International Journal of Research and Development in Engineering Science
ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/
Regular Issue, Vol. 5, Issue.5 (September – October), 2023 , Pages: 5 - 9
Received: 01 December 2022 ; *Accepted*: 13 August 2023 ; *Published*: 25 September 2023
https://doi.org/10.63328/IJRDES-V5RI5P2
Brief Review: Casual Research – Case Study Research Paper

An Investigation on the Synthesis of Silver Nanoparticles Naturally and their Possible Applications

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Abstract: This extensive overview includes numerous research on the environmentally friendly synthesis of AgNPs utilizing various plant extracts. Scholars have investigated novel production of AgNPs, utilizing techniques such aqueous root extracts, UV-visible spectroscopy, and solution plasma. Certain properties of the extracted nanoparticles were confirmed by electron microscopy (EM), DLS, and XRD, among other approaches. These characteristics included spherical forms, monodispersity, and crystalline structures. Many plant sources are covered by the studies: Piper nigrum, Justicia adhatoda, Achillea bibersteinii, Calliandra haematocephala, Malus domestica, Piper betle, orange peel, Excoecaria agallocha L., Melia dubia, Shikakai, Reetha, Eucalyptus leucoxylon leaves, Pistacia atlantica, Prunus japonica, Azadirachta indica, Thevetia peruviana, peach gum polysaccharide, tea leaf, Piper nigrum, Justicia adhatoda, Achillea bibersteinii, Calliandra haematocephala, Piper betle, banana peel, Melia dubia, Shikakai, Reetha, and marigold flowers are among the many plant sources covered by the studies. The produced AgNPs showed promising characteristics for use in colorimetric sensing, antibacterial activity, catalysis, and other fields. Their diameters ranged from 7 to 121 nm. The adaptability and promise of green synthesis techniques in generating AgNPs with distinctive properties from a range of plant sources are highlighted by this review.

Keywords: Nature, Nanoparticles, AgNPs, TEM, FCC, H_2O_2.

1. Introduction

The investigation of ecologically friendly synthesis techniques for silver nanoparticles (AgNPs) has drawn a lot of attention. This varied collection of studies looks into the application of a range of plant extracts, including those from Piper nigrum, Justicia adhatoda, Achillea bibersteinii, Calliandra haematocephala, Malus domestica, Piper betle, orange peel, Excoecaria agallocha L., Melia dubia, Shikakai, Reetha, Eucalyptus leucoxylon leaves, Pistacia atlantica, Prunus japonica, Azadirachta indica, Thevetia peruviana, peach gum polysaccharide, tea leaf, Piper nigrum, Justicia adhatoda, Achillea bibersteinii, Calliandra haematocephala, Piper betle, Malia dubia, Shikakai, Reetha, and marigold flowers.

According to the investigations, novel techniques like solution plasma, UV-visible spectroscopy, and aqueous root extracts are used in the synthesis of AgNPs. Analytical methods such as XRD, DLS, and EM have demonstrated that the resultant nanoparticles have a variety of properties, including spherical forms, monodispersity, and crystalline structures. The simplicity, speed, and environmental friendliness of these green synthesis techniques are among its benefits. The generated AgNPs' size and shape, which range from 7 to 121 nm in several experiments, demonstrate how adaptable these techniques are. The importance of these green synthesis techniques in creating nanomaterials with specific features and little environmental impact is highlighted by the possible uses of AgNPs in colorimetric sensing, antibacterial activity, catalysis, and other areas.

2. Literature Review

Zhiwei Nguyen Van Hao et al. [2023] discusses novel, rapid, simple, and environmentally friendly way to prepare green AgNPs. The artificially created AgNPs were evenly distributed throughout the solution and measured an average size of 8 nm. The nanofluid prepared with a 4-minute preparation time show 18.3% enhancement.

Hanady et al. [2016] synthesised AgNPs from leaf extract of Catharanthus roseus. application of UV-visible spectroscopy for AgNP characterization. The spherical shape of the AgNPs synthesised from C. roseus leaf extract

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ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 5, Issue 5, 2023 , https://doi.org/10.63328/IJRDES-V5RI5P2

is indicated by the SPR peak at 425 nm. Additionally, the single SPR peak indicates that the AgNPs are comparatively monodisperse, or have a restricted size distribution.

A range of spectroscopic techniques were employed by Selvaraj Arokiyaraj et al. [2016] to study the process of synthesising AgNPs from Rheum palmatum root extracts. The shape of the nanoparticles was found to be both hexagonal and spherical. The average particle size was found to be 121±2 nm using the DLS method, and the Zeta potential was found to be 21.6 mV.

Natural synthesis and characterisation of AgNPs with extract from banana peels are covered by Haytham M. et al. [2015]. AgNPs UV Visible spectra showed a distinctive SPR peak at 433 nm. AgNPs UV A noticeable SPR peak was visible in the visible spectrum at 433 nm. A description of AgNPs was given. XRD demonstrated that they were crystalline. Monodispersed, spherically-shaped nanoparticles were seen using SEM and field emission scanning electron microscopy. The DLS data revealed that the nanoparticles' average size was 23.7 nm.

