Green Synthesis and Characterization of Silver Nanoparticles using aqueous extract of *Tamarindus indica* Fruit Shell

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ABSTRACT

Green synthesis of metal nanoparticles has become a main branch of nanotechnology and there is an increasing commercial demand for nanoparticles due to their ample applications. Nanoparticles play a major role in the field of engineering and medicine. This study investigates an efficient and sustainable route of Silver nanoparticle preparation from aqueous silver nitrate (AgNO3) using fruit shell extract of *Tamarindus indica* well adorned for their wide availability and medicinal property. For the synthesis of silver nanoparticles using the fruit shell extract of *Tamarindus indica* as a reducing agent from silver nitrate (AgNO3) has been investigated. The synthesis of silver nanoparticles mostly helps in enhancement of their antimicrobial and antioxidant properties. The synthesized tamarind silver nanoparticles have been characterized using Ultraviolet Visible Spectroscopy (UV–Vis Spec), Fourier Transform Infrared Spectroscopy (FT-IR) and Scanning Electron Microscopy (SEM) and synthesized Silver Nanoparticles showed an absorption peak at approximately 450 nm in the UV-visible spectrum. The morphological study of Silver nanoparticles using SEM suggests that the nanoparticles are spherical in shape with a diameter around 20 to 200-nm. This method is rapid, simple without any hazardous chemicals as reducing or stabilizing agents and economical to synthesized SNPs.

KEYWORDS: *green synthesis, nanotechnology, nanoparticle, Tamarindus indica, UV–Vis, SEM*

I. INTRODUCTION

The advance and very applicable technology is nanotechnology and it was derived from the term of nano it is the billionth of meter or 10^{-9} m. The Nano come ultimately from the Greek word for dwarf, and is also related to the Spanish word Nino [1]. In recent years, green synthesis of silver nanoparticles (AgNPs) has gained much interest from researchers. In this concern, Indian plants has yet to reveal numerous sources of cost-effective non- hazardous reducing and stabilizing compounds utilized in preparing AgNPs(2). Nanoparticles, compared to bulk materials, exhibit improved characteristics due to their size, distribution and morphology and are widely used in numerous scientific fields. Among metallic nanoparticles, silver nanoparticles (AgNPs) are very important especially due to their physiochemical and antimicrobial properties which help in therapies, molecular diagnostics and in devices used for medical procedures. A major drawback of the chemical synthesis is that it involves the use of hazardous chemicals and toxic by-products are obtained. Therefore, there is a constant need for economic and eco-friendly methods to synthesize them and the use of aqueous or alcoholic plant extracts is rapidly expanding and gaining importance (3). Silver is a nontoxic, safe inorganic antibacterial agent used for centuries and it has the capability of killing different type of diseases causing microorganisms [4]. Metallic nanoparticles are being utilized in every stage of science along with manufacturing including medical fields and are still delightful the scientists to travel around new dimensions for their respective worth which is usually attributed to their corresponding small sizes. Among several noble metal nanoparticles, silver nanoparticles have attained a special focal point. Typically silver nanoparticles are synthesized by chemical method using chemicals as reducing agents which later on become responsible for various biological risks due to their general toxicity; engendering the serious concern to develop eco-friendly processes. Thus, to solve the objective; biological approaches are coming up to fill the void; for instance green synthesis using biological molecules derived from plant sources in the form of extracts exhibiting superiority over chemical and/or biological methods. These plant based biological molecules undergo highly controlled assembly for making them suitable for the metal nanoparticle synthesis (5).

II. MATERIALS AND METHODS

2.1 Collection of Plant Material

Tamarindus indica fruit shells were collected from Koratti village, Tirupattur, Vellore Dt, Tamil Nadu, India, on the basis of cost effectiveness, ease of availability and medicinal property. *Tamarindus indica* shells were collected locally and rinsed thoroughly first with tap water followed by distilled water to remove all the dust and unwanted visible particles, cut into small pieces and dried at room temperature and then grounded into powder for storage.

2.2 Preparation of plant extract

To prepare the aqueous *T. indica* shell extract, 10g of the plant powder was mixed with 100ml of deionized water in the 250ml Erlenmeyer flask. The mixture was then heated in the hot plate at 60 °C for 20minutes. The prepared solution was initially filtered through normal filter paper mesh so that the unwanted materials could be filtered out; then the extract was filtered through Whatman filter paper No. 1. The filtered extract was used as the reducing and stabilizing agent.

