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IJPBS |Volume 2| Issue 3 |JULY-SEPT|2012|10-14

Research Article
Biological Sciences

SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES

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ABSTRACT

Silver nanoparticles exhibit new optical properties, which are observed neither in molecules nor in bulk metals. In the present study silver nanoparticle colloid was produced by chemical reduction method of silver salt (silver nitrate AgNO3) solution. The silver nanoparticles were characterized by using UV-VIS spectrometer and Scanning Electron Microscope (SEM). The Surface Plasmon Resonance peak in absorption spectra of silver colloidal solution showed an absorption maximum at 450 nm which indicated formation of silver nanoparticles. The size range 44nm to 56.55nm of silver nanoparticles was determined by using Scanning Electron Microscope (SEM). The absorbance range of prepared silver nanoparticles solution was checked on 1st day, 5th day, 18th day and on 30th day. There was no obvious change observed in peak position for 30 days, depicting the stability of Silver nanoparticles.

KEYWORDS

Silver nanoparticles, synthesis of silver nanoparticles, characterization of silver nanoparticles.

INTRODUCTION

Nanotechnology is an emerging field of science which involves synthesis and development of various nanomaterials. Particles in the nano-range display unique physical and chemical properties and represent useful materials in biological applications. The integration of nanoparticles with biological molecules has lead to the development of diagnostic devices, contrast agents, and important tools in cancer therapy. Nanoparticles are now being developed for various biological applications such as medicines, antimicrobial agents[1,2,3] wound dressing[1,4], drug targeting and deliveries [1,5,6] , transfection vectors [1,7] , bioimaging, and labeling agents [1,8] etc.

Colloidal particles are increasingly receiving attention as an important starting point for the generation of micro and nanostructures.[9, 10] Nanoparticles are under active research because they posses interesting physical properties differing considerably from that of the bulk phase. It comes from small sizes and high surface/volume ratio [9, 11]. The extremely small size of nanoparticles means they exhibit enhanced or different properties when compared with the bulk material. In the case of silver nanoparticles this allows them to easily interact with other particles and increases their antibacterial efficiency. This effect can be so great that one gram of silver nanoparticles is all that is required to give antibacterial properties to hundreds of square meters of substrate material.

Silver nanoparticles can be synthesized using various methods: Biological, chemical[16], electrochemical[9,12]γ-radiation[9,13] photochemical [9, 14], laser ablation[9, 15] etc. The most popular preparation of Ag colloids is chemical reduction of silver salts by sodium borohydride or sodium citrate. This preparation is simple, but the great care must be exercised to make stable and

reproducible colloid. However, Solution temperature, concentrations of the metal salt, reducing agent and reaction time influences the particle size.

In the present work, the synthesis of silver nanoparticles from aqueous solution of silver nitrate using trisodium citrate as a reductant is carried out. Further silver nanoparticles were characterized using UV-VIS spectrometer and scanning electron microscopy.

MAERIAL AND METHODS

Synthesis of silver nanoparticles: Silver Nanoparticles were prepared by chemical reduction method. All solutions were prepared in distilled water. 50 ml of 0.001 M Silver nitrate was heated to boiling using hot plate magnetic stirrer. To this solution 5 ml of 1% tri-sodium citrate was added drop by drop. During this process solution was mixed vigorously. Solution was heated until color change is evident (yellowish brown). Then it was removed from the heating element and stirred until cool to room temperature [9].

Mechanism of reaction could be expressed as follows:

$$4Ag^{+} + C_6H_5O_7Na_3 + 2H_2O \rightarrow 4Ag^{0} + C_6H_5O_7H_3 + 3Na^{+} + H^{+} + O_2\uparrow$$

CHARACTERIZATION OF SILVER NANOPARTICLES

The optical properties (absorbance) of colloidal solution were evaluated with UV-VIS spectrometer at a wavelength range of: 200 nm –1100 nm. It measures the intensity of light passing through a sample (I), and compares it to the intensity of light before it passes through the sample (I_o). The ratio I / I_0 is called the transmittance, and is usually expressed as a percentage (%T). The absorbance, A, is based on the transmittance: $A = -\log(\%T)$ [11]. The absorption phenomenon shown by the nanoparticles is due to surface Plasmon resonance. The optical absorption spectra of metal nanoparticles are dominated by surface Plasmon resonance, which shift to longer wavelengths with increasing particle size. The position and shape of the Plasmon absorption of nanoparticles are strongly dependent on the particle size, dielectric constant and surface adsorbed species.

Further characterization was done by Scanning Electron Microscope (SEM). The diameter of the AgNP was determined. A scanning electron microscope (SEM) is a type of electron microscope that images a sample by scanning it with a beam of electrons in a raster scan pattern. The electrons interact with the atoms that make up the sample producing signals that contain information about the sample's surface topography, composition, and other properties such as electrical conductivity.

