CUSCUTA REFLEXA EXTRACT BASED GREEN SYNTHESIS OF SILVER NANOPARTICLES

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Abstract

The present investigation shows a rapid biological approach for the synthesis of silver nanoparticles (AgNPs) using biologically active *Cuscuta Reflexa* (Amarbel) extract as a reducing and stabilizing agent. The formation and structure of nanoparticles were characterised using different analytical techniques including UV-Visible (surface plasmon resonance), Flourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM). The formation and structure of nanoparticles were examined using High resolution transmission electron microscope (HRTEM). The corresponding absorption peak at 413 nm confirms the synthesis of silver nanoparticles. FTIR analysis revels that the phytoconstituents present in *Cuscuta Reflexa* (Amarbel) extracts were actively involved in the reduction of silver ions. The surface morphology study of silver nanoparticles rested on the extracts residue give an idea about the asymmetric spherical structure of nanoparticles.

Keywords: Silver Nanoparticles, *Cuscuta Reflexa*, Green synthesis, Surface Plasmon Resonance, HRTEM.

Introduction

Nanotechnology has developed to become an emerging and important field in present research with potential applications in the field of medicine, electronics, substrates catalysis, biosensing and synthesis. Recently nanotechnology represents a green and economic alternative to physical and chemical synthesis methods of nanoparticles [1]. This silver nanoparticle with different shapes and sizes has been usually synthesized by various physical (such as electro deposition and laser ablation) and chemical (such as chemical reduction and polyol) methods [2-4]. The surface plasmon resonance (SPR) of nanoparticles is caused by the combined alternations of the conduction band electrons interacting with electromagnetic radiation. This phenomenon is principally responsible for their annihilation properties in the visible range of the spectrum, and thus is directly responsible for the impact on various technologies. Since the plasmon resonance depends strongly on the NPs shape, size and environment [5]. Green synthesis has advantages over physical and chemical methods because it is cheap, environment friendly, provides a means of producing different nanoparticles in industrial quantities, and does not require the use of chemicals or energy [6]. Plant represents a natural and renewable source of biologically active phytoconstituents, which could be effectively utilized for the synthesis of metal nanoparticles. The synthesis of nanoparticles with natural phytochemicals is a non-toxic, greener, cost effective and environmentally acceptable procedure. The plant biomolecules may act as both stabilizing and reducing agents in the synthesis of various metal nanoparticles. The use of folk medicinal plants for the synthesis of nanomaterials will effectively enhance their biological activities [7, 8]. Silver nanoparticles have wide range of pharmacological, biomedical, and industrial applications due to there their unique properties in multidisciplinary research fields. Several plants products have been successfully used for cheap, efficient and rapid extracellular synthesis of silver nanoparticles [9, 10]. In the present investigation *Cuscuta reflexa Roxb.* is widely used for green synthesis of silver nanoparticles. *Cuscuta*

reflexa Roxb. is a coiling leafless stem parasite having pale white flowers. The plant widely distributed throughout India as a condensed yellow wiry mass on plants and trees. The biomolecules identified in *Cuscuta reflexa* plant are: Cuscutine, Quercetin, Cuscutamide, Kaempferol, Amarbelin and Reflexin. *Cuscuta reflexa* plant is also famous for its folk medicinal uses such as antibacterial and anticancer, etc. [11]. Silver nanoparticles has been synthesised using *Cuscuta reflexa Roxb.* V. from one step green synthesis method. Synthesised nanomaterial's characterized by ultraviolet-visible (UV-Vis) spectroscopy, flourier transform infrared spectroscopy (FTIR) and scanning electron microscopy (SEM). Phytoconstituents present in cuscusta given as:

