Preparation and characterization of silver nanoparticles prepared by floral aqueous extract of plant *Alstonia scholaris* Linn. R. Br. by Green synthesis approach.

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Abstract

In recent times the fast and rapid research innovation done in the field of the Herbal Drug Industry as well as nanosciences and nanotechnology. They open the different doors of research related to the field of diagnosis, treatment, cure, and prevention of several diseases etc. Herbal-based formulation containing nano-range particles shows good effectiveness and better bioavailability in systemic circulations recorded their several advantages. Plant-based phytoconstituents are potential agents used for the synthesis of silver nanoparticles. Green synthesis-based inorganic silver nanoparticles are a fresh and promising alternative to chemically produced nanoparticles.

In this study green synthesis of silver nanoparticles using aqueous floral extract of *Alstonia scholaris* Linn. R. Br. UV-Vis spectrometer uses to monitor the reduction of Ag ions and the formation of silver nanoparticles with the plant extract. Particle size distribution TEM and FE-SEM have been used to investigate the morphology characters of prepared silver nanoparticles. FT-IR was performed to measure the different functional groups present in the nanoparticles. The peaks in the XRD pattern are associated with that the face-centered-cubic (FCC) form of metallic silver. The average grain size of silver nanoparticles is found to be 6.45 nm.

Keywords: Green synthesis, Silvernanoparticles, *Alstonia scholaris*, Aqueous floral extract.

1. Introduction

Nanoparticles are the smallest size particles they have remarkably different properties and activities. Nanotechnology is the newer technology in which we are using small particle size (10-100 nm), shape, and quite unique in nature solid colloidal particles of the materials. It is widely used in different fields because of its various good advantages and applications [1-4] They are classified and categorized in many ways, but application-based classification is very important for the classification of Nanoparticles. Organic and inorganic nature-based classification has easily differentiated the Nanoparticles. The different types of metallic Nanoparticles are widely used in past and recent times eg. Gold, Silver, Copper, Iron, Zinc, etc. Silver nanoparticles show good antimicrobial characteristics, and at present, their severalapplications are being explored in consumer products such as medicines, shampoo, hygieneproducts, and contraceptives [5-10].

Alstonia scholaris Linn. R. Br. Plant is a large evergreen garden tree, belonging to the family Apocynaceae. It is growing up to 15–21 m in height, with a straight often. They contain different types of important alkaloids and other secondary metabolites. These substances are responsible for showing different types of medicinal properties. The ethnomedicinal data shows that all the parts of the plant are used for medicinal purposes Bark, including Leaves, Flower, latex, etc [11-13].

In the present study, we prepared silver nanoparticles using the aqueous floral extract of *Alstonia scholaris* by green synthesis approach and they are formulated and characterized.

2. Material and Method

2.1 Chemicals

All chemicals used by Merck Pvt. Ltd. and solvents were Qualigens.

2.2 Plant material

Flowers are collected from the medicinal garden of Vikram University campus Ujjain (Voucher specimen MIPS- AS-001) according to session and shaded dry. Dry flowers are grinded using a mechanical mixer and formed a coarse powder.

2.3 Successive solvent extraction method

Take coarsely powdered flower (40 g) were extracted by Soxhlet using non-polar to polar solvents (300 ml). Then, after extraction, solvents were removed by Rotavapor (Buchi, England), and a solid mass of aqueous extracts was procured. [14]

2.4 Green synthesis of silver nanoparticle using *Alstonia scholaris* flower aqueous extract

In the green synthesis of silver nanoparticles firstly take 0.01M of an aqueous solution of silver nitrate (99.99%) was used. 10 mL of Floral aqueous extract was added to 100 ml of 0.01M silver nitrate aqueous solution and allowed at the ambient condition to react. After different time intervals, the colour change of the reaction mixture is observed from transparent yellow to dark brown indicates that the formation of silver nanoparticles. The silver nanoparticles solution was collected and UV-vis spectral analysis was used to investigate the reduction mechanism of silver ions into nanoparticles in the solution. The silver nanoparticles solution was allowed to centrifuge and the excess liquid was removed by evaporation in a dryer yielding black-brown coloured silver nanopowder [15-17].

