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Biomimetic synthesis and characterization of plant –mediated silver nanoparticles using *cephalandra indica* extract and evaluation of their antibacterial activity

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ABSTRACT

The synthesis of nanoparticles has been entirely a chemical process till last few years. Because of environmental threat, the development of eco-friendly processes for the synthesis of nano-materials is the need of the day. One approach that shows great potential is synthesis of nanoparticles using micro-organisms and plants. The present study deals with the synthesis of silver nanoparticles and investigating the effect of process variables like reductant concentrations, reaction pH, mixing ratio of the reactants and interaction time on the morphology and size of silver nanoparticles synthesized using aqueous extract of previously unexploited plant Cephalandra indica leaves. These nanoparticles were characterized with UV-Vis spectrum, FTIR and SEM analysis which revealed that the morphology and size of silver nanoparticles were strongly dependent on the process parameters. Within 4 hrs interaction period, the nanoparticles are polydisperse and nearly spherical shape with size ranging from 40 to 90nm in size. Further these biologically synthesized nanoparticles were found to be highly toxic against different bacterial species.

Introduction

Synthesis of nanoparticles using biological entities has great interest due to their unusual optical (Krolikowska *et al*., 2003), chemical (Kumar *et al*., 2003). Hence, both unicellular and multicellular organisms are known to produce inorganic materials either intra-or extra cellular (Mann et al., 1996), photo electrochemical (Chandrasekhar an and Kamat, 2000) or electronic.

Plants have always been an exemplary source of drugs and many drugs currently available have been derived directly or indirectly from them. One such medicinal plant is, *Cephalandra indica* (also known as *Coccinia indica* and Ivy Gourd) is an indigenous plant variety of Central Africa, India and Asia. It is cultivated abundantly in India (Assam. Bihar, Orissa Maharashtra, Andhra Pradesh, and Tamil Nadu) as a vegetable and its wild form is also found in many parts of India. It is commonly known as 'Kundru' in India. This plant has been wildly used in traditional Indian medicinal system (Ayurvedic, Unani, and Siddha) *Cephalandra indica* is a climbing shrub with white flowers. Every part of the plant exhibit pharmacological activities, and is employed for treating various human ailments.

Materials and methods

Plant material and preparation of the extract:

The leaves of *Cephalandra indica* were collected from Trichy, Tamil Nadu, India. Fresh leaves were washed with distilled water and the cleaned leaves were dried with water absorbent paper and there were finely cut into small pieces. A known amount of leaves were added to 100mL of deionized water and boiled for 15 min in a water bath. The mixture were then filtered through what man No.1 filter paper (pore size 25 µm), to obtain aqueous extract of definite concentrations.

1mM aqueous solution of Silver nitrate (AgNO3) were prepared and stored in brown bottle and used for the synthesis of silver nanoparticles, a known concentration of leaf broth were interacted with 1mM AgNO3 solution at a definite mixing ratio. The flasks were incubated in room temperature for 4 hours.

Characterization of silver nanoparticles:

UV-Visible spectra analysis:

Preliminary characterization of the silver nanoparticles was carried out using UV–visible spectroscopy .The reduction of Ag ions was monitored by measuring the UV–visible spectra. UV–visible spectra were recorded on Hitachi double beam spectrophotometer (model U- 2900) from 200 to 800 nm. The distilled deionized water was used as blank.

FTIR spectroscopy analysis:

The FTIR measurements were carried out for both the fresh leaf extract of *Cephalandra indica* and Silver nanoparticles solution, using Perk in Elmer (Spectrum One) spectrophotometer.

Scanning Electron Microscope analysis of silver nanoparticles:

The thin films were prepared in glass slides and then observed in Scanning Electron Microscopic (SEM, Hitachi, and S-3000N) for the analysis of the nanostructures of the samples. Thin films of the sample were prepared by using spin coater (Delta spin) and the films were dried by putting it under the IR lamp (Philips) for 5 min.

Results

Figure 1 shows the UV–visible spectra of the nanoparticles recorded from the reaction medium after 4 hours, obtained on varying the concentrations of aqueous extract. The particles synthesized with 10% broth concentration gave a very weak Plasmon resonance band at 417 nm. On increasing the concentration to 20%, λmax increased to 444 nm .On further increasing the concentration to 30 , 40, 50% a small change in λmax to 441 nm were noted. The observed changes in the λmax

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values were not very significant taking into consideration with ±5% experimental error range. The maximum absorbances were noted at 20 and 40% concentration. On broadening of peak indicated that the particles are polydispersed.

