Biological Forum – An International Journal **15(5): 1305-1309(2023)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Biosynthesis and Characterization of Silver Nanoparticles using *Simarouba glauca* DC

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(Received: 06 March 2023; Revised: 03 April 2023; Accepted: 11 April 2023; Published: 20 May 2023)
(Published by Research Trend)

ABSTRACT: Nanotechnology is a field of modern science which deals with the isolation characterization and its application in all aspects of life. An intriguing area of science is nanoparticle research, given how closely nanoparticle properties relate to size, there are many opportunities for unanticipated findings. The usually surprising and unusual behavior of nanoparticles holds great promise for cutting-edge technological application purposes, but also possesses considerable challenges to scientists. The fundamental disadvantage of the physical and chemical processes for producing silver nanoparticles is that they are very expensive, require dangerous, poisonous compounds, and may have adverse effects on the environment and human health. Because green synthesis is less expensive, produces less pollution, and enhances environmental and human health safety, it is more advantageous than standard chemical synthesis. The term "green synthesis of nanomaterials" refers to the synthesis of various metal nanoparticles employing bioactive agents such as plant materials, microbes, and bacteria. The creation of nanoparticles from bacteria and plants is now possible because of green synthesis technology, which is also economically feasible and biologically safe. Silver is one of the safe inorganics antibacterial, antifungal agents used for centuries and has been recognized as a nontoxic substance. Biomolecules present in plant play a role in reducing and capping the nanoparticles from metallic ions. *Simarouba glauca* is a readily set up of reducing and capping agent for the synthesis of nanoparticles. The demonstration carried out gave ideal results for biosynthesis of silver nanoparticle from *simarouba glauca.* Absorption spectra was observed at 430 nm resulting from the surface Plasmon resonance (SPR). Collectively, this study covers the isolation of green nanoparticles using fresh leaves of *Simarouba glauca* and its characterization with the help of UV-Vis Spectroscopy, EDX and SEM.

Keywords: Nanotechnology, Silver nanoparticles, *Simarouba glauca,* UV- Vis Spectroscopy, SEM, EDX.

INTRODUCTION

In 1974, Professor Norio Taniguchi of the Tokyo University of Science used the word "nanotechnology" for the first time (Sun and Gupta 2020). The study and production of nanoparticles is known as nanotechnology. Nanoparticles are the tiny and small things with size ranging from 1nm to 100nm. Nanoparticles (NPs) a novel term According to, Penn *et al.* (2003), nano biotechnology envisions the application of nanotechnology in biological systems. Due to their exceptional electrical, optical, and magnetic capabilities, nanoscale particles have attracted a lot of attention (Qiu *et al.*, 2020). Due to their lack of hazardous chemicals and presence of natural capping agents, plants serve as a better source for the production of nanoparticles (Khan *et al*., 2018). As a result, while considering the environment's safety, green synthesis is a better method for creating nanoparticles. Generally speaking, green nanotechnology refers to the utilization of biological sources, such as fungi, bacteria, or plants, in the manufacture of nanoparticles using various biotechnological methods. The biosynthesis of green nanoparticles through bio reduction technique is gaining importance due to its easy, cheaper and eco-friendly nature. The biosynthesis of green nanoparticles from plant sources displays various useful characteristics which will be helpful in drug application and their utilization. Hence the biosynthesis, characterization and biomedical evaluation of green nanoparticles from plant sources is of paramount significance. This is a revolutionary developing technology in the medical field for the creation of biological nanoparticles with an ecologically friendly and environmentally favorable strategy (Bhadwal *et al*., 2014). Because of their distinctive physical and chemical characteristics, silver nanoparticles (AgNPs) are rapidly being used in a variety of industries, including medicine, food, health care and retail items. Among them include mechanical, electrical wiring or thermal as well as in biological products (Gurunathan *et al.*, 2015; Li *et al.*, 2010; Mukherjee *et al.*, 2001). To evaluate the structural characteristics of nanoparticles, such as size, surface charge, and UV visible spectra, etc. Due to the fact that the bio-green process of synthesising NPs uses no hazardous chemicals, it has garnered a lot of interest. Consequently, bio-green synthetic NPs may be attractive materials, providing fresh opportunities in the fields of medicine, energy, and environmental research (Samuel *et al.*, 2022). Many methods of analysis were used for analyzing the formed nanoparticles, including ultraviolet visible spectroscopy (UV-vis spectroscopy), X-ray diffractometry (XRD), Fourier transform infrared spectroscopy (FTIR), X-ray photoelectron spectroscopy (XPS), dynamic light scattering (DLS), scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), and others (Gurunathan *et al.*, 2015; Sapsford *et al.*, 2014). Characterization is extremely important, and the confirmation of nanoparticle characteristics is carried out by a variety of instrumentation analyses, including ultraviolet-visible spectrophotometry (UV-Vis), Fourier transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), scanning electron microscope (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), annular dark-field imaging (HAADF), and intracranial pressure (ICP) (Vijayaram *et al.*, 2023). Nanoparticle characterization is essential after synthesis since a nanoparticle's physicochemical features can have a significant impact on its biological properties. To deal properly with the safety issue and fully use the possible advantages of any a nanomaterial for the benefit of humans, nanomedicines in the health care industry, for agriculture, the generated nanoparticles must be characterized (Lin *et al.*, 2014; Pleus, 2012).

