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Characterisation Of Azadirachta indica based SilverNano Particles

[1]Dr. K. Priya Rajini, [2]Dr. M. Mary Sheeba & [3]Dr.C. Agatha Christie
Department of chemistry & Research Centre , Nanjil catholic college of arts and science,
Kaliyakkavilai,Kanyakumari District, Tamilnadu,629153, India

Abstract: Silver nanoparticles (AgNPs) are becoming increasingly important for various crucial applications, including antimicrobial, anticancer, catalytic, and anti-inflammatory. AgNPs biosynthesized from plant extracts have attracted considerable attention because of their eco-friendliness, simplicity, cost-effectiveness, and stability. This study investigated the potential of using fruit and leaf extracts of the medicinal plant *Azadirachta indica* as a capping and reducing agent for the biosynthesis of AgNPs. The size, shape, and optical properties of AgNPs significantly affect their chemical, physical, and biological activity. Therefore, this study optimized the biosynthesis conditions as a first attempt for *A. indica* fruit extracts to produce AgNPs with precise morphology. Subsequently, the biologically manufactured AgNPs were characterized using suitable techniques, the green synthesis of silvernanoparticles using plant Azadirachta indica leaf extract and a silvernitrate,($AgNO_3$). AgNPs are produced by the reduction of $AgNO_3$, with the aqueous leaf extract. The formation of AgNPs was recognized by the change of colour from blue to black. The synthesized nanoparticles were then characterized through UV-Vis spectrophotometry FTIR, , and SEM analysis.

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Keywords: Greensynthesis,Azadirachtaindica,silvernanoparticles

I. Introduction

A nanoparticle or ultrafine particle is usually defined as a particle of matter that is between 1 and 100 nanometres (nm) in diameter. *Vert, M. et al (2012)* .The term is sometimes used for larger particles, up to 500 nm] or fibers and tubes that are less than 100 nm in only two directions. In recent studies, silver nanoparticles (AgNPs) are the most popular metal nanoparticles Desireddy A. et al (2013), . AgNPs have gained immense importance, Kandiah M et a l(2021) primarily because of their large surface area, which enables coordination with many ligands, a feature not commonly found in many other types of nanoparticles Alharbi N. S (2022) . The chemical, biological, and physical properties of AgNPs make them good candidates for various applications in pharmaceuticals, water treatment, biolabeling, food industries, optics, textile coatings, catalysis, light emitters, energy science, integrated circuits, antimicrobial deodorant fibers, sensors, and drug delivery Kumari S.(2022)]. AgNPs have different shapes, including octagonal, diamond, and thin sheets, but a spherical shape is preferable in most applications. Akshaya T et al (2022)., AgNPs can be formulated chemically, physically, or biologically Samuel M. S (2022). Chemical methods may result in AgNPs retaining toxins during the synthesis Karmous .I et al (2021) Physical methods may require high pressure and irradiation Ganachari S.(2019). Biological methods that employ bacteria, fungi, and yeast to synthesize AgNPs ranging from 1 to 100 nm might be an alternative and are considered safe for humans and the environment Hublikar L. V.,et al (2021). Green or biological nanotechnology can improve the quality of life in several fields, including food, biomedical, and agricultural Kowshik M et al (2023) . In addition, the nanoscale provides higher surface-to-volume ratios, which allow them to be applied in a wide range of fields, including antibacterial properties, medicine, diagnostics, anticorrosion, microelectronics, catalysis, biofertilizers, and nanosensors Saha P et al (2022).. In addition, large-scale nanoparticles can be synthesized with green chemical processes, which can also be used to decrease pollution by absorbing environmental toxins and acting as a green corrosion inhibitor in acidic and basic media. It is also helpful for therapeutic applications, corrosion research, and cytotoxicity research In present situation, silver nanoparticles (AgNPs) are in great use in the medicinal, pharmaceutical, agricultural industry and in water purification. These nanoparticles can be synthesized either chemically or biologically. But the chemical process for synthesis of silver nanoparticles is more elaborate and leaves behind toxic effect that adversely affects the ecosystem. On the other hand, biological synthesis of silver nanoparticles is less time consuming, less costly, and more ecofriendly; therefore, in recent time, scientists are looking forward to the possible biological methods for the synthesis of silver nanoparticles Karthick Raja S., (2013) The synthesis process mainly requires metal precursors (AgNO3), reducing agents, stabilizing agents, and capping agents Non-spherical nanoparticles of gold (Au), silver (Ag), and platinum (Pt) due to their fascinating optical properties are finding diverse applications. Non-spherical geometries of nanoprisms give rise to high effective cross-sections and deeper colors of the colloidal solutions. Saha J (2017)