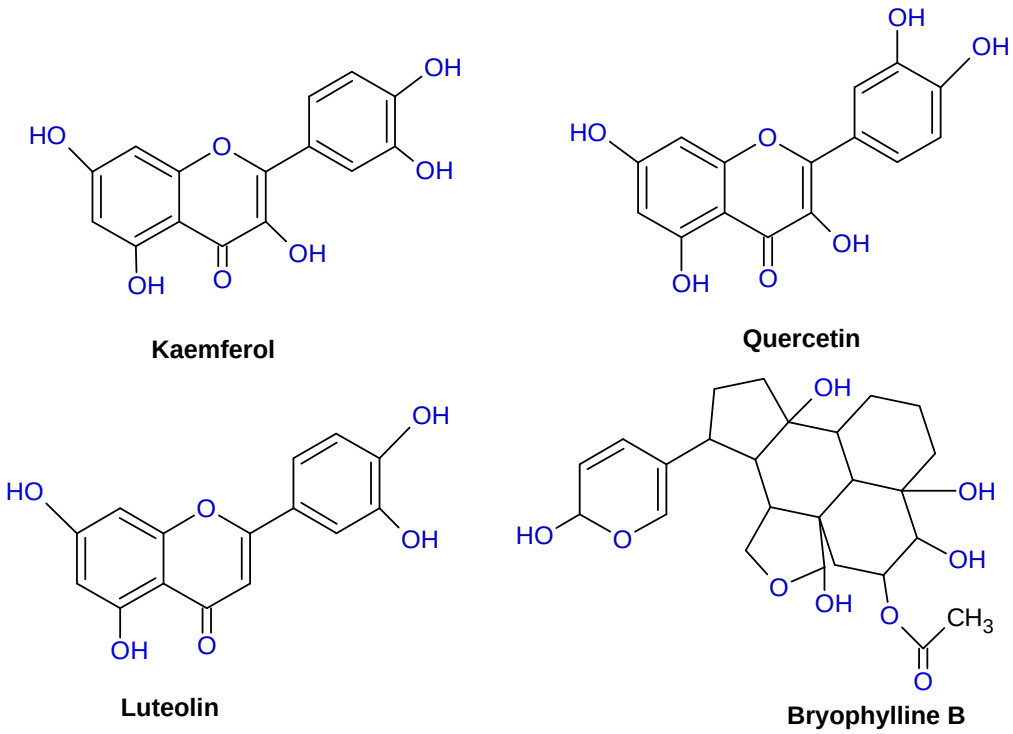

Fig 1: Phytoconstituents present in cuscusta extracts

Experimental

Collection and preparation of aqueous plant extracts

Cuscuta Reflexa (Amarbel) collected from forest located at Sarguja district Chhattisgarh, India. Fresh *Cuscuta Reflexa* were first washed with clean tap water to remove the dirt and other contamination and further rinsed with double distilled water. About 20 gm of finely cut *Cuscuta Reflexa* were kept in Erlenmeyer flask beaker containing 100 mL double distilled water and boiled for 25 min. The extract was cooled down and filtered using Whatmann filter paper no.1. These plant extract was stored at 4 °C temperature for further use.

Green synthesis of silver nanoparticles

For the synthesis of Ag nanoparticles, the mixture containing plant extract and silver nitrate in the ratio of 1:10 was kept for agitation in rotary evaporator at room temperature (35-40◦C) at 100 rpm for few hrs. The colour of the solution turned into reddish brown indicating the formation of Ag nanoparticles indicates the reduction of Ag^{+} to Ag^{0}. Formation of Ag^{0} was also confirmed by using UV-Visible spectroscopy [12].

Characterization of nanoparticles

The reduction of Ag salt and formation of Ag nanoparticles was scrutinized through visual change in colour of solutions i.e. colourless to red brown. UV-Vis spectra was recorded with SHIMADZU UV- Visible 1800 spectrophotometer in the wavelength region from 200 to 800 nm for confirmation of silver nanoparticles formation. The synthesized silver NPs were characterized using Fourier transform infrared spectrophotometer for detection of surface functional groups (Thermo Nicolet, AVATAR-370-FTIR (USA) over a range of 500-

4000 cm^{-1}, resolution 4.000 cm -1). Scanning electron microscope (SEM) images were performed on Scanning electron microscope ZEISS EVO SEM 18 model equipped with INCA 250 EDS X-MAX 20mm Detector Oxford used for SEM analysis. Thin film of the sample was prepared on copper grid by simply dropping a very small amount the sample. Size and distance of nanoparticles measurements were made using High resolution transmission electron microscope (HRTEM) (JEM-2100, JOEL, Philips, Japan). The XRD patterns of the samples measured the size of nanoparticles using a PANalytical 3 kW X'pert Powder–Multifunctional, Netherland X-ray diffractometer. For the measurement Cu Ka radiation was used with an angular range of $5° < 2\theta < 60°$ at room temperature.

Result and discussion

UV-Visible spectra: UV-Visible is the effective tool for the characterization of synthesized silver nanoparticles. Green synthesis of silver NPs has been followed by change in the surface Plasmon resonance (SPR) band of the aqueous dispersion. Fig. 2 shows the UV–visible spectra of the corresponding aqueous dispersion of silver NPs obtained by using CRRE. The change in the colour of the silver salt solution from colourless to red brown is the clear evidence of the reduction of the silver ions to NPs. The intense and high peak is appear in the spectrum near at 423 nm corresponding to SPR absorption band suggesting the small size and stability of synthesised silver nanoparticles [13]. The SPR band can give valuable information regarding the shape and size of the synthesized nanoparticles. The reduction in particle size leads to the decrease in the maximum wavelength (blue shift) and the increase in particle size causes the increase in the maximum wavelength (red shift) [14].