2.4.1 Optimization of parameters for the synthesis of silver nanoparticles Optimization of external factors is critical to control reaction parameters. UV–vis analysis was done to obtain the optimum wavelength for silver nanoparticles. [18]

2.4.2 Optimization of pH for the formation of silver nanoparticles

pH was varied from 5 to 9 with a difference of to estimate the optimal pH of silver nanoparticles. [19]

2.5. Characterization of Silver Nanoparticles

2.5.1. Spectroscopical analysis

UV visible spectroscopy was performed on the aqueous floral extract of *Alstonia scholaris*-based silver nanoparticles with suitable dilutions to analyze absorbance and λ_{max} by Shimadzu 1800 (Shimadzu Corporation, Kyoto, Japan), and the spectra were taken [20], [21].

2.5.2. FTIR analysis

FT-IR studies of silver nanoparticles were done with an FT-IR spectrometer (Aligent Cary 630) from Diya Lab Mumbai using the dried powders between 4000–700 cm− 1 by means of the KBr pellet method [22].

2.5.3. Particle size analyser by Malvern

Dynamic Light Scattering measures the translational diffusion coefficient of particles that are subject to Brownian motion by analyzing the intensity fluctuations of laser light scattered by the particles. The particle hydrodynamic size is then determined by modeling the particles as perfect solid spheres and applying the Mie and Rayleigh scattering theories. [23]

2.5.4. FE Scanning electron microscopy

Silver nanoparticles were allowed to dry in a vacuum. Morphological analysis was done by Carl Zeiss, Model Supra 55 (Made in England) [24].

2.5.5. Transmission electron microscopy (TEM)

The size of the nanoparticles was calculated by transmission electron microscopy (Tecnai T20, 200 Kev FEI instrument) from Sprint Testing Solutions Mumbai. Silver nanoparticles were loaded on TEM grids and kept in desiccators and transferred onto a specimen holder. The particle size of silver nanoparticles was estimated using Image J 1.45 s software (NIH, USA) [25].

2.5.6 X-ray diffraction study (XRD)

silver nanoparticles were characterized by XRD (Panalytical B.V. Lelyweg 1 7602 EA ALMELO The Netherland). [26]

3. Results

The aqueous floral extract of silver nanoparticles was dark brown in color (Fig. 1) nanopowder was stable. The optimum concentration of *Alstonia scholaris* Linn for nanoparticle synthesis was 10 mL of Floral aqueous extract added to 100 ml of 0.01M silver nitrate aqueous solution. It was observed that acidic pH (3–5) was inhibiting synthesis for silver nanoparticles. A highly basic pH was optimum for the synthesis of green synthesis-based silver nanoparticles. In earlier studies, it was established that alkaline pH is favorable for the synthesis of silver nanoparticles

3.1 UV–vis analysis

UV visible spectroscopy spectra of the aqueous floral extract of *Alstonia scholaris*-based silver nanoparticles with suitable dilutions. The intensity of the absorption peak at 425 nm is recorded. (Fig. 1) shows spectra of aqueous floral extract of *Alstonia scholaris*-based silver nanoparticles. UV range from 200 to 700 nm and Millipore water was used as a blank to adjust the baseline.

