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MORPHOLOGY STUDIES ON SILVER NANOPARTICLES SYNTHESIZED BY GREEN METHOD USING TRIDAX PROCUMBENS AND OCIMUM TENUIFLORUM LEAF EXTRACTS

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Abstract-- In this work, an effort was made to study the morphology of silver nanoparticles formed during green synthesis from silver nitrate solution using binary leaf extract from Tridax Procumbens and Ocimumtenuiflorum, collected from Kancheepuram district. The leaves were cleaned and washed thorough double distilled water and extract was prepared by boiling technique. The colour change in the solution after adding the extract, from transparent to brown showed the formation of silver nanoparticles. This is repeated for various concentrations of silver nitrate solution. The synthesized silver nanoparticles were subjected to Ultraviolet-Visible (UV-Vis) Spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscope (SEM), Dynamic Light Scattering (DLS) and Zeta Potential analyses. The Surface Plasmon Resonance (SPR) peaks in UV-Vis spectra confirmed the presence of nanoparticles and absorption peaks in FTIR spectrum showed the presence of stabilizing and capping agents in the extract. DLS analysis confirmed the nanoparticle formation and their size range. The zeta potential measured using Zeta sizer provided details of nanoparticle stability.

I. INTRODUCTION

Nanoparticles are any type of particles which have their grain size less than 100 nanometer at least in any one of its dimension [1]. Nanoparticles have greater surface to volume ratio due to their reduced grain size. The higher surface to volume ratio results in enhanced physical and chemical properties of nanoparticles. Nanoparticles compromise the gap between material properties between bulk and atomic/molecular levels. The nanoscience spread its application in various fields such as electronics, materials, medicine and bio-technology towards the edge of science evolution [2, 3]. Nanotechnology makes the usage of nanoparticles through design, production of devices and systems by controlling the grain size and shape at nanometre scale [4].Nowadays metal nanoparticles have greater impact in medicine, sensing, etc., because of their characteristic properties. Among metals, Silver nanoparticles gain much attention because of their peculiar physical and chemical properties. They have anti-bacterial and anti-viral properties and throw applications in medical and other industries. All the above properties of silver nanomaterials can be controlled by controlling their grain size.

Silver nanoparticles can be synthesized by various physical and chemical methods and these methods are not environment friendly. Some of these methods may impart for adsorption of toxic substances on to the surface of nanomaterials. In order to avoid this, toxic free, environment friendly green methods are employed nowadays. Green synthesis methods employ certain principles that will reduce the usage of hazardous substances during the synthesis of nanomaterials [5].

II. SCOPE OF THE STUDY

The scope of this study is to synthesize silver of nanoparticles using bi-component mixture of extracts from two different plant leaves and to study the morphology of synthesized silver nanoparticles.

III. MATERIALS AND METHODS

Materials

Plant materials

Plants are the best resources of various bio active ingredients which act as reducing and capping agents. These agents act on silver nitrate solution and yield silver nanoparticles by the reduction process (6-8). The bio active ingredients are available in various parts of the plant such as plant stem, root, leave and flowers, etc. In this study plant leaves were used for the synthesis of silver nanoparticles.

Sample Collection

Fresh leaves of plants of Tridax Procumbens and Ocimumtenuiflorum were collected from Kancheepuram district.

Sample preparation

The fresh leaves were washed several times with plain water and then finally with distilled water. 10g leaves of Tridax Procumbens and Ocimumtenuiflorumare weighed and boiled for 45 minutes in100 ml of distilled water and it is filtered using Whattman filter paper. Then the binary extract is stored in refrigerator for further use. This extract is used as reducing and stabilizing agent. Aqueous solutions of silver nitrate at various concentrations ((0.001, 0.015, 0.002, 0.0025, 0.003M) were prepared by adding required amounts of silver nitrate in 100 ml of double distilled water and it is stirred for 1 hour. Further 20 ml of silver nitrate solutions are taken from each concentration to synthesize silver nanoparticles.