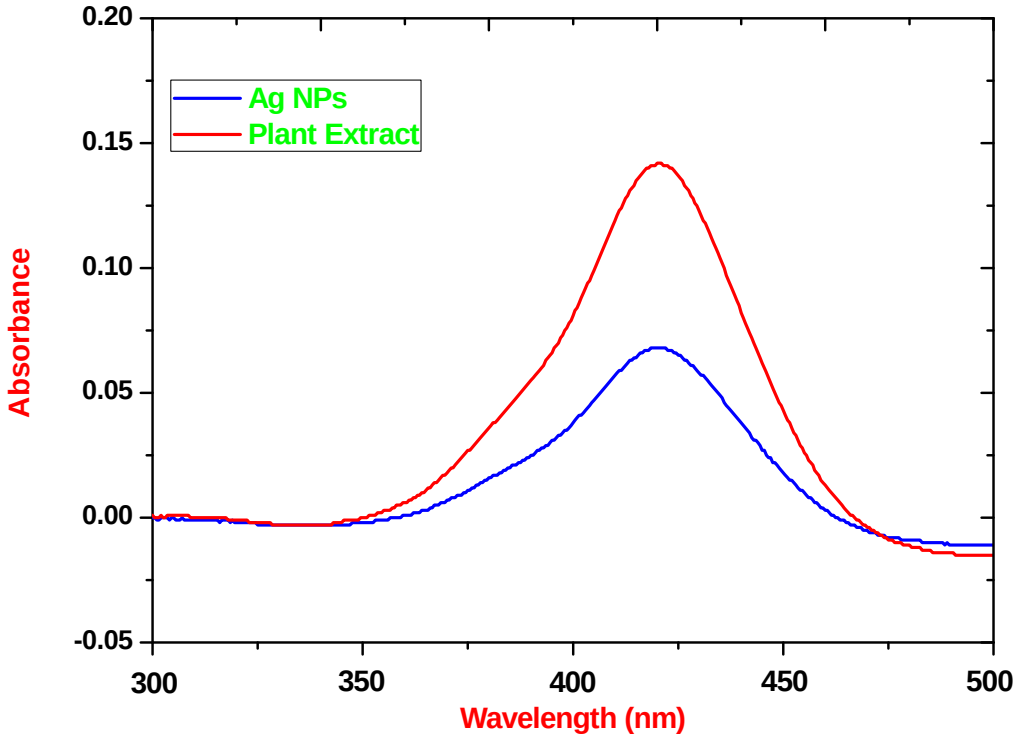

Fig.2: UV-Visible spectra of silver nanoparticle synthesized from CRRE

FT-IR spectral analysis: FT-IR gives information regarding the various functional groups present in plant extract that are associated with the silver nanoparticles. Fig. 3 shows the FT-IR spectra of the synthesized AgNPs where corresponding peaks are observed at 1021.89, 1626.83 and 3389.96 cm^{-1} respectively. The broad peak obtained at 3389.96 cm^{-1} corresponds to the O-H and/or N-H bond stretching vibrations. The peaks at 1021.89 cm^{-1} may be observed due to the stretching vibrations of C-O bonds. Presence of peak at 1626.83 cm^{-1} suggest the appearance of carbonyl groups [15]. Studying and analysing the characterization result of FTIR, synthesis of well isolated and morphologically near uniform silver nanoparticles can be supported.

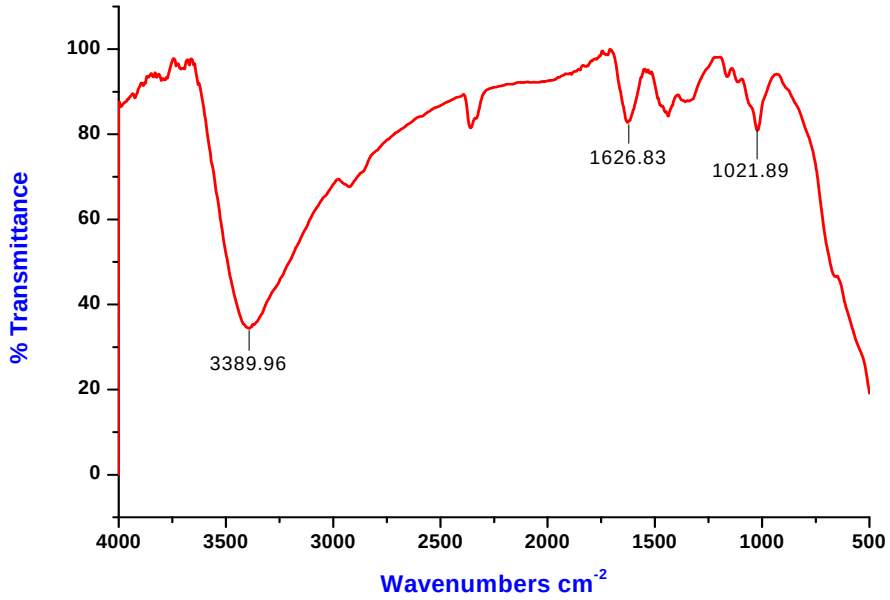

Fig. 3: FTIR spectrum of purified silver NPs synthesized by using CRRE.

