Research Article

Phytosynthesis and Characterization of *Curcuma amada* Mediated Silver Nanoparticles

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ABSTRACT

Silver nanoparticles are the glorious metallic material due to their wide applications in the pharmaceutical and industrial sectors. In this study, *Curcuma amada* rhizome are used for the silver nanoparticle synthesis. *C. amada* mediated $AgNO_3$ nanoparticles are synthesized by and characterization studies (UV, FTIR, XRD, DLS, SEM and TEM). In UV spectra, three peaks observed at 413, 418 and 995nm confirmed the presence of silver particles in the green synthesized Ag nanoparticles. FTIR spectra exhibited various functional groups (N-H stretching vibrations, alkane, amide stretching, carboxylic acid, stretching and rocking C-C bonds, NH_2 stretch and S-S stretch) of the nanoparticles. green synthesized Ag NPs electron microscopic analysis revealed agglomerated irregular shape with homogenously. The crystal plane lattice of the nanoparticles is revealed by XRD. Agglomerated irregular structures of silver nanoparticles with average particle size 32-55nm. Our study concluded that *Curcuma amada* mediated silver nanoparticles exhibited the nanoparticles properties.

Keywords: *Curcuma amada*, Ag nanoparticles, UV, SEM.

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INTRODUCTION

Nanoparticles are the excellent materials with enhanced properties widely utilized for the various industrial, agrochemical, mechanical, pharmaceutical and cosmetic sectors. Due to their diverse application and demand, nanoparticles productions has been increased to threefold within the last decade.[1-3] Chemically synthesised nanoparticles utilization leads to the environmental contamination due to the high redox activities with the non-targeted species.[4] To overcome this issue, the researchers showed much attention towards either microbe mediated or phytomediated nanoparticle synthesis.

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The perennial herb, *Curcuma amada* (Roxb.) belongs to the family Zingiberaceae which is commonly known as mango ginger. It is a well-known plant for their intense aroma with camphoraceous smell and edible rhizome. It has numerous pharmacological and therapeutic applications. In Siddha, the plant extracts are used to treat hypercholesterolemia, dermal infections, anti-inflammatory, anti-venom for snake and insect bites.[5,6] Sathak *et al.*[7] explained the importance of phytocompound for the synthesis of metallic nanoparticles from bulk particles and their wide applications.

Silver nanoparticles are synthesised from different plants such as roots, leaf and seeds.[8-10] Ethnobotanical value rich plants such as *Jatropha curcas, Cassia auriculata, Chrysanthemum morifolium, Mimusops elengi, Morinda citrifolia* and *Cinnamon zeylanicum*[8-12] are used as an alternative

source for the chemical products. Phytocompounds are biodegradable, cost effective and non-toxic to the non-targeted species and compounds.[13]

Silver Nanoparticles (Ag NPs) are the widely used metallic nanoparticles due to their high catalytic and membrane diffusion mechanism. Ag NPs has the ability to inhibit the mitotic spindle apparatus and microbial enzyme machinery.[14] Green synthesis of nanoparticles are the metallic nanoparticles are synthesised along with the phytometabolites which enhances the redox potential of the particles. The objectives of our study are to synthesise the *C. amada* mediated silver nanoparticles. Phyto mediated silver nanoparticle's structure, size and morphology are evaluated by various characterization techniques such as FTIR, UV-Vis spectroscopy, DLS, SEM and TEM.

MATERIALS AND METHODS

Green synthesis of Ag nanoparticles

The rhizome, *Curcuma amada* is collected from the local farmer and identified. Plant callus selected and washed with distilled water. 40g of plant sample are ground well with 200 mL of distilled water and filtered through Whatmann filter paper. Plant filtrate mixed with 180 mL of aqueous $AgNO_3$ (1mM). The mixture kept for plasmon excitation (incubation) for the reduction of silver ions with phytocompounds for 24 hr at 35°C.[15] The mixture colour changed into dark brown considered as the indicator of the silver ion reduction for silver nanoparticles synthesis. After 8 hr, the mixture is centrifuged (10000rpm) for 15 min. Supernatant collected and washed with distilled water for several times. Finally, *C. amada* mediated silver nanoparticles are obtained.