RESULTS AND DISCUSSION

The spectroscopic observations indicate that the chrome yellow solution of silver nanoparticles do not aggregate because of the stable position of the absorbance peak (**Fig.1**). As the particles increase in size, the absorption peak usually shifts toward the red wavelengths. Increase of absorption indicates that amount of silver nanoparticles increases. The silver colloidal particles possess a negative charge due to the adsorbed citrate ions; a repulsive force worked along particles and prevented aggregation.

Fig 1: Chrome yellow solution of silver nanoparticles

As shown in **Fig.2**, The absorption peak of silver nanoparticles was observed at 450 nm. UV-VIS absorption results confirmed the formation of silver nanoparticles prepared in liquid by chemical reduction method (silver nitrate AgNO3 reduced by tri-sodium citrate $C_6H_5O_7Na_3$). The absorbance range of prepared silver nanoparticles solution was checked on 1st day, 5th day, 18th day and on 30th day. There was no obvious change observed in peak position for 30 days, depicting its stability.

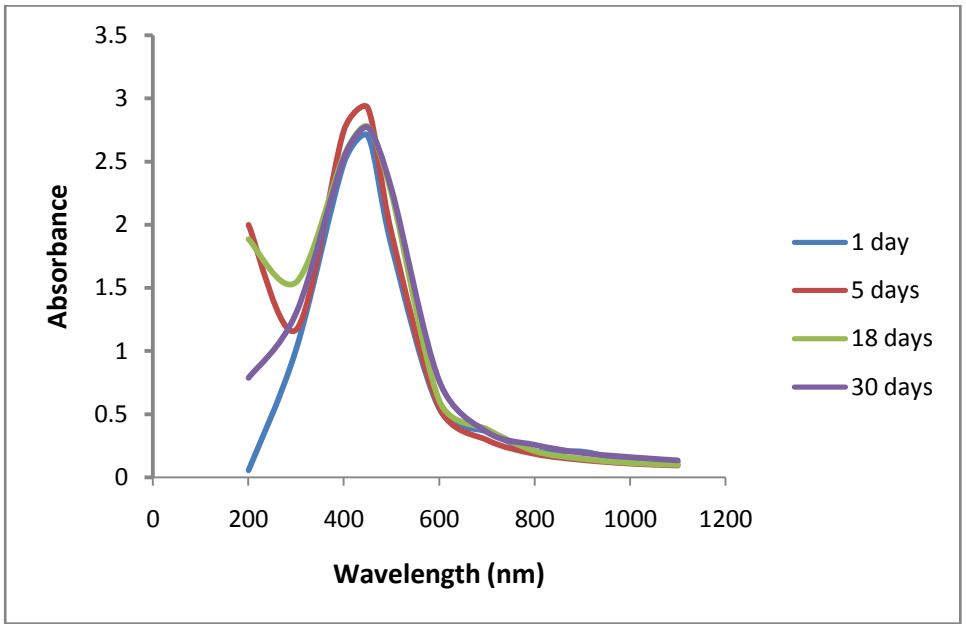

Fig2: UV-Visible absorption Spectra of silver nanoparticles.

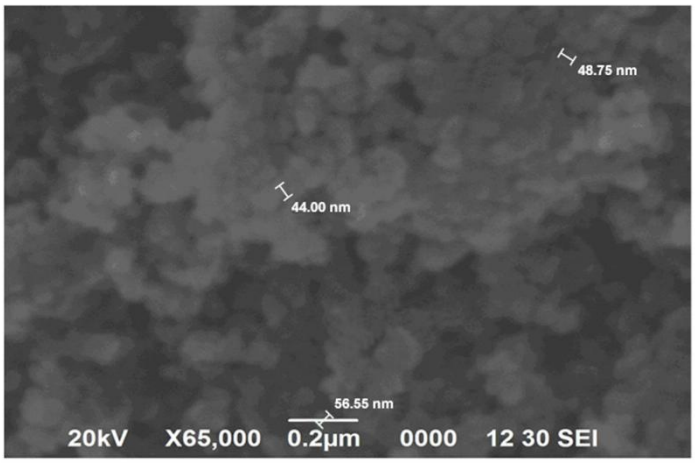

Fig.3: SEM image of Silver nanoparticles showing the size ranging from 44nm to 56.55nm

Further characterization of silver nanoparticles was done by using Scanning Electron Microscope (SEM). The Scanning Electron Microscope (SEM) image of the silver nanoparticle synthesized is shown in the **Figure 3** which indicates well dispersed particles that are more or less spherical. The size of these particles ranges from 44nm to 56.55nm which confirms their nanostructure.

CONCLUSION

In conclusion, silver nanoparticles with diameter ranging from 44nm to 56.55nm were synthesized using Tri-sodium citrate as a reducing agent. The silver nanoparticles were characterized by UV/Vis and SEM. UV/Vis spectra show the characteristic plasmon absorption peak for the silver nanoparticles ranging from 400 to 500 nm. There was no obvious change observed in peak position for 30 days, depicting the stability of Silver Nanoparticles.

ACKNOWLEDGEMENT

We are grateful to Karnataka State Council for Science and Technology (KSCST), Bangalore for providing financial support for this study.

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