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Synthesis of silver nanorods using *Coscinium fenestratum* extracts and its cytotoxic activity against Hep-2 cell line

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ABSTRACT

Silver nanorod has attracted considerable interest due to its potential applications in display technologies, thermoelectric and electronic devices, optoelectronic devices and biomedicine. In this study, crystalline silver nanorods were successfully prepared from $AgNO_3$ using *Coscinium fenestratum* extract as a reducing agent. The products were characterized by UV–visible spectroscopy, FTIR (Fourier-transform IR) spectroscopy and SEM (scanning electron microscopy) analysis. Bundle-like nanostructures were observed by SEM analysis and the diameters of the nanorods were found to be in the range of 28.5–68.0 nm. The MTT assay results revealed that silver nanorod exhibit significant cytotoxic effect on HEp-2 cells.

1. Introduction

Nanoparticle synthesis has received considerable attention in recent years as a result of its optical, electronic, magnetic, and chemical properties and their potential applications in subsequent technology development. Silver nanoparticles can be used in areas such as chemical analysis [1], integrated circuit [2], cell electrode [3] and antimicrobial deodorant fibre [4]. Silver nanorods and nanowires with well-defined dimensions and aspect ratios are particularly interesting to fabricate and study because they exhibit high electrical conductivity, thermal conductivity and unusual optical properties among all the metals. Recently, much effort has been devoted to the synthesis of silver nanorods (AgNR) and nanowires. For example, silver nanorods and nanowires have been prepared by using DNA [5], carbon nanotubes [6], mesoporous silica [7] and polymers [8] as templates. Murphy and coworkers have successfully synthesized high-quality silver and gold nanorods and nanowires by using a rod-like micellar template of cetyltrimethylammonium bromide (CTAB) instead of hard template [9]. Hu et al. have synthesized silver nanorods and nanowires by using a surfactant-assistant route [10]. They used sodium dodecylsulphonate as a capping agent but not as a soft template. Xia et al., [11] have demonstrated a polyol process that generated silver nanowires by reducing silver nitrate with ethylene glycol in the presence of poly vinyl pyrrolidone (PVP). Caswell et al. [12] reported a seedless and surfactantless wet chemical approach to produce silver nanowires in the presence of NaOH. However, the final products of all these chemical methods were characterized by problems such as relatively low yields, low aspect ratios, irregular morphologies, non-uniformity in size, or polycrystalline domain structure.

The development of reliable green process for the synthesis of silver nanoparticles is an important aspect of current nanotechnology research. Nanomaterials such as Ag, Au, Pt and Pd have been synthesized by different methods, including hard [13], using fungi [14], plants [15] and bacteria [16]. Among these, silver nanoparticles play a significant role in the field of biology and medicine due to their attractive physiochemical properties. The highly reactive metal oxide nanoparticles exhibit excellent bactericidal action against Gram-positive and Gram-negative bacteria [17]. The strong toxicity of silver against wide range of microorganisms is well known and silver nanoparticles have been recently shown to be a promising antimicrobial material. Sondi and Sondi [18] studied the antimicrobial activity of silver nanoparticles against *Escherichia coli* as a model of Gram-negative bacteria.

Although most of the studies are focused on nanoparticle applications, studies describing the impact of nanoparticles on human health and the possible application of nanoparticles as anticancerous drug are limited [18,19]. Whereas, the present study was aimed at synthesis of silver nanorods using the shade dried *Coscinium fenestratum* plant extract and evaluation of their cytotoxic activity against HEP-2 cell line.

Objectives of the study

1. To synthesize the silver nanorods using the extracts of *C. fenestratum.*

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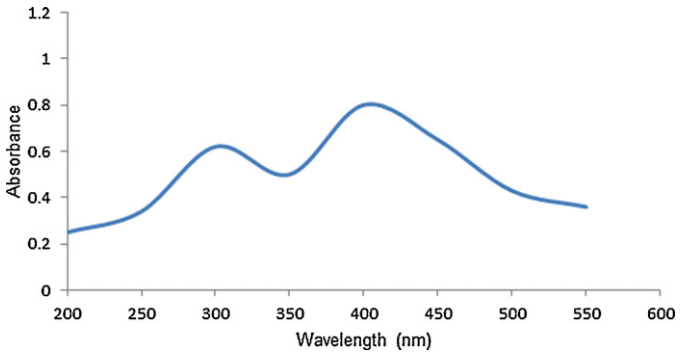

Fig. 1. UV–visible spectra of *Coscinium fenestratum* extract containing silver nanorods (AgNRs).

2. To characterize the synthesized nanorods using UV-spectroscopy, FTIR and SEM.
3. To evaluate the anticancerous activity of silver nanorods.