IV. METHODS

Ultraviolet-visible (UV-Vis) spectroscopy analysis

UV-Vis spectrophotometer facility at SCSVMV University, Enathur, Kancheepuram was availed to confirm the formation of silver nanoparticles. The SPR peaks in UV-Vis spectrum are the characteristics of silver nanoparticle present in the solution (7).

Fourier Transform Infrared (FTIR) Spectroscopy

The Silver nitrate solution mixed with the extract was analyzed with FTIR spectroscopy using the facility at SCSVMV University, Enathur, Kancheepuram. The various bio active agents present in the extract are indicated by the absorption peaks of FTIR absorption spectrum (7).

Scanning Electron Microscope (SEM)

The formation of silver nanoparticles was initially confirmed by the change in colour of the solution from transparent to brown. The solution becomes dark brown as it left for longer duration undisturbed. SEM analysis was carried out on the solution to study the size and shape of nanoparticles. SEM facility available at St.Joseph's college, Trichy was utilized for this study.

Dynamic Light Scattering (DLS) and Zeta Potential analysis

DLS technique is very much useful in detecting the silver nanoparticle size range and z-average particle size present in the solution, the silver nitrate solution mixed with the extract was subjected to DLS and Zeta potential analysis using Zeta Sizer facility at Anna University, Chennai. Zeta potential is concerned with surface of nanomaterial and plays dominant role in the stability of nanoparticles.

V. RESULTS AND DISCUSSION

UV-Vis Spectroscopic Study

The binary leaf extract added to silver nitrate ($AgNO_3$) solution performed reducing operation as it contain bio active agents and this resulted in color change of the solution from transparent to brown indicating the nanoparticle formation. The colour change is due to the excitation of Surface Plasmon vibrations with the silver (8). Figure 1 shows UV –Vis absorption spectra of silver nanoparticles with different concentrations of silver nitrate. The Surface Plasmon Resonance (SPR) peaks starting at 430 nm represents the presence of silver nanoparticle (8) and the peak intensity increases with concentration and SPR peak is subjected to red shift.

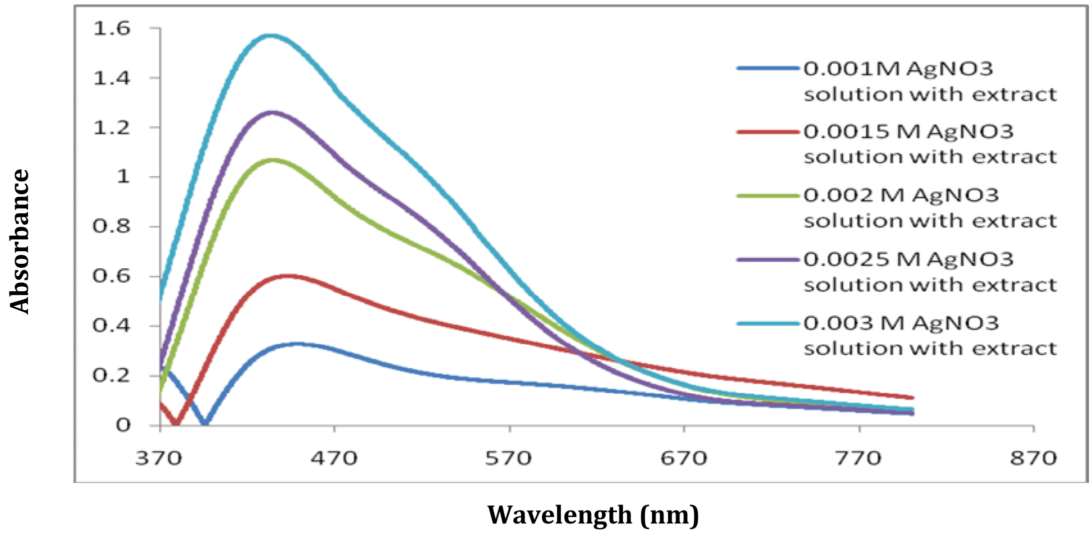

Fig.1. UV- Vis spectra of Silver nitrate solutions at different concentrations

FTIR Spectroscopic study

FTIR Spectroscopy is very much useful in identifying bio agents present in the leaf extract which are responsible for reduction and capping of the bio-reduced silver nanoparticles (5). The observed peaks values are 3307, 1635, 520 and 450 cm-1. The peaks observed at 3307 cm^{-1} belongs to O-H stretching and denotes alcohol or phenol.