MATERIAL AND METHODS

Plant material. Fresh leaves of *Simarouba glauca* were collected from Shenoli, Tal. Karad, Dist. Satara.

Plant Extract preparation. Aqueous leaf extract was prepared. Fresh leaves (10 gm) were boiled with 100ml distilled water for 20 minutes at 60°C. After cooling the filtrate was filtered through Whatman’s filter paper No. 1. Extract was stored at refrigerator for further use.

Assay for of silver nanoparticles. The plant extract (10 ml) was added to 90 ml 1 mM silver nitrate ($AgNO_3$) solution (1:9) with constant stirring for the bio reduction process. Visible observation was done. The complete reduction of Ag+ into AgNPs (Ag) occurred within 25–30 mins of reaction. Further, the solution was kept for an incubation period of 24 h at room temperature.

UV-Vis Spectroscopy After the color change the absorption spectra was taken between 300 nm to 800 nm. The analysis was done after 24 hour using LAB MAN model no LMSP UV 1200 UV-Vis Spectroscopy.

Isolation of silver nanoparticles. One fundamental Centrifugal force causes nanoparticles to settle down. The method for separating nanoparticles is centrifugation. The silver nanoparticles (AgNPs) were purified using ultra cooling centrifugation. The supernatant was discarded and the pellet was collected in evaporating dish, further its was allowed to dry at room temperature to obtain the powder of silver nanoparticles.

SEM. Obtained silver nanoparticle powder was used for further analysis. The morphological features of synthesized silver nanoparticles from *Simarouba* extract was studied by Scanning Electron Microscope (JSM-6480 LV). After 24 hrs. of the addition of $AgNO_3$ the SEM slides were prepared by making a smear of the solutions samples were characterized in the SEM at an accelerating voltage of 20 KV.

EDX. SEM/EDX was used to assess the surface morphology and elemental composition (Dada *et al.*, 2017; Dada *et al.*, 2016). The purity and entire chemical make-up AgNPs are revealed by the EDX spectrum.

RESULTS AND DISCUSSION

Visible observations. Once the aqueous extract of the plant was introduced into a 1mM AgNO3 solution nanoparticle synthesis was initiated. Silver ions were reduced to silver nanoparticles. Reaction mixture develops a pale yellow to dark brown color in response to the synthesis of AgNPs (Fig. 1). As silver nanoparticles show color change from colorless to yellowish brown or dark brown in aqueous solution (Singh *et al.*, 2010).

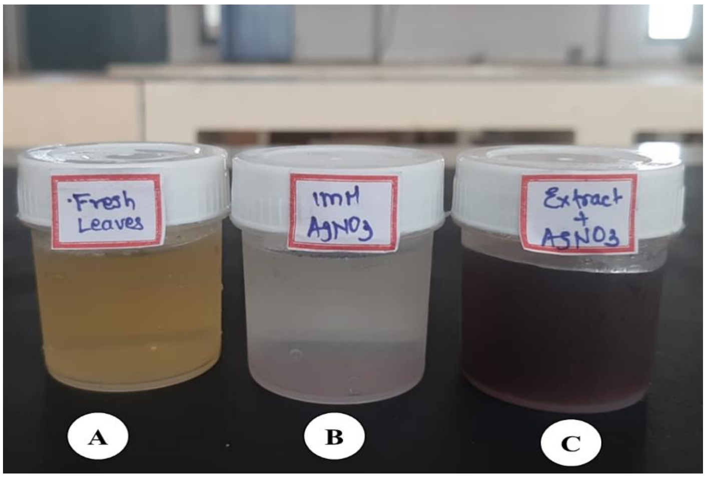

Fig. 1. Synthesis of Silver nanoparticles: A) Plant Extract; B) 1 mM $AgNO_3$ Solution; C) Plant Extract + 1 mM $AgNO_3$.