2.3 Preliminary phytochemical analysis

The phytochemical tests were performed using various reagents. The experiments were determined by prescribed phytochemical tests, which indicated the presence of the secondary metabolites i.e. alkaloids, phenols, glycosides, terpenoids, flavonoids, tannins, saponins and quinones in aqueous extract of tamarind shell. [6].

2.4 Green synthesis of Silver Nanoparticles

10mM solution of silver nitrate was prepared in an Erlenmeyer flask. Then 400 ml of plant extract was added separately to 100 ml of 10mM silver nitrate solution and made upto 1000ml with double distilled water. Then the mixture was stirred for 2 hours at 45°C using hot plate method with magnetic stirrer. The mixture was centrifuged for 20 minutes with 4000 RPM and the precipitate was washed with water and centrifuged. Then collect the pellet as SNP, placed it in hot air oven with proper temp 35-40 °C and collect the pellet for further studies. Reduction of Ag^{+} to Ag^{0} was confirmed by the color change of solution from colorless to brown.

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Figure 1: Tamarind Fruit Shell

III. CHARACTERIZATION:

Characterization of silver nanoparticles is done by using UV- Visible spectrometer and Fourier Transform infrared spectroscopy and SEM

3.1 Characterization studies

The biosynthesized silver nanoparticles were characterized by different methods. A color change from pale yellow to reddish brown upon incubation was observed indicating the formation of nanoparticles. The UV spectra of the biosynthesized nanoparticles were recorded using an Elico SL-159 UV Spectrophotometer by continuous scanning from 300 to 700 nm and the plant extracts was used as the reference for the baseline corrections. A Fourier Transform Infra Red Spectrometer is used to obtain the infra red spectra of absorption and emission of the formed silver nanoparticles. The advantage of using an FTIR is that it simultaneously collects spectral data in a wide spectral range. 10 µl of the sample of the formed silver nanoparticles from the

fruit shell extract was subjected to FTIR analysis using a Paragon 500, Perkin Elmer-RX1 spectrophotometer in the diffuse reflectance mode at a resolution of 4cm−1 in KBr pellets. To determine the morphology of the synthesized silver nanoparticles using fruit shell extract, the sample was analysed with Zeiss 700 Scanning electron microscope (SEM).

IV. RESULTS AND DISCUSSION

4.1 Visual observation study:

The present study deals with the biosynthesis of silver nanoparticles (AgNPS) using tamarind fruit shell extract. The reduction of silver ions (Ag^{+}) into silver (Ag^{0}) nano particles in the presence of fruit shell extract is followed by color change and the formation of AgNPS was visually observed.

(a) (b) (c)

Figure 2: (a) Tamarind Fruit Shell Extract (b) Aqueous Silver Nitrate (10mM) Solution (c) Silver Nano Particles (SNP)

It was observed that the color of the mixture changed after mixing the extract with silver nitrate solution. This confirms that silver ions can be reduced by the extract of tamarind fruit shell to form stable AgNPS in water. The reason for the brown colour is due to the extraction of surface Plasmon vibrations in the silver metal

nanoparticles [7], [8]. This color change is due to the reduction of nanoparticles with the help of electrons present in the fruit shell extract [9].

4.2 UV –Visible spectrophotometer

This color changed nanoparticle solution was analyzed by UV-Vis spectrophotometry shows a broad absorption peak at 450 nm further confirms the formation of nanoparticles are AgNPs. The same type of results was observed in leaf extract mediated synthesis of AgNPs from *Couroupita guianensis* [10-11]. The color change pattern and broad peak obtained in UV-vis spectrophotometry are due to Surface Plasmon Resonance nature of AgNPs present in the medium. These nanoparticles absorb light at different wavelengths and excited due to charge density at the interface between conductor and insulator to give a respective peak on UV-Vis spectrophotometry.

