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Biosynthesis of Silver nanoparticles using Desmodium Gangeticum leaf extract

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ABSTRACT

A range of methods is available for the synthesize nanoparticles. However, these methods are associated with the production of undesirable byproducts which are quite hazardous and high costs. Thus, a number of efforts are being made to develop novel cost-effective safe & reliable "green" procedures which caned produce desired nanoparticles. In this study, we caned successfully develop a green synthesis method for preparation of silver nanoparticles using Desmodium gangeticum leaf extract as reducing & capping agents. The method was found a quite effective inversion of silver ions to silver nanoparticles in a short interval of time. The developed nanoparticles exhibited Surface plasmon resonance at around 500 nm. The particles are nearly spherical, and the size ranged between 16-64nm. The average size was noted to be around 40 nm. The nanoparticles were characterized for their morphology using UV-vis, TEM, FTIR analysis and FESEM. The developed method carries the advantage of the completion of the reaction in a short time. The crystalline nature of the synthesize nanoparticles was assessed & confirm by XRD & EDX Studies. From FTIR studies, it can be understood that the flavonoids could be adsorbed on the metal surface by interaction with carbonyl groups. The process was carried out in the environment-friendly condition.

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INTRODUCTION

Nanotechnologies are a Potential alternative for the treatment of various diseases because they have a unique biological effect based on their structure and shape (Suganthy *et al.*, 2018). In the last few years, the FDA has approved many pharmaceutical companies for the development of nanotechnology-based drugs. In the recent years, metal nanoparticles have captured attention as drug carrier due to their unique properties (Deyev *et al.*, 2017; Khutale and Casey, 2017; Kumar and Gopidas, 2010). In particular, the metal nanoparticles showed great potential due to immense surface area & high content of surface atoms. Gold & silver nanoparticles were found to be highly significant due to attributes like conductivity, stability; catalytic potential and antimicrobial Properties (Castro *et al.*, 2010; Lee *et al.*, 2014; Qian *et al.*, 2008). Inorganic metal nanoparticles were noted to be quite effective against pathogens & diseases like cancer. Gold nanoparticles carry some unique features like flexible core size, which make them suitable for drug delivery, especially gene delivery as promising scaffolds.

These nanoparticles carry immense scope in diagnosis and damage of cancer cell. The cancer cells are specifically adsorbed onto the nanoparticles of particular shape and are better detected by photon detecting device used for diagnosis. The size and shape of the nanoparticles play an important role in deciding the level of sensitivity detection. A range of methods is available for the synthesize nanoparticles. However, these methods are associated with the production of undesirable byproducts which are quite hazardous and high costs (Gurunathan *et al.*, 2015). Thus, a number of efforts are being made to develop novel cost-effective safe & reliable "green" procedures which caned produce desired nanoparticles. Plants offer a suitable medium for nanoparticles synthesis as they act as natural capping agents (Singhal *et al.*, 2011).

For the present study we selected Desmodium Gangeticum leaf as it exhibits a range of pharmacological effects like anti-Cancer, anti-diabetic, anti-hyperlipidemia, antioxidant, and hypotensive activities (Srivastava, 2013; Srivastava *et al.*, 2014, 2015b,a). The chemical analysis indicated the presence of alkaloids, tannins, phenols, flavonoids, terpenoids. Leaf extract is reported to possess have marked anti-oxidant activities (Govindarajan *et al.*, 2007; Arabshahi *et al.*, 2007). The present work was aimed at development & validation of a rapid, cost-effective, simple green, one-step method, for the synthesis of nanoparticles.

MATERIALS AND METHODS

Fresh leaves of *Desmodium Gangeticum* were obtained from the Camus of Dr Y.S Parmar University Solan, Himachal Pradesh, India. All other chemicals of analytical grade were purchased from Hi-Media Labs procured from Hi-media Labs.

