Spectrochimica Acta Part A 83 (2011) 392–397

Contents lists available at SciVerse ScienceDirect

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy

journal homepage: www.elsevier.com/locate/saa

Green synthesis of silver nanoparticles using *Macrotyloma uniflorum*

V.K. Vidhu, S. Aswathy Aromal, Daizy Philip*

Department of Physics, Mar Ivanios College, Thiruvananthapuram 695 015, India

A R T I C L E I N F O

Article history:
Received 2 June 2011
Received in revised form 17 August 2011
Accepted 24 August 2011

Keywords:
Green synthesis
Silver nanoparticles
Macrotyloma uniflorum
Surface plasmon resonance

A B S T R A C T

Green synthesis of noble metal nanoparticles is a vast developing area of research. In this paper we report the green synthesis of silver nanoparticles using aqueous seed extract of *Macrotyloma uniflorum*. The effect of experimental parameters such as amount of extract, temperature and pH on the formation of silver nanoparticles was studied. The as prepared samples are characterized using XRD, TEM, UV–Visible and FTIR techniques. The formation of silver nanoparticles is evidenced by the appearance of signatory brown colour of the solution and UV–vis spectra. The XRD analysis shows that the silver nanoparticles are of face centered cubic structure. Well-dispersed silver nanoparticles with anisotropic morphology having size ~12 nm are seen in TEM images. FTIR spectrum indicates the presence of different functional groups in capping the nanoparticles. The possible mechanism leading to the formation of silver nanoparticles is suggested.

1. Introduction

Green nanotechnology is an area of interest having significant focus in present scenario with important objective of facilitating the manufacture of nanotechnology based products eco-friendly and safer for all beings with sustainable commercial viability. The "green synthesis" of metal nanoparticles receives greater attention due to their unusual optical, chemical, photo-chemical and electronic properties [1]. Metal nanoparticles especially the noble metals; have mainly been studied because of their strong optical absorption in the visible region caused by the collective excitation of the free electron gas. This coherent electron motion gives rise to the surface plasmon absorption and decays non-radiatively by electron–electron collisions on the order of a few femtoseconds. The resonance frequencies as well as the width of the plasmon absorption band depend upon the size of the metal nanoparticles [2]. Among noble metal nanoparticles, silver nanoparticles have wide area of interest as they have large number of applications such as in non-linear optics, spectrally selective coating for solar energy absorption, biolabelling, intercalation materials for electrical batteries as optical receptors, catalyst in chemical reactions and as antibacterial capacities.

Many interesting methods are being employed currently to the green preparation of nanosized silver nanoparticles using various plant extracts including hibiscus leaf extract [3], honey [4], mangifera indica [5], murraya koenigii leaf [6] Cashew leaf [7], glucose in the presence of soluble starch as a stabilizing agent [8–10], sucrose and maltose [11], black tea leaf extract [12], Indian gooseberry fruit extract [13], sundried camphor leaves [14], aloevera plant extracts [15]. Also Njagi et al. [16] have reported the biosynthesis of silver nanoparticles at room temperature using aqueous sorghum bran extracts. Safaepour et al. [17] reported the green synthesis of silver nanoparticles using Geraniol as reducing agent and they investigated its cytotoxicity against fibrosarcoma. Also Kumar et al. [18] reported synthesis of silver nanoparticles embedded antimicrobial paints based on vegetable oil. Recently green synthesis of silver nanoparticles is reported using cycas leaf [19] and weed resources [20]. Dubey et al. [21] shown that silver nanoparticles can be synthesized from extract of Eucalyptus Hybrida leaf. Biosynthesis of silver nanoparticles using coriandrum sativum leaf extract and their application in nonlinear optics has been studied by Sathyavathi et al. [22]. Dubey et al. [23] have investigated the bioprospective of sorbus aucuparia leaf extract in development of silver and gold colloids. Ahamed et al. [24] reported the green synthesis, characterization and biocompatibility of silver nanoparticles using garlic clove extract as reducing and stabilizing agent. Kumar et al. [25] have synthesized silver nanoparticles using syzygium cumini leaf and seed extract as reducing and stabilizing agent. Viable methodologies for the synthesis of high quality nanostructures have been reported by Patete et al. [26]. Recently, green synthesis of silver nanoparticles using rosa rugosa [27] and tansy fruit extract [28] have been investigated. Dwivedi and Gopal [29] studied the biosynthesis of silver and gold nanoparticles using chenopodium leaf extract. Biogenic production of nanoparticles using plants and microorganisms has been reported recently [30].