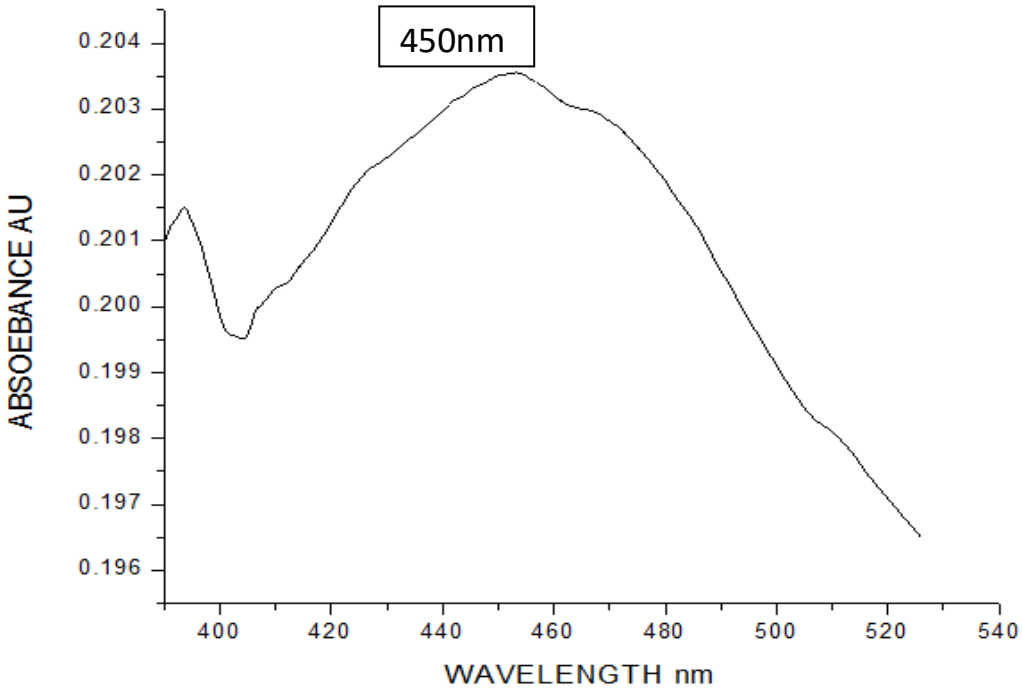

Figure 3: UV-Vis Spectra analysis

4.3 FT-IR Analysis

FT-IR is a sensitive tool to analyze functional groups present in the biological samples. It relies on the light absorbance between 4000 cm^{-1} to 400 cm^{-1} of the electromagnetic, infrared region. FTIR measurements were carried out to identify the possible biomolecules responsible for the capping and efficient stabilization of the silver nanoparticles synthesized by the plant extracts (Figure 4). The FTIR spectrum showed the various peaks at 465,533, 583,667,774, 1063, 1201, 1232, 1384, 1607, 2863, 2921, 3370, 3899.55 cm^{-1}. The band at 3370cm^{-1} exhibits N-H stretching vibrations. The peak at 1384 cm^{-1} is due to the presence of nitrate ions after its reduction. The peaks like 2921 cm^{-1}, 2863cm^{-1} OH stretching vibrations of carboxylic group and 1063 cm^{-1} gives rise to C-N stretching of amine group. The methylene group exhibits two bands at 2921 cm^{-1} and 2863 cm^{-1}. The band at 1607cm^{-1} indicates C=O stretching vibrations of carbonyl group. These results suggest that the carboxyl group (-C=O), hydroxyl (-OH) and amine (-NH) group of fruit shell extracts are responsible for the reduction of silver ions due to their capping and stabilizing ability. The above result shows similarity to leaves extract of *Artemisia vulgari* [12]. The characteristic functional groups noticed in SNPs may be expressed from Tamarind shell extract as it contains various phytochemicals with the aforesaid functional groups. The same type of results was observed in *Myristica fragrans* seed extract mediated synthesis of AgNPs [13]. Based on these FTIR studies, we suggest that the bio-molecules present in plant extracts play dual role in formation and stabilization to AgNPs.