Characterization of green synthesized Ag nanoparticles

By using potassium bromide pellets, the active groups of the green synthesized Ag NPs are analyzed by FTIR spectroscopy (Nicolet 660 Avatar, US), the particles associated are observed in the ranges of 400 to 4000/cm.[16] The functional and active groups of the phytocompound mediated silver nanoparticles are analyzed by UV visible spectroscopy (Shimadzu UV-2550).[17] For the analysis of 2θ angle of the Ag NPs, XRD (Shimadzu 7000) are used. Morphology and particle size of the Ag NPs are analyzed by SEM (MA10 ZEISS) and TEM (JEM 1400).[18]

RESULTS AND DISCUSSION

Curcuma amada rhizome extract showed a significant concentration of bioactive pharmacognostical products which are used as the main active ingredient for the various therapeutic drugs.[19] Shirsath *et al*.[20] reported that rhizome parts of the *C. amada* contains high amount of curcuminoids by aqueous extract. Sujata and Virendra[21] also evidenced the importance of *Curcuma sp*. for the metallic nanoparticles synthesis due to their high surface interaction abilities.

In our study, *C. amada* Rhizome extract mixed with $AgNO_3$ solution, facilitated the plasmon excitation which resulted the conversion of yellow colour solution into brownish red colour Ag NPs. *C. amada* mediated Ag NPs UV-visible spectroscopy results evidenced the presence of three peaks at 413, 418 and 995nm. Peaks observed at 413 and 418nm confirmed the presence of Ag ions in the synthesized nanoparticles whereas the peak observed at 995nm represented the phytoproduct presence in the testing sample (Ag NPs).

Similar results are evidenced by the *Azadirachta indica* mediated Ag NPs,[22] olive extract mediated Ag NPs[23] and phytomediated Ag NPs.[24] *S. indicum* mediated Ag NPs UV spectral absorbance peak is observed at 430nm. Gola *et al*.[25] reported the presence of peak at 422nm for Ag NPs. Khatoon *et al*.[26] also evidenced the peak at 427, 425 and 421nm absorbance for the synthesized silver nanoparticles.

In FTIR spectra (Figure 1), broad peak observed at 3413.16cm^{-1} due to the presence of N-H stretching vibrations, 2923.91 and 2852.64cm^{-1} indicated the alkane, 1631.22cm^{-1} indicated the C=O amide stretching, 1384.01, 1320.70 and 1105.30cm^{-1} denoted –C-O of carboxylic acid or –C-OC- linkage. 1078.20, 1054.19 and 944.84cm^{-1} indicated the presence of C-O, C=O stretch. Bands at 865.83, 837.67, 779.98 and 618.51cm^{-1} represented the presence of stretching and rocking C-C bonds, NH_2 stretch and S-S stretch. Strong peaks observed at 577.45 and 520.86cm^{-1} are indicated the strong binding of phytocompounds with silver ions. Phytomediated $AgNO_3$ nanoparticles generally has high affinity towards the reduction and stabilization mechanism due to the carboxyl and hydroxyl groups present in the phytocompounds.[27] Rautela *et al*.[13] confirmed the presence of peaks at 1038, 1508, 1643 and 1745cm^{-1} in FTIR spectra of the green synthesized silver nanoparticles. Similar results are evidenced by Chaturvedi *et al*.[28] and Das *et al*.[29]

Green synthesized Ag nanoparticles crystal structure are predicted by X ray diffraction lattice pattern showed three peaks at 28.50°, 40.67° and 50.30° which

