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Synthesis of silver nanoparticle and its application

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ABSTRACT

In this work, silver nanoparticles have been synthesized by wet chemical technique, green synthesis and microbial methods. Silver nitrate (10^{-3} M) was used with aqueous extract to produce silver nanoparticles. From the results it was observed that the yield of nanoparticles was high in green synthesis. The size of the silver nanoparticles was determined from Scanning Electron Microscope analysis (SEM). Fourier Transform Infrared spectroscopy (FTIR) was carried out to determine the presence of biomolecules in them. Its cytotoxic effect was studied in cancerous cell line and normal cell line. MTT assay was done to test its optimal concentration and efficacy which gives valuable information for the use of silver nanoparticles for future cancer therapy.

1. Introduction

Nanotechnology is an emerging technology that attracts researchers from various fields like physics, chemistry, electrical engineering, material sciences and life sciences especially in biomedical application and biotechnology (Catherine, 2012; Kruis et al., 1998; Pankhurst et al., 2003). The main advantage of nanotechnology is the ability to utilize the special properties that materials possess when they have nanoscale dimensions (1–1000 nm). Further, the ability to engineer these particles on such a small scale allows them to interact in special ways with biological systems, as they are roughly the size of many native proteins (Rhyner, 2008). Nanomaterials, due to their sheer size show unique and considerably changed physical, chemical, and biological properties compared to their macroscale counterparts (Li et al., 2001).

Nanoparticles can be synthesized by chemical, green and microbial methods. Each method has its own advantages and limitations. Present study dealt with the synthesis of silver nanoparticles by chemical (Fang et al., 2005), green (Neethu Hari et al., 2013) and microbial methods (Sarkar et al., 2011). In this study we exploit the advantages of each method to find out the economical as well as eco-friendly method for the nanoparticles production and its application.

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2. Materials and methods

2.1. Materials

Allium sativum commonly called as garlic was collected from local grocery shop. The plant materials were thoroughly washed with water several times. The whole plant was used for obtaining the extract. Silver nitrate was purchased from Himedia Labs, India. Silver nitrate was stored in dark colored bottles. 1 mM solution of silver nitrate was prepared using deionized water. This solution has to be stored in dark colored bottles and stored in a refrigerator. This was done to avoid photosensitive reaction of silver nitrate when exposed to light. Two microorganisms were taken for the synthesis of silver nanoparticles. They are *Aspergillus niger* and *Aspergillus flavus.* The organisms were purchased from MTCC, Chandigarh, maintained and grown in 100 ml of potato dextrose broth at 25 °C.

2.2. Procedure for synthesis of silver nanoparticles from A. sativum

The plant was chopped into pieces and 6 g of this plant material was weighed. It was added to 50 ml of deionised water. This mixture was kept at room temperature for 24 h. After 24 h, solid garlic pieces were removed from the solution. The pale transparent garlic extract was collected. 50 ml of 10^{-3} M silver nitrate was added to the garlic extract solution. Within 2 h, light orange color change was observed, which indicates the presence of silver nanoparticles. The solution was allowed to age for 48 h to yield a deep orange/brown color. The extract was filtered using whattmann filter paper (no. 42) to remove the large aggregates. The extract was then lyophilized to get the silver nanoparticles.

2.3. Chemical synthesis

50 ml of 10^{-3} M silver nitrate was heated to boiling. To this solution 5 ml of 1% tri-sodium citrate was added drop by drop. During this process solution was mixed vigorously and heated until the color change was evident (pale brown). Then it was removed from the heating element and stirred until cooled to room temperature. The aqueous solution was lyophilized and the powdered nanoparticles were obtained and taken for further analysis.

2.4. Microbial synthesis

Two microorganisms *A. niger* and *A. flavus* were utilized for the synthesis of silver nanoparticles. The organisms were grown in 100 ml of potato dextrose broth at 25° C, for 48 h. After the incubation, mycelia biomass was separated by filtration, washed with sterile distilled water to remove traces of media components, resuspended in 100 ml distilled water and incubated at 25 °C. After 24 h, the suspension was filtered through Whatman filter paper no. 42. The cell filtrate and biomass were challenged with 10^{-3} M silver nitrate solution and incubated at room temperature. The extract was lyophilized to obtain the silver nanoparticles.