3.2. FT-IR analysis

FT-IR spectra show different frequency ranges between 3600-3200 cm-1 representing a hydroxyl (− OH) group peak report at 3365.8. (C-H) stretching from 2950-2840 peak report at 2922.2, (N-H) Primary Amines 1650-1550 peak report at 1561.8, and carbonyl (C –O) stretching of at (1275-1200) peak report at 1282.2, (Fig. 2)

3.3 Particle size

Silver nanoparticles Dynamic Light Scattering size measurements were performed on a Zetasizer Nano(Malvern Panalytical Ltd., UK) equipped with a maximum 4 mW He−Ne laser emitting at 633 nm and Zetasizer Software, v. 7.13. Samples were contained in ZEN0040 (Malvern Panalytical) low-volume disposable cuvettes. Each measurement was performed at a noninvasive back-scattering angle of 173° (in the dispersant) after thermally equilibrating the sample at 25 °C for 3 min. (Fig.3)

3.4 FE-SEM

The reflected secondary electrons are captured by detectors and converted into images. In, among all the microscopy techniques, SEM is the most efficient method for the measurement of nano-level and identified easily different particle sizes and shapes of nanoparticles. It can also determine the basic information about the surface morphology of nanoparticles in the nanoscale.Fig.4 (A–B) illustrates the FESEM studies of Silver Nanoparticles.

3.5 TEM

Transmission electron microscopy (TEM) is an important method of characterizing nanoparticle morphology (size and shape). TEM images of nanoparticles are typically acquired in brightfield mode, based on the contrast generated by electron scattering from heavy atoms. The different image analysis software to obtain statistical distributions in particle size and shape. Individual nanoparticles can also be assessed for uniformity in shape or size. TEM study shows a measured Minimum particle size for AgNP-AS of 10 nm. Fig 5 (A-E).

3.6 X-ray diffraction studies

X-ray diffraction pattern of AgNP-AS had Bragg's reflections of (111), (200), (220) and (311) planes, which confirms the face-centered cubic (FCC) crystalline structure of silver (Fig. 6). Synthesized of AgNPs using floral extract of *Alstonia scholaris* was shown in Fig. 4. The XRD was done to determine the crystalline nature of AgNPs and the resulting peaks were found at 37.90°, 44.05°, 64.25° and 77.20° representing (111), (200), (220) and (311) face-centered cubic structure of silver which were compared with the standard powder diffraction card of Joint Committee on Powder Diffraction Standards (JCPDS), silver file No. 04–0783. A few intense unassigned peaks were also noticed which were raised at 320, 45.950, 54.60 and
57.20 .t.

4. Conclusion

The green synthesis-based method of AgNPs using aqueous floral extract of *Alstonia scholaris* was shown to be fast, eco-friendly, and cheaply produced nanoparticles that are in nano size and shape. Silver nanoparticles began to form with the addition of leaf extract to silver nitrate as shown by the UV-vis spectrum at 425 nm. The XRD peaks are ascribed to the FCC structure of silver. The synthesized silver nanoparticles were spherical in shape and particle size was found about 6.45 nm from XRD results in addition justified further by the SEM. The FT-IR spectrum ascribed the biological molecules which perform dual functions of formation and stabilization of silver nanoparticles in the aqueous medium. So, it can be summarized that green synthesis is an effective and eco-friendly method of producing metal nanoparticles.

Declaration of Competing Interest

The authors report no declaration of interest.

Fig. 1. UV-visible spectra of silver nanoparticles prepared by *Alstonia scholaris* Linn aqueous floral extract.