Biosynthesis of silver nanoparticles using Desmodium Gangeticum leaf extract

The silver nitrate solution was prepared in the concentration of 10-3 M using Deionized water as a solvent. Fresh leaves from selected plants (10 g) cut into small size were taken in a flask and then washed with double distilled water. Then 200 mL of double distilled water is poured into the flask and heated for 3 min in a microwave oven to subdue the enzymes and proteins which play a crucial role in the reduction process. The solution is then filtered while hot through 10 μm filter to remove the solid fibrous matters. The clear solution thus obtained was used for the nanoparticles synthesis. Silver nitrate solution was made to react with the above plant extract (1:1) mixing ratio at 30°C in a rotary shaker at 120 rpm. (Inbakandan *et al.*, 2010; Konwarh *et al.*, 2011).

Characterization

UV-visible spectroscopy

The progress of reduction of silver ions was monitored by scanning the solutions after diluting twenty times with millipore water between 200nm-700nm. Spectroscopy is considered a simple and effective technique to assess nanoparticle formulation.

X-ray diffraction

The nanoparticle powders were subjected to X-ray diffraction analysis with generator speed of 40 Kv at 30 mA current. The scanning range was kept between 10-100.$^{\theta}$

Particle size analysis

The particle size analysis of the prepared nanoparticles was done using SALD. The particle size was assessed on the basis of time selected variations in the scattering of laser light by the nanoparticles.

HR-TEM analysis

The freeze-dried nanoparticles were evaluated using high-resolution transmission electron microscopy (HR-TEM). A few groups of nanoparticulate suspension was put on carbon-coated aluminum grids. These were dried and tested by TEM at 200 Kv.

FESEM

The synthesized nanoparticles were also characterized by FESEM. The samples dried at RT for five days were placed on pin stabs and further coated with carbon under vacuum.

RESULTS AND DISCUSSION

EDX Analysis

Ultraviolet visible spectroscopy

The mixing of silver nitrate solution with leaf extract solution resulted in light yellowish color changed to dark brown color within a few mins. This change in colour, indicating the formation of nanoparticles. The mixture of aqueous $AgNO_3$ solution and leaf extract solution was subjected to microwave irradiation to effect a microwave-assisted synthesis. The UV-vis spectrum as obtained post completion of the reaction is given in Figure 1. It was noted that the absorbance increased with time, resulting in oocurs at 500 nm. Surface plasmon peak confirms the impact of aqueous Desmodium Gangeticum leaf extract in reducing silver ions to silver nanoparticles (Song and Kim, 2009).

X-ray diffraction

XRD studies carried out to assess crystallenity of the synthesized Silver nanoparticles and results are