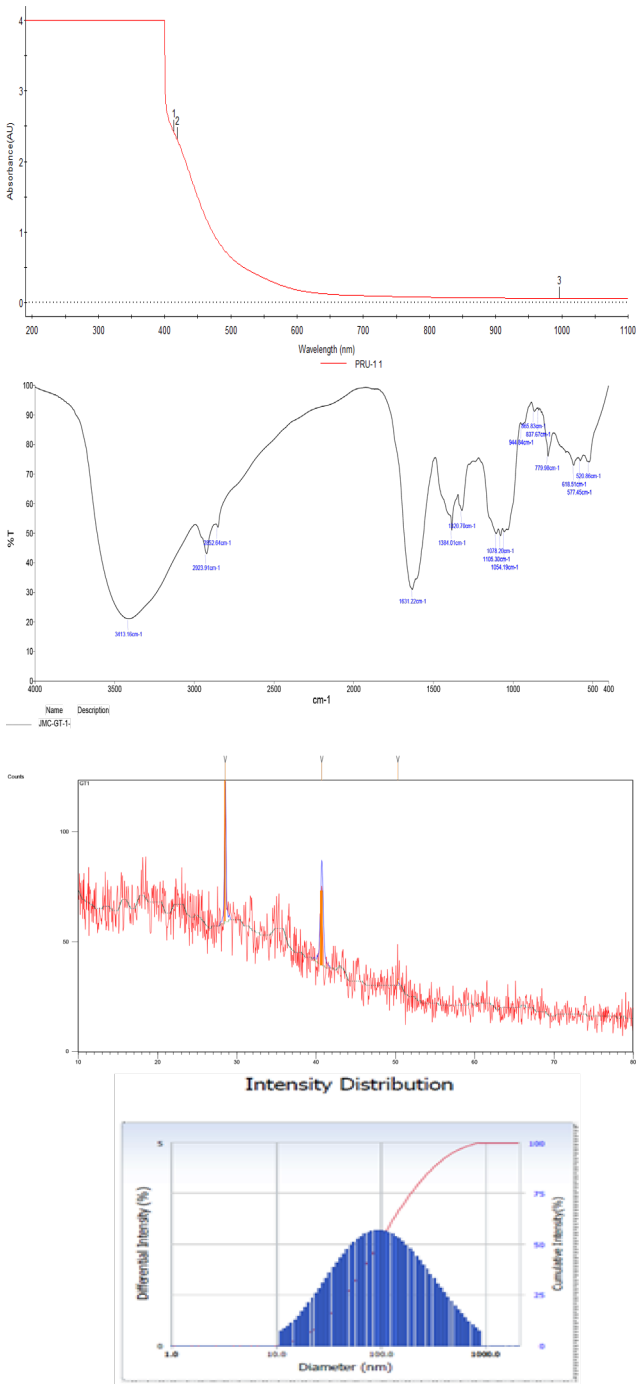

Figure 1: *Curcuma amada* mediated AgNPs characterization analysis.

represented the cubic face centered silver crystal. Morphology of the nanoparticles are confirmed by SEM and TEM analysis. The green synthesized Ag NPs electron microscopic analysis (Figure 2) revealed agglomerated irregular shape with well dispersed homogeneity. The agglomerated compound diameter is ranging between 32-55nm. The tested particle size distribution is analyzed by DLS whereas the average

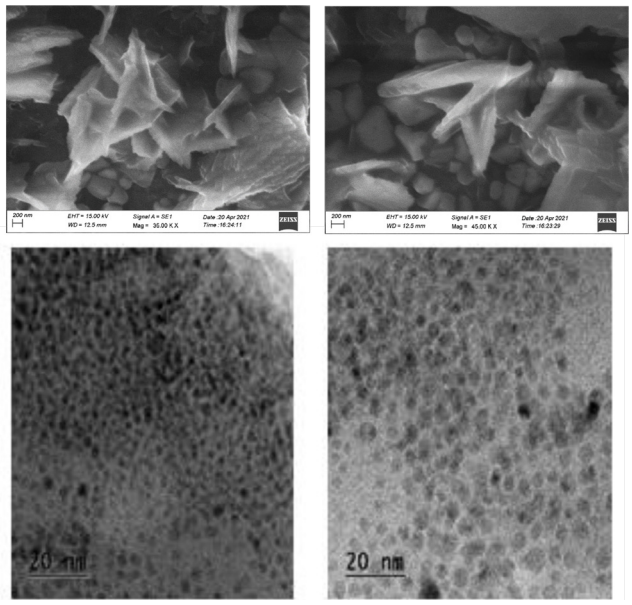

Figure 2: SEM and TEM image of biosynthesized AgNPs using *Curcuma amada* rhizome extract.

diameter of the particles is measured as 152.3nm (D10: 25.2nm, D50: 92.3nm). Similar results are evidenced by Suman *et al.*,[8] Gavhane *et al.*[30] and Reddy *et al.*[31]

CONCLUSION

Curcuma amada mediated silver nanoparticles are synthesized by plasmon excitation (downstream) process. Brownish red colour supernatant are collected and subjected to various characterization studies. UV analysis of *C. amada* mediated Ag NPs exhibited three peaks at 413, 418 and 995nm confirmed the presence of silver. Various functional groups such as amide, alkane, carboxyl, carbonyl is identified. XRD and DLS analysis revealed face centered agglomerated irregular shaped particles with the size ranging between 32-55nm with 152.3nm diameter.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

Ag NPs: Silver nanoparticles, **FTIR:** Fourier transform infrared spectroscopy; **SEM:** Scanning electron microscopy, **TEM:** Transmission electron microscopy.

SUMMARY

Green synthesis of nanoparticles is a promising field which is considered as a remedy for various chemical based pharmaceutical and biological treatments. C. amada mediated Ag NPs synthesized by downstream process and their size ranged between 32-55nm. Characterization studied revealed the presence of silver ions and their functional groups, plane lattices and shape.

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