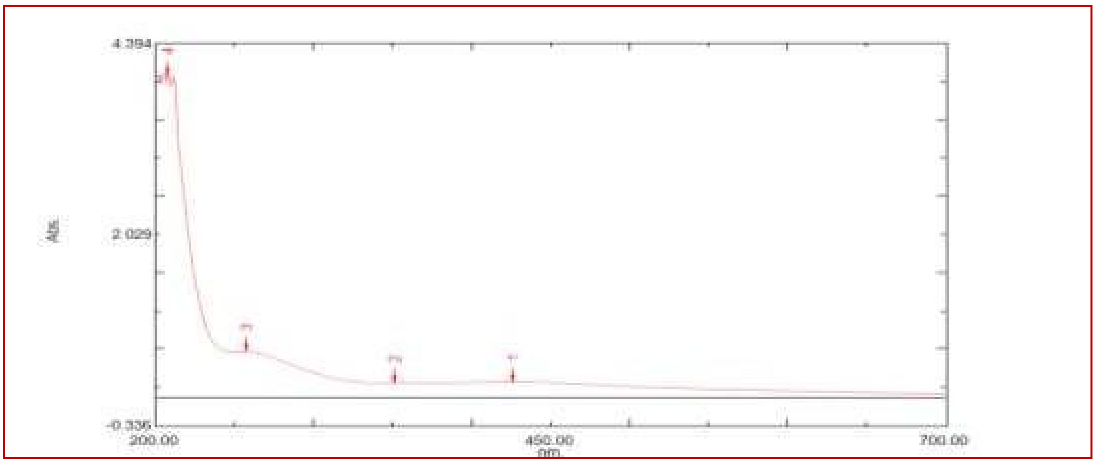


Fig. 2. FT-IR analysis of silver nanoparticles prepared by *Alstonia scholaris* Linn aqueous floral extract.

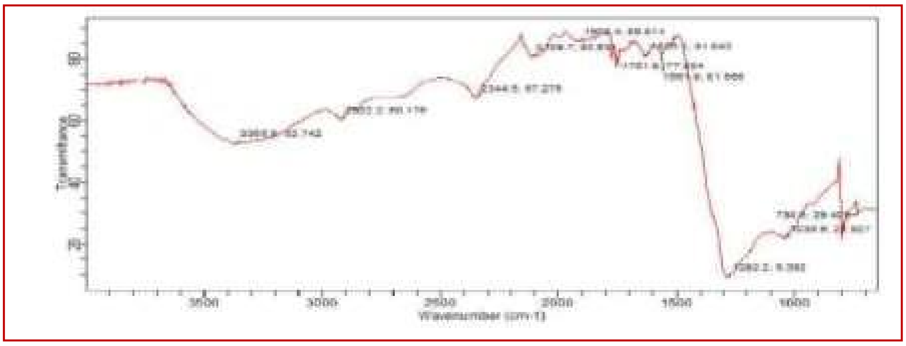


Fig. 3. Particle size distribution report graph of silver nanoparticles prepared by *Alstonia scholaris* Linn aqueous floral extract.

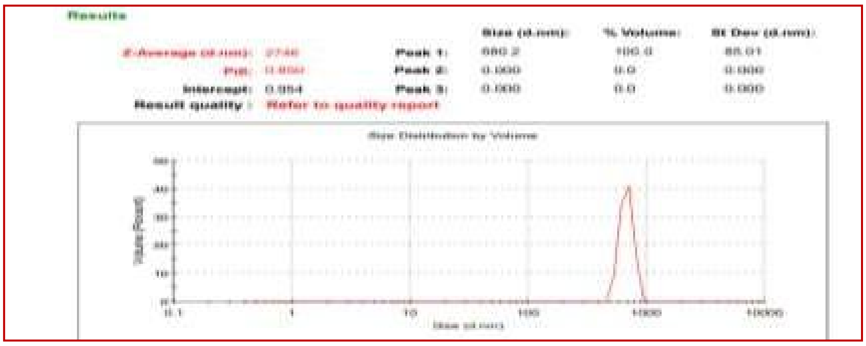


Fig. 4. FE-Scanning electron microscopy images of silver nanoparticles prepared by *Alstonia scholaris* Linn aqueous floral extract.