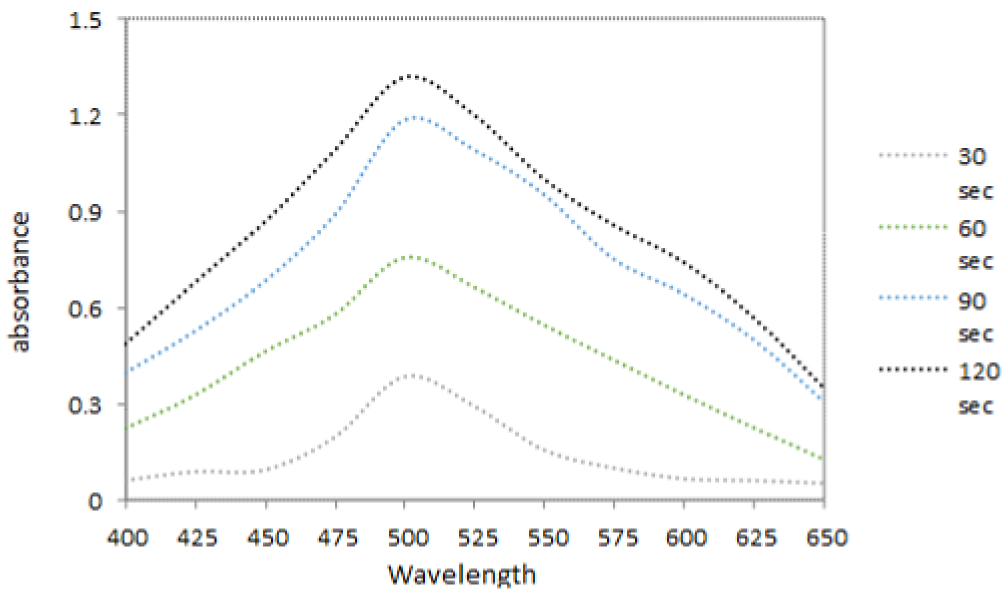

Figure 1: Uv-vis spectra Plant mediated Silver nanoparticles synthesis

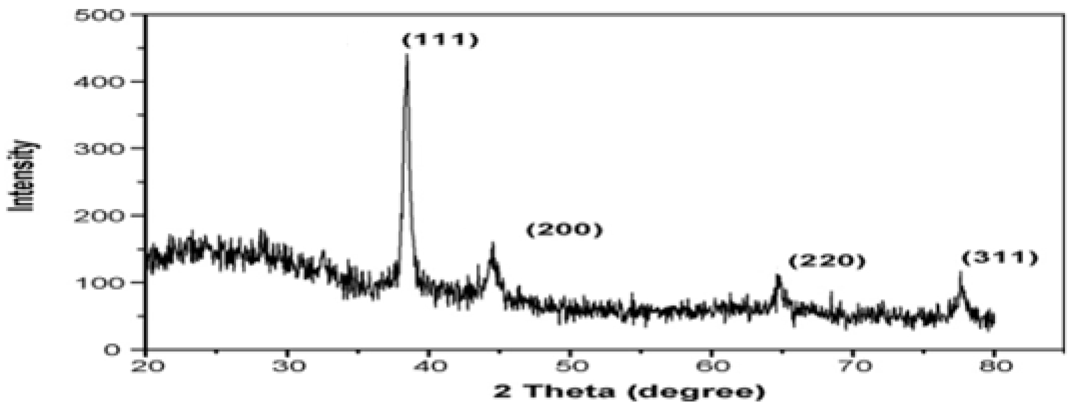

Figure 2: XRD Patterns of Crystalline Silver Nanoparticle

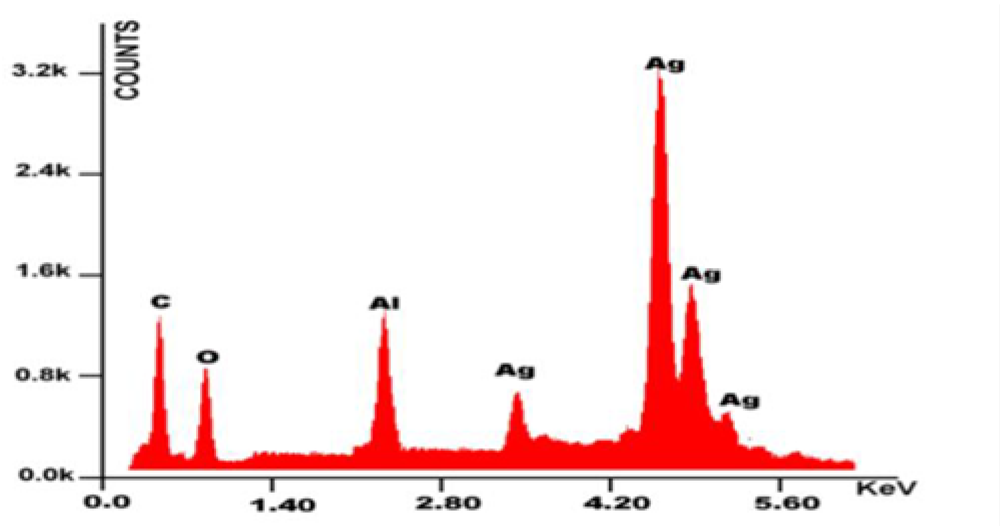