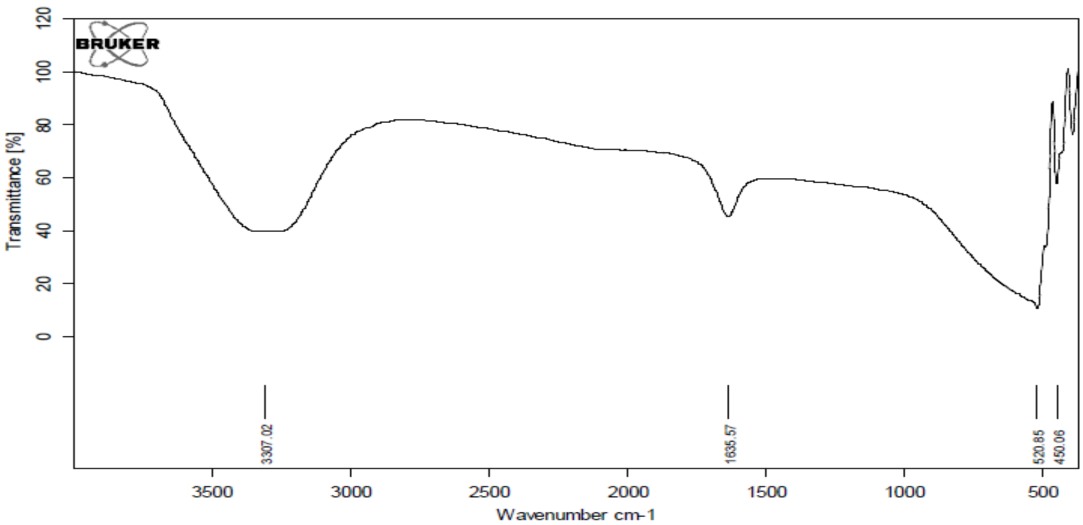

Fig.2 FTIR spectra of 0.001Msilver nitrate solution with leaf extract

The peak observed at 1635 cm-1 denotes the presence of native proteins in the extract. These proteins interact with silver nanoparticles. The peak observed at 520 cm^{-1} depicts O-C-O in plane bending. The weak transitions at 450 cm^{-1} may be due to presence of water. The UV – Vis spectroscopy results confirm the existence of silver nanoparticles through SPR peaks in the spectrum. The peaks are not very sharp and this may be due to the presence of cubical silver nanoparticles (6, 7). Further FTIR spectroscopy confirmed the presence of reducing and stabilizing agents present in the leaf extract mixture.

