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Eco-friendly Green Synthesis and Characterization of Silver Nanoparticles Derived from *Murraya koenigii* Leaves Extract

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Eco-friendly green synthesis of silver nanoparticles (AgNPs) was carried out using leaves extracts of plant *Murraya koenigii* (curry leaves) and 1 mM silver nitrate solution. During this synthesis the leaf extract works as a reducing agent. The characterization of silver nanoparticles was carried out using UV-visible spectra, scanning electron microscopy and FTIR. The characteristic surface plasmon resonance (SPR) absorption peak was found at 340 nm in UV-visible spectra confirms the formation of silver nanoparticles. The morphological study from SEM images gave an idea about the formation of asymmetrical spherical shape silver nanoparticles which are rested on the leaves extract residue. FTIR spectrum clearly suggested the green synthesis of silver nanoparticles initiated by the leaves extract. This green synthesis method is quite fast, easy to perform and does not involve the use of any harmful and costly chemicals.

Keywords: *Murraya koenigii*, Silver nanoparticles, Plant extract.

INTRODUCTION

Importance of the material is depends upon its properties. The properties in turn depend on the shape and size of the materials. Nanostructure science and nanotechnology are modern, interesting, very useful and fast developing branches of science and technology which deals with synthesis, characterization and applications of different types of nanostructured (at least one dimension less than 100 nm, more typically less than 50 nm) materials [1]. These materials are playing an increasing role in our day to day life, as more and more products based on nanosize materials are coming into the market. The nanomaterials exhibit the properties that are very different and useful from the macroscale properties of the same substance. The excellent, remarkable and useful properties that these materials have, develops and attracts the keen interest of the researchers all over the world. Nanoparticles mostly use in the areas of pharmacy, chemical reagents, electronic devices, environment and bioscience [2]. Among all types of nanoparticles investigated, silver nanoparticles (AgNPs) are the most common as they are simple to produce by reducing silver ions in the aqueous solution of silver nitrate. Silver also has an excellent antifungal, antibiotic, antimicrobial property which enables it to use as an antiseptic agent for wounds treatment [3]. Numerous methods of preparation have been reported to synthesize AgNPs. Some of these methods are laser ablation, thermal decomposition of metal compounds, γ-irradiation, electron irradiation, chemical reduction, photochemical methods, microwave processing and biological methods [4]. These methods suffer from the various drawbacks like toxicity and high cost of chemicals [5]. Therefore more investigations are required now a days to search a green eco-friendly process that does not make the use of toxic chemicals in the synthesis methodology. Biological synthesis of AgNPs by using different medicinal plant extracts is considered as simple, inexpensive and eco-friendly method for the bulk production of AgNPs [6]. The interesting reagents involved in such synthesis of nanoparticles from the plants are the phytochemicals that present in the plant. The important phytochemicals which spontaneously reduce the metal ions are flavonoids, terpenoids, carboxylic acids, quinones, aldehydes, ketones and amides [7]. The variety of plants are being studied till present for their role in the synthesis of nanoparticles The literature search showed that the many researchers have synthesized AgNPs from the leaves extracts of the plants like *Butea monosperma* (flame of forest, palas) [8], *Piper longum* [9], *Sesbania grandiflora* [10], *Musa balbisiana* (banana), *Azadirachta indica* (neem) and *Ocimum tenuiflorum* (black tulsi) [11], tea leaf [12], glycine max (soybean) [13], aloevera plant [14] *etc*. The present investigation throw light on the synthesis of AgNPs from the leaves extract of plant namely *Murraya koenigii* (curry leaves) due to its potential medicinal value.

EXPERIMENTAL

The leaves extract of plant *Murraya koenigii* (Curry leaves) was used in the present work of the synthesis of silver nanoparticles by green method

Preparation of silver nitrate solution: 500 mL of 1 mM silver nitrate solution was prepared by dissolving 0.0849 g in distilled water.

Preparation of plant extract: The plant leaf extract was prepared by using 25 g of fresh leaves, collected from the local area. Fresh leaves were washed extensively with water followed by final two to three times wash with distilled water to remove all the dust and other impurities. The leaves were cut into small pieces and then shade-dried for 2-3 days. The shade-dried small leaves pieces were then boiled in 100 mL of distilled water using water bath for 15 min. After boiling the solution was cooled and filtered using Whatman filter paper No. 1 to get clear solution which was then stored at 4 °C until further use within one week [15]. Each step carried out with hygiene and clean surrounding to achieve good results.