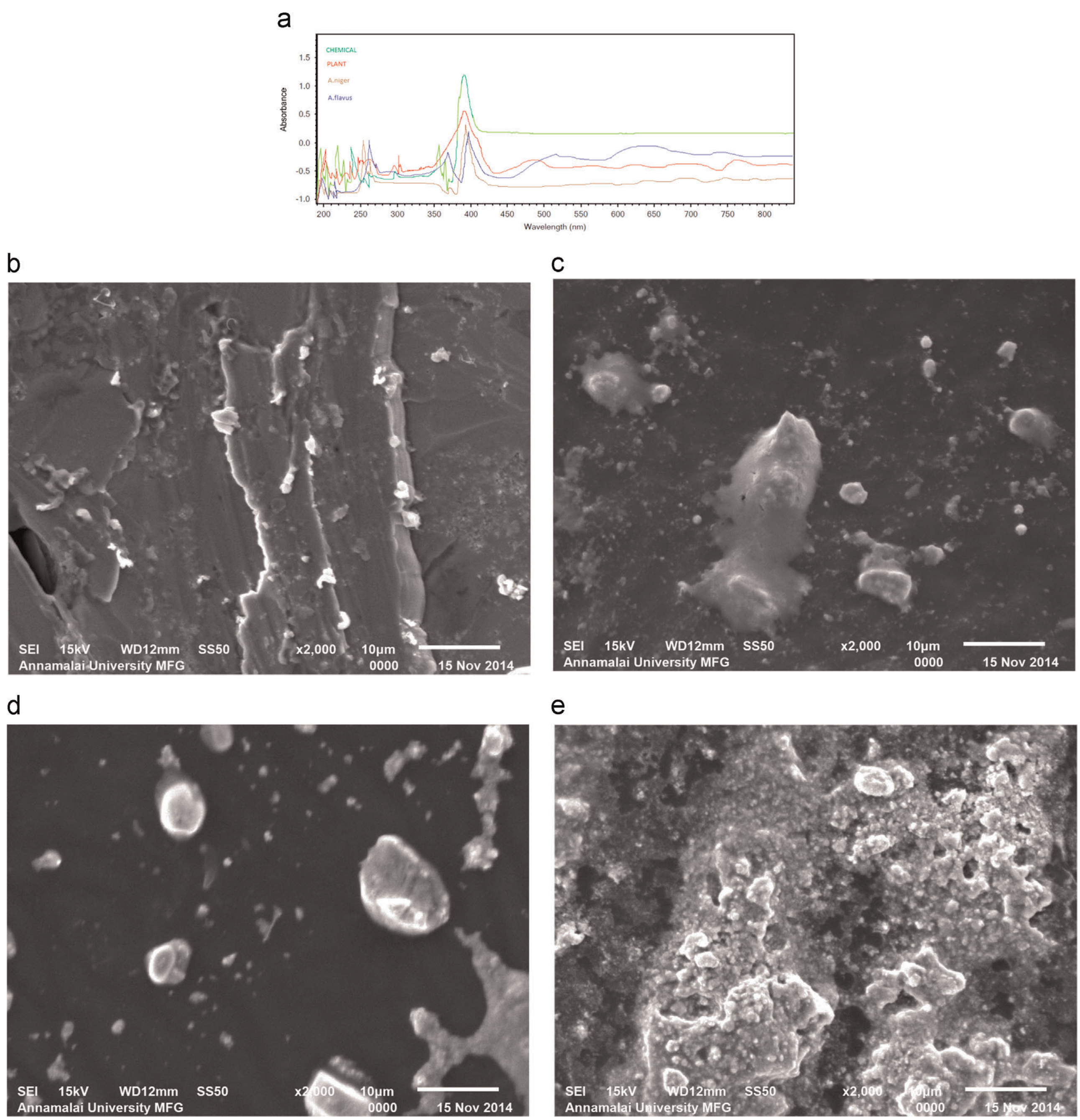

Fig. 1. (a) UV–vis spectra *of* chemical, *A. sativum, A. niger and A. flavus* extract mediated AgNPs. (b) SEM image for *A. niger* mediated AgNps. (c) SEM image for *A. flavus* mediated AgNps. (d) SEM image for *A. sativum* mediated AgNps. (e) SEM image for chemical mediated AgNps. (f) FTIR spectra for silver nitrate. (g) FTIR spectra for *A. niger* mediated AgNPs. (h) FTIR spectra for *A. flavus* mediated AgNPs. (i) FTIR spectra for *A. sativum* mediated AgNPs. (j) FTIR spectra for chemical mediated AgNPs.