The synthetic AgNPs made with Melia dubia plant extract were the subject of the V. Kathiravan et al. [2017] inquiry. XRD and SEM investigations show that the nanoparticles are spherical and have an average size of 7.3 nm.
AgNPs are produced environmentally by utilising plant extracts from Shikakai and Reetha is investigated by Ujjal Kumar Sur et al. [2018]. The generated AgNPs were examined using TEM, and XRD. The average size of the nanoparticles was discovered to be 30 nm.

Mukunthan KS et al. [2017] used aqueous leaf extracts of Catharanthus roseus (C. roseus) to create an easy, quick method for synthesising AgNPs. SEM showed that between 67 and 48 nm-sized AgNPs were produced. The particles' face-centered cubic shape and crystalline nature were both shown by XRD.

Eucalyptus leucoxylon leaf extract was used in Mehdi Rahimiehdi et al.'s [2017] investigation into the environmentally friendly synthesis of AgNPs. The generated AgNPs were almost spherical in shape and had a diameter of about 50 nm. They were created at room temperature in less than 120 minutes of reaction time.

The synthesis of AgNPs utilising a seed aqueous extract of Pistacia Atlantica is discussed by Babak Sadeghi et al. [2015]. (PA). The UV-visible spectra of the diluted solutions (1:4) of the reaction mixture were monitored in order to track the synthesis of Ag-NPs in a solution. A twin beam spectrophotometer was used to record UV-visible spectra between 300 and 800 nm with a resolution of 1 nm.

Through the use of a straightforward, room-temperature method and Prunus japonica using leaf extract as a reducing agent, Arthanari Saravanakumar et al. (2016) looked into the low-cost, environmentally benign natural AgNP synthesis using AgNO3. When the produced AgNPs were examined using the XRD technique, it was discovered that they had a crystalline structure with FCC geometry.

Using an aqueous leaf extract from Azadirachta indica, Shakeel Ahmed et al. (2016) looked into the environmentally friendly synthesis of AgNPs. TEM, UV-visible spectrophotometer, photoluminescence, DLS, and other techniques are used to characterise synthesised. We saw absorbance with the UV-visible spectrophotometer. peak between 436 and 446 nm.

Utilising Thevetia peruviana latex as a reducing agent, AgNPs were successfully synthesized from AgNO3 by Rupiasih et al. [2017]. With a shoulder at 395 nm, the UV-Visible spectrum revealed absorption at 570 nm. AgNPs formation's functional groups were validated by FTIR spectra analysis. Particle size distribution between 10 and 30 nm was revealed by TEM analysis to be spherical in nature.

Ecological AgNP synthesis induced by sunlight irradiation using peach gum polysaccharide was studied by Ning Yang et al. [2018]. The AgNPs' average particle size, which crystallised in a face-centered cubic, was 23.5677.87 nm. By using FTIR, the potential synthesis mechanisms were clarified. The use of the PG-mediated AgNPs in analytical processes for colorimetric H_2O_2.sensing was successful.

The AgNPs synthesis using tea leaf extract has been made easy, affordable, and ecologically friendly, according to research done by Qian Sun et al. [2017]. The reaction between tea extract and silver nitrate was used to create the AgNPs, and it took place at room temperature for two hours. The synthesised AgNPs were examined using a thermogravimetric analyzer, zeta potential analyzer, FTIR, TEM, and XRD. The artificially produced AgNPs in a range of size from 20 to 90 nm and were almost spherical in shape.

The AgNP swere created using stem extract and Piper nigrum leaf, according to Kanniah Paulkumar et. al. [2016] investigation. For stem and leaf synthesized AgNPs the reduction of Ag metal ions into AgNPs is shown by the peak at 460 nm in the UV-visible spectra. The thin-layer TEM images demonstrate that the AgNPs produced by the leaf and stem, respectively, had sizes between 7 and 50 nm and 9 and 30 nm.

The Thirumagal group [2020] An investigation into the manufacture of AgNPs using leaf

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ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/ , IJRDES, Vol. 5, Issue 5, 2023 , https://doi.org/10.63328/IJRDES-V5RI5P2

extract from Justicia adhatoda. The AgNPs were produced at different concentrations of J. adhatoda leaf extract using the silver nitrate bioreduction technique. Particle size was the FCC structure of the lattice strain (W-H plot), which was found to be 30 nm, was visible. TEM was employed in this study to determine the spherical shape of the particles at different concentrations (16–21 nm in particle size).

The green manufacturing of AgNPs using Achillea Bibersteinii flower extract is covered by Javad Baharara et al. [2017]. The absorbance peak at 460 nm, revealed by the UV-visible spectroscopy analysis, indicated the formation of AgNPs. A TEM measurement revealed an average particle diameter of 12 ± 2 nm. Zeta potential analysis indicates that Ab.Ag-NPs exhibit strong stability. The Ag element is also included in the EDX analysis.

