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Green Synthesis of Nano Silver Particles Using Some Selected Plant Species: Comparative Studies

KEYWORDS: Biosynthesis, silver nanoparticles, brassica (Brassica nepus), neem (Azadhiracta indica), stevia (Stevia rebaudiana).

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ABSTRACT *Silver nanoparticles were synthesized using leaf extracts of three selected plants belonging to different family of brassicaceae(Brassica nepus), meliacea (Azadhiractaindica) and asteracea (Stevia rebaudiana). Each of the three plants housed a large number of phytochemicals that are capable of reducing ionic silver to atomic silver. Nano silver particles were produced by mixing 90ml of 1mM aqueous solution of silver nitrate with 10ml of the extract in each case. Characterization was done by physical observation of colour change, UV-Vis spectroscopy and transmission electron microscopy (TEM). There were variations in colour changes which were attributed to the participating phytochemical presence in each of the plants. Size variations were also found with the average of 12.10nm, 20.30nm and 18.80 using the extracts from brassica, neem and stevia respectively.*

INTRODUCTION

Currently, the biosynthesis of silver nanoparticles (AgNPs) is gaining considerable importance mainly due to its distinct properties that make it differ from its bulkcounterpart (Song and Kim, 2009). As a result of the large continuous requirements of AgNPs for different applications, there have been tremendous effortsto produce nanoparticles of varying chemical compositions, sizes, shapes and controlled polydispersity (Shankar et al. 2003). Until recently, chemical methods of synthesizing AgNPs have been maintained as the most widely technique, despite the potential hazard these chemicals pose to the environment. Different plants have the potential for synthesizing AgNPs due to the presence of various phytochemicals within the plant which are acting as reducing as well as stabilizing agent. (Ahmad et al 2010).This research was aimed at producing eco-friendly silver nanoparticles using different plant materials and compares the sizes different.

MATERIALS AND METHODS

Preparation of plant extract

Fresh leavesof stevia, neem and brassica were collected from different areas and brought to laboratory where they were thoroughly washed with distilled water and chopped into pieces. 10 g each was taken into three different flasks of 100ml sterile double distilled water and boiled for 5 minute at 80^0C.The extracts were decanted andthen filtered using Whatman filter paper and used as reducing and stabilizing agent for the biosynthesis of silver nanoparticles.

Preparation of silver nanoparticles

10 ml each of the three different extracts were added into 90 ml of 1 mM Silver nitrate ($AgNO_3$)and incubated in the dark, overnight at room temperature.1mM aqueous solution of $AgNO_3$ was prepared,one for each of the extracts. The successfulformation of silver nanoparticles was indicated by characteristics colour changeswhich ranges from brown to reddish and deep brown. (Figure 1).

UV-visible spectrum analysis

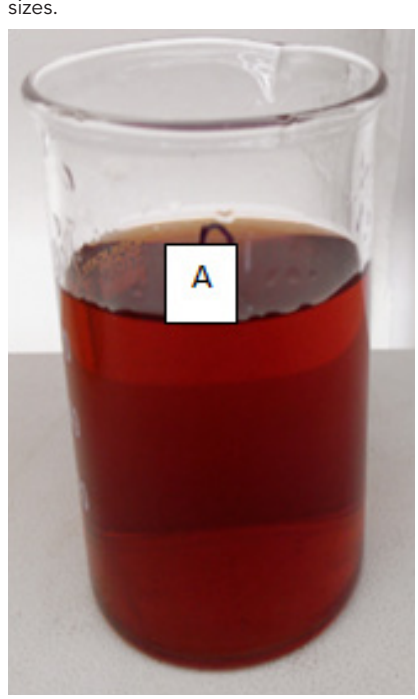
Equal amount of sample aliquot and distilled water (1ml each) were mixed in a 10 mm-optical-path-length quartz cuvettes , and the UV-Vis spectrum of the reaction medium was carried out to detect the reduction of pure Ag+ ions. The concentration of AgNPs produced was measured using a Systronics UV double beam spectrophotometer, at a resolution of 1 nm, between 200 and 800 nm (Figure 2, 3 & 4).

Transmission electron microscopy (TEM) analysis

High-resolution, Hitachi H 7500 transmission electron microscopy was used to get the micrograph image of the green synthesized AgNPs (Figure 5).

