Silver nanoparticles from *Switenia mahagony* :Green Synthesis and Characterisation

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Abstract

The synthesis of metal and semiconductor nanoparticles is an expanding research area due to the potential applications for the development of novel technologies. In this work, we describe a cost effective and environment friendly technique for green synthesis of silver phyto nanoparticles and their antibiogram from 3mM silver nitrate solution through the extract of *Switenia mahagony* as reducing as well as capping agent. In the process of synthesising silver nanoparticles, we observed a rapid reduction of silver ions leading to the formation of stable crystalline silver nanoparticles in the solution. The herbal leaves and their medicinal properties were already discussed in varieties of ayurvedic studies. The synthesis of silver phyto nanoparticles were prepared by adding silver nitrate solution solution (3mM) to the plant extract. Nanoparticles were characterised using UV-Visible absorption spectroscopy, FTIR, XRD, XRF, TEM AND SEM analysis. The biomass of plants produces their nanomaterials by a process called bio mineralisation. It was concluded from the above studies that 3 mM concentration of silver nanoparticles showed the best concentration amongst the various concentrations prepared and also their characterisation showed that these nanoparticles synthesised were mostly globular in structure, and proved to have the functional groups in the terminal ends as well as showed sharp peaks by XRD studies.

Keywords: Herbal extract, Silver nanoparticles, UV- VIS, FTIR, TEM, SEM, XRD

1. Introduction

Nanotechnology concerns with the development of experimental processes for the synthesis of nanoparticles of different sizes, shapes and controlled dispersity **(**Manish Dubey *et al.,* 2009**).** This provides an efficient control over many of the physical and chemical properties (Baker *et al.,*2005) and their potential application in optoelectronics.(Landsdown & Williams, 2007; Mukherjee *et al.,* 2001),recording media (Sun *et al.,*2000) sensing devices (Mayes *et al.,*2003; Han *et al.,*2005),catalysis (Moreno-Manas & Pleixats, 2003) and medicine (Jose A Rojas-Chapana & Michael Giersig, 2006; Tadanori Yamada et al. 2003; Robert A Freitas, 2005).

To date, metallic nanoparticles are mostly prepared from nobel metals (ie, Ag, Pt, Au and Pd) (Tadanori Yamada et al. 2003). Among the nobel metals, silver (Ag) is the metal of choice in the field of biological system, living organisms and medicine Green synthesis of nanoparticles is an emerging branch of nanaotechnology (Leela & Vivekanandan, 2008). The use of environmentally benign materials like plant leaf extract, bacteria and fungi for the synthesis of silver nanoparticles offers numerous benefits of eco-friendliness and compatibility for pharmaceutical and biomedical applications as they do not use toxic chemicals in the synthesis protocols (Vyom Parashar *et al.,* 2009). Bio-inspired synthesis of nanoparticles provides advancement over chemical and physical methods as it is a cost effective and environment friendly and in this method there is no need to use high pressure, energy, temperature and toxic chemicals (Goodsell, 2004).

Disease causing microbes that have become resistant to drug therapy are an increasing public health problem. Therefore there is an urgent need to develop new bactericides. Silver nanoparticles take advantages of the oligodynamic effect that silver has on microbes (Prabu *et al.,* 2010). In the present study, reducing silver ions present in the aqueous solution of silver nitrate by the help of *Switenia mahagony* extract and their antibacterial assessment was performed to produce novel drugs to overcome drug resistance and adverse reaction.

2. Materials and Methods

2.1 Materials

Switenia mahagony collected from the Anna University Campus, Chennai, India. The extract was used for reducing and capping

agent. Silver nitrate was purchased from Merck Limited, India. Lyophilised cultures of microorganisms were procured from the department of Microbiology, King's Institute, and Chennai. Hi-Media Laboratories supplied the nutrient media used here.

2.2 Methods

2.2.1 Preparation of the Extract

Extract have been prepared by using fresh leaves of *Switenia mahagony,* weighing 20grams.Washed thoroughly thrice in distilled water, cut into fine pieces, transferred into a 500ml Erlenmeyer flask with 100ml of distilled water and boiled for 10minutes.It was then filtered to obtain the plant extract.