According to Selvaraj Raja et al. (2015), AgNPs were synthesized with leaf extract from Calliandra haematocephala. Measured 414 nanometers in length. Utilizing SEM and EDS, the elemental silver was found. employed to evaluate the silver nanoparticles' morphology. The crystalline quality and innocence XRD used to find the amount of AgNPs, and the results indicated the presence of structured FCC structure of metallic Ag planes (111) and (220).

The natural synthesis of AgNPs using fruit extract from Malus domestica is discussed by K. ROY et al. [2017]. TEM and XRD were used to analyse the morphology and various phases of the AgNPs, respectively. Apple fruit extract lowered the concentration of silver ions and created stable, metallicAgNPs. These tightly spherical nanoparticles had an average particle size of 20 nm.

Synthesis of AgNPs using piper is discussed by P. Shanmuga Praba et al. [2016]. In order to create the AgNPs, Betle used a 1 mM silver nitrate solution in a plant extract. The AgNPs absorption spectra, which included the solution, revealed a peak at 444 nm.

Awad et al.'s investigation focused on the creation of AgNPs utilising an orange peel extract [2017]. The synthesised NPs were characterised using a UV-Visible spectrophotometer and a Zitasizer, which estimates 91 nm as the average particle size.

AgNPs were synthesised by R. Bhuvaneswar et al. [2016] using the mangrove plant Excoecaria agallocha L. A. An intense absorption in UV-visible spectroscopy was the first sign of AgNP production, colour shift from yellow to dark brow, the spectra at 440 nm. In addition, the synthesised AgNPs FCC crystalline The XRD pattern validates a structure with average size of 20 nm.

The green synthesis of silver nanoparticles from the marigold flower is covered by Hemali Padalia et al. [2017]. UV-visible the produced AgNPs spectra show maximum peak at 430 nm. The particles, which varies in between 10 to 90 nm, were found to be spherical, hexagonal, and irregular by TEM analysis.

The properties, applications, and natural of AgNPs using diverse extracts were examined by Muhammad Rafique et al. [2015]. The review emphasises the benefits of green synthesis over traditional techniques, including its affordability, environmental friendliness, and scalability. Plant extracts are used to create AgNPs, which have superior optical, catalytic, and antimicrobial qualities. AgNPs possible uses in the industrial, environmental, and biomedical fields are also covered in the review.

3. Result and Discussion

Using a variety of plant extracts, the reviewed works provide a broad spectrum of environmentally friendly production techniques for silver nanoparticles (AgNPs). Plants such as Paramignya trimera, Catharanthus roseus, Rheum palmatum, banana peel, Melia dubia, Shikakai, Reetha, Eucalyptus leucoxylon leaves, Pistacia atlantica, Prunus japonica, Azadirachta indica,

Thevetia peruviana latex, peach gum polysaccharide, tea leaf, Piper nigrum, Justicia adhatoda, Achillea Bibersteinii flower, Calliandra haematocephala, Malus domestica fruit, Piper Betle, orange peel, and marigold flower are among the plants that are employed in the synthesis processes. The AgNPs that were produced showed a range of forms and sizes, from 7.3 nm to 91 nm, including spherical, hexagonal, and irregular.

Various characterization techniques, including UV-visible spectroscopy, XRD, TEM, SEM, FESEM, DLS, and FTIR, were employed in the green synthesis methods. These methods verified the crystalline nature, shape, and size distribution.

The research also investigated the potential uses of synthetic AgNPs in the environmental, industrial, and biological domains, as well as improved thermal conductivity in nanofluids and colorimetric H2O2 sensing.

Together, the findings demonstrate the adaptability and usefulness of green-synthesised AgNPs, providing a sustainable and environmentally beneficial substitute for traditional synthesis techniques. The observed differences in AgNPs size, shape, and other characteristics between studies highlight the impact of plant extracts and synthesis circumstances on the final attributes of the nanoparticles.

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4. Conclusion

Although The reviewed research, taken as a whole, demonstrate the wide and varied range of green synthesis techniques for producing silver nanoparticles (AgNPs) from different plant extracts. An extensive range of plant sources and ecologically friendly techniques, including solution plasma, demonstrate the dedication to sustainable and environmentally friendly nanoparticle synthesis. AgNPs that were synthesized range in diameter from 7.3 nm to 91 nm and exhibit a variety of shapes, including spherical, hexagonal, and irregular shapes.

The successful synthesis of AgNPs has been confirmed through the use of characterization methodologies like UV-visible spectroscopy, XRD, SEM, andTEM, which have also provided insights into the crystalline nature, shape and size distribution of AgNPs. The investigations also show how crucial reaction parameters and the amount of plant extract are in defining the characteristics of the final nanoparticles.

Green-synthesized AgNPs have a broad range of uses, from colorimetric H2O2 detection to improved thermal conductivity in nanofluids, demonstrating their potential in a variety of sectors. The combined results highlight the adaptability and potential of green synthesis techniques for AgNPs, providing a sustainable substitute for conventional methods and creating opportunities for their use in a range of technological and biological contexts. A growing body of information in the field of green nanotechnology is being contributed by the observed variations in nanoparticle characteristics across researches, which highlight the influence of plant extract composition and synthesis conditions on the final attributes of AgNPs.

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