Synthesis of silver nanoparticles: The synthesis was carried out using 1 mM silver nitrate solution and leaf extract. 2 mL of leaf extract was added drop wise to 10 mL of 1 mM silver nitrate solution with continuous stirring using magnetic stirrer. A gradual and noticeable change of colour of silver nitrate solution was observed from colourless to brown after 24 h at room temperature suggesting formation of silver nanoparticles. The nanoparticles formed were separated out from the colloidal solution by pouring the sample mixture into a watch glass and evaporating until it get dried off. The dried sample was then scrubbed and the powdered form of sample was stored in a sterile air tight glass bottle.

Characterization of silver nanoparticles: Synthesis of nanoparticles by reducing the respective metal ion solution with leaves extract may be easily observed by UV-visible spectroscopy. Metal nanoparticles have free electrons at its surface, which yield a characteristics surface plasmon resonance (SPR) band in the UV-visible spectrum. This resonance band is because of the strong interaction of the free surface electrons of metal nanoparticles with light of particular wavelength. The colour of metal nanoparticles governed by their shape and size. The reduction of Ag^+ was confirmed from the UV-visible spectrum of the solution from region 300-600 nm using an equiptronics microprocessor based single-beam spectrophotometer (EQ-825A). The FT-IR characterization is used to investigate the biological entities and their functional group that are present in the synthesized silver nanoparticles. Scanning electron microscope (SEM) analysis is useful to examine shape, size and surface texture of nanoparticles formed.

RESULTS AND DISCUSSION

UV-visible spectra: Synthesized silver nanoparticles were characterized by UV-visible spectroscopy. The UV-visible spectrum of the AgNPs solution recorded after 24 h is shown in Fig. 1. The sharp and high peak is appear in the spectrum at 340 nm corresponding to the characteristics surface plasmon resonance (SPR) absorption band, suggesting the stability and tiny size of the silver nanoparticles [16]. High absorbance

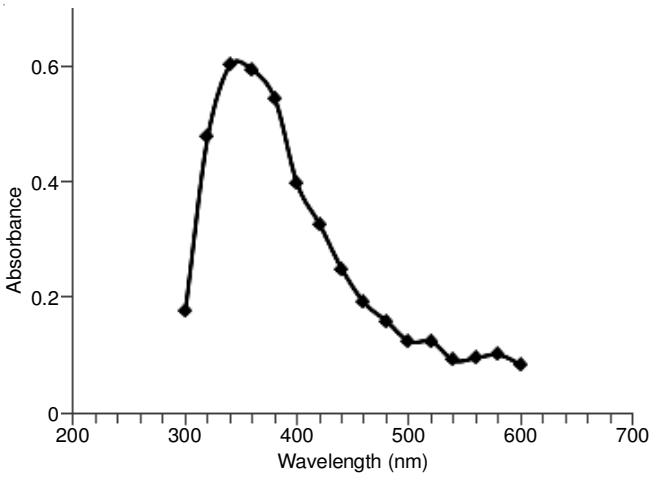

Fig. 1. UV-visible absorption spectra of AgNPs using curry leaves extract recorded after 24 h

indicates a high conversion of Ag^+ to Ag^0 as nanoparticle leading to higher concentration of AgNPs [17].

FT-IR spectra: FTIR gives the information about functional groups that are associate with the synthesized silver nanoparticles. FT-IR also helps to understand the conversion of simple inorganic entity $AgNO_3$ to elemental silver by the reducing action of the different phytochemicals which also play the role of stabilizing and capping agent. FTIR spectrum (Fig. 2) clearly illustrates the green synthesis of silver nanoparticles initiated by the leaves extract. In the spectra, the broad peak at 3233.61 cm^{-1} corresponds to N-H or O-H stretching in amino acids, alcohols and phenols. The peak at 2932.71 cm^{-1} corresponds to C-H stretching in alkanes and aldehydes, The weak peak at 2098.93 cm^{-1} corresponds to C≡C stretching in alkynes, The peak at 1580.92 cm^{-1} corresponds to C=C stretching in aromatic ring, The peak at 1394.32 cm^{-1} corresponds to CH_2 and CH_3 deformation, The peak at 1043.73 cm^{-1} corresponds to C-O stretching, The peak observed in the range 850-550 cm^{-1} are associated to C-Cl stretching in halogen compounds. Therefore the synthesized nanoparticles were seems to be present in the vicinity of proteins and metabolites such as terpenoids having functional groups as alcohols, ketones, aldehydes and carboxylic acids. As the phenolic group has more tendencies to bind metal, it might infer that phenols bring