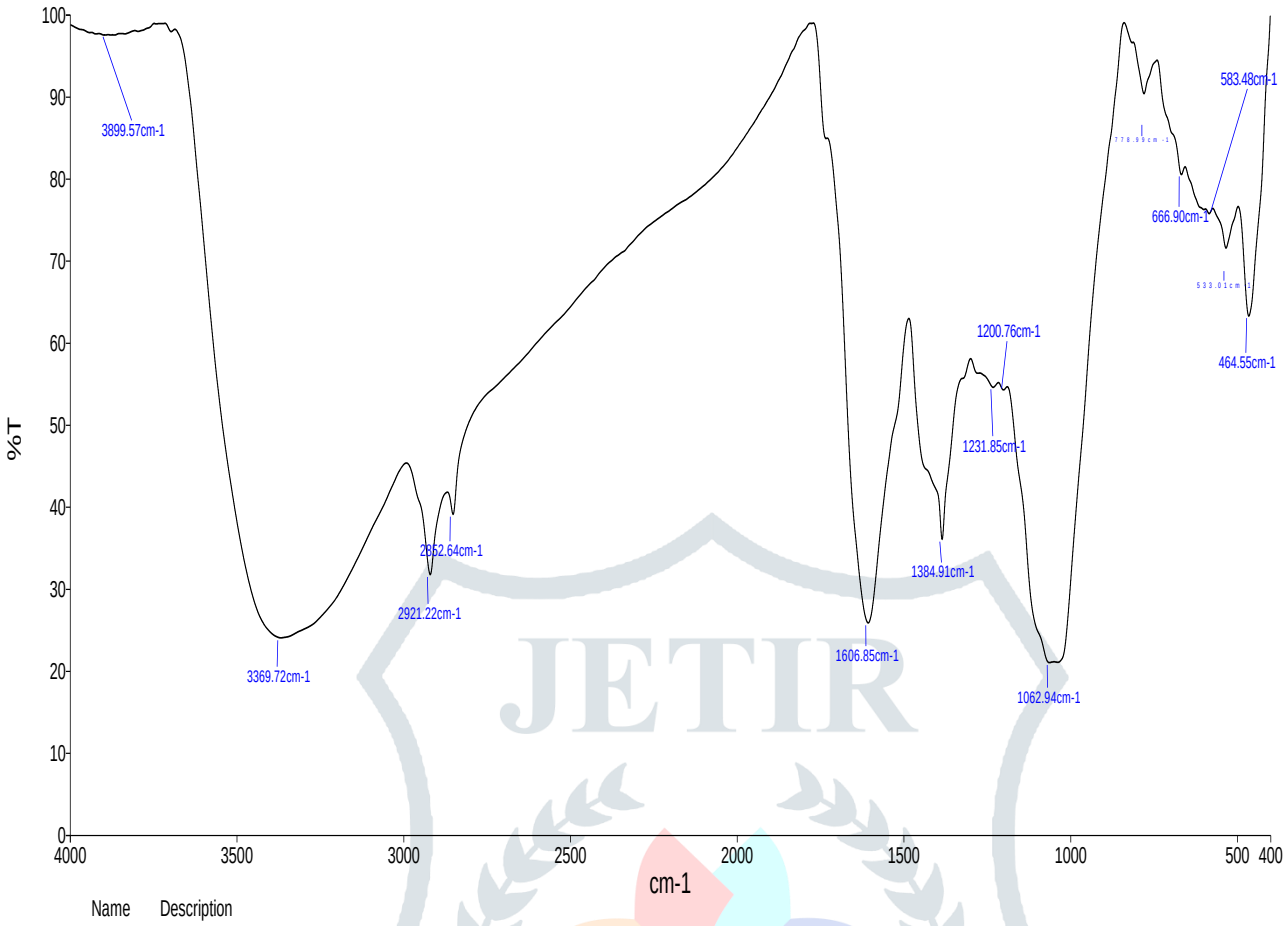

Figure 4: FT-IR Spectra analysis

4.4 SEM Analysis

Figure 5 shows the SEM images of the same synthesized silver nanoparticles sample. SEM images showed that most of the silver nanoparticles are predominately spherical in shape and well dispersed with close compact arrangement. The size of the synthesized silver nanoparticle was observed to be 20 to70 nm.