A. Image B.Image

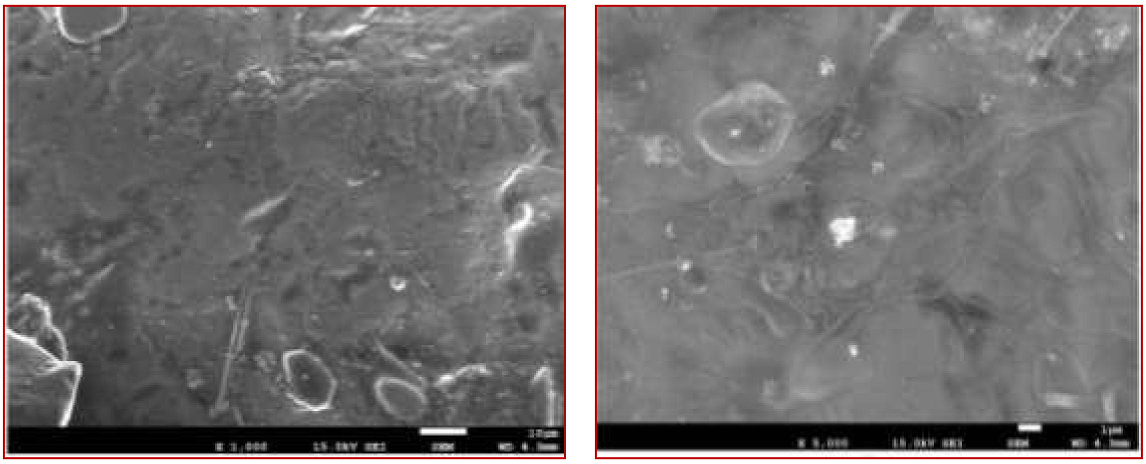
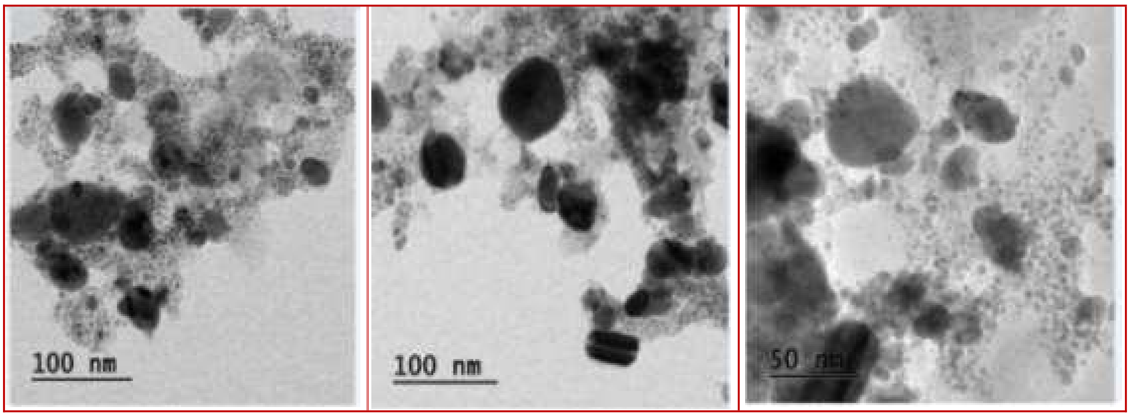


Fig. 5. FE- Scanning electron microscopy images of silver nanoparticles prepared by *Alstonia scholaris* Linn aqueous floral extract.