Scanning Electron Microscope

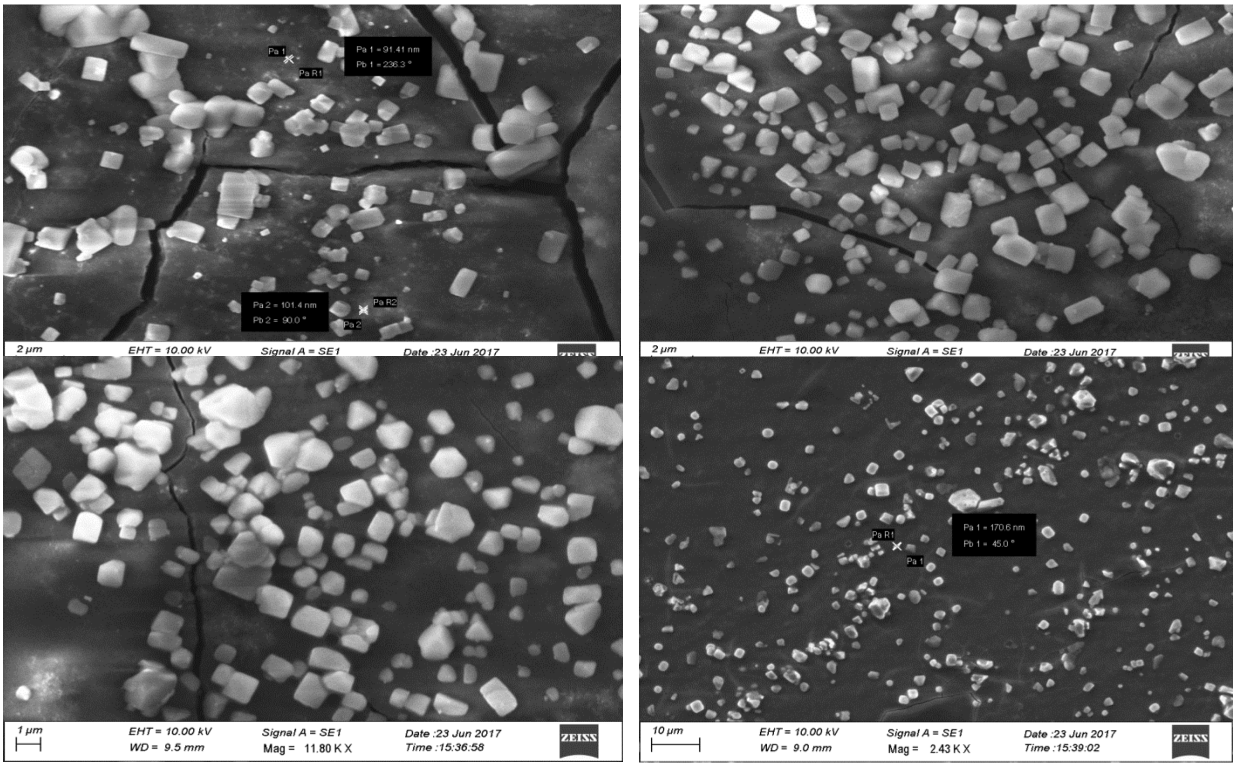

Fig.3.SEM image of silver nanoparticle synthesized from 0.001M silvernitrate solution with leaf extract

The solution with leaf extract was subjected SEM analysis after preparing the samples for SEM study. The SEM images are shown in the figure3. The SEM images show clearly the presence of nanoparticles in the nanoscale range 91 – 170 nanometer. The majority portion of nanoparticle show cubical shape. But some of the nanoparticles are in spherical shapes, but not well defined. The SEM images show approximately 30 % of particles are in nanoscale while the other exceeds in size and some of the nanoparticles are in various shapes than cubical one. From the above results, it may be concluded that the nanoparticles formed are at various shapes, but cubical nanoparticles are in majority. This morphology could be due to the bio-active agents of the extract mixture. The bi-component nature of extract may also be a reason for the formation of multi shaped nanoparticle formation.

