Green Synthesis of Silver Nanoparticles Using a Common Weed *Amaranthus spinosus*

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Short Communication

Green Synthesis of Silver Nanoparticles Using a Common Weed *Amaranthus spinosus*

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Nanotechnology deals with the production, characterization, application of materials in which at least one dimension is in the range of 1-100nm. Due to their small size, nanoparticles show unique physical and chemical properties hence they are applicable in various fields [12]. So, the production of nanoparticles and evaluation of their applications in different fields has become an important area of research. There are two major approaches for nanoparticles synthesis, the Top-down approach in which nano size particles are produced by breaking down their bulk material using some physical or mechanical methods like milling, sputtering, thermal ablation and the Bottom-up approach in which atoms self-assemble to new nuclei which grow into nano size particles using chemical and biological methods [6]. Among all these methods for the synthesis of nanoparticles, the biological or green synthesis is the eco-friendly and cost-effective one. It excludes the use of toxic chemicals, high temperature or pressure [9]. The biological or green synthesis methods exploit microorganisms or plants for nanoparticles synthesis. The synthesis using microbes requires complex steps like isolation of microbes and maintenance of their cultures hence synthesis using plant extract is comparatively more rapid and easy [7]. The main principle behind using plant extract for nanoparticles synthesis is based on the fact that the biomolecules in plants can act as natural reducing and stabilizing agents for the process [12]. Weeds are unwanted plants and can be employed for this purpose to make the process more beneficial. In the present study, we have demonstrated the green synthesis of silver nanoparticles using *Amaranthus spinosus* leaf extract which is a spiny weed from the pigweed family.

a) *Preparation of plant leaf extract*

After collecting the plant material, the healthy and green leaves were separated. The separated leaves were washed with tap water first and then with distilled water to remove all the dust. After washing, the leaves were blotted and dried at room temperature then cut into small pieces. 10 grams of them were taken and placed into a flask containing 100 ml of distilled water. The mixture in the flask was then kept in a boiling water bath for 15 minutes. The solution was then filtered using Whatman No.1 filter paper. The filtrate is stored in the refrigerator at 4°C for further use [10].

b) *Synthesis and characterization of silver nanoparticles*

i. The leaf extract of *Amaranthus spinosus* is mixed with 1 mM silver nitrate solution in a 1:9 ratio. The mixture was then incubated in a hot water bath at 70°C for 1-2 hour [2].

ii. After the color of the mixture changed to yellowish-brown the absorption spectrum was obtained by diluting a small amount of the sample into distilled water [11]. The absorption spectrum was recorded between 200-800 nm using a UV-VIS Spectrophotometer (LAB MAN, Model No-LMSP-UV1200).

iii. The elemental composition of synthesized particles was determined using Energy Dispersive X-ray Spectroscopy (EDS, Oxford Instruments) with built-in FE-SEM.

iv. The size distribution of the silver particles in the solution was determined by measuring the dynamic fluctuation of light scattering intensity caused by the Brownian motion of the particles [3] using a Zetasizer Ver. 7.11, Malvern Instruments Ltd., UK.

v. The TEM analysis of synthesized silver nanoparticles was done to obtain the morphological features of the particles using TECNAI 200 kV, Philips, Netherlands.

When the leaf extract of *Amaranthus spinosus* and silver nitrate solution were mixed and incubated together the color of the mixture changed to yellowish-brown (Fig 1) which indicated the formation of silver nanoparticles in the solution since silver nanoparticles exhibit yellowish-brown color in aqueous solution [11].

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Fig 1 (1) Leaf extract of *Amaranthus spinosus* (2) Solution containing silver nanoparticles

In the UV-Visible spectroscopic analysis of the resultant solution, the absorbance peak was observed at 425 nm (Fig 2). This is due to the Surface Plasmon Resonance shown by the silver nanoparticles in the solution [1].