Macrotyloma uniflorum, commonly known as horse gram is a herbaceous plant with lots of medicinal properties. Different parts of the plant are used for the treatment of heart conditions, asthma,

* Corresponding author. Tel.: +91 471 2530887; fax: +91 471 2532445.
E-mail addresses: daizyp@rediffmail.com, philipdaizy@yahoo.co.in (D. Philip).

1386-1425/$ – see front matter © 2011 Elsevier B.V. All rights reserved.
doi:10.1016/j.saa.2011.08.051

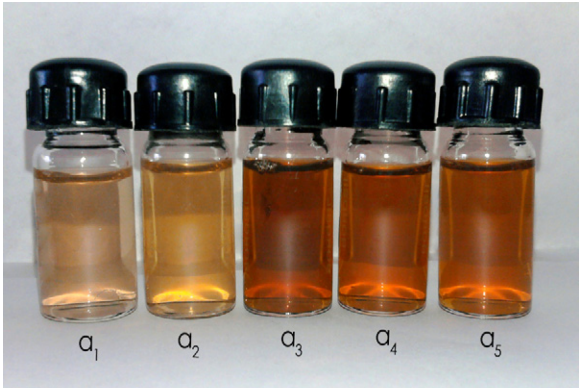

Fig. 1. Photograph of silver colloids at room temperature.

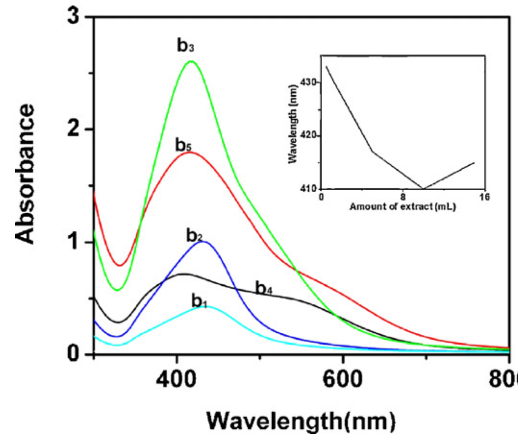

Fig. 3. UV–vis spectra of samples at 373 K (b_1–b_5). The inset shows the variation of SPR band with quantity of extract.

bronchitis, leucoderma, urinary discharges and for treatment of kidney stones. *M. uniflorum* could play a role in antioxidation as when it is exposed to toxic levels of lead. Horse gram seeds are good source of antioxidants, iron, molybdenum and phenolic compounds. The dried seeds of horse gram are readily available and can be kept for a long time without any damage. The cost effectiveness, availability, portability are the properties supporting the selection of horse gram as a candidate to synthesize silver nanoparticles. In the present study, we report the green synthesis of silver nanoparticles using the extract of horse gram as reducing and protecting agents.

