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Green Synthesis of Silver Nanoparticles using Aqueous Extract of *Orthosiphon stamineus* Fresh leaves

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ABSTRACT

The need for nanoparticles has increased as a result of their many applications in electronics, chemistry, energy, and medicine. The short half-life, environmental friendliness, reproducibility, and economic feasibility of the biosynthesized AgNPs generated a great deal of attention. The current work reports on the creation of a technique that combines silver nitrate solution with Orthosiphon stamineus leaf broth to produce silver nanoparticles. The leaf extract of Orthosiphon stamineus is an effective capping and reducing agent. The morphology, size, crystallinity, arrangement, and microstructure of the

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choreographed AgNPs are investigated. The biosynthesized nanoparticles were characterized by UV, FTIR, SEM, and XRD. Subjective observations of the variation separation design (which shifted from orange-ruddy to dim brown) can reveal the combination of silver nanoparticles. The FT-IR analysis was used to study the chemical groupings. The silver nanoparticles' face-centered cubic (FCC) crystalline structure was identified. The size of the particles ranges to 30 nm. This technique is unique in that it uses a silver nanoparticles based extract from the leaves of Orthosiphon stamineus.

1. Introduction

A very long time ago, many Greeks, Romans, Persians, and Egyptians used silver in one form or another to preserve food. Before Alexander Flemming discovered antibiotics, silver was widely utilized as an antibacterial agent. A reducing biological agent and a silver nitrate solution are usually used in the production of green AgNPs. Particles smaller than 100 nm are essentially what the word "nanotechnology" alludes to. Metal nanoparticles are extensively studied because of their unique optical, electrical, and catalytic characteristics. Among the various subfields of nanotechnology, green nanotechnology provides more economical and effective ways to create nanoparticles. Nanotechnology is important to biology and medicine because of its exceptional physical and chemical capabilities.

Because AgNPs Synthesis is easier to execute and more adaptable to the nanosystem, it facilitates easier control over the size and form of AgNPs. The product's powder form was likewise obtained by oven-drying the AgNPs suspension. AgNPs are commonly characterized using FTIR, UV-Vis Spectra, SEM, XRD, and EDAX. There are two ways to synthesis nanoparticles: top-down and bottom-up. It has been studied how leaf extracts from Orthosiphon stamineus can bio reduce aqueous Ag+ ions.

Silver nanoparticles with comparatively well-defined dimensions are formed when metal ions are reduced by the leaf extract of Orthosiphon stamineus. To isolate and identify it, infrared spectral analyses are employed. All of the results show that silver nanoparticles with distinct shapes have formed. The intriguing metal nanoparticles known as AgNPs, or silver nanoparticles, have unique physical and chemical characteristics. The biosynthesis of AgNPs from plant extracts has been the subject of several published investigations throughout the years.

A popular spice in tropical regions with high temperatures and year-round precipitation is Orthosiphon stamineus, also known as "Misai Kucing" in the local dialect. Tea leaves are made in Southeast Asia by gathering and drying Orthosiphon stamineus leaves. In order to attract honey bees, butterflies, and quiet birds to its nectar, Orthosiphon stamineus is used in arrangements. Gout, joint discomfort, and disorders connected to incendiaries are the main conditions for which Orthosiphon stamineus is used. Subsequently, the plant's potential ameliorative effects in vitro have been studied. It bears every indication of being a massive source of methylated flavonoids and rosmarinic acid-producing compounds.

2. Materials and methods

2.1 Plant Materials and Chemicals

Fresh leaves of Orthosiphon stamineus, also referred to as Poonaimeesai, were gathered from the Perambalur area in Tamil Nadu, India. Whatman No. 1 filter paper, an Erlenmeyerl flask, a beaker, a funnel, a pipette, and a spatula were among the glassware imported from Trichy. The substance, which contained silver nitrate ($AgNO_3$), was acquired from a Trichy, Indian laboratory. All of the other reagents utilized in this investigation were analytical grade.

a b

Figure 1. (a) *Orthosiphon stamineus* L., (b) Picture of aqueous solution of *O.stamineus* leaf

2.2 Making leaf broth

To get rid of any debris, we cleansed the leaves of Orthosiphon stamineus with running tap water and then distilled water. The leaves were macerated by being shade-dried at room temperature for two to three weeks in order to remove the moisture. The leaves were ground into a fine powder in order to create plant extracts. In 20 ml of double-distilled water, about 2 g of recently pile-up dried leaves were cooked for 30 minutes at 40 °C. After boiling, the extract was filtered using Whatman No. 1 filter paper. The supernatant should be collected and kept at 4°C in an airtight container for future nanoparticles manufacturing.