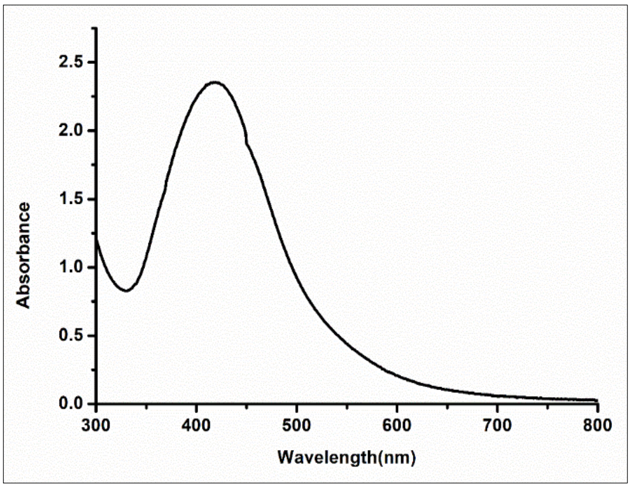

Fig 2 The UV-Visible spectrum of the solution containing silver nanoparticles

In the EDX pattern of synthesized particles, the absorption peak was observed at 3KeV (Fig 3) which is typical for the absorption of metallic silver nanoparticles [7]. The major elemental composition of synthesized particles was silver (89.43%) with a negligible amount of carbon (10.18%) and magnesium (0.39%).

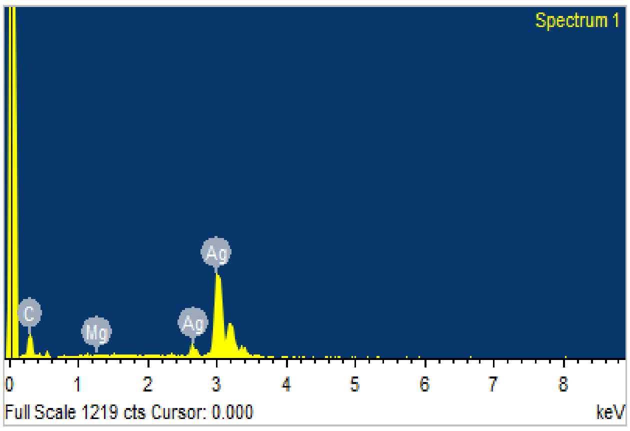

Fig 3 The EDX pattern of synthesized silver nanoparticles

As per the particle size analysis of synthesized AgNPs by dynamic light scattering (DLS) system the Z-average (d.nm) was 76.05 with a polydispersity index 0.378 (Fig 4).

			Size (d.nm):	% Intensity:	St Dev (d.n...
Z-Average (d.nm):	76.05	Peak 1:	79.36	89.5	46.04
PdI:	0.378	Peak 2:	18.46	5.5	3.859
Intercept:	0.851	Peak 3:	4608	4.0	855.4

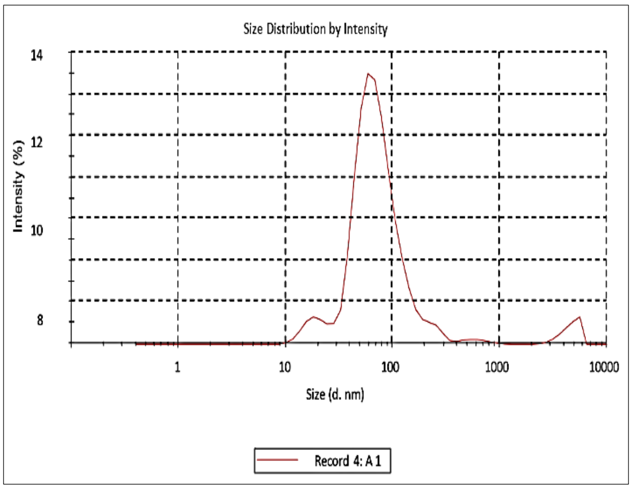

Fig 4 DLS size distribution plot of synthesized silver nanoparticles

The TEM analysis images of synthesized silver nanoparticles revealed that the particles were spherical in shape, polydisperse in nature with a size below 100nm (Fig 5).

SUMMARY

An environment-friendly approach for silver nanoparticles synthesis is demonstrated in the present study using *Amaranthus spinosus* a spiny pigweed. The potential of *Amaranthus spinosus* leaf extract to aid the synthesis of silver nanoparticles is evaluated in a simple way. After mixing the leaf extract of *Amaranthus spinosus* with silver nitrate solution, the formation of silver nanoparticles was observed. Synthesized particles were characterized by using UV-Visible spectroscopy, Energy Dispersive X-ray Spectroscopy, Dynamic Light Scattering and Transmission Electron Microscopy. UV-Vis spectrum of the solution containing silver nanoparticles demonstrated a peak at 425nm. The energy-dispersive X-ray spectroscopy of the synthesized particles demonstrated a peak at 3KeV and silver as a major elemental composition (89.83%). DLS analysis for particle size provided the Z-average (d.nm) 76.05 with polydispersity index 0.378 and TEM analysis revealed that the particles were below 100nm in size and mostly spherical. Leaf extract of *Amaranthus spinosus* acted well as a source of natural reducing agents for silver nanoparticles synthesis. The use of plant extract is indeed a simple, nontoxic and rapid method for nanoparticles synthesis and utilization of weeds for this purpose offers a way for weed control.