SEM Analysis: SEM analysis is used in order to study the morphology and size of the bio-synthesized silver nanoparticles. Fig. 4 shows the SEM image of the as-synthesized silver NPs. It is clear that the Ag NPs are homogeneous and relatively sphere-shaped particles distributed over the leaves extracts residue. Using SEM analysis the accurate surface quality couldn't possible to investigate since silver nanoparticles are being found to present along with the residue of plant extracts

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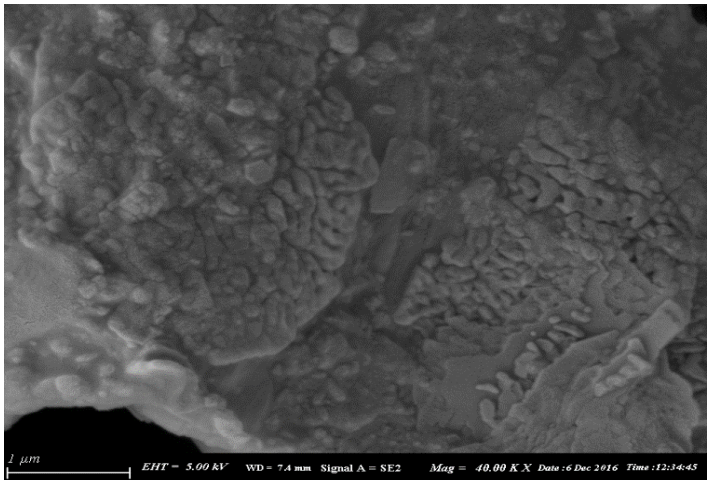

Fig. 4: SEM image of silver NPs synthesized by using CRRE

HRTEM Analysis:

HRTEM micrographs of silver nanoparticles at room temperature showed very well dispersed silver nanoparticles (Figure 5) synthesized using cuscuta as reductant and stabilizer. Statistical analysis based on over hundred silver nanoparticles shows that the majority of the NPs were approximately 10nm in diameter. The images of Figure 4 reveal the spherical shape of the NPs which agrees with the UV-Vis spectra obtained.

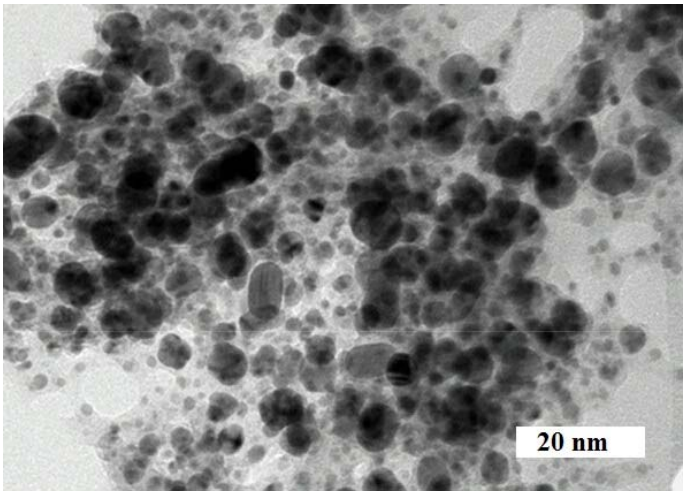

Fig. 5. HRTEM images for the nanoparticles synthesized from cuscusta

Conclusion

It is the first time to use *Cuscuta Reflexa* (Amarbel) extract to prepare metal nanoparticles. It proves to be an environmental, rapid green approach for the NPs synthesis providing a cost effective and an efficient way for the synthesis of AgNPs. Therefore, this reaction pathway satisfies all the conditions of a green chemical pathway. Stable and tiny silver nanoparticles were synthesized by reducing silver salts to silver nanoparticles using *Cuscuta Reflexa* (Amarbel) extract as reducing as well as capping agent. *Cuscuta Reflexa* (Amarbel) extract not only prevents the oxidation but also protects the silver nanoparticles from the aggregation. The FTIR spectra indicated that phytochemicals present in extracts might be responsible for the stabilization and reduction of silver nanoparticles and showed that the morphology of NPs was mostly unsymmetrical sphere-shaped.

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