UV-V is Spectrophotometer Analysis: UV-V is spectroscopy is the most essential and quickest technique for confirming the formation of nanoparticles (Anandalakshmi *et al.,* 2016). The UV-Vis spectrophotometer was used to record the SPR of the biogenic AgNPs (Fouda *et al.,* 2022). Reduction of silver ions into silver nanoparticles during exposure to plant extracts was observed as a result of the color change. The color change is due to the Surface Plasmon Resonance phenomenon. The metal nanoparticles have free electrons, which give the SPR absorption band, due to the combined vibration of electrons of metal nanoparticles in resonance with light wave. The absorbance peak of silver nanoparticles were observed around 430 nm in case of *Simarouba glauca* (Fig. 2). According to Njagi *et al.* (2011) absorbance within the wavelength range (400-450 nm) matches silver nanoparticle because of surfaces excitation. The present study found the SPR peak for *Simarouba glauca* at 430nm that can be attributed to the presence of the surface plasmon resonance (it is the result of the collective movement of free electrons in the silver when light falls on it), which is a characteristic of AgNPs. This result is close to the source Feng *et al.* (2022). So, it is confirmed that Simarouba *glauca* leaf extract has more potential to reduce Ag+ ions into Ag nanoparticles which will be beneficial for further research on synthesis of silver nanoparticles from *Simarouba glauca* leaf extracts.

SEM Analysis. SEM provided further insight into the morphology and size details of the silver nanoparticles. Comparison of experimental results showed that the diameters of prepared nanoparticles in the solution have sizes of several nm.

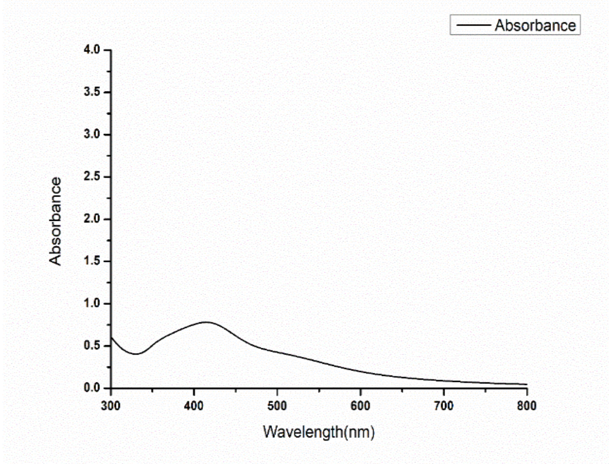

Fig. 2. Absorbance peak of synthesized silver nanoparticles using UV-visible spectrophotometer.

The shape and content of Ag-NPsd were examined using scanning electron microscopy combined with energy-dispersive X-rays (SEM) (Khan *et al.,* 2016). The size of the prepared nanoparticles is 80-100 nm which falls in the ideal range of between 1-100 nm. The size was more than the desired size as a result of the proteins which were bound in the surface of the nanoparticles. The result showed that the particles were of more or less cubical shape. The shape varies due to change in concentration of plant and $AgNO_3$ solution. Characterization of nanoparticles is an important aspect of nanoparticles synthesis which are achieved by microscopic techniques such as SEM (Awwad and Salem 2012; Vanaja *et al.,* 2013; Sasikala *et al.,* 2014; Mohanta *et al.,* 2017).

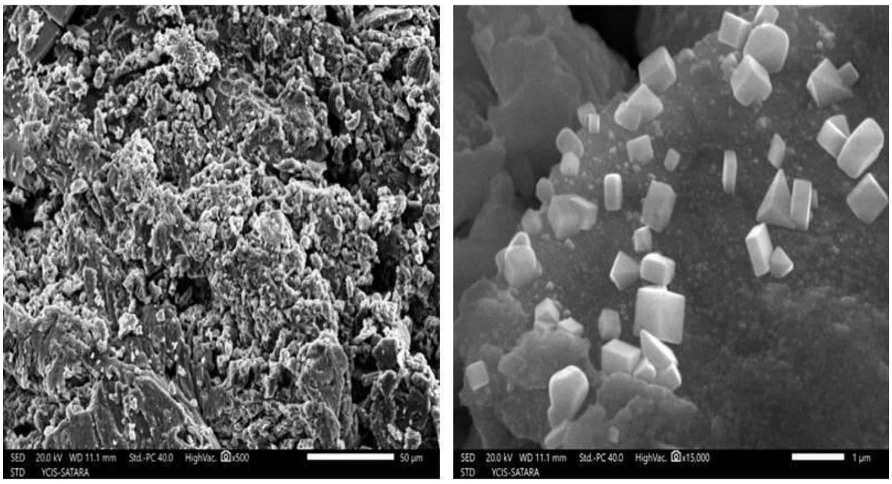

Fig. 3. SEM analysis of *Simarouba* AgNPs.