Figure 3: EDX of silver nanoparticles

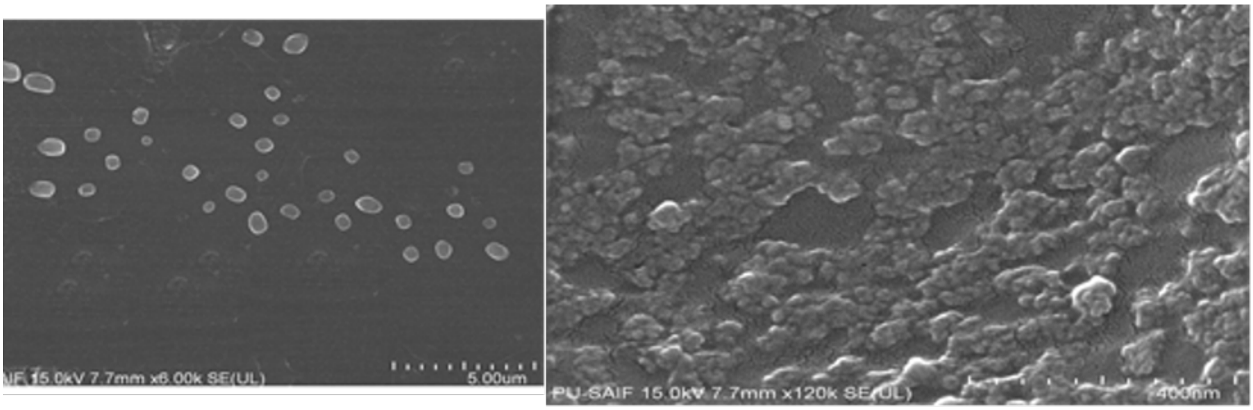

Figure 4: FESEM images of silver nanoparticles

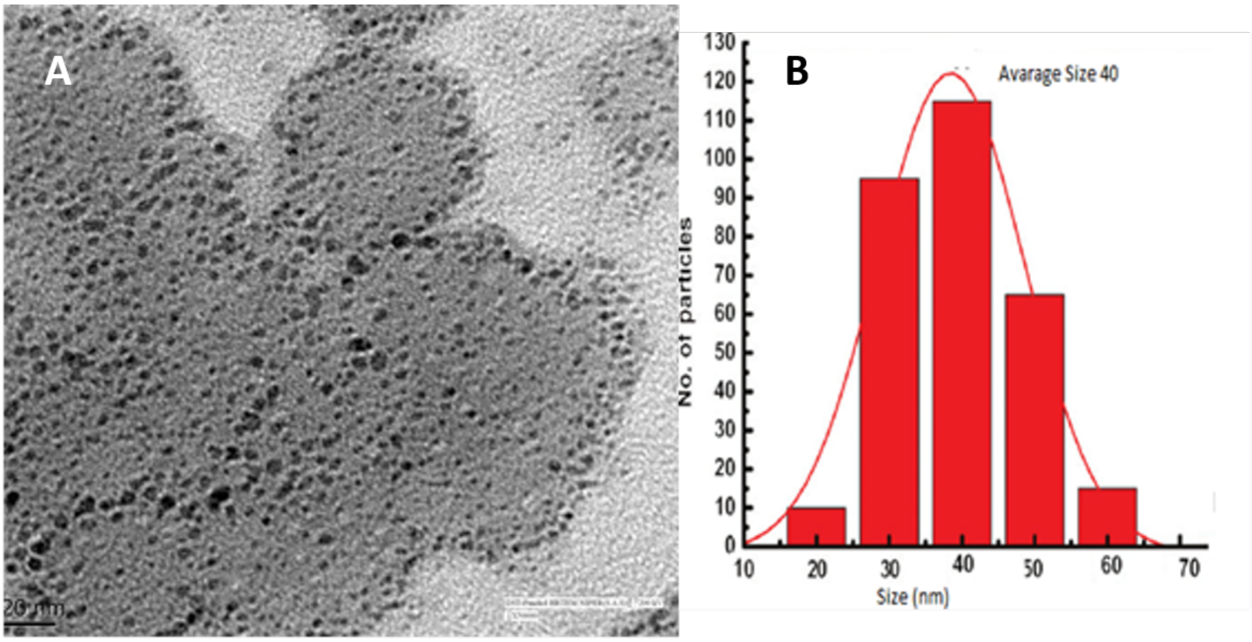

Figure 5: A) Hr-Tem Image of Silver Nanoparticles and (B)Size Distribution Histogram Silver Nanoparticles