Silver nanoparticles have high conductivity, powerful signal capacity, and biocompatibility. Due to the properties, they have an important role in electrochemical sensor platforms. Over the last 20 years scientists put a huge effort for design the novel methods for biomedical applications with using the silver NPs and their composites . Silver NPs composites are metal oxides, silicate, polymers, graphene, fibers, dendrimers, etc. These composites enhance the biosensing properties because of various types of materials . Dispersion and avoiding to aggregation of silver NPs effect sensitivity and stability. Silver nanoparticles are nanoparticles of silver of between 1 nm and 100 nm in size. While frequently described as being 'silver' some are composed of a large percentage of silver oxide due to their large ratio of surface to bulk silver atoms. Numerous shapes of nanoparticles can be constructed depending on the application at hand. Commonly used silver nanoparticles are spherical, but diamond, octagonal, and thin sheets are also common. Silver nanoparticles (AgNPs) are increasingly used in various fields, including medical, food, health care, consumer, and industrial purposes, due to their unique physical and chemical properties. These include optical, electrical, and thermal, high electrical conductivity, and bio logical properties

I.MATERIALS AND METHODS

I.I Preparation of Leaf Extract for Silver Nanoparticles

Azadirachta indica leaves were collected and washed twice with distilled water and dried at 40°C. Dried leaves were finely powdered in an electric grinder and stored at room temperature in an airtight container till further use.

I.2. Aqueous Extract

Ten grams of dried powder of cannonball leaves was added to 100 mL of distilled water and stirred for 6 h at slow heat. Every two hours the contents were filtered through eight layers of muslin cloth, and the filtrate was centrifuged at 1000 rpm for 25 min. This process was repeated twice, and the supernatant was pooled and concentrated by using a rotary vacuum evaporator at reduced pressure. The concentrated extract was sterilized and stored at 4°C

I.3 Synthesis of Silver Nanoparticles

$AgNO_3$ solution and neem extract were mixed 5:1 ratio well heated for 3hours at 100 ^{o}C. After 3 hours the solutions were taken out and cooled. Silver nano particles were formed. Time and color change were recorded along with periodic sampling and scanning by UV-Visible (UV-Vis) spectrophotometer. Suitable controls were maintained all through the conditions of experiments. Complete reduction of Ag+ ions was confirmed by the change in color from light or faint to yellowish colloidal brown. The colloidal solution was kept aside for 24 hour for complete bio-reduction and saturation denoted by UV-Vis spectrophotometric scanning. The solution was sealed and stored properly for further use. The formation of silver nanoparticles was further confirmed by different spectrophotometric analysis.

2.Charecterisation of green synthesis nanoparticles

2.1UV spectra analysis

The optical properties and colour change of the synthesised nanoparticles were analysed by Biochrom UV-Vis spectroscopy . Following addition of $AgNO_3$ to the aqueous extract of *A. indica*, 1 mL of the mixture was collected at different time intervals to monitor the bio-reduction of Ag^+. Absorbance from 200 to 700 nm at 10 min, 30 min, 60 min, 120 min, and 3 h were analysed to determine the absorbance peak.

2.2.FTIR Analysis

For Fourier transform infrared (FTIR) spectroscopy measurements, dry powder of the nanoparticles was obtained in the following manner: After 24hour of the reaction, synthesized dispersion of aqueous silver nanoparticles was centrifuged at 3,500 rpm 854/6 for 15 minutes, following then the pellets were re-dispersed in deionized water. The process of centrifugation and re-dispersion by deionized water was repeated three times to ensure better separation of free entities from the metal nanoparticles. The purified pellets were then dried and powder subjected with potassium bromide (KBr) to FTIR spectroscopy measurement. The spectrum was recorded using FTIR model transmittance mode operating at a resolution of 4 cm^{-1}.

