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GREEN SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES BY USING *PSIDIUM GUAJAVA* LEAF EXTRACT

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ABSTRACT

In this study, a rapid, simple approach was applied for the synthesis of silver nanoparticles by using *Psidium guajava* aqueous leaf extract. The plant extract acts as both reducing agent and capping agent. The green synthesized silver nanoparticles were characterized by using physicochemical techniques viz, UV-Visible, Fourier Transform Infrared Spectrophotometer [FTIR], and particle size analyser. UV-Visible spectrophotometer showed an absorbance peak in the range of 419nm. The compounds responsible for silver ions and the functional groups present in plant extract were identified and investigated by FTIR technique. The characterization data reveals that the particles were in crystalline in nature with an average size of 62nm. Silver nanoparticles (Ag NPs) were rapidly synthesized using an aqueous extract of guava leaf with $AgNO_3$ solution within 15min at room temperature, without the involvement of any hazardous chemicals.

Keywords: Nanoparticles, green synthesis, Silver, *Psidium guajava* and reducing agents.

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1. INTRODUCTION

Nanomaterials and nanostructures usually ranging from 1 to 100nm, based on specific characteristics such as size, morphology and distribution which exhibit their remarkable potential in the field of biology and medicine. Nowadays, nanomaterials are at the emerging trends in the field of nanotechnology[1,2]. The environment-friendly process in chemistry is known as green synthesis method, which is a result of the worldwide problem associated with environmental concerns [3-7]. Among many nanomaterials, silver is one of the most commercialised nanomaterials with five hundred tons of silver nanoparticles per year [8].

Nanomaterials are superior because of their unique size-dependent property. Although there are many chemical and physical methods also produce pure, well-defined nanoparticles successfully but their methods were potentially dangerous to the environment and quite expensive. But the use of plant extract could be an alternative to physical and chemical methods for the production of nanoparticles in an eco-friendly pattern.

Production of silver nanoparticles is estimated to increase in the next few years because of its profound role in the field of catalysis, high sensitivity, bio-molecular detection, medicine and biosensors. It has been acknowledged to have strong inhibitory and bactericidal effects. The Noble silver nanoparticles are striving towards the edge-level utilities in every aspect of science and technology including the medical fields, thus cannot be neglected just because of their source of generation. Hence, it is becoming a responsibility to emphasise on an alternate as the synthetic route which is not only cost effective but should be environmentally friendly in parallel. Keeping in view of aesthetic sense, the green synthesis is rendering themselves as key procedures and proving their potential at the top. The techniques for obtaining nanoparticles using naturally occurring reagents such as sugars, bio-degradable films, plant extracts, and microorganisms as reductants and capping agents could be considered attractive for nanotechnology [9,10].

Very recently plant extract of Gloriosa superba [11], Ocimum tenuiflorum[12], are brimming in literature considering the vast potentiality of plants as a source this work aims to apply a biological green technique for the synthesis of silver nanoparticles as an alternative to the conventional methods. In this regard, leaf extract of Psidium guajava (commonly known as guava) species of family Myrtaceae was used for bio-conversion of silver ions to nanoparticles. This plant is commonly available in India and the leaves of Psidium guajava tree have a long history of medicinal uses that are still employed today [13].

This guava leaves have several chemical constituents such as coumarins, essential oils, triterpenes and ellagitannins [14,15]. In this paper, an attempt was made to study the synthesis of silver nanoparticles from leaves of Psidium guajava without using any additional harmful chemical/physical methods. The method applied is simple, cost-effective, easy to perform and sustainable.

2. EXPERIMENTAL

Typically, a plant extract mediated bioreduction involves mixing the aqueous extract with an aqueous solution of the appropriate metal salt. The synthesis of nanoparticles occurs at room temperature and completes within a few minutes.

2.1. Preparation of Plant Extract

Psidium guajava leaf extract was used to prepare silver nanoparticles on the basis of cost-effectiveness, ease of availability and its medicinal property. The guava leaves were collected from the trees growing in the fields. It was thoroughly washed in distilled water to remove mud and other dust particles and poached for 20 minutes in 100mL distilled water taken in a pan and then cooled at room temperature. Once it is cooled, 20mL extract of dark green was filtered to a conical flask using watt man filter paper and kept in the refrigerator for further usage.

2.2. Green Synthesis of Silver Nanoparticles

Silver nitrate GR used as such (purchased from SRL Chemicals, India).100mL, 1mM solution of silver nitrate was prepared in an Erlenmeyer flask. Then 1,2,3,4 and 5mL of plant extract was added separately to 10mL of silver nitrate solution keeping its concentration at 1mM. Silver nanoparticles were also synthesized by varying concentration of silver nitrate. This set up was incubated at in dark chamber to minimize photo-activation of silver nitrate at room temperature. The reduction of Ag^+ to Ag was confirmed by the colour change of solution from colourless to brown. Its formation was also confirmed by UV-Visible spectroscopy.