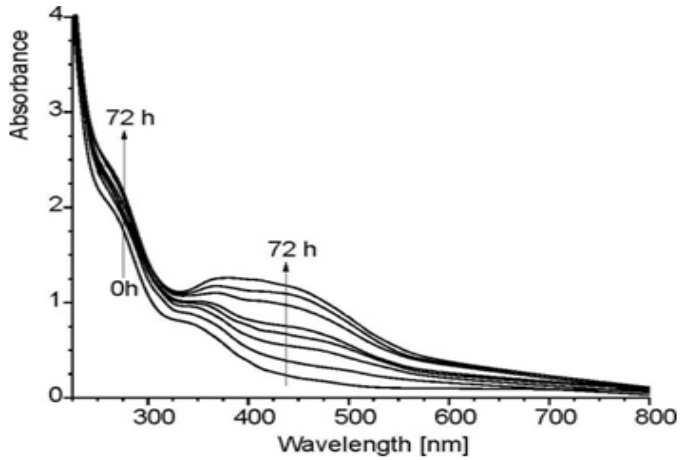
2.3 Synthesis of Nanoparticles

1mM, 3 mM and 5mM solution of silver nitrate was prepared.5ml of plant extract was mixed with each 25ml of 1mM, 3mM and 5mM silver nitrate respectively . The formation of reddish brown colour was observed and λ max at different time intervals were taken for 8 hours, using a UV-Visible spectroscopy. Then the solution is stored in room temperature for 24 hours for the complete settlement of nanoparticles. After 24 hours centrifuge the reaction mixture, discard the supernatant. Add 1ml of distilled water to the pellet and wash by using centrifugation. Collect the pellet by using acetone/ethyl acetate/Alcohol. Dry in the watch glass and store the nanoparticles.

2.4 Analysis of Silver nanopaticles:

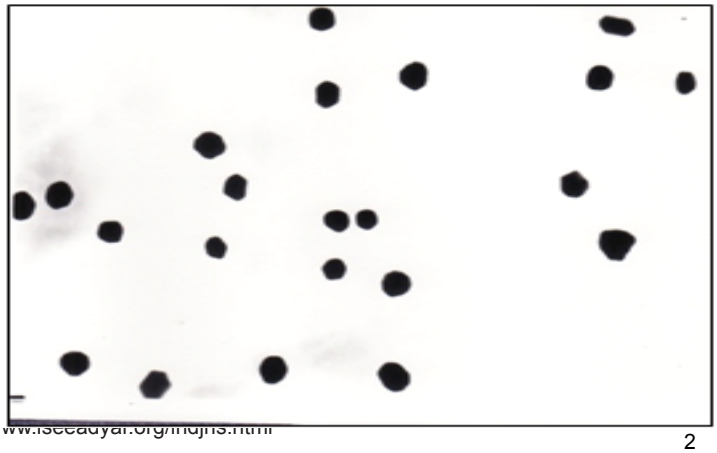
a. UV-Vis Spectra analysis: The reduction of pure silver ions was observed by measuring the UV-Vis spectrum of the reaction at different time intervals taking 1ml of the sample, compared with 1 ml of distilled water used as blank.UV-Vis spectral analysis has been one by using An Elico spectrophotometer at a resolution of 1 nm from 200to 1100 nm (Fig.1).

