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SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLE USING *EICHHORNIA CRASSIPES* LEAF EXTRACT

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ABSTRACT

Green synthesis of silver nanoparticles (AgNPs) recently much attention focused in chemists and researchers. In this concern, Indian flora has yet to divulge innumerable sources of cost-effective non-hazardous reducing and stabilizing compounds utilized in preparing AgNPs. In the present study to synthesis the AgNPs using *Eichhornia crassipes* leaf extract. The AgNPs were characterized by UV-visible (vis) spectrophotometer, scanning electron microscopy (SEM). Fourier transform infrared spectrometer (FTIR) analysis was carried out to determine the nature of the capping agents in each of these leaf extracts. The green synthesis method is eco-friendly, of low cost and capable of producing AgNPs at room temperature. Here, *Eichhornia crassipes* leaf extract act as both reducing and stabilizing agents. The AgNPs were characterized by UV - Vis, FTIR and SEM analysis. The UV-Vis spectral studies confirmed the surface plasmon resonance of green-synthesized silver nanoparticles. Biomolecules were responsible for reducing and capping of AgNPs, which were confirmed by FTIR measurements. SEM studies revealed spherical and uniform-shaped silver nanoparticles with size in the range 10-40nm. In this present study, flavonoids in the *Eichhornia crassipes* leaf extract play an important role in the formation of silver nanoparticles.

KEYWORDS

Eichhornia crassipes, Silver nanoparticles, Scanning Electron Microscopy (SEM) and Fourier Transform Infrared Spectrometer.

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INTRODUCTION

Nanotechnology is a new and emerging field of science that is bound to have tremendous impact on mankind by helping solve major challenges facing humanity in health and energy. This is due to the practical applications of metal nanoparticles in various areas such as medicine[1]. The range of nanoparticles approximately 1 to 100nm.

Nanoparticles can be synthesized using various approaches including chemical, physical, and biological methods[2]. Different types of nano materials like copper, zinc, titanium, magnesium, gold, alginate and silver have come up but silver nanoparticles have proved to be most effective as it has good antimicrobial efficacy against bacteria, viruses and other eukaryotic microorganisms[3]. Of these, silver nanoparticles are playing a major role in the field of nanotechnology and nano medicine.

Plant and plant products commonly used for the synthesis nanoparticles due to free from toxic chemicals as well as natural capping agents. Many such experiments have already been started such as the synthesis of various metal nanoparticles using *Azadirachta indica (Neem)*[4], *Aloe vera*[5] and *Emblica officinalis (amla, Indian Gooseberry)*[6] in the field of pharmaceutical applications and biological industries. The medicinal value of the chosen plant *Eichhornia crassipes* leaves has not been extensively worked out. Therefore, the present study was to investigate the synthesis and characterization of silver nanoparticles from *Eichhornia crassipes* leaf extract.

MATERIAL AND METHODS

Collection of plant materials

The *Eichhornia crassipes* leaves were collected in January 2015 from Koraiyaru River, Mannargudi, Thiruvarur district, Tamil Nadu. The leaves were identified and authenticated by Dr. S. John Britto, The Director, the Rapiant Herbarium and centre for molecular systematics, St. Joseph's college Trichy-Tamil Nadu. India. A Voucher specimen has been deposited at the Rabinat Herbarium, St. Josephs College, Thiruchirappalli, Tamil Nadu, India.

Synthesis of Ag nanoparticles using leaf extracts

The dried leafs were pulverized well with mortar and pestle to make a powder. Twenty grams of powder sample was mixed into 100 ml of deionized water and the mixture was boiled for 10 min. After cooling the leaf extract was filtered with Whatman No.1 filter paper. The filtrate was stored at 4°C for further use.

