RESEARCH PAPER | Zoology | Volume : 4 | Issue : 7 | July 2014 | ISSN - 2249-555X

Green Synthesis of Silver Nanoparticles by Using Aristolochia Indica Leaf Extract

KEYWORDS: Silver nanoparticles, Aristolochia indica, UV and SEM

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ABSTRACT *The present study describes a novel green synthesis of silver nanoparticles by using Aristolochia indica leaf extract. The green synthesized silver nanoparticles had been confirmed by UV-Vis spectrum and Scanning electron microscope (SEM) analysis. Based on the findings, it seems very reasonable to believe that this greener way of synthesizing silver nanoparticles is an environmentally viable technique.*

Introduction

The Ag NPs were reported to possess anti-bacterial (Sathishkumar et al., 2009), antiviral (Rogers et al., 2008), anti-fungal activities (Panacek et al., 2009). Synthesis of nanoparticles using plants or microorganisms can potentially eliminate this problem by making the nanoparticles more bio-compatible. Indeed, over the past several years, plants, algae, fungi, bacteria, and viruses have been used for low-cost, energy-efficient, and non-toxic production of metallic nanoparticles (Thakkar et al., 2009). Aristolochia indica commonly known as Eeswara mooligai, has been used as a traditional medicine to treat on the sting of scorpion or centipede and on insect bites. The hexane, ethyl acetate and methanol extracts of Aristolochia indica were found to possess adulticidal, repellent and larvicidal activities against adult and early fourth-instar larvae of Culex gelidus and Culex quinquefasciatus (Kamaraj et al., 2010), and the bio insecticidal effects of methanol extract of Aristolochia baetica showed larval growth inhibition against Tribolium castaneum (Jbilou et al. 2008). The recent reports include the synthesis of nanoparticles using medicinal plants (Mukunthan and Elumalai 2011). This stands as a great application in the field of nano-medicine. Medicinal property of the extract and nano-silver could play vital role in treatment of many diseases.

Materials and methods

Plants and Chemicals

Aristolochia indica L. (Aristolochiaceae) leaves were collected from Malaiyur Hills, Dharmapuri district. Tamil Nadu, South India, in June 2011.The taxonomic identification was made by Dr. C. Hema, Department of Botany, Arignar Anna Government Arts College for Women, Walajapet, Vellore, India. The voucher specimen (ZD/AB/K127) was deposited in our research laboratory for further reference. Silver nitrate ($AgNO_3$, analytical grade) was purchased from Sigma-Aldrich, USA (99.9% pure).

Synthesis of Ag NPs by Aristolochia indica leaf extract

Aristolochia indica leaves were washed thoroughly in tap water for 10 min in order to remove the dust particles and rinsed briefly in deionized water. The plant leaf broth solution was prepared by taking 10 g of washed and finely cut leaves in a 250 mL Erlenmeyer flask along with 100 mL of deionized water and then boiling the mixture at 60°C for 5min. After boiling, the solution was decanted, and 15mL of this broth was added to 85mL of 3mM aqueous $AgNO_3$ solution and the resulting solution became brown in colour. This extract was filtered through nylon mesh (spectrum), followed by Millipore hydrophilic filter (0.22µm) and used for further experiments (Parashar et al., 2009). A control setup was also maintained without Aristolochia indica extract and colour intensity of the extracts was measured at 420 nm at different intervals (5, 10, 15, 20, 25 and 30 min).

Results

UV-vis spectra

The aqueous $AgNO_3$ solution turned into yellowish brown colour within 1 h of the addition of leaf aqueous extract of A. indica and is shown in (Fig. 1) Intensity of brown colour increased in direct proportion to the incubation period. It was due to the excitation of surface plasmon resonance (SPR) effect and reduction of $AgNO_3$. The silver SPR was observed at 420 nm which steadily increases in intensity as a function of time of reaction (ranging from 5 to 30 min) without showing any shift of the wavelength.

Scanning electron microscope (SEM) analysis

SEM determinations of the sample ($AgNO_3$) showed the formation of nanoparticles, which were confirmed to be of silver by SEM. SEM analyses of the synthesized Ag NPs were clearly distinguishable which measured an average size of 112.35 nm (Figs. 2 a and b). The asymmetrical dispersed nanoparticles and mostly aggregated infrequently free crystals structures.