2.3 Synthesis of Silver nanoparticles

An Erlenmeyer flask filled with 50 ml of silver nitrate solution—two millimoles of AgNO3 in 200 milliliters of double-distilled water—swere used for the typical reaction that produced silver nanoparticles. Next, in order to prevent the AgNO3 solution from becoming photo activated, 5 milliliters of O. stamineus's aqueous extract were added to the mixture. The mixture was then allowed to incubate at room temperature in the dark. A magnetic stirrer was used to agitate the suspension for an hour in order to see the color change. The creation of the solution's brownish hue denotes the production of silver nanoparticles.

Techniques for characterization:

The produced silver nanoparticles were characterized according to standard procedures utilizing the following tools and techniques: i) A Perkin Elmer UV spectrophotometer was used to identify ultraviolet (UV-visible) spectrum records. Pure Ag+ ion reduction was seen in AgNP produced solutions at wavelengths between 200 and 800 nm. ii) Fourier transform infrared spectroscopy (FTIR), a method for identifying some potential proteins from Oa technique leaf extract that may stabilize functional groups and transition from Ag+ to Ag°. To collect the pellets, the mixture was also twice centrifuged for 10 minutes at 10,000 rpm. In the 4000-400 cm-1 wave number range, the transmittance of the dried AgNPs that have been KBr-ground is 100%. iii) To identify the pictures, a Carel Zeiss EVO-18 scanning electron microscope (SEM) was utilized. SEM was used to analyze morphological traits like size and form. A copper grid coated in carbon was given a drop of distributed AgNPs. The experiment was dried for five minutes under a mercury lamp, and pictures were taken. iv) The produced AgNPs was examined using CuKα radiation (1.540 Ao), and powdered XRD patterns were captured by the XPETRO PRO X-ray diffractometer. The amorphous form of the nanoparticles was disclosed by the XRD pattern.

3. Result and Discussion

3.1 UV-visible Examination of Spectral Data

The samples' maximum absorbance and wavelength were measured using the UV-vis spectrophotometer. The absorbance of the solution was measured by subjecting it to radiation at 350–500 nm (Fig. 2). The silver colloids' distinct band was visible at 460 nm. The creation of nano-sized silver metal is shown by the suspension's color changing from brown to dark brown during the synthesis process.