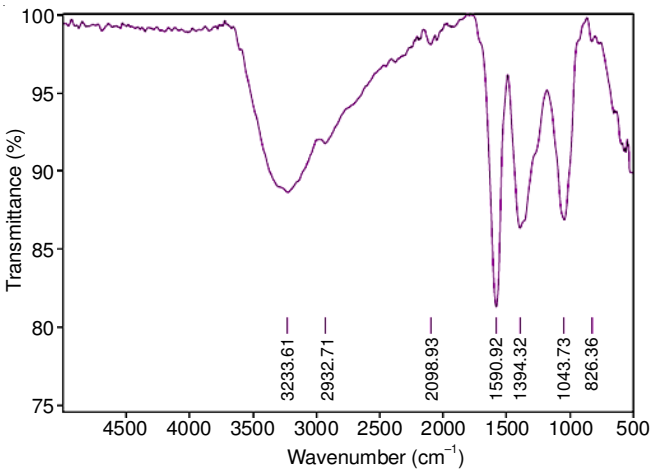

Fig. 2. FTIR spectra of AgNPs using curry leaves extract

about the capping of Ag nanoparticles there by preventing the agglomeration and stabilize the medium. Thus the biological entities could play the dual role of fabrication and stabilization of Ag nanoparticles in aqueous solution [18].

SEM: The surface morphology of the nanoparticles was obtained by scanning electron microscopy (SEM) analysis. Fig. 3 shows the SEM image of silver nanoparticles. The image shows the formation of unsymmetrical spherical shape silver nanoparticles which are randomly distributed on the leaves extract residue. It is because of the fact that the sample for SEM study was prepared by the evaporation of colloidal solution of nanoparticles. The accurate surface texture could not possible to investigate since AgNPs are being found to present along with the phytochemicals mass residue of the leaves extract.

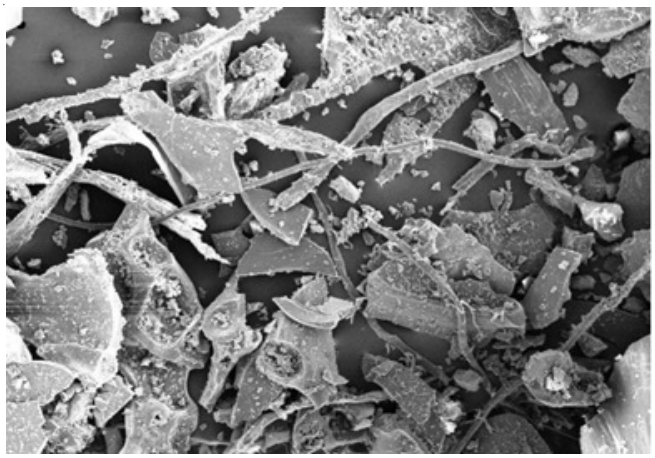

Fig. 3. SEM image of silver nanoparticles (AgNPs) using curry leaves extract

Conclusion

The above discussed eco-friendly green synthesis of silver nanoparticles by using plants leaves extract has found to satisfy all these requirement and therefore it can be adopted for the bulk production of AgNPs. The SPR absorption in UV-spectra at 340 nm clearly indicates the synthesis of AgNPs. The SEM studies were helpful in studying the surface morphology of AgNPs. FTIR studies confirmed the biosynthesis of the AgNPs by the reducing action of phytochemicals. It can be concluded that AgNPs synthesized in present work are found very stable which may be due to the presence of phenolic capping and stabilizing group present in the leaves extract.

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