For the Ag nanoparticles synthesis, 5 ml of *Eichhornia crassipes* leaf extract was added to 45 ml of 1 mM aqueous $AgNO_3$ solution in a 250 ml Erlenmeyer flask. The flask was then incubated in the dark at 5hrs (to minimize the photo activation of silver nitrate), at room temperature. A control setup was also maintained without leaf extract. The Ag nanoparticle solution thus obtained was purified by repeated centrifugation at 10,000 rpm for 15 min followed by re-dispersion of the pellet in de-ionized water. Then the Ag nanoparticles were freeze dried using SEM analysis[7].

UV and FTIR Spectroscopic analysis

The reduction of pure Ag+ ions was examined under visible and UV light for proximate analysis. For UV spectrophotometer analysis, the AgNPs were centrifuged at 3000 rpm for 10 min and filtered through Whatmann No.1 filter paper by using high pressure vaccum pump. The sample is diluted to 1:10 with the deionized water. The reduction of pure Ag+ ions were scanned in the wavelength ranging from 300-900 nm using Perkin Elmer Spectrophotometer and the characteristic peaks were detected. FTIR analysis was performed in the ranging from 400-4000 cm^{-1} and their functional groups. The peak values of the UV and FTIR were recorded. Each and every analysis was repeated twice for the spectrum confirmation.

SEM analysis of silver nanoparticles

In this research work, VEGA 3 SEM machine were used to characterize mean particle size, morphology of nanoparticles. The freeze dried sample of AgNPs solution was sonicated with distilled water, small drop of this sample was placed on glass slide allowed to dry. A thin layer of platinum was coated to make the samples conductive VEGA 3 SEM machine was operated at a vacuum of the order of 10-5 torr. The accelerating voltage of the microscope was kept in the range 10-20 kV.

RESULTS AND DISCUSSION

Synthesis of Silver Nanoparticles

A study on phytosynthesis of Ag nanoparticles by the aqueous leaf extract of *Eichhornia crassipes* was carried out in this work. During the visual

observation, silver nitrate incubated with leaf extract showed a color change from yellow to brown within 5 h whereas no color change could be observed in silver nitrate without leaf extract. The appearance of brown color in leaf extract treated flask is clear indication for the formation of Ag nanoparticles (Figure No.1). This color arises due to excitation of surface Plasmon vibrations in Ag nanoparticles. Sivakumar[8] reported that color change was observed at 90 minutes from light green to light brown color, indicating the formation of silver nanoparticles which also indicated the presence of silver nanoparticles. we have demonstrated the efficiency of *Eichhornia crassipes* leaf extract in the rapid synthesis of silver nanoparticles possessing a variety of fascinating morphologies owing to its diverse groups of phytochemicals like phenolics, favonoids, polyphenols, reducing sugars, anthraquinones, terpenoids and anthrones.

UV-VIS spectral analysis

The UV-visible spectroscopy proved to be a very useful technique for the analysis of silver nanoparticles. The UV-vis spectra of reaction medium recorded as a function of reaction time using silver nitrate and *Eichhornia crassipes* leaf broth. It is observed that the maximum absorbance of Ag nanoparticles occurs at 418 nm (Figure No.2). According to Njagi[9], this band corresponds to the absorption by colloidal silver nanoparticles in the region (400-450 nm) due to the excitation of surface plasmon vibration. Appearance of this peak, assigned to a surface plasmon, is well-documented for various metal nanoparticles with size ranging from 2 nm to 100nm[10-11].

Fourier Transform Infra-Red spectral analysis

FTIR spectrum was examined to identify the possible biomolecules responsible for capping and efficient stabilization of the Ag nanoparticles synthesized by plant leaf extract. The peaks observed for Ag nanoparticles formed through reduction by *Eichhornia crassipes* at 3436 cm^{-1} (Alcohol, Phenol), 1637.76, 1079.03 and 1045.51cm^{-1} (amine) and 690.56cm^{-1} (Aromatic) suggest the presence of flavonoids and phenols adsorbed on the surface of Ag nanoparticles (Figure No.3). The analysis of IR spectrum useful to identify the different functional groups involved in the synthesis of AgNPs. The immediate reduction and capping of silver ion into silver nanoparticles in the present analysis might be due to flavanoids and proteins. The flavonoids present in the leaf extract are powerful reducing agents which may be suggestive of the formation of AgNPs by reduction of silver nitrate. The involvement of water-soluble flavonoid in the reduction of metal ions using plant extracts is also evidenced from Prabhu[12] study.