2.3. Characterization of Synthesized Silver Nanoparticles

UV-Vis spectral analysis was done by using Shimadzu UV-Visible spectrophotometer. The UV-Visible absorption spectrophotometer with a resolution of 1 nm between 200 and 800nm was used. FT-IR spectra were recorded in Perkin Elmer (1750) FTIR Spectrophotometer. The size of synthesized silver nanoparticle was determined by using zeta potential. SEM analysis was recorded in LEO 435VP SEM.

3. RESULTS AND DISCUSSION

3.1. Colour Change

The particles exhibit different colour when they are in nanoscale compared to its bulk state. Silver nanoparticles will be either black or brown in colour which is shown in Figure 1. After the addition of guava leaves extract, the colour of the solution changed from colourless to brown colour.

Figure 3.1: 1). 0.01 M Silver nitrate is added to 100mL distilled water, vigorously stirred under 80° C, and 2). After the addition of guava leaf extract.

3.2. UV-Vis Spectral Analysis

The noble silver metal nanoparticle was showed a well-defined absorption peak at 419 nm and confirmed the reduction of silver by the colour change from colourless to yellowish red[10]. UV-Visible spectroscopy analysis was carried out on SYSTRONICS spectrophotometer from a range of 200 to 800nm. The double distilled water was used as blank.[16].

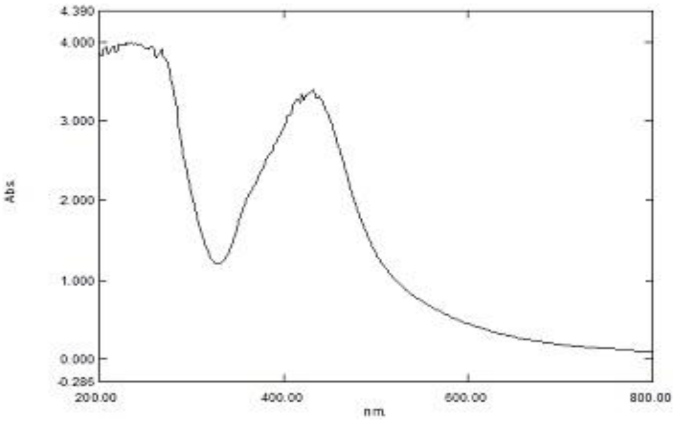

Figure 3.2: UV–Vis Spectra of Ag Nanoparticles Synthesized by Using Guava leaf Extract

3.3. FTIR Analysis

The dual role of plant extract as capping and reducing agent and presence of functional groups was confirmed by FTIR analysis of silver nanoparticles. The broadband of the spectrum shows vibrational stretches at 3317 cm^{-1} was due to O-H stretch[17], 2125 cm^{-1} was due to -C≡C- stretch, the peak 1635 cm^{-1} due to -C=O-stretching [18] and peak obtained i.e. 579 cm^{-1} due to C-X stretching [19]. The FTIR results confirmed that the some of the organic compounds from plant extract formed as a reducing/capping on the nanoparticles. From the spectrum reveals that the carbonyl group (C=O i.e., 1635 cm^{-1}) was involved in the reduction of Ag^+ to Ag.

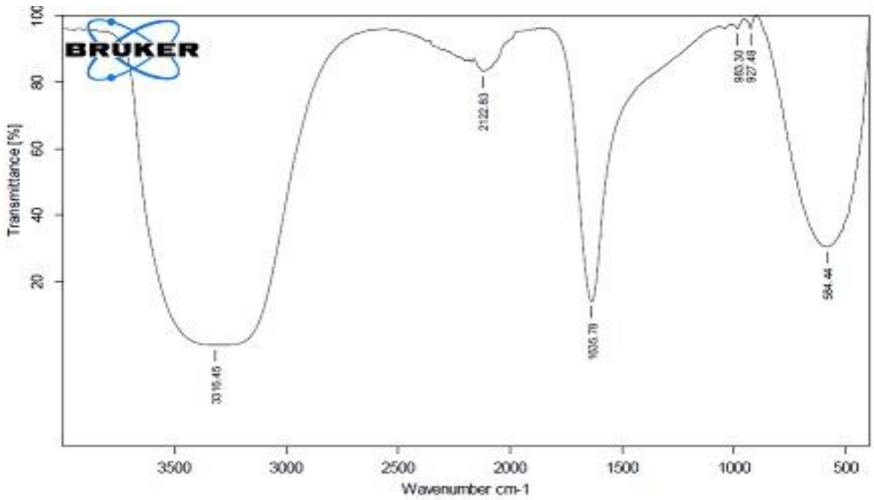

Figure 3.3: FTIR Spectrum of Silver Nanoparticles

3.4. Particle Size Determination

Particle size determination of synthesized AgNPs was shown under by intensity. The size of silver nanoparticles was synthesized with Psidium guajava leaf extract was characterised by dynamic light scattering experiment. The average size of the synthesized silver nanoparticles from Psidium guajava leaf extract was found to be 62 nm. [20]