The biosynthesized silver nanostructure by employing *Cephalandra Indica* leaf extract were further demonstrated and confirmed by FTIR (Figure 2) and the structural view under the SEM

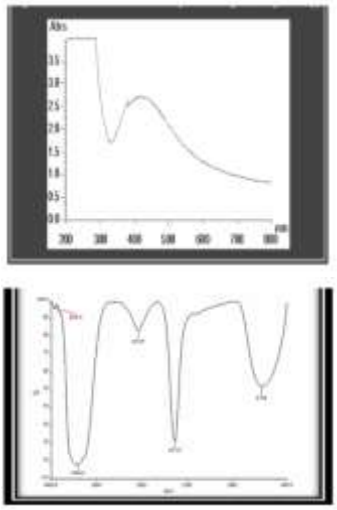


Figure: 2 a- FTIR spectral analysis of leaf extract of Cephalandra indica

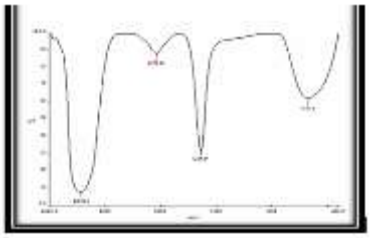
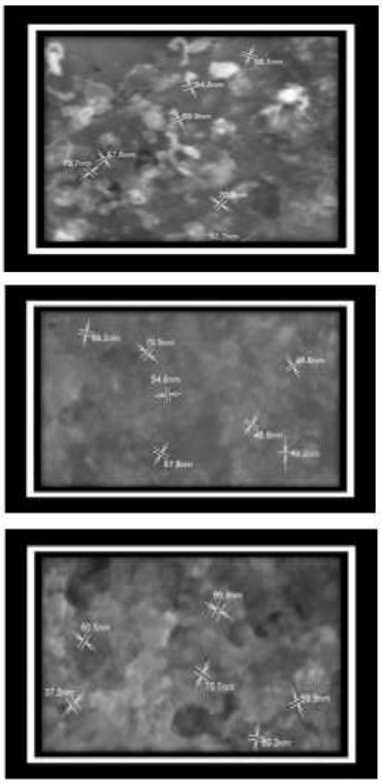


Figure: 2b - FTIR spectral analysis of silver nano particles.



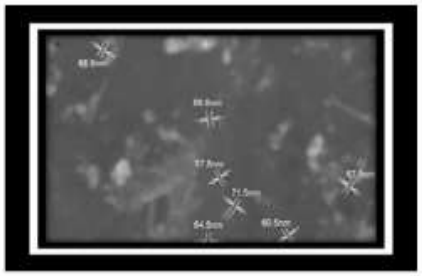


Fig 3: SEM image of silver nanoparticles formed at 20% concentration (a) (1:4) ratio (b) (2:3) ratio (c) (3:2) ratio (d) (4:1) ratio

Figure 2 shows the FTIR spectra of aqueous extract of fresh leaves and purified silvenanoparticles, respectively. Both of them showed the presence of bonds due to O–H stretching (around 3,430 cm-1), aldehydic C–H stretching (around 2,910 cm-1), C=C group (around 1,600 cm-1) and germinal methyl group (around 1,380 cm-1). These bands are indicative of terpenoid group of compounds present in the aqueous leaf extract. Some of the major chemical constituents present in leaves have been identified through detailed studies using 1D, 2D NMR and FT-IR as quercetin rhamnoside (0.45%), a flavonoid, quercetin (0.257%) and nimbin (0.19%). A few other constituents also present are nimbocinone (250 ppm), a protomeliacin (precursor for limnoids), nimbandiol (130 ppm) and nimbal, 6-deacetyl (120 ppm) From FT-IR results it can be inferred that some of the bio-organics from broth formed a strong coating/capping on the nanoparticles.The SEM image showing the high density silver nanoparticles synthesized by *Cephalandra indica* the extract further confirmed the development of silver nanostructures. The nanoparticles formed are polydisperse and nearly spherical shape. The nanoparticles formed are polydisperse and nearly spherical shape From Figure. 3a, the size (diameter) of the nanoparticles lie within 50-80 nm region nanoparticles. Figures, 3b 3c, and 3d shows that the size of the silver nanoparticles lie within 40-70 nm, 50-90nm, 50-90and the average size of the nanoparticles lie within40-90nm.

Conclusion

Nanotechnology will assume an essential place in drug delivery and human therapeutics. A wide variety of nanoparticles exists already and diverse method of synthesis has been employed. In this present work we have synthesized nanoparticles of silver by a simple method using the Cephalandra indica plant extract. The structural and morphological properties of the synthesized nanoparticles were characterized. SEM results showed that the silver nanoparticles thus formed were spherical with particle size of 40-80nm. The nanoparticle synthesis is also affected by concentration of the plant extract, ratio between the plant extract and silver nitrate, Ph and time duration. The present work proves that Cephalandra indica plant extracted synthesis is a new useful method using cheap precursor for preparation of silver nanoparticles. The effective parameters of the synthesis of nanoparticles were determined. The current simple cost effective and environmental friendly synthesis method using Cephalandra indica plant extracted solution gives a potential avenue for further practical scaleup of the production process and applications.

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