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Green Synthesis of Silver Nanoparticles by Caralluma fimbriata L. and its Characterization

KEYWORDS: Nanotechnology, Nanoparticles, FTIR, XRD and SEM.

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ABSTRACT *Nanotechnology is a rapidly growing technique, due to its wide application in various fields viz. Medical, Engineering, Chemistry, Biotechnology and Physics etc. In this study, the Silver Nanoparticles were synthesized by using aqueous extract of Caramulla fimbriata L. This shrub is generally available in Western Ghat region particularly Sahyadri mountain in Maharashtra. The synthesized Silver nanoparticles were characterized by UV-Visible spectroscopy, FTIR, XRD (X-ray diffraction) and SEM (Scanning Electron Microscopy). The UV-Vis spectroscopy shows Plasmon resonance of AgNPs at 452 nm. The X-ray Diffraction analysis show the average particle size is about 18.35 nm. This green synthesis process indicates that it is more convenient method than other chemical process.*

1. Introduction

The word "nano" is used to indicate one billionth of a meter or 10^{-9}. The term nanotechnology was coined by professor Noria Taniquichi of Tokyo Science University in the year 1974 to describe precision manufacturing of materials at the nanometer level.

"Nano" is a Greek world synonymous to dwart meaning extremely small. Nano technology is one of the areas of Frontier research. It has wide applications in science and technology for developing new materials. Use of nanoparticles is gaining attention in the present century as they possess well defined chemical, optical & mechanical properties[1]. Nanoparticles are viewed as fundamental building blocks of nanotechnology. Number of approaches are available for synthesis of Silver nanoparticles e.g. fossil method, thermal decomposition of silver compounds, electrochemical, sonochemical, microwave assisted process and recently via green chemistry route[2].The use of plant materials for the synthesis of nanoparticles could be more advantageous as it does not require elaborate process such as intracellular synthesis and multiple purification steps or the maintenance of microbial cell cutlers. Silver nanoparticles also exhibit a potent cytoprotective activity towards HIV-infected cell's because of such wide range of application numerous synthetic methods have been developed[3].Silver nanoparticles containing material are used in medicine to reduce infection in burn treatment[4].

Caralluma fimbriata is an erect branched shrub growing 20-30 cm in height. Stems are leafless, four angled, fleshy, green and tapering to a point. Leaves are minute and present only on young branches in flowering period July-August. It has been eaten in rural India and also used for purported ability to suppress hunger and appetite and to enhance stamina.

2. MATERIAL AND METHODS

2.1. Collection of sample

Fresh *Caralluma fimbriata* sample were collected from village Pimpalgaon matha which is situated in Tahsil Sangamner, Maharashtra, India. The collected sample is washed with distilled water thoroughly then stem is cut in to small pieces.

2.2. Preparation of plant extract

Stem pieces weighing 40 gm are directly transferred into a previously washed 250 ml beaker containing 200 ml distilled water. This mixture is boiled for 30 minutes. Mixture was cooled at room temperature and then filterd through ordinary filter paper. Filtrate is collected in 250 ml previously washed beaker. This filtrate was again filtered through Whatmann No. 41 filter paper. The collected filtrate is used for synthesis of silver nano particle.

2.3. Synthesis of silver nanoparticles

Aqueous solution of 0.1M $AgNO_3$ was used for synthesis of nanoparticles. 1 part of above aqueous plant extract (Fig.2.a.) was mixed with 9 parts of $AgNO_3$ solution

so as to make (1:9) proportion in an Erlenmeyer flask. These solutions were kept in sunlight for 90 minutes.

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After time of period the color of the solution turns to brown, indicating the formation of AgNPs (Fig.2.b).Then it was centrifuged and the mixture was collected after discarding the supernatant. The particles of AgNPs were dried in Petri dish.

Fig.1. Caralluma fimbriata L. plant

2.4. Characterization of synthesized silver nano particles

The bio-reduction of Ag^+ ion in aqueous solution was monitored with the help of UV-Visible spectroscopic analysis method. UV-Visible spectroscopic analysis of silver nanoparticles was carried out as a function of time needed for bioreduction at room temperature on model UV-2100 series and FTIR (JASCO 4100) was used to study the optical properties of silver NPs. The structural and chemical composition of silver NPs were analyzed by SEM (JEOL JSM-6360) and XRD (Brukar D8-Advanced Diffractometer).