2. Experimental

2.1. Chemicals and cell lines

All the chemicals used were of analytical grade and purchased from Sigma (St. Louis, MO, USA). HEp-2 (human larynx cancer) cell line was obtained from King Institute of Preventive Medicine, Chennai, India. The cells were maintained as monolayers in 25 cm^2 plastic tissue culture flasks at 37 °C in a humidified atmosphere containing 5% CO_2 in air. Exponentially growing cells were used in all the experiments.

2.2. Plant material and preparation of the extract

C. fenestratum plant sample was collected from Bonacaud Estate, Trivandrum, Kerala, by Dr. K. Kamarudeen and the voucher specimen was deposited in the herbarium of Iqbal College, Peringamala, Trivandrum. Freshly collected *C. fenestratum* leaves along with tender stem samples were shade dried and powdered. 5 g of the powdered samples were boiled for 10 min in 100 ml sterile distilled water and filtered through Whatman No. 1 filter paper (pore size 25 μm). The filtrate was further filtered through 0.6 μm sized filters. The filtrate was used for the present study.

2.3. Synthesis of silver nanoparticles

1 mM aqueous solution of silver nitrate ($AgNO_3$) was prepared and used for the synthesis of silver nanoparticles. 10 ml of *C. fenestratum* extract was mixed with 90 ml of aqueous solution of 1 mM silver nitrate for the reduction into Ag^+ ions and incubated overnight at room temperature in dark.

2.4. UV–vis spectra analysis

Silver nanoparticles (AgNPs) are soluble in distilled water and the colour changes were observed visually. A dark brownish colouration indicates the formation of silver nanoparticles. The reduction of pure Ag^+ ions was monitored by measuring the UV–vis spectrum of the reaction medium after overnight incubation, after diluting a small aliquot of the sample into distilled water. UV–vis spectral analysis was done by using Systronics UV double-beam spectrophotometer (model 2201), at a resolution of 1 nm, between 200 and 600 nm using 10-mm-optical-path-length quartz cuvettes.

2.5. FTIR (Fourier-transform IR) and SEM analysis of silver nanorods

FTIR studies on the samples were carried out using Nicolet Impact 400 FTIR spectroscopy to ensure the formation of silver nanorods. A scanning electron microscope (JEOL 6380A; Tokyo, Japan) was used to record the micrograph images of synthesized silver nanorods.

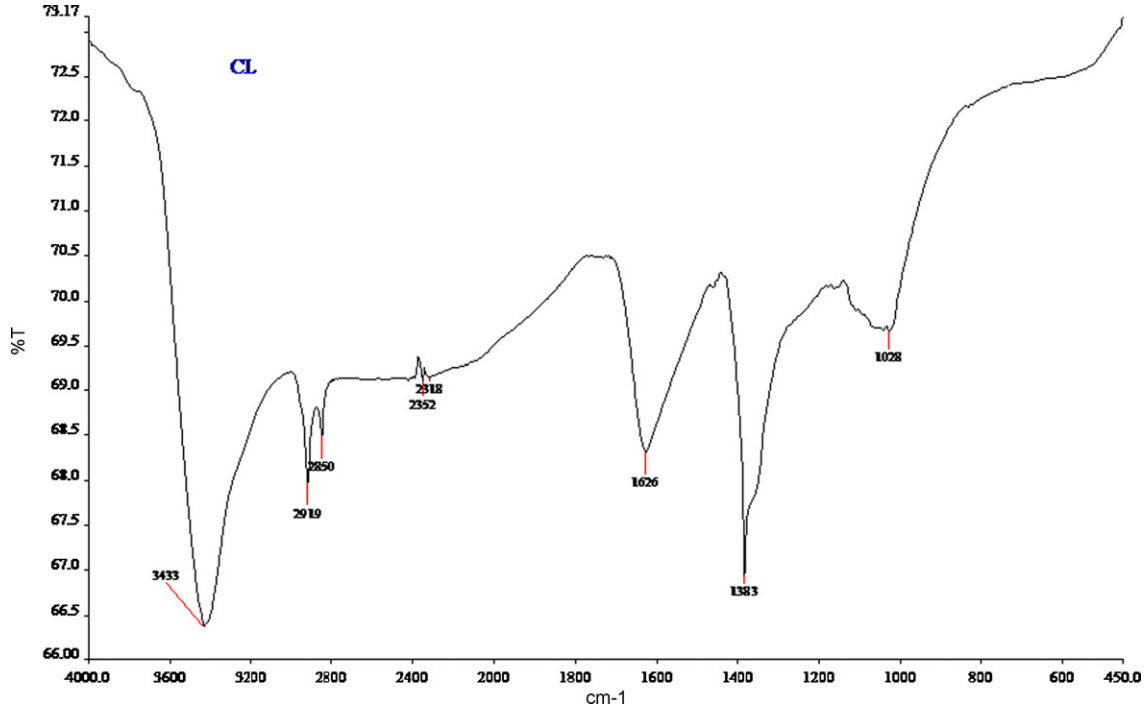

Fig. 2. FTIR spectra of silver nanorods (AgNRs).