Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy 135 (2015) 373–378

Contents lists available at ScienceDirect

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy

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

Antibacterial and catalytic activities of green synthesized silver nanoparticles

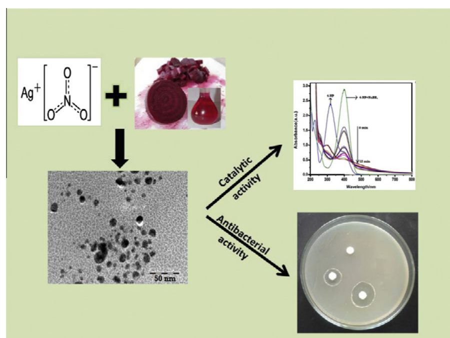
M.R. Bindhu, M. Umadevi *

Department of Physics, Mother Teresa Women's University, Kodaikanal 624101, Tamil Nadu, India

HIGHLIGHTS

- Ag NPs were synthesized using beetroot extract as reducing agent.
- Spherical Ag nanoparticles were prepared.
- Shows good antimicrobial and catalytic activity.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 29 March 2014
Received in revised form 1 July 2014
Accepted 18 July 2014
Available online 27 July 2014

Keywords:
Green synthesis
Silver nanoparticles
Surface plasmon resonance
Antibacterial activity
Catalytic activity

ABSTRACT

The aqueous beetroot extract was used as reducing agent for silver nanoparticles synthesis. The synthesized nanoparticles were characterized using UV–visible spectroscopy, X-ray diffraction (XRD) and transmission electron microscopy (TEM). The surface plasmon resonance peak of synthesized nanoparticles was observed at 438 nm. As the concentration of beetroot extract increases, absorption spectra shows blue shift with decreasing particle size. The prepared silver nanoparticles were well dispersed, spherical in shape with the average particle size of 15 nm. The prepared silver nanoparticles are effective in inhibiting the growth of both gram positive and gram negative bacteria. The prepared silver nanoparticles reveal faster catalytic activity. This natural method for synthesis of silver nanoparticles offers a valuable contribution in the area of green synthesis and nanotechnology avoiding the presence of hazardous and toxic solvents and waste.

Introduction

Metal nanoparticles have been extensively studied for many years because of both their attractive optical and electronic properties related to the quantum size effect and their promising applications in areas such as optics, optoelectronics, catalysis, nanostructure fabrication and chemical/biochemical sensings [1]. Metal catalysts play a key role in a wide range of chemical industries, since they enable the environmentally friendly conversion of various chemical substances. The recent escalation of energy, environmental and resource issues has led to the ever increasing importance of catalytic processes. Thus, extensive efforts have been devoted to the development of high-performance catalytic materials that can promote desired reactions more effectively and selectively. In particular, nano-sized metal particles attract increasing attention as highly active heterogeneous catalysts, due to their unique electronic properties and extremely large specific surface areas. The use of silver ion or metallic silver as well as silver nanoparticles can be exploited in medicine for burn

* Corresponding author. Tel.: +91 04542241685.
E-mail address: ums10@yahoo.com (M. Umadevi).

http://dx.doi.org/10.1016/j.saa.2014.07.045
1386-1425/

treatment, dental materials, coating stainless steel materials, textile fabrics, water treatment, sunscreen lotions, etc. and posses low toxicity to human cells, high thermal stability and low volatility. Among various metal nanoparticles, AgNPs have several effective applications as antibacterial, sensors and detectors besides their biomedical applications due to their attractive physiochemical properties [2,3].

Increasing the awareness towards green chemistry and other biological processes has led to a desire to develop an eco-friendly approach for the synthesis of nanoparticles which has several advantages such as simplicity, cost effectiveness, compatibility for antibacterial, antioxidant, and antitumor activity of natural products. In very recent years, many interesting methods are being applied currently to the green preparation of nanosized silver nanoparticles such as green synthesis of nanoparticles where plant extract is used for the synthesis of nanoparticles without any chemical ingredients [4,5]. Sharma et al. [4] presented an extended overview of silver nanoparticles preparation by green synthesis approaches including mixed-valence polyoxometallates, polysaccharides, Tollens, irradiation and biological. Recently the studies started under green chemistry for the search of benign methods for the development of nanoparticles and searching antibacterial, antioxidant, and antitumor activity of natural products.

Biosynthetic processes have received much attention as a viable alternative for the development of metal nanoparticles where plant extract is used for the synthesis of nanoparticles without any chemical ingredients. Extracts of *Daucus carota*, *Solanum lycopersicums*, *Hibiscus cannabinus* leaf, *Moringa oleifera* flower, *Murraya koenigii* leaf, mushroom, coconut oil, Macrotyloma *uniflorum,* neem leaf, geranium leaf and *Ananas comosus* have been found suitable for the green synthesis of silver nanoparticles [6–16].