Fig.2 (a) *Caralluma fimbriata* **plant extract (b) $AgNO_3$ mixed with** *Caralluma fimbriata* **plant extract.**

3. Results and Discussion

Characterization of silver nanoparticles

From XRD pattern (Fig.3.) of silver nano particles, the peaks at 2θ = 27.55˚, 31.9˚, 37.902˚, 45.96˚ represents the (320), (110) and (211) Bragg's reflections of the face-centered cubic structure of silver, respectively. The size of the silver nano particles were determined from X-ray diffraction using the Debye –Scherrer formula given as D = $0.9\lambda/\beta \cos\theta$, where D is the average crystalline size (A˚), λ is the X- ray wavelength used (nm), β is the angular line width at half maximum intensity and θ is the Bragg's angle. For (110) reflection at 2θ = 31.9, for β = 0.45 radians, λ = 1.54 A˚ and θ = 15.95, the average size of the silver nano particles is estimated to be around 18.35 nm.

Fig.3. XRD analysis of silver nano particles.

SEM images (Fig.4) of the silver solution confirms the existence of very small and uniformly spherical nano particles. The large size particles were observed due to aggregation of nano particles of silver. The composition of element was determined by SEM (JEOL JSM-6360).

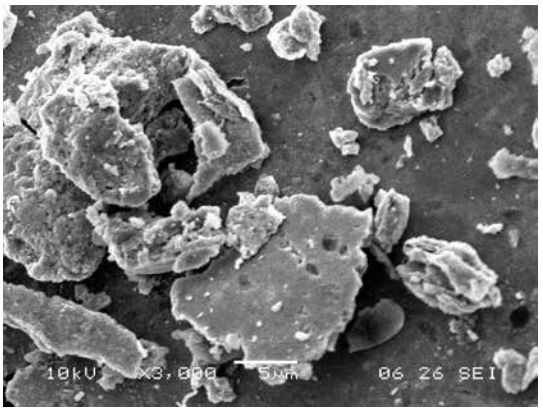

Fig.4.SEM analysis of silver nanoparticles

The colorless silver nitrate solution forms the brown color (Fig.2.b) indicating the formation of silver nanoparticles. The appearance of the brown color was due to the excitation of the surface Plasmon vibrations, which are in the range of 400-500 nm[5]. The UV-Visible spectra (Fig.5) of nanoparticles show Plasmon resonance at 452 nm. From FTIR analysis (Fig.6), the peaks around 3440.39 cm^{-1} and 1384.64 cm^{-1} correspond to O-H bond vibration and NO_3^- group respectively.

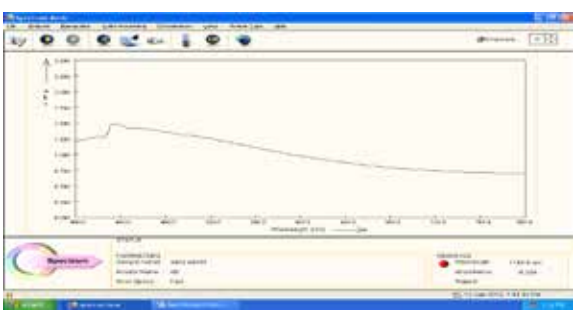

Fig.5 UV Visible Spectra of Silver nanoparticles

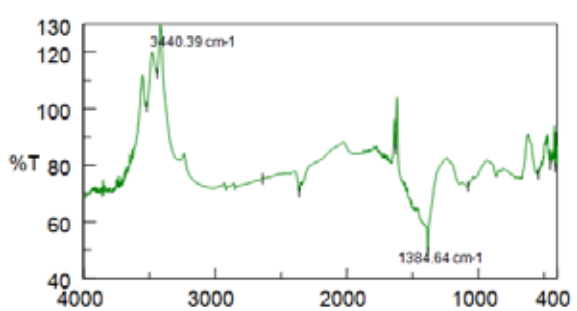

Fig.6.FTIR spectroscopy analysis of silver nanoparticles

CONCLUSION

Caralluma fimbriata plant extract is capable for the synthesis of nano particles of silver by green and eco-friendly method. The synthesized nanoparticles were analyzed by UV-Visible Spectrophotometer, FTIR, SEM and XRD which shows the average particle size about 18.35 nm. The synthesized silver nanoparticles may exhibit significant biological activity.

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