A. Image B.Image C.Image



D.Image E.Image

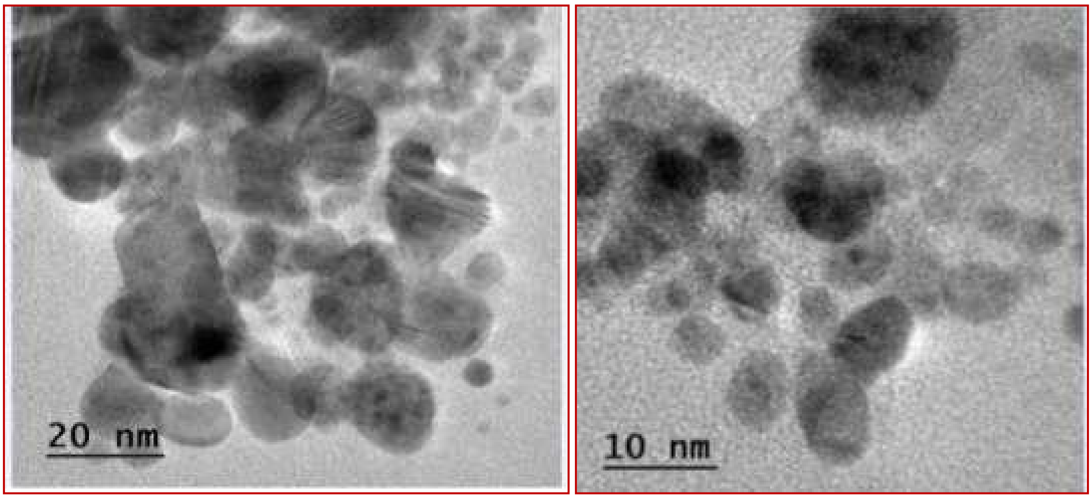
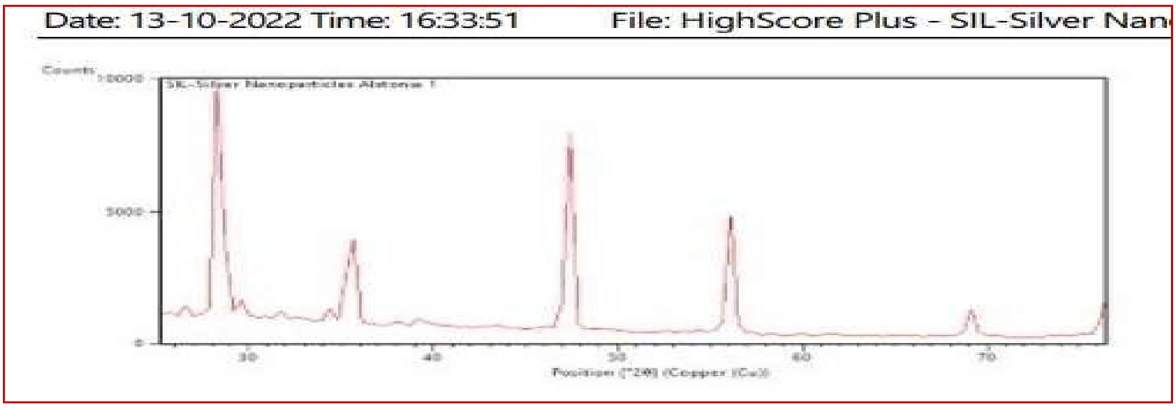
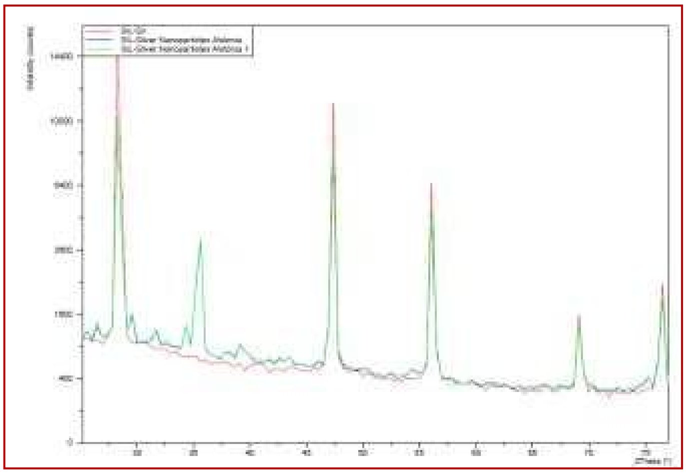


Fig. 5. X-Ray diffraction of silver nanoparticles prepared by *Alstonia scholaris* Linn aqueous floral extract.





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