2.3.SEM Spectra

It is evident from Figure 1 (UV visible absorption spectrum) that a sharp peak is obtained for the solution containing 7 ml of AgNO3 and 3 ml of neem extract. So this formulation was taken for further study. A few drops of the solution containing silver nanoparticles prepared (by mixing 7 ml of AgNO3 and 3 ml of neem extract) were placed on a glass plate and dried. Then SEM was recorded.

3.RESULT AND DISCUSSION

3.1.UV-Vis Spectroscopy

The formation of silver nanoparticles using leaf and leaf derived callus extracts was confirmed by measuring the UV-visible spectrum of the reaction mixture at wavelengths ranging from 200 to 800 nm. The UV-visible absorption spectra of silver nanoparticles synthesized by using 1 mM $AgNO_3$ with leaf and leaf derived callus extracts revealed a Surface Plasmon Resonance band at 440 nm and 445 nm in the spectrum, respectively, which clearly indicated the presence of spherical silver nanoparticles. Broadening of the peaks at the base indicated that the nanoparticles are poly dispersed . The difference in the intensity and the band position of leaf and callus extracts synthesized silver nanoparticles is due to leaf extracts yielding smaller and stable nanoparticles more than the callus extract.

The maximum absorption was obtained at 440 nm (Figure 11).. UV-Vis spectra show no evidence of absorption in the range of 400–800 nm for the plant extract and the plant extract solution exposed to $AgNO_3$ ions shows a distinct absorption at around 434 nm which corresponds to surface plasmon resonance (SPR) of silver nanoparticles established at 420 nm in previous studies Mulvaney P (1996). It is observed that the silver SPR band occurs initially at 430 nm; after completion of the reaction, the wavelength of the SPR band stabilizes at 434 nm. Green synthesized AgNPs were stable for six months without shifting the surface plasmon absorbance band . Govindaraju K(2010)

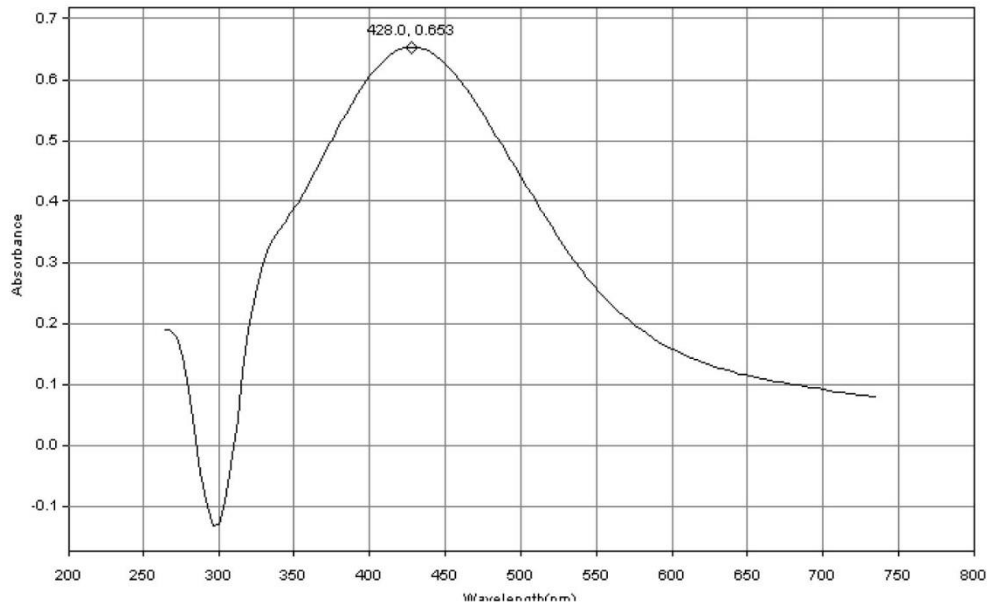

Figure 1 UV-visible spectrometer analysis in Azadirachta indica leaf Nano particles

3.2.FTIR Analysis

FTIR spectroscopy is an essential technique for molecular figure printing, which can detect the functional group of plant secondary metabolites that act as capping or reducing agents. Various bands appeared in the FTIR spectrum between 400 and 4000 cm−1.These functional groups indicate the presence of plant biocomponents as capping and stabilizing agents of AgNPs. . The FTIR band at 1669 to 534cm^{-1} corresponds to the functional groups indicate the presence of plant biocomponents as capping and stabilizing agents of AgNPs These biomolecules are responsible for the reduction process of Ag+ to AgNPs .