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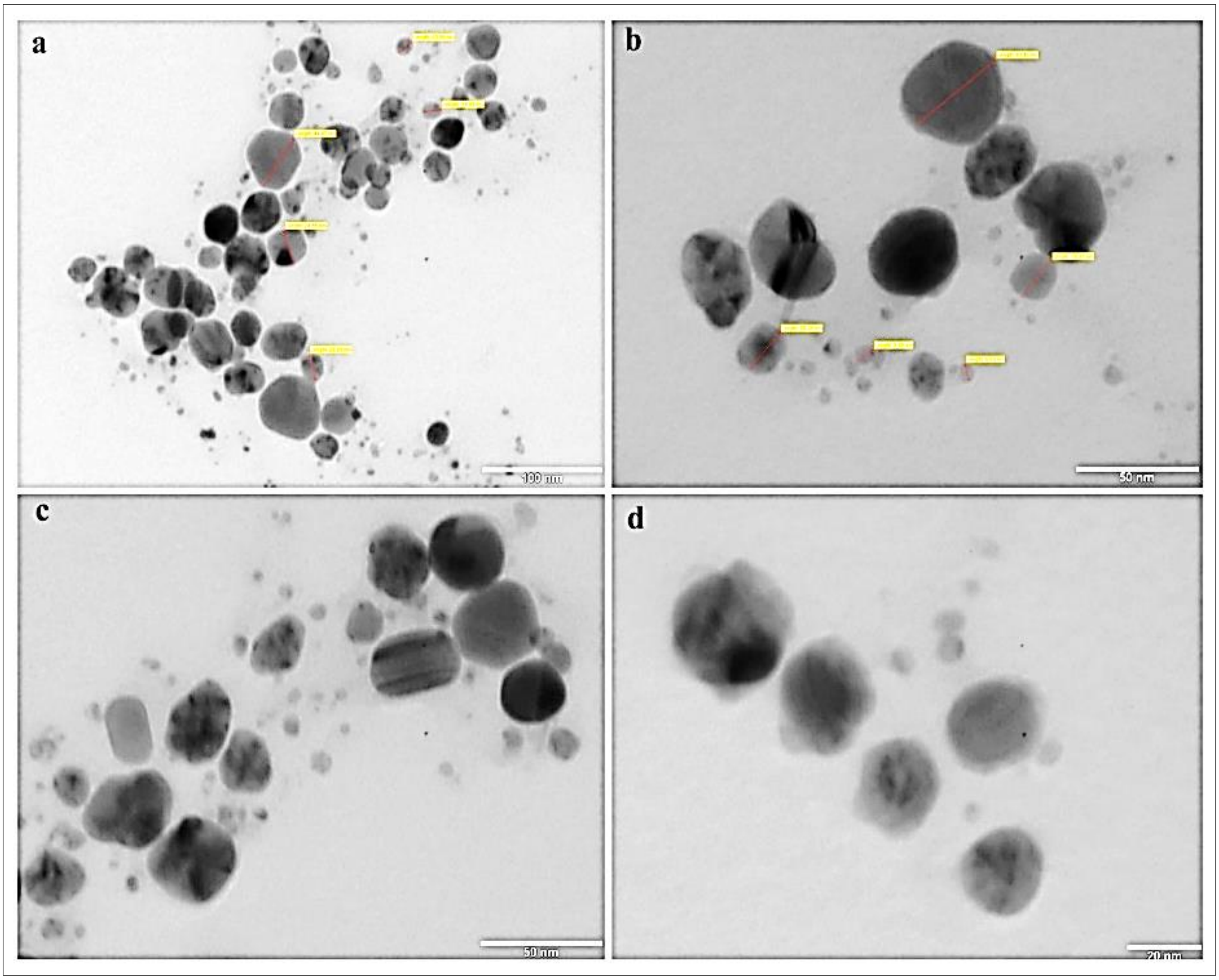

Fig 5 TEM images of synthesized silver nanoparticles

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