Fig .1 *UV Absorption Specta of Silver Nanoparticles from Switenia mahogany*



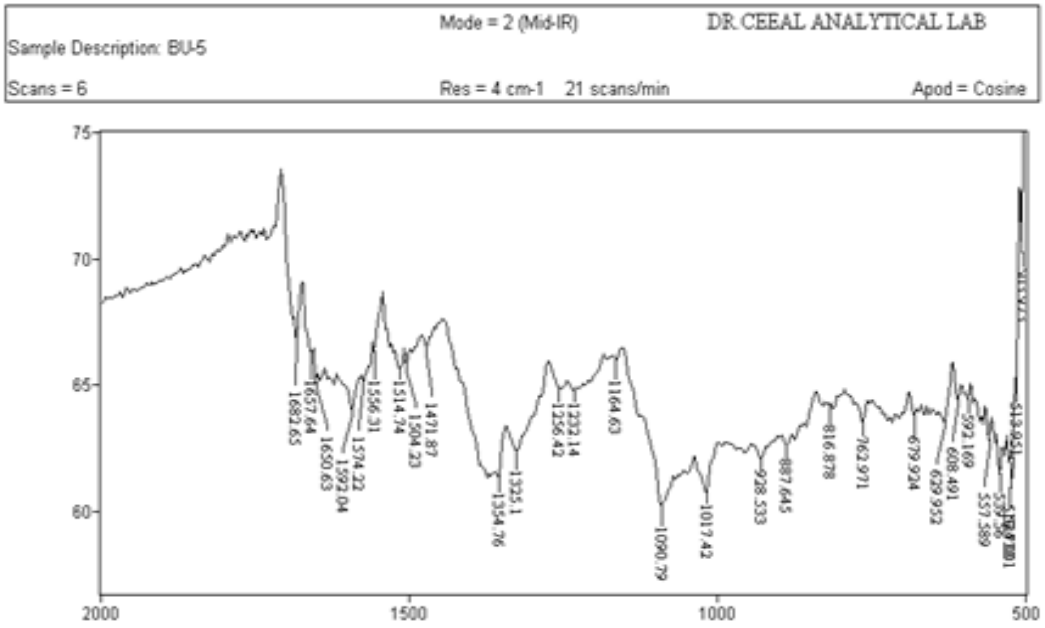
b.TEM analysis of silver nanoparticles: Sample is dispersed in double distilled water. A drop of thin dispersion is placed on a "staining mat". Carbon coated copper grid is inserted into the drop with the coated side upwards.After about ten minutes, the grid is removed and air-dried. Then screened in JEOL JEM 100SX Transmission Electron Microscope at an accelerating voltage of 80kv (Fig.2).

Fig: 2 *TEM Analysis of Swetinia Mahogany Nanoparticles*



c. FTIR Analysis: Perkin-Elmer spectrometer FTIR Spectrum ONE in the range4000–400 cm−1 at a resolution of 4 cm−1.was used. The sample was mixed with KCl procured from Sigma. Thin sample disc was prepared by pressing with the disc-preparing machine and placed in Fourier Transform InfraRed [FTIR] for the analysis of the nanoparticles (Fig.3).

Fig: 3 *FTIR Analysis of Swetinia mahagony Nanaoparticles*



d. **XRD Analysis:** X-ray diffraction (XRD) analysis of drop-coated films of silver nanoparticles in sample was prepared for the determination of the formation of silver nanoparticle by an X'Pert Pro X-ray diffractometer operated at a voltage of 40kv and a current of30mAnwith Cu Kα radiation.

e. **SEM analysis:** After the preparation of the nanoparticles, the suspension of nanoparticles in water was used for SEM analysis by fabricating a drop of suspension onto a clean electric Stubs and allowing water to completely evaporate. SEM observations were carried out on a ZEISS EVO 40 EP Electron microscope (Fig.4A,B).

Fig:4A *SEM Analysis of Swetinia mahogany*

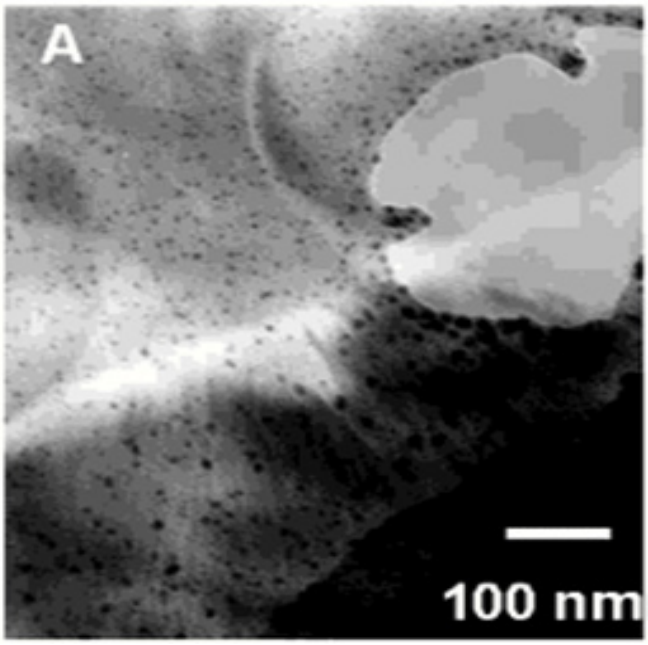
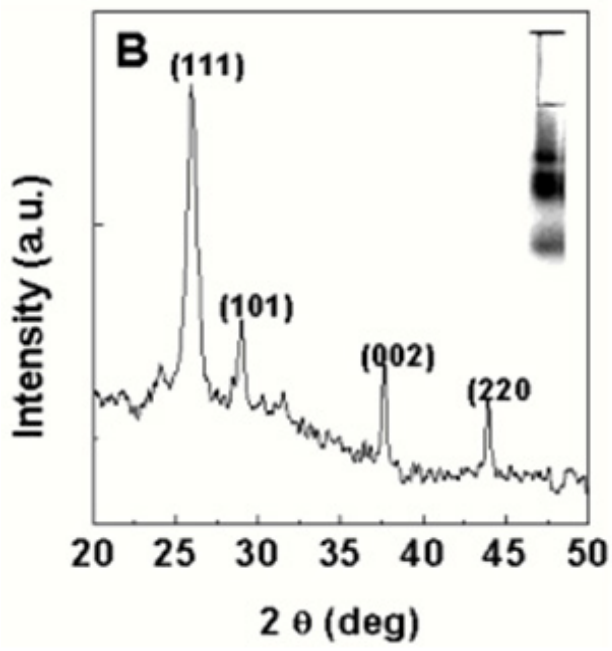