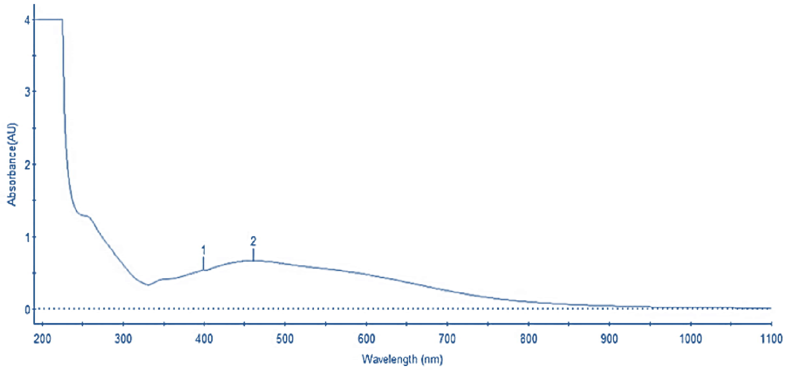

Figure 2.UV-vis spectrum of $AgNP_S$ using *Orthosiphon stamineus* leaf extract

3.2 Spectrum analysis with FTIR

Our vacuum-dried leaf extract powder's FTIR spectra (Fig. 3) reveal a maximum absorption peak at 3854.65 cm-1, which is due to O-H stretching vibrations. Because of the strong, broad OH stretching of the alcohol group in the leaf extract, there is a band at 3331.62 cm-1. The stretching alkane (strong) of the C-H group corresponds to the infrared peaks at 2925.19 cm-1. One can attribute the medium intensity stretching vibration of the carboxyl group (-OH) to the peak at 2425.95 cm-1 and 2397.62 cm-1. C=C stretching was observed at the peak at 1604.13 cm-1, indicating the presence of a main alkene group. The C-H bending vibration and the C-O-C stretching are related to the peaks that appeared at 1382.97 cm-1 and 1359.18 cm-1. The stretching vibration of the alcohol group (C-O) band can be attributed to the relatively tiny peak at 1112.72 cm-1 and 1051.93 cm-1. The Alkene group's C-H bending is responsible for the band at 825.71 cm-1. C-Cl stretching of halo compounds was seen in the bands at 777.82 cm-1 and 618.50 cm-1. The presence of molecules on the surface of silver nanoparticles was shown by the FT-IR study.

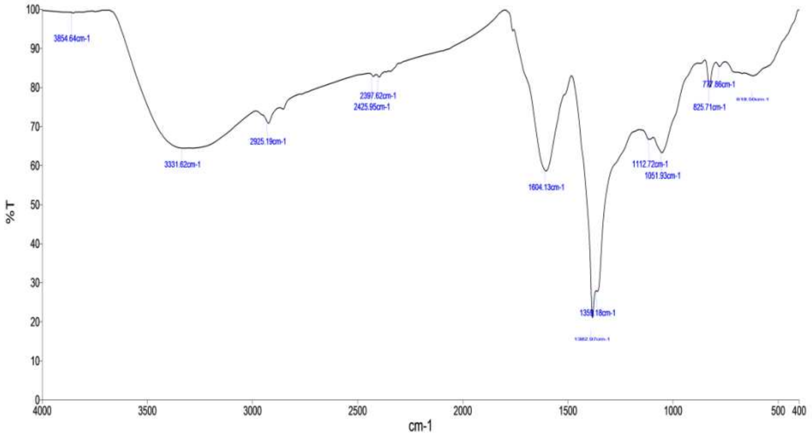

Figure 3.FT-IR spectrum of AgNPs using *Orthosiphon stamineus* leaf extract

3.3 SEM Analysis

Using a scanning electron microscope, the size, shape, and dispersion of green produced silver nanoparticles were examined. Nanoparticles agglomeration was visible in the SEM micrograph. With a diameter range of around 10–40 nm, it is evident that the silver nanoparticles are uniform and generally spherical (Fig. 4).