Statistical analysis

A simple statistical tool, histogram was used to represent the nanoparticles sizes and its number as obtained in the TEM images. Histogram was plotted for particle number against sizes.



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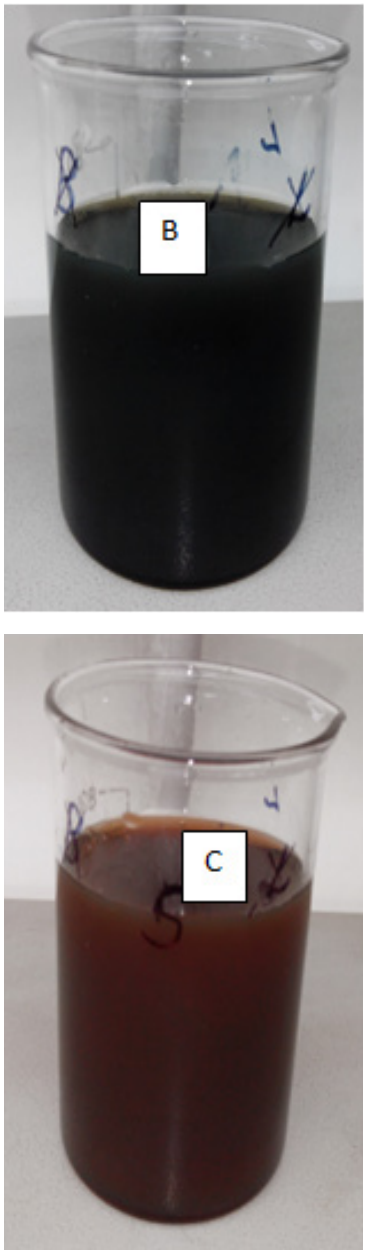
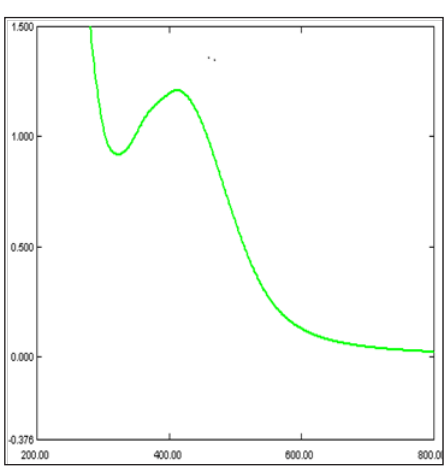


Figure 1:AgNPs synthesized using leaf extracts from brassica (A), neem (B) and stevia (C).



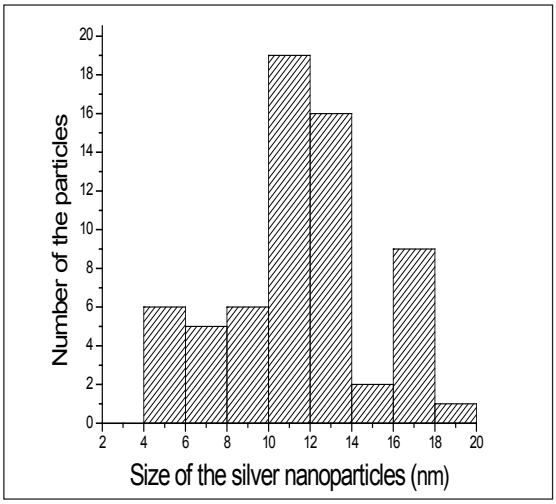
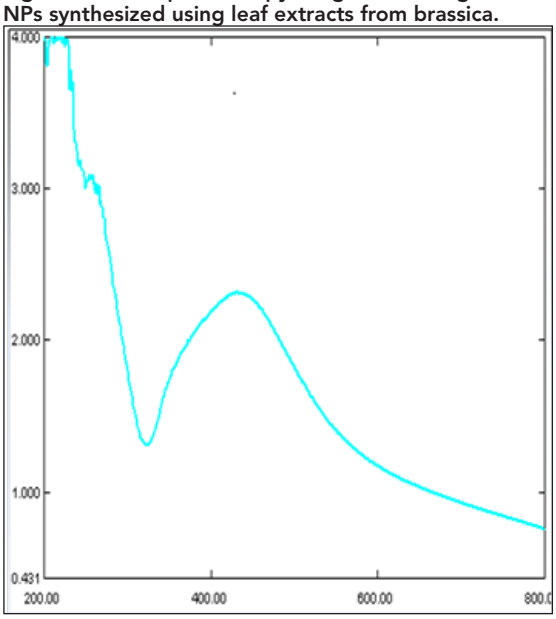


Figure 2:UVVis spectroscopy image and histogram of Ag-NPs synthesized using leaf extracts from brassica.