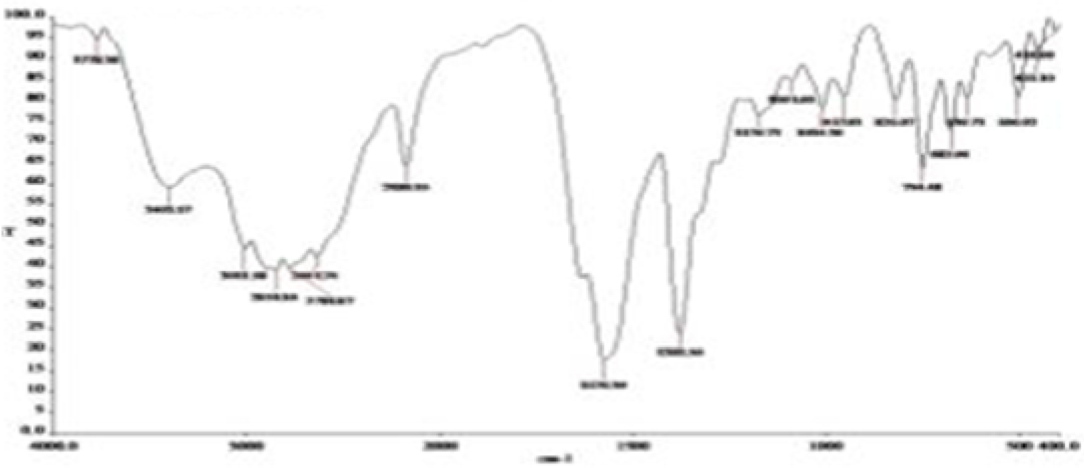

Figure 6: FTIR Spectra of Plant mediated Silver nanoparticles

depicted in Figure 2. Prominent peaks observed at (111), (200), (220) and (311) are the Silver nanoparticles and match the standard JCPDS file 04-0783 pattern.

Figure 3 depicts the results of EDX studies. The graph exhibits the presence of elemental Silver. This suggested the reduction of Silver ions to elemental Silver.

Field Emission scanning electronic microscope

FESEM images at resolutions of 100 nm and 400 nm are given in Figure 4. A careful observation indicates the presence of bio moiety covering the metal surface of all noano particles (AgNP). This organic moiety seems to be responsible for the reduction of Silver ions to silver nanoparticles also interparticle binding as well. The nanoparticle was noted to be well dispersed and nearly spherical in shape.

High-Resolution Transmission Electron Microscopy

The synthesized particles were subjected to HR-TEM (Figure 5 A &Figure 5 B). The morphology of functionalized nanoparticles could be clearly seen in the image. The particles are nearly spherical, and the size ranged between 16-64nm. The average size was noted to be around 40 nm, and the particles were found to be discretely distributed.

FTIR

The mixture was subjected to FTIR analysis (Figure 6). The interpretation of IR spectra indicated peaks at 15.76.39 cm^{-1} which corresponds to C=O bonds while adsorbed bond at 3408.53 cm^{-1} can be assigned to O-H bonding. It can be conveniently inferred from IR spectra that the peaks indicate the presence of flavonoids and terpenoids, which may be held responsible for enhanced reduction & capping. Though terpenoids being practically insoluble in water and hence may not be playing any significant role in the reduction. It can be understood that the flavonoids could be adsorbed on the metal surface by interaction with carbonyl groups.

CONCLUSION

A Simple, Cost-effective, rapid and environment-friendly method for green synthesis of silver nanoparticles was successfully developed using plant-based reducing & capping agent. The method is less time-consuming, and coned be accomplished at room temperature without any complexity. The method could be used for large scale production of silver nanoparticles.

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