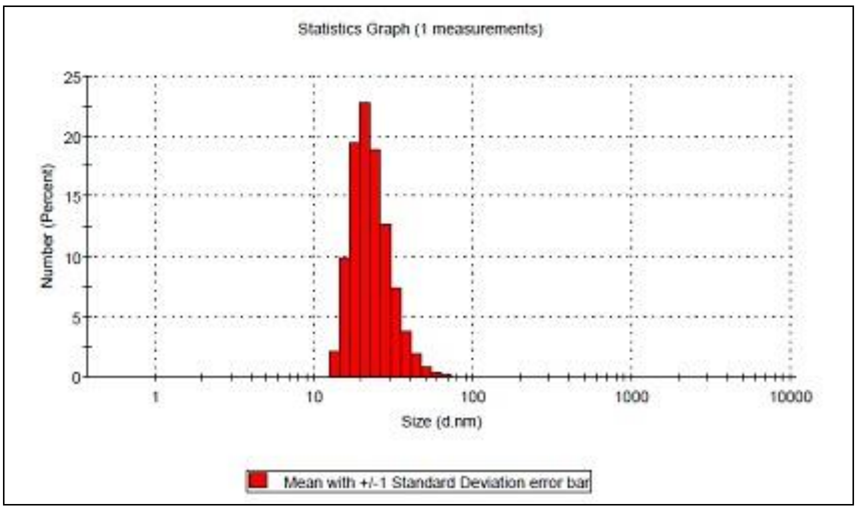

Figure 3.4: Particle size Distribution Pattern of Ag nano Particle was synthesized by Reducing $AgNO_3$ using Guava leaf Extract

3.5 Morphology of silver nanoparticles

The Scanning electron microscopy [SEM] has been used to identify the size, shape and morphology of silver nanoparticles. The SEM images of synthesised silver nanoparticles were shown in Figure 3.5. Size and shape of the silver nanoparticles depend on the precursor, reducing agents used to synthesize nanoparticles and shows that silver nanoparticles are crystalline in nature[12].In the present study, the SEM analysis confirms the formation of silver nanoparticles, which contains the crystalline structure as shown in Fig.3.5.

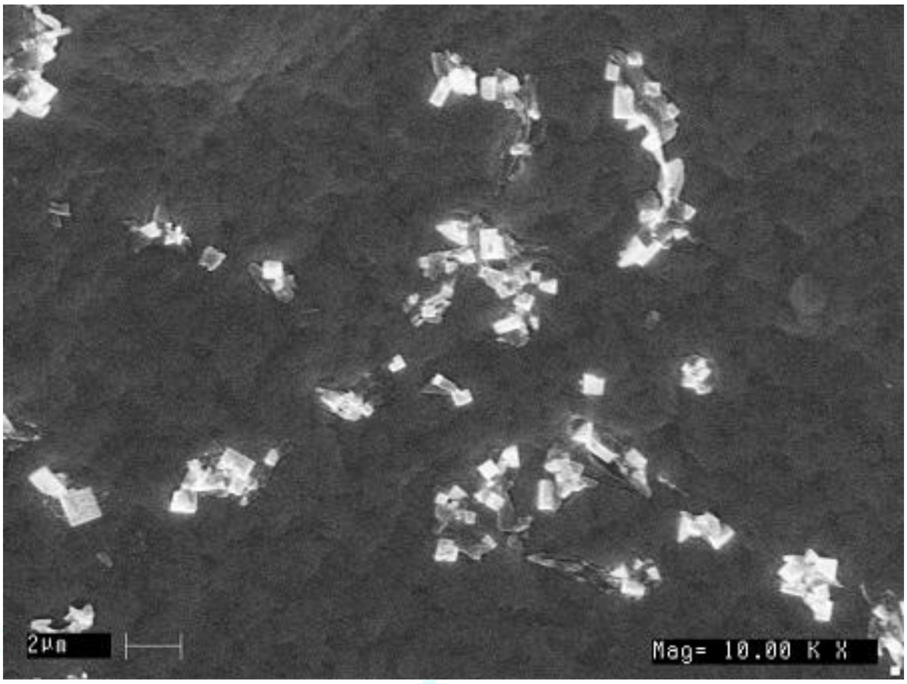

Figure 3.5: SEM Analysis of Silver Nanoparticles

4. CONCLUSIONS

In this study, there was presented a simple one-pot green synthesis of stable silver nanoparticles using *Psidium guajava* extract at room temperature was reported. The use of natural extracts, distilled water and non-toxic reagents proves to be an eco-friendly, rapid green approach for the synthesis of silver nanoparticles which was a cost-effective and efficient way of synthesis. The size of AgNPs was estimated at 62 nm. SEM analysis showed that silver nanoparticles were crystalline in nature. The reduction of silver nanoparticles was confirmed by UV-Visible spectroscopy and FTIR technique. Benefits of using plant extract for synthesis is that it is cost effective, energy efficient, protecting environment and human health also leading to lessen waste and safer products. This eco-friendly method could be a competitive alternative to the conventional physical/chemical methods were used for the synthesis of silver nanoparticles.

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