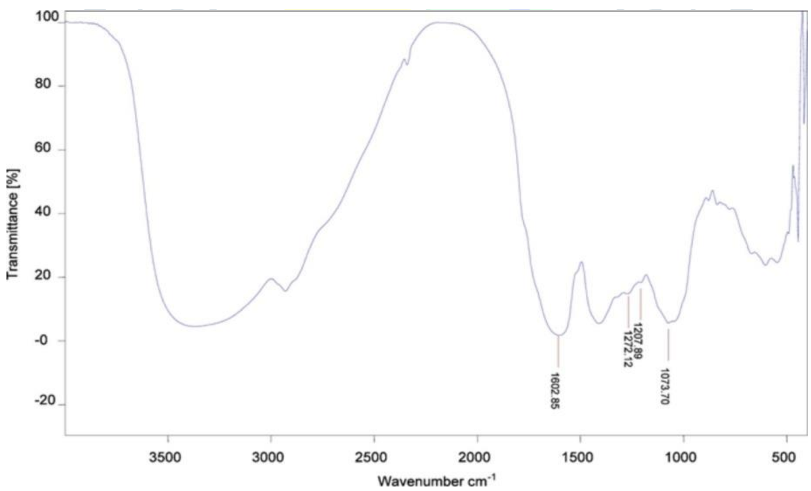

Figure 2. FTIR spectrum of Azadirachta indica leaf Nano particles

3.3.SEM

SEM is a powerful technique for evaluating surface structures, including nanoparticle size, morphology, and shape. A SEM image of these AgNPs shows their spherical and generally uniform shape . According to the particle size distribution histogram, the average size of AgNPs is 28.32 .Previous studies also support our results .

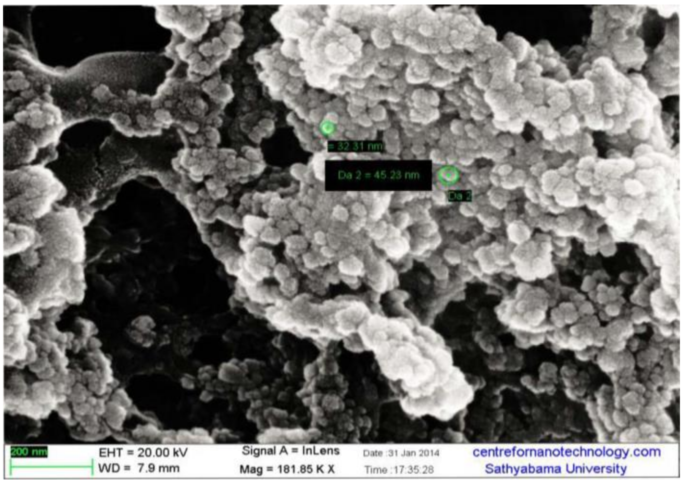

Figure 3. SEM Image of Azadirachta indica leaf Nano particles

4.CONCLUSION

Silver nanoparticles have been synthesized by reducing silver ions with an aqueous extract of neem leaves. The silver nanoparticles have been characterized by UV-visible absorption spectroscopy FTIR spectroscopy and SEM have also been record. The particle size of silver nanoparticle is found to be 43.23 nm. The UV-visible absorption spectra of silver nanoparticles synthesized by using 1 mM $AgNO_3$ with leaf and leaf derived callus extracts revealed a Surface Plasmon Resonance band at 440 nm and 445 nm in the spectrum, respectively, which clearly indicated the presence of spherical silver nanoparticles . The FTIR band at 1669 to 534cm^{-1} corresponds to the functional groups indicate the presence of plant biocomponents as capping and stabilizing agents of AgNPs. These biomolecules are responsible for the reduction process of Ag+ to AgNPs.SEM is a powerful technique for evaluating surface structures, including nanoparticle size, morphology, and shape. A SEM image of these AgNPs shows their spherical and generally uniform shape.Silver nano particles are one of the most attractive nonmaterial's for commercialization applications. As antibacterial agents silver nanoparticles were used for wide range of applications from disinfecting medical devices and home appliances to water treatment.

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