Dynamic Light Scattering and Zeta Potential Analysis

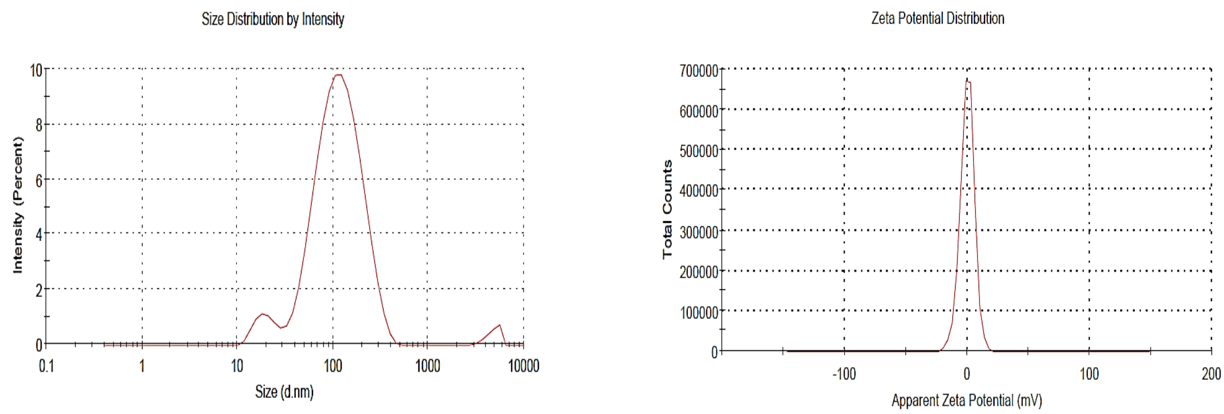

Fig.4a.DLS and Zeta potential of synthesized silver nanoparticles from 0.001M silver nitrate solution with leaf extract

The DLS and Zeta potential analysis results are shown in figure-4a for 0.001M solution. From the results, the calculated z-average particle size distribution of silver nanoparticles is 91.42 with minimum peak at 19.79 nm.

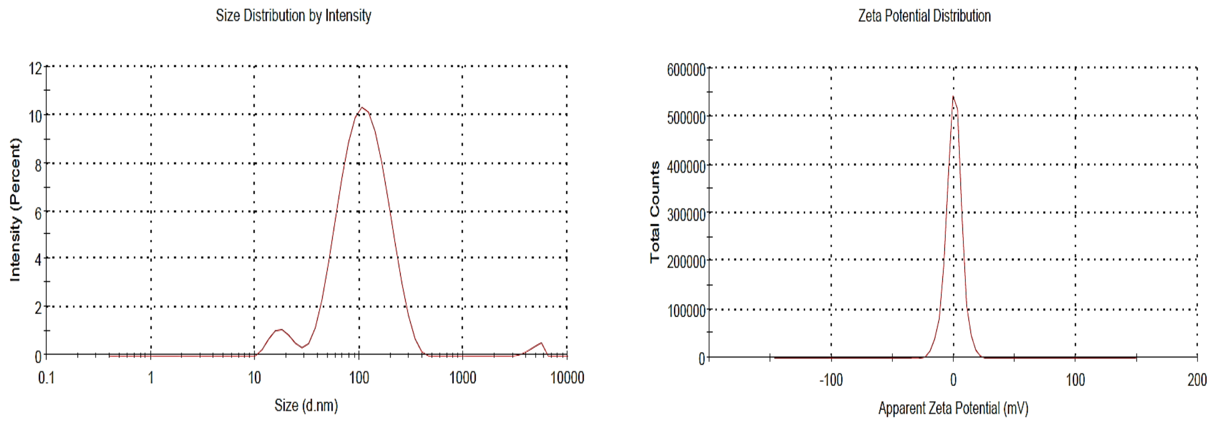

Fig 4b.DLS and Zeta potential of synthesized silver nanoparticles from 0.003M Silvernitrate solution with leaf extract

The DLS and Zeta potential analyses results are shown in fig 4b for 0.003M solution. From the results, the calculated z-average particle size distribution of silver nanoparticle is 89.94 nm with minimum peak at 18.52 nm. This confirms the results offered by SEM images where nanoparticles with a range 91 – 170 nanometer were detected. The Z-Average size is intensity based and higher values show the presence of large size particles in more number. The corresponding average zeta potential value is -0.0244 and 0.065 mV (Fig. 4a&4b) at 0.001 and 0.003M of silver nitrate solutions with leaf extract respectively.Since zeta potential decides the agglomeration action [6] in nanoparticles, agglomeration will be less if zeta potential is more and vice versa.

VI. CONCLUSIONS

UV-Visible analysis showed increase in peak intensity along with SPR peak red shift [7] with increase in concentration of silver nitrate in solution. This may be due to larger nanoparticle formation and red shift indicates the agglomeration and hence indicates larger nanoparticles.The multi-shaped nanoparticles as indicated by SEM may be due to the bi-component nature of extract mixture.The Zeta potential values showed a minimum level of stability of nanoparticlesand this may be increased by implementing various physio-chemical conditions.DLS results offered a range of nanoscale for the nanoparticles and confirmed the results of SEM.

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