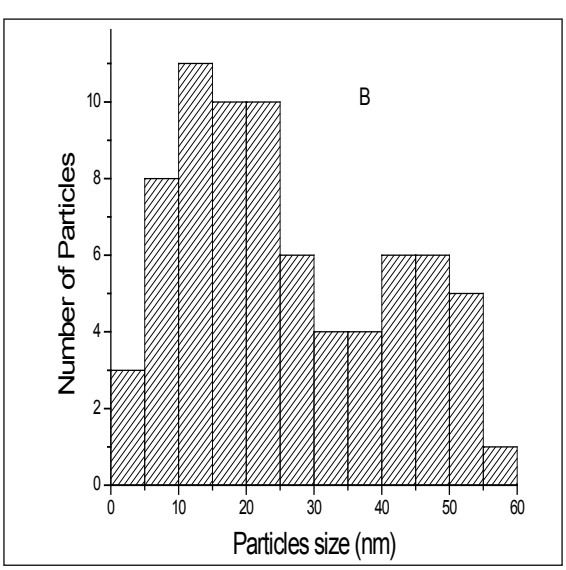


Figure 3:UVVis spectroscopy image and histogram of Ag-NPs synthesized using leaf extracts from neem.

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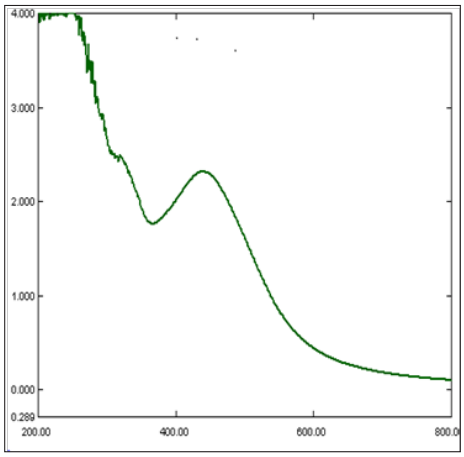


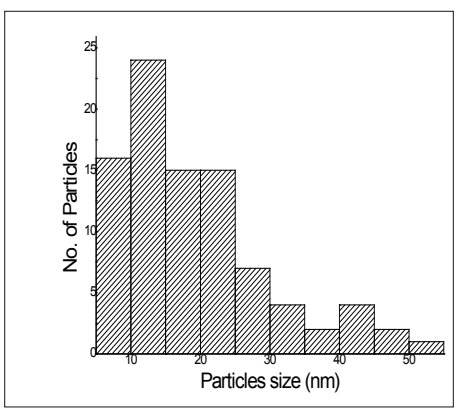
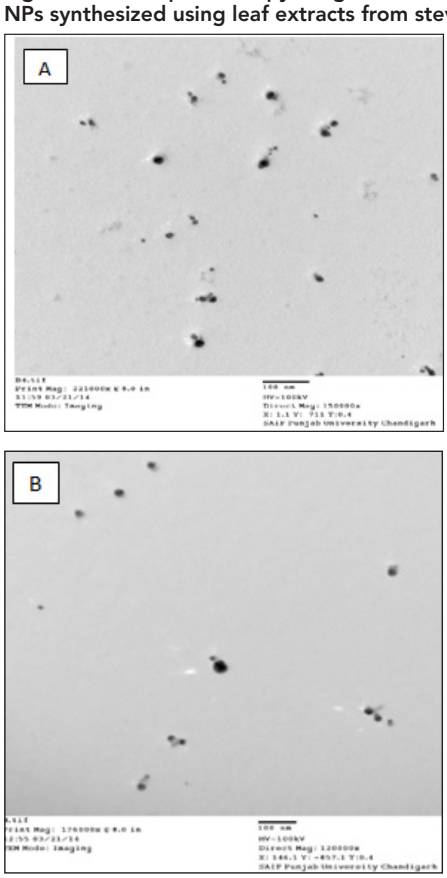


Figure 4:UVVis spectroscopy image and histogram of AgNPs synthesized using leaf extracts from stevia.