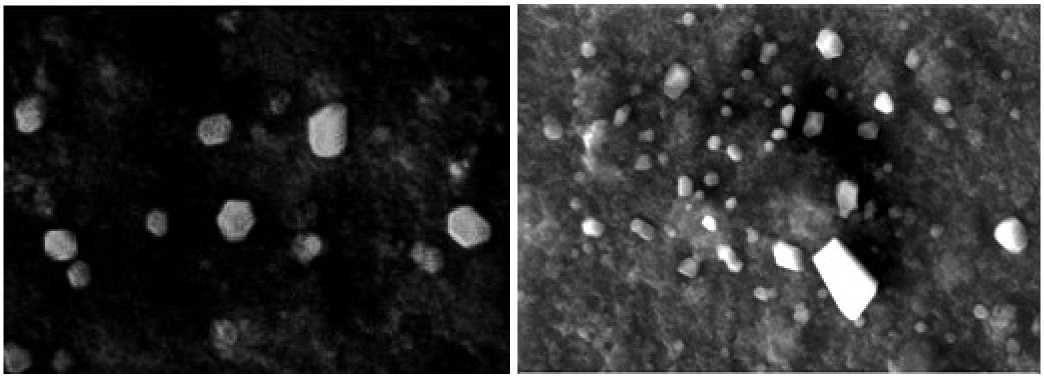

Figure 4. The typical SEM images of $AgNP_S$ of *Orthosiphon stamineus* leaf

3.4 X-Ray Diffraction Analysis

To confirm that AgNPs were generated as a single material throughout the synthesis, XRD measurement was carried out. Four strong peaks with 2q values ranging from 10 to 80 nm are shown in the XRD pattern. The silver nanoparticle was given a face-centered cubic (FCC) shape based on the angular positions of the Bragg's peaks (Fig. 5). The values of the intense peak 38.03, 44.23, 64.51, and 77.43, which correspond to the (111), (200), (220), and (311) planes, are related to the green synthesis of silver nanoparticles as described in JC-PDS file no.04-078. The XRD pattern implied that the use of plant extracts limits crystallite development.

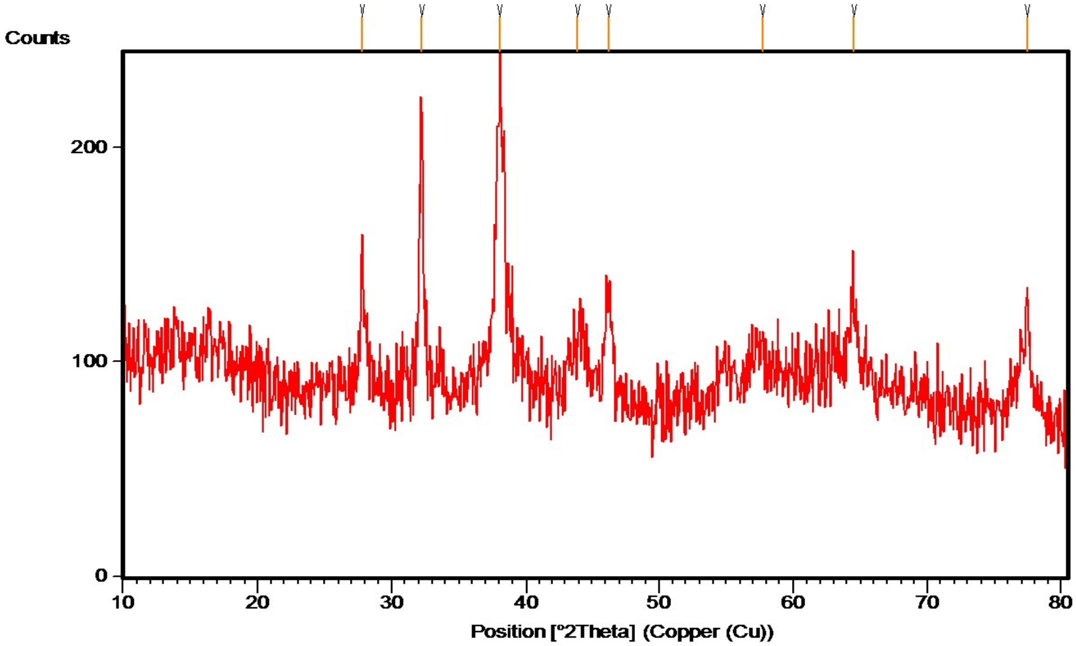

Figure 5. XRD pattern of $AgNP_S$ synthesized using supernatant of *Orthosiphon stamineus* leaf

4. Conclusion

This paper reports the first-ever synthesis of AgNPs using an aqueous extract of Orthosiphon stamineus solution using a unique green approach. Biomedical and environmental applications could benefit from the novel green synthesis of silver nanoparticles made with O. stamineus leaf extract because it is more compatible, scalable, pollutant-free, fast, economically feasible, and requires less time to complete. The above approach yields quite stable AgNPs that remain unchanged even after approximately a month if the nanoparticle solution is stored in a light-proof location. SEM, UV-visible, FTIR, and XRD spectra were used to examine the bio reduced silver nanoparticles. In order to create nanoparticles, leaf extract was utilized as a capping and reducing agent. Not to mention, the low cost of the raw components required for the synthesis makes it a cost-effective approach. Current studies are being conducted on other plant-mediated production of silver nanoparticles.

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