Fig :4B XRD Analysis of Swetinia mahogany



3. Results and Discussion

It was seen that amongst the three different concentrations of silver nitrate, 3mM concentration of silver nitrate produced more silver nanoparticles compared with the other two. Hence, further studies of analyzing the silver nanoparticles and their application in antibacterial activity was carried out with the nanoparticles produced with 3mM concentration of silver nitrate.

Recent studies have demonstrated that specially formulated metal oxide nanoparticles have good antimicrobial activity (Ahmad *et al.,*2003). The antibacterial and antiviral actions of silver, silver ion and silver compounds have been thoroughly investigated (Durán *et al.,*2005; Saiffudin *et al.,* 2009). Microbes are unlikely to develop resistance against silver, as they do against conventional and narrow target antibiotics because the metal attacks a broad range of targets in the organisms, which means that they would have to develop host mutations simultaneously to protect themselves. Thus silver ions have been used in dental resin composites (Leff *et al.,*1996), in synthetic zeolites (Belly & Kydd, 1982) and in coatings of medical devices Found that silver nanoparticles undergo size dependent interaction with HIV-I. Furr et al. (1994) have also reported the size dependent interaction of silver nanoparticles with Gram-negative bacteria.

Report from (Balaji Dasaratrao Sawle *et al.,*2008) states that upon addition of silver ions into the filtered cell free filtrate in the dark samples changes its color from almost colourless to brown with intensity increasing during the period of incubation. (Reynolds, 1963) reported the conversion of 3mM silver nitrate solution to nanosilver by *Fusarium oxysporum* in an aqueous medium due to the change in color of the reaction mixture from pale yellow to dark brown.

An UV-VIS spectrum is one of the important and easy techniques to verify the formation of metal nanoparticles provided surface plasmon resonance exists for the metal (Sondi & Salopek-Sondi, 2004). Ahmad et al. (2003) reported that silver nitrate solution when incubated with spent mushroom substrate synthesis of silver nanoparticles purified solution yielded the maximum absorbance at 436nm. Mukherjee et al. (2002) reported that the UV-VIS spectrum of the solution of *Coriolus versicolor* shows the maximum absorption band at 440nm.

A long tailing on the larger wavelength side may be due to the small amount of aggregated particles. Apart from this, the absorption peak at 210 nm was assigned to the strong absorption of peptide bonds in the filtrate. The absorption at 280 nm indicated the presence of tryptophan, tyrosine or phenylalanine residues in the protein. This observation indicates the release of proteins into filtrate that suggests a possible mechanism for the reduction of metal ions present in the solution.

Observation of the strong but broad surface Plasmon peak has been well known in the case of various metal nanoparticles over a wide size range of 2-100nm (Reynolds, 1963). Sondi & Salopek-Sondi, 2004) suggested that the shoulder at 370nm corresponded to the transverse plasmon vibration in silver nanoparticles, whereas the peak at 440nm due to excitation of longitudinal plasmon vibrations. In the present study, the peak value was observed at 381nm.

4. Conclusion

It was concluded from the above studies that 3 Mm concentration of silver nanoparticles showed the best concentration amongst the various concentrations prepared and also their characterisation showed that these nanoparticles synthesised were mostly globular in structure, and proved to have the functional groups in the terminal ends as well as showed sharp peaks by XRD studies.

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