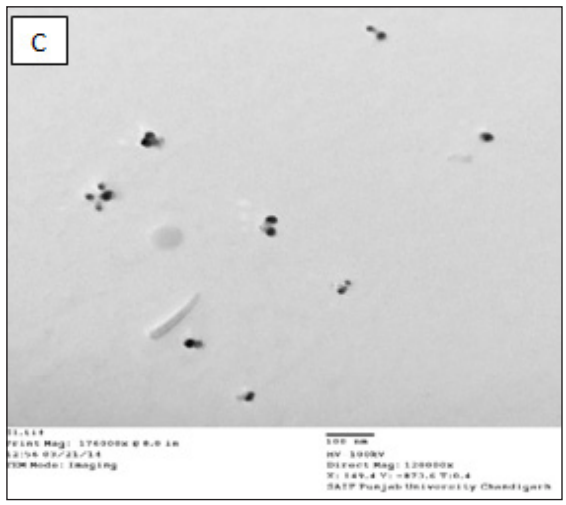


Figure 5: TEM image of AgNPssynthesized using leaf extracts from brassica (A), neem (B) and stevia (C).

RESULT AND DISCUSSION

Plant mediated synthesis of nano silver particles is first observed upon addition of the plant extract into the colourless 1mM aqueous solution of $AgNO_3$. This is detected by characteristic colour change of the reaction mixtures which occurs due to the reduction of ionic silver to atomic silver owing the activities of phytochemicals present in reaction mixture (Fig 1). Silver nanoparticles show different colour changes ranging from brown to dark brown, and sometimes reddish or yellowish-brown colour in aqueous solution due to the phenomenon of surface Plasmon (Jae and Beom, 2009). Characteristics colour change was the initial indication of the successful formation of the AgNPs. Further analysis using UV-Vis spectroscopy and transmission electron microscopy confirmed the biosynthesis of the nanoparticles using all the three plants extracts.

The use of UV–Vis spectroscopy is employed in metal nanoparticles characterization to obtain information on formation and stability of the particles (Philip et al. 2011). Strong relationship between UV-visible absorbance characteristics and sizes and shapes of the particles were established (Mubayiet al. 2012). Using UV-Vis spectroscopy, maximum surface Plasmon absorption band was obtained at the peak of 430 nm, 433 nm and 445 nm in nanoparticles synthesized using leaf extracts from brassica, stevia and neem respectively. Absorbance peak was obtained at 430 nm in AgNPs synthesized using methanol extract of Brassica oleracea leaf (Chowdhury et al. 2014). Sriram and Pandidurai, (2014) obtained the maximum absorbance peak at 460 nm using Psidiumguajavaand also an absorbance peak at 420 nm was obtained using Piper nigram leaf extract (Jacob et al.2013). Using extract from Dalbergiasissoo, maximum absorption was detected at the 425 nm (Singh et al. 2012). Forough and Farhadi, (2010) obtained a surface plasmonabsorption band with a maximum of 425 nm, showing the presence of spherical Ag nanoparticles which was later confirmed by further analysis.

The result of TEM analysis confirmed the successful formation of spherical AgNPs. The average sizes of the nanoparticles obtained were 12.10 nm, 20.30 nm and 18.80 using the extracts from brassica, neem and stevia respectively. Size ranges were 4-20 nm, 2-60 nm and 6-50 respectively in similar order as above. Silver nanoparticles of comparably higher size (20-50 nm) were synthesized using neem leaf extract (Shukla et al. 2010), whereas equally same size range (2-50 nm) as obtained here (6-50 nm) was obtained by Yilmaz et al.(2011) using stevia leaf extract. There was also report (Chowdhury et al. 2014) of silver nanoparticle using the methanol extract of Brassica oleraceawith size range of 10-21 nm.

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CONCLUSION

Biosynthesis of nano silver particles using plant sources is largely adopted due to its eco-friendly nature and cost effectiveness.In this study, the potential of Brassica nepus,Azadhiractaindicaand Stevia rebaudiana in synthesizing AgNPs was investigated. Researches on biosynthesis conducted using a number of plants attested to their ability to reduce $Ag^{+}$to Ag^{o}leading to the successful formation of silver nanoparticles.

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