Electron microscopy of Ag nanoparticles

SEM analysis was carried out to understand the topology and the size of the Ag-NPs, which showed the synthesis of higher density polydispersed spherical Ag-NPs of various sizes. The SEM image showing the high density silver nanoparticles synthesized by the leaf extract further confirmed the development of silver nanostructures. Most of the nanoparticles aggregated and only a few of them were scattered, as observed under SEM. The SEM analysis showed the particle size between 10-40nm as well the cubic, face-centred cubic structure of the nanoparticles. Similar results were reported for phyto-synthesised silver nanoparticles[13]. This result strongly confirms that *Eichhornia crassipes* leaf extract might act as a reducing and capping agent in the production of silver nanoparticles.

Figure No.1: Colour changes before (Plant extract) and after (AgNPs) the process of reduction of Ag^+ to Ag nanoparticles and control ($AgNO_3$)
$AgNO_3$ = 1 mM $AgNO_3$ without *Eichhornia crassipes* extract
AgNPs = 1 mM $AgNO_3$ with *A. Eichhornia crassipes* extract after 5 hrs of incubation (Brown colour)

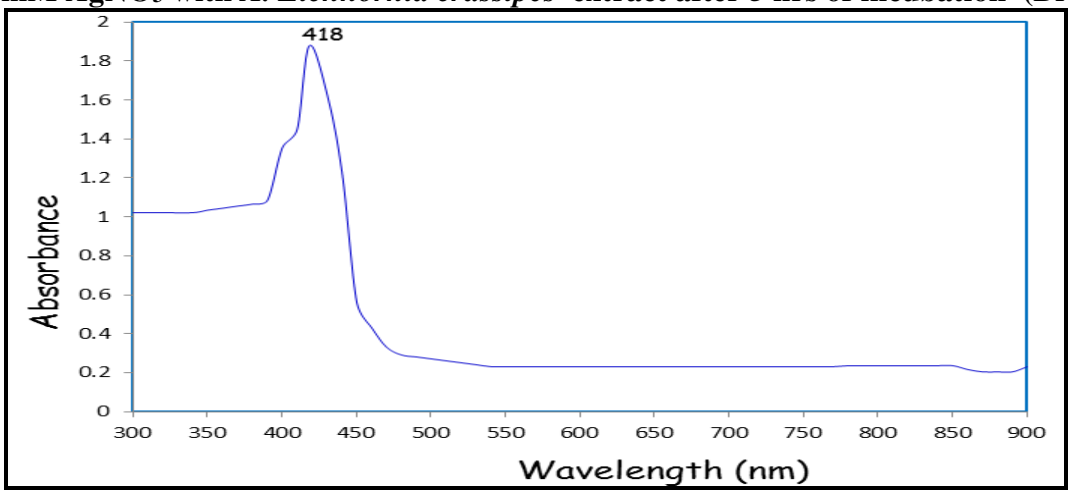

Figure No.2: UV-Vis Spectral analysis of AgNP

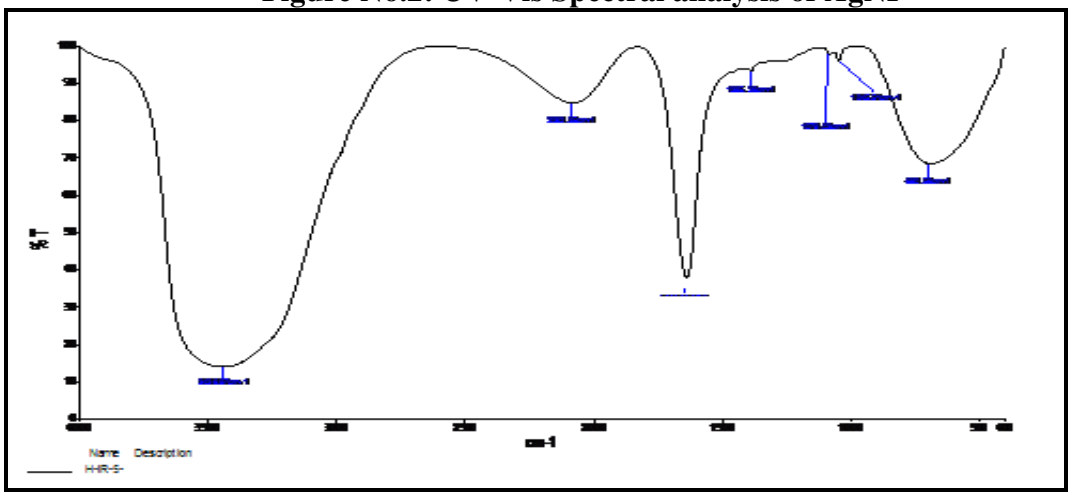

Figure No.3: FTIR analysis of AgNPs

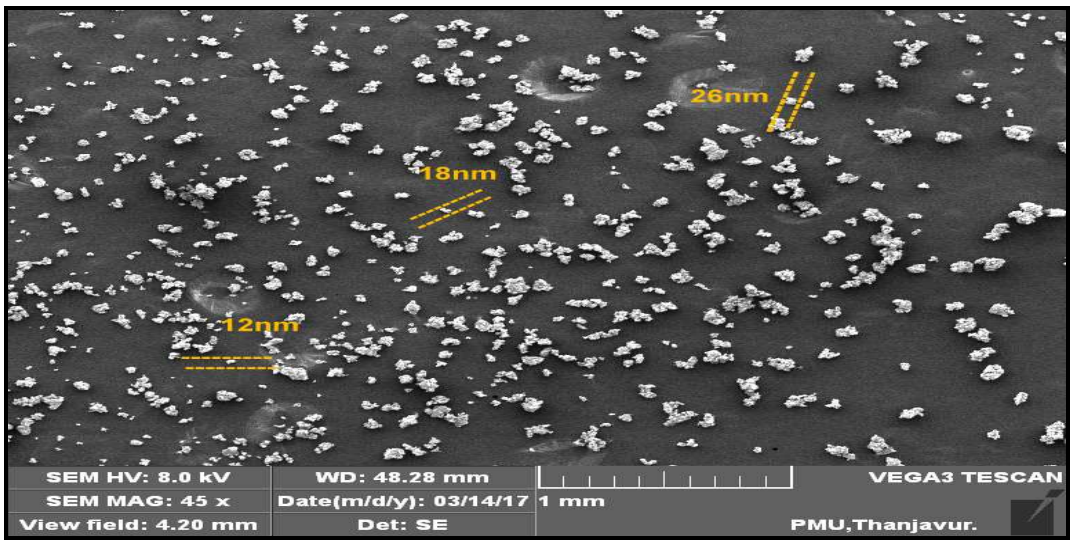

Figure No.4: High resolution scanning electron microscopic (SEM) image of silver nanoparticles (AgNPs). Polydispersed (Cluster) AgNPs ranged between 10-26nm

CONCLUSION

The synthesis of AgNPs using green technology which is eco-friendly and low cost. Here, *Eichhornia crassipes* leaf extract act as both reducing and stabilizing agents. The AgNPs were characterized by V-Vis, FTIR and SEM analysis. The UV-Vis spectral studies confirmed the surface plasmon resonance of green-synthesized silver nanoparticles. Biomolecules were responsible for reducing and capping of AgNPs, which were confirmed by FTIR measurements. SEM studies revealed spherical and uniform-shaped silver nanoparticles with size in the range 10-40 nm. In this present study, flavonoids in the *Eichhornia crassipes* leaf extract play an important role in the formation of silver nanoparticles.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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