2. Experimental

The sundried whole seeds of horse gram were purchased from local market. It was thoroughly washed in de-ionized water and sundried. Silver nitrate ($AgNO_3$) was obtained from Sigma Aldrich chemicals. All glasswares were thoroughly cleaned using aquaregia and rinsed with de-ionized water. For the preparation of the extract, 10 g of horse gram was boiled in 100 mL de-ionized water for 2 min and filtered. The filtrate obtained is used as such for the synthesis

The reaction process was carried out at three different experimental conditions one at room temperature, another with varying the pH of the stock solution and the third one by heating the solution. Sample a_1 was prepared by adding 0.5 mL horse gram extract at room temperature to 30 mL of 5.9×10^{-4} M silver nitrate solution under vigorous stirring. The stirring was continued for 2 min. The formation of silver nanoparticles was indicated by the appearance of signatory brown colour (Fig. 1) of the solution within 1 h. Similarly samples a_2–a_5 was prepared by adding 1 mL, 5 mL, 10 mL and 15 mL of extract respectively. The reduction was observed to be fast at lower concentration of extract. The reduction was very fast in the case of a_1 which has a light yellow colour developed within 30 min. For a_2 the reduction was completed within 45 min. The reduction occurred slowly in the case of a_3, a_4 and a_5 and was completed within 1 h (approximately). The samples b_1–b_5 was prepared by adding the same quantity of extracts as used above to boiling silver nitrate solution starting from 0.5 mL extract. Here the formation of silver nanoparticles was identified by change in the colour of the stock solution to brown within 20 min. The sample c_1 (pH 6) was prepared by adding 10 mL horse gram extract to 30 mL silver nitrate solution. The samples c_2–c_5 were prepared by varying the pH of the solution (pH 7, pH 8, pH 9, pH 10) respectively. The samples were stable for 2 months.

The absorption spectra of as prepared silver nanoparticles were recorded by UV-2450 Shimadzu UV spectrophotometer. The FTIR spectrum of silver nanopowder was obtained using an IR-Prestige Shimadzu spectrometer. TEM images and electron diffraction patterns were obtained with a Philips CM 200 transmission electron microscope. The XRD pattern of dried silver nanoparticles was recorded by an XPERT-PRO Diffractometer with Cu Kα radiation (λ = 1.5406 Å).

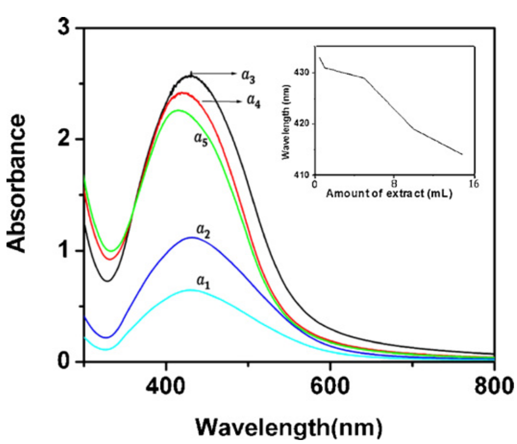

Fig. 2. UV–vis spectra of samples at room temperature (a_1–a_5). The inset shows the variation of SPR band with quantity of extract.

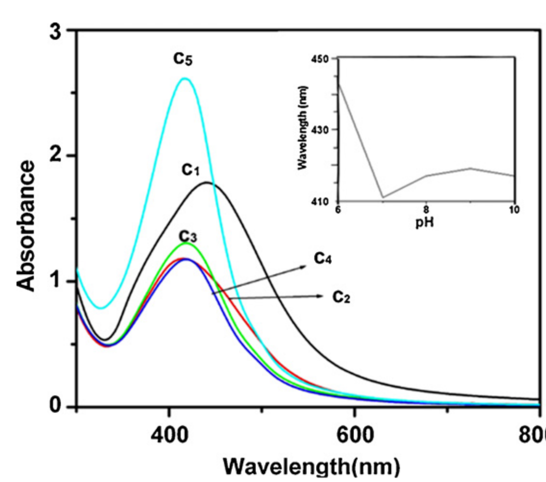

Fig. 4. UV–vis spectra of silver nanoparticles samples with (c_1) pH 6, (c_2) pH 7, (c_3) pH 8, (c_4) pH 9, (c_5) pH 10. The inset shows the variation of SPR band with pH.