Discussion

The aqueous $AgNO_3$ solution turned into yellowish brown colour within 1 hj with the addition of leaf extract of Aristolochia indica The silver SPR was observed at 420 nm which steadily increased in intensity as a function of time of reaction (ranging from 5 to 30 min) without showing any shift of the wavelength maximum. In UV spectral analysis, the generation of colour was due to excitation of surface plasmon in metal nanoparticles (Mulvaney, 1996). Mukherjee et al. (2008) have reported that the reduction process of Ag^+ to Ag NPs occurs possibly in the presence of enzyme NADPH-dependent dehydrogenase. The exact route in which the electrons are shuttled is a matter of investigation. The information regarding environment responsible for high stability of metal nanoparticles is not comprehensively available. These sharp

Volume : 4 | Issue : 7 | July 2014 | ISSN - 2249-555X

Bragg peaks might have resulted due to the capping agent stabilizing the nanoparticles. SEM micrographs of the reaction mixtures containing 10 mg of Aristolochia indica leaf extract powder and 1.0 mM of $AgNO_3$ solution were incubated for 15 minutes and magnified to 10,000X and 15,000X which revealed particle size of 97.07-133.33 nm. For the SEM studies, reaction mixtures were air-dried on silicon wafers. As a result, a coffee ring phenomenon was observed. Jayaseelan et al. (2011) reported the SEM micrographs of the synthesized Ag NPs of Tinospora cordifolia and its size was measured 55–80 nm, and the synthesized Ag NPs using leaf extract of Acalypha indica measured 25–85 nm in size (Tian et al., 2007). The formation of Ag NPs as well as their morphological dimensions in the SEM study demonstrated that the average size was from 100 – 400 nm with inter-particle distance, where as the shapes were spherical and cubic in Ipomoea aquatic but only spherical in Enhydra fluctuans and Ludwigia adscendens extracts (Roy and Barik, 2010).

Conclusion

In conclusion, we propose an eco-friendly method for Ag NPs synthesized by the green chemistry approach using the aqueous leaf extract of Aristolochia indica within 30 minutes. The leaf extract of Aristolochia indica is environmentally benign and renewable and is capable of acting as both reducing and stabilizing agent. Particles were mostly aggregated and spherical in shape with an average of 112.35 nm. The present study demonstrated the use of a natural, low-cost biological reducing agent, Aristolochia indica extract (aqueous) used for synthesis of metal nanostructures, through efficient green nanochemical methodology. Use of Aristolochia indica leaf extract offers an affordable, environment friendly technique for synthesis of large scale silver nanoparticles

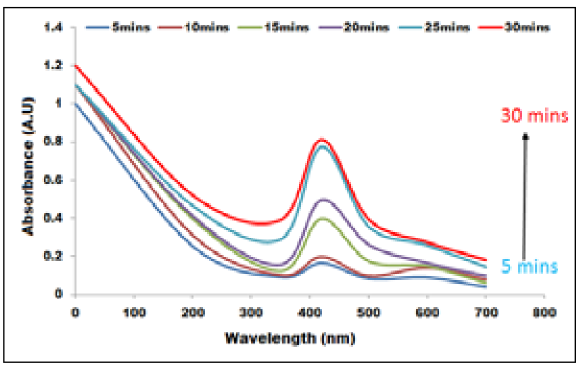

Figure. 1. UV–vis spectra of aqueous AgNO3 with A. indica leaf extract at different time intervals

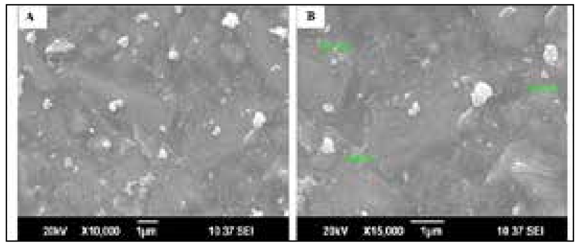

Figure 2 (A) SEM image of Ag NPs from A. indica leaf extract magnification at 10,000X, inset bar: 1 µm, (B) SEM image magnification at 15,000X, inset bar: 1 µm

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