparticles was determined against *Staphylococcus aureus, Pseudomonus aeruginosa*, *Shigella sonnei* and *MRSA* whereas cytotoxicity studies carried out against Vero cells. The bacteria *S. aureus*, *P. aeruginosa* and *MRSA* were chosen due to their association with life threatening hospital infections (Paling et al., 2020, Nathwani et al., 2014). Moreover, *S. sonnie* was chosen since it causes *shigellosis* a global endemic affecting children, with greater incidence of mortality and morbidity occurring in Africa (Rogawski McQuade et al., 2020).

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