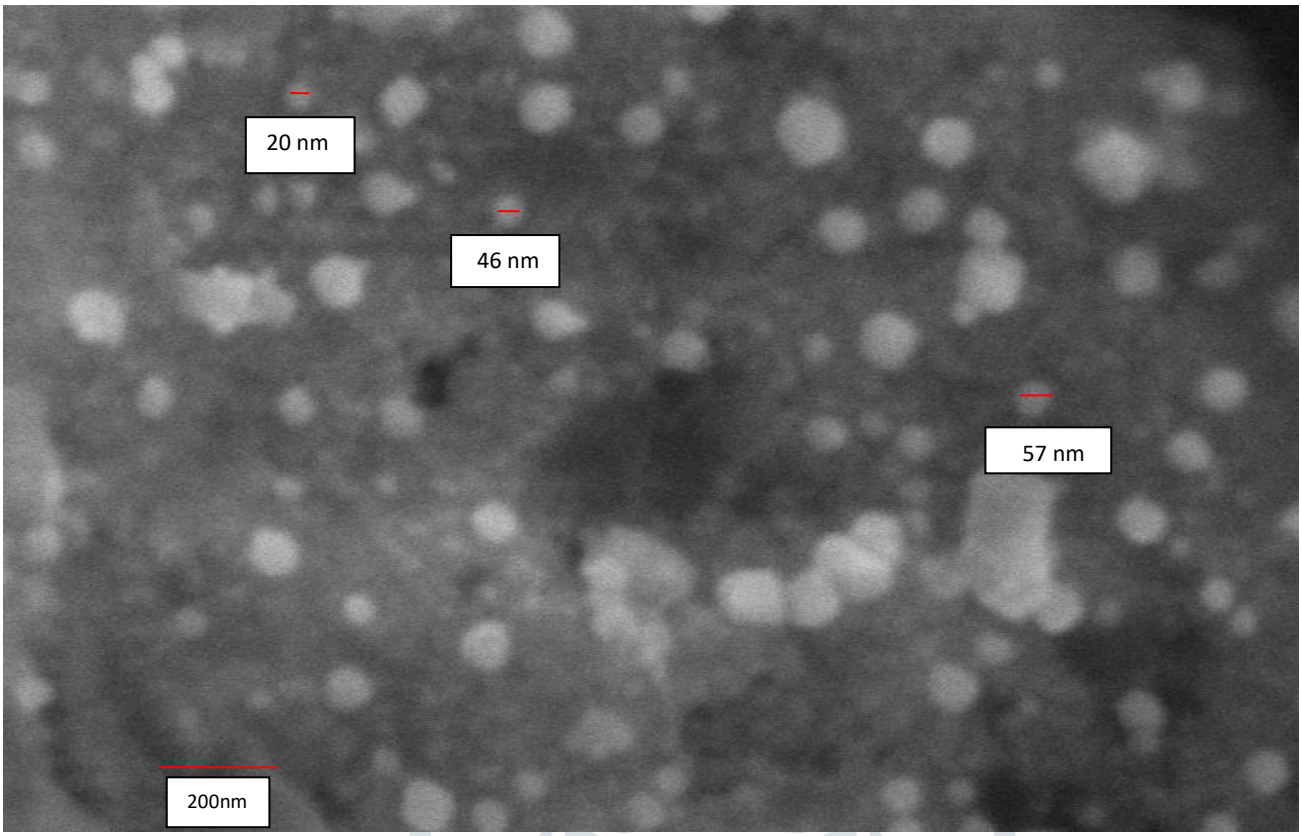

Figure 4: SEM Analysis

V. CONCLUSION

In the present study, we report an eco-friendly, non-toxic, cost-effective method for the synthesis of Silver Nanoparticle was carried out using a green reducing agent obtained from *Tamarindus indica* fruit shell. The characterization results obtained from UV –Vis, FT-IR and SEM analyses revealed the presence of plant extract, on the surface of the nanoparticles, indicating that the plant extract was efficient in reducing the silver salt to silver nanoparticles. UV Visible absorbtion peak at 450 nm is confirmed the presence of Silver Nanoparticle. FTIR peaks confirm the presence of biomolecules such as secondary metabolites. SEM analysis shown that synthesised silver nano particles are of spherical in shape around 20 to 70nm. In this method, naturally occurring materials are acts as reducing agents such as biomolecules present in plant extract as a simple and alternative to complex physical or chemical synthetic procedures.

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