EDX: Synthesized particles were studies through EDX pattern which showed absorption peak at 3KeV. It is particular for the silver nanoparticle absorption and silver as a major elemental component (Manjamadha and Muthukumar 2016). After removing impurities by alcohol wash EDX pattern for silver nanoparticles show two sharp peaks of AgLa, AgLb are seen. The atom and mass percentage of Ag is 100.00 $\pm$ 2.56 (Fig. 4). According to Fathi *et al*. (2017) this is also a confirmatory test for synthesis of silver nanoparticles in the sample. The elemental composition of the nanoparticles was ascertained using the EDX analysis. The spectra displayed peaks for C, N, and O as well as absorption peaks for Ag at about 3 keV (Paramesh *et al*., 2021).

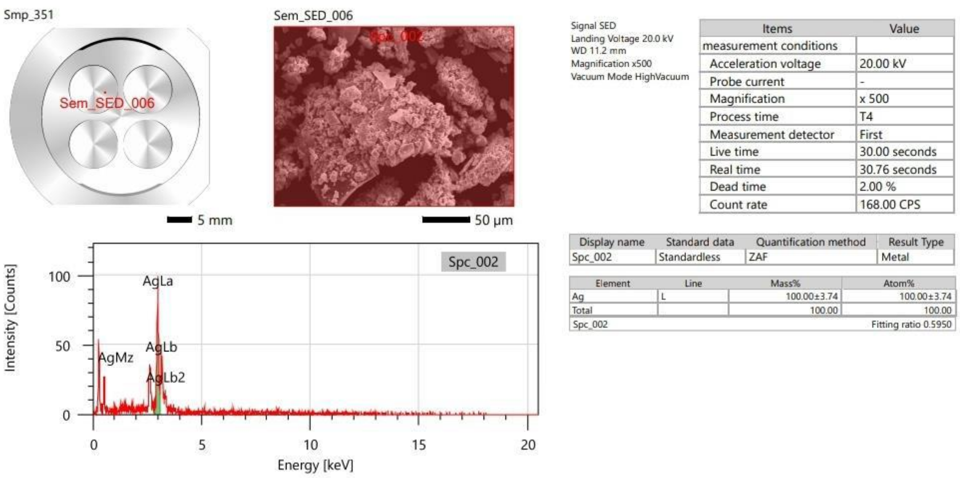

Fig. 4. EDX Analysis of *Simarouba* AgNPs.

CONCLUSIONS

Growing interest in green chemistry and nanotechnology over the past few decades has pushed for the use of green synthetic methods for the production of nanomaterials via plants, microbes, and other creatures. Researchers have been concentrating on green synthesis of nanoparticles in recent years by using an eco-friendly methodology. Due to its affordability, benign method, accessibility, and eco-friendliness, plant extract-mediated nanoparticles have garnered a lot of attention in research, as have their prospective uses in a variety of sectors. The quick biological synthesis of silver nanoparticles using *S.glauca* leaf extract offers an easy, effective, and environmentally friendly method for producing nanoparticles. It is clear that employing a green synthesis approach to create silver nanoparticles is a simpler and more efficient process. The synthetic nanoparticles were cubical shape with estimated diameters between 80 and 100 nm. The techniques used for characterization like UV-Vis spectroscopy, SEM and EDX all of these methods demonstrate the critical significance that plant extract content and metal ion ratio which play important role in determining the shape of nanoparticles. The obtained silver nanoparticles have potential technological uses in the agricultural sector and this straightforward process has several benefits like cost effectiveness, compatibility with nonfertilizer applications, and large-scale commercial production.

FUTURE SCOPE

As *Simarouba glauca* is rich in Phytochemicals like Carbohydrates, Alkaloids, polyphenols etc. It is theorized that these phytochemicals must be the reason for reduction of silver nitrate to silver nanoparticles. Apt concentration of Silver nanoparticles acts as a prime factor for magnifying seed germination. Therefore, this will be helpful in increasing the productivity & this might show prominent effect on germination & seedling behavior of the economically important crop plant.

Acknowledgement. One of the authors (Varsha S. Yadav) is thankful to Department of Botany and Principal, Sadguru Gadage Maharaj College, Karad for provided necessary research Facilities and SARTHI-Pune for providing financial support.

Conflict of Interest. None.

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How to cite this article: Varsha S. Yadav and Manasi S. Patil (2023). Biosynthesis and Characterization of Silver Nanoparticles using *Simarouba glauca* DC. *Biological Forum – An International Journal*, *15*(5): 1305-1309.