In this work, silver nanoparticles were synthesized using beetroot extract as reducing agent. Beetroot is a commonly available vegetable and an excellent source of folate and a good source of manganese and betaines. It also contains potassium, magnesium and iron as well as carbohydrates, protein, powerful antioxidants, soluble fibre, vitamins A, B6 and C, and folic acid. They are a wonderful tonic for the liver, works as a purifier for the blood, and can prevent various forms of cancer. Betaines helps to reduce the concentration of homocysteine, a homolog of the naturally occurring amino acid cysteine. Betanins are used industrially as red food colorants. Main objective of this present study is to synthesize silver nanoparticles using beetroot extract as reducing agent and to reveal its catalytic and antimicrobial activity.

Experimental methods

Materials

Beetroots were purchased from local market, Kodaikanal, Tamilnadu, India. Silver nitrate ($AgNO_3$) is obtained from Sigma Aldrich Chemicals. The water used throughout this experiment was distilled water. All glasswares have been properly washed with distilled water and dried in oven before use.

Preparation of beetroot extract

5 g Of beetroot pieces were boiled with distilled water for 2 min. The extract was then separated by centrifugation at 1000 rpm for 5 min to remove insoluble fractions and macromolecules and finally a red extract was collected for further experiments.

Preparation of silver nanoparticles

For the green synthesis of silver nanoparticles, 1 ml of beetroot extract was mixed to 50 ml aqueous solution of $AgNO_3$ (3 mM) and stirred continuously for 5 min at room temperature and it was turned to brown in colour after 7 h which gives silver colloid (B1). Similarly by adding 5 and 10 ml of extract four more set of samples henceforth called B5 and B10 respectively were prepared. UV–visible spectra were taken when the solutions were in solution form. After one month the solutions were dried at 100 °C for 1 h. The dried powders were taken for the different characterization such as X-ray diffraction (XRD), Transmission Electron Microscope (TEM).

Characterization of synthesized nanoparticles

The X-Ray Diffraction (XRD) analysis was conducted by PANalytical X'pert – PRO diffractometer using monochromatic Cu Kα radiation (λ = 1.5406 Å) running at 40 kv and 30 mA. The FTIR spectra of the samples were recorded over a spectral range of 400–4000 cm^{-1}. The optical properties of the silver nanoparticles were studied using UV–visible absorption (UV-1700 Spectrometer of SHIMADZU) spectrometer with samples in quartz cuvette. Morphology and size of the prepared silver nanoparticles was done using a JEOL JEM 2100 High Resolution Transmission Electron Microscope operating at 200 kV. The catalytic reduction of

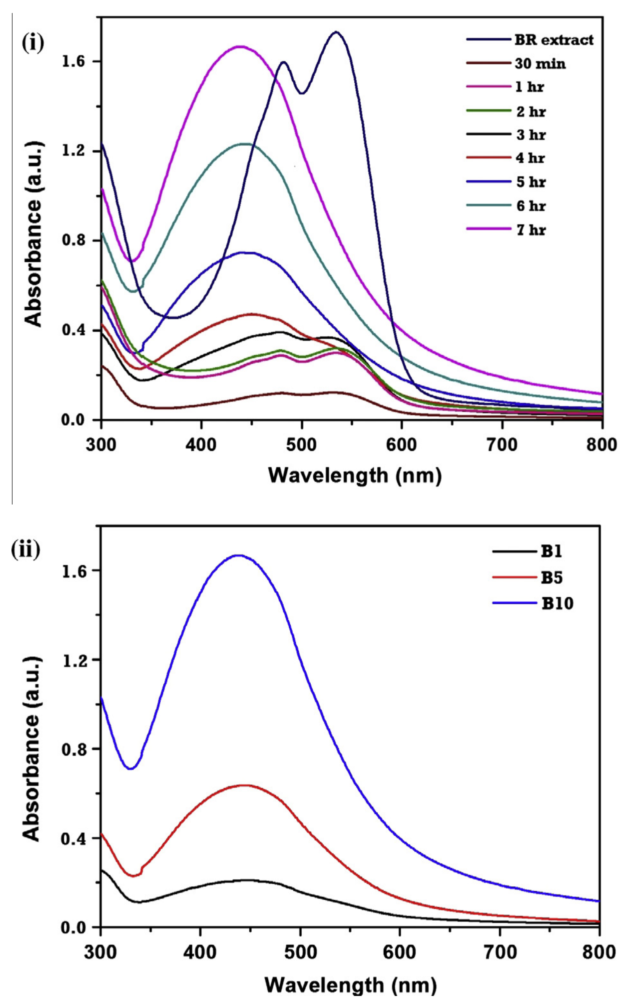


Fig. 1. Optical absorption spectra of silver nanoparticles (i) at different reaction time, and (ii) at different concentration of beetroot extract.