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# Synthesis of silver nanopaticles using *Ocimum tenuiflorum* leaf extract

**B Rubiga, S Panimozhi**
Assistant Professor, Department of Chemistry, Theivanai Ammal College for Women, Villupuram, Tamil Nadu, India

**Abstract**
In current materials science, nanotechnology is the most active area of research. Among the many metallic nanoparticles used in biomedical applications, silver nanoparticles (AgNPs) are one of the most important and fascinating nanomaterials. The most developing type of synthesis is green synthesis of nanomaterials, which involves a variety of chemical and physical approaches. We also go over AgNps characteristics and characterization methods like as UV-Vis spectroscopy, Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), and FTIR spectroscopy. The AgNPs were stabilized by eugends, terpenes, and other aromatic compounds present in the extract, according to FTIR analysis. Finally, we explore the future of AgNPs.

**Keywords:** silver nanoparticles, synthesis, characterization, applications, antifungal, ocimum tenuiflorum

## Introduction
Due to their physical and chemical qualities, silver nanoparticles are now widely used in a variety of industries, including medicine, health care, consumer goods, food, and industry. Optical, electrical, and thermal properties, as well as high electrical conductivity and biological properties, are among them [1, 2, 3]. AgNPs have recently been found in a variety of textiles, wound dressings, keyboards, and biomedical equipment [2, 4, 5]. Researchers have consistently grown a later approach for synthesis of most mono disperse AgNPs that is efficient in terms of both synthesis rate and energy consumption. Nanomaterials are commonly used in chemical and physical processes such as the sol process, micelle, chemical precipitation hydrothermal method, pyrolysis, and chemical vapour deposition [6]. Size, shape, size distribution, surface area, aggregation, shape solubility, and other quality characteristics of nanoparticles are all important. Size, shape, size distribution, surface area, aggregation, shape solubility, and other quality characteristics of nanoparticles are all important. Before determining toxicity or biocompatibility, use to make an educated guess [7]. Many analytical approaches, like as ultraviolet visible spectroscopy (UV-Vis spectroscopy), Fourier transform infrared spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and Transmission electron microscopy (TEM), have been employed to estimate the of nanomaterials [8, 9]. Finally, this study concludes with a conclusion and an outlook on AgNPs in the future.

## Experiment
### 1. Physical and Chemical Techniques
Nanoparticles are commonly synthesized utilising three main methodologies, including physical, chemical, and organic techniques. Nanoparticles are made by solid or liquid utilising a tube furnace at atmospheric pressure in physical ways [10-13]. For combing AgNPs, traditional physical methods such as flame fulfill and pyrolysis were applied [14-15].

### 2. Plant Composition
The habit of Ocimumtenuiflorum is a dazzling furze with many imparipinnate leaves. The following is a list of Ocimumtenuiflorum classifications.
Family: Holy Basil
Sub Family: Lamiaceae
Genus: Ocimum
Species: O.tenuiflorum
Botanical Name: OcimumTenuiflorum
Kingdom: Plantae
Common Name: Ocimum Sanctum

### 3. Collection and Preparation of Plant Materials
Fresh Tulasi leaves Ocimumtenuiflorm is the name of the plant. The leaves were gathered from a nearby location. Then I washed it 5-6 times with distilled water and tap water. Leave these leaves to dry for 8 to 9 days.

**4. Synthesis of Silver Nanoparticles**

With the use of a mortar and pestle, the leaves were dried and ground into a fine powder. A beaker containing 4 grams of finely ground powder and 100 milliliters of distilled water was filled with the powder and heated for 30 minutes. The extract was allowed to cool. The leaf extract was then filtered and mixed with 20ml silver nitrate solution at a concentration of 1mM. Leave for a day and a night in a dark room. Precipitate will form automatically. Then whatman filter paper was used to filter it. The filter paper will be rolled and burned in a crucible, and then the powder will be characterised.

**5. Characterization**

A variety of analytical procedures are used to characterise products, including ultraviolet-visible spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), Transmission Electron Microscopy (TEM), and Scanning Electron Microscopy ((SEM).

**UV-Visible Spectroscopy**

UV-Visible spectroscopy is a technique for determining how many flashes a material absorbs and scatters. AgNPs were reduced and capped in part thanks to biomolecules. The ultraviolet (UV) ranges from 100 to 400 nanometers in wavelength.

**FTIR**

The structure, each band of the produced nanoparticles, and the stretch of bonds were all revealed by FTIR Spectroscopy. The identification of functional groups was made possible by a vibrational analysis using FTIR (Fourier Transform infrared Spectroscopy). The MCF -7 breast cancer cell line was found to be inhibited by the cytotoxiticity examination of the green produced silver nanoparticles. The spectra was recorded using an FTIR spectrometer.

**TEM**

The TEM (Transmission Electron Microscopy) is a widely used and important method for the characterization of nanomaterials. It is used to obtain quantitative calculations of particle and size, size distribution, and morphology. As a result, sample preparation is critical in order to obtain the best quality figure possible.

**SEM**

SEM (Scanning Electron Microscopy) is a surface imaging technique capable of resolving varied particle sizes, size distributions, nanomaterial forms, and the surface morphology of manufactured particles at the micro and nanoscales, among other electron microscopy approaches.

**Results and Discussion**

Scanning electron microscope (SEM) and Transmission electron microscope (TEM).

**1. SEM Analysis**

A few drops of the silver nanoparticle-containing solution were deposited on a glass plate and dried. After that, SEM was recorded. Figure 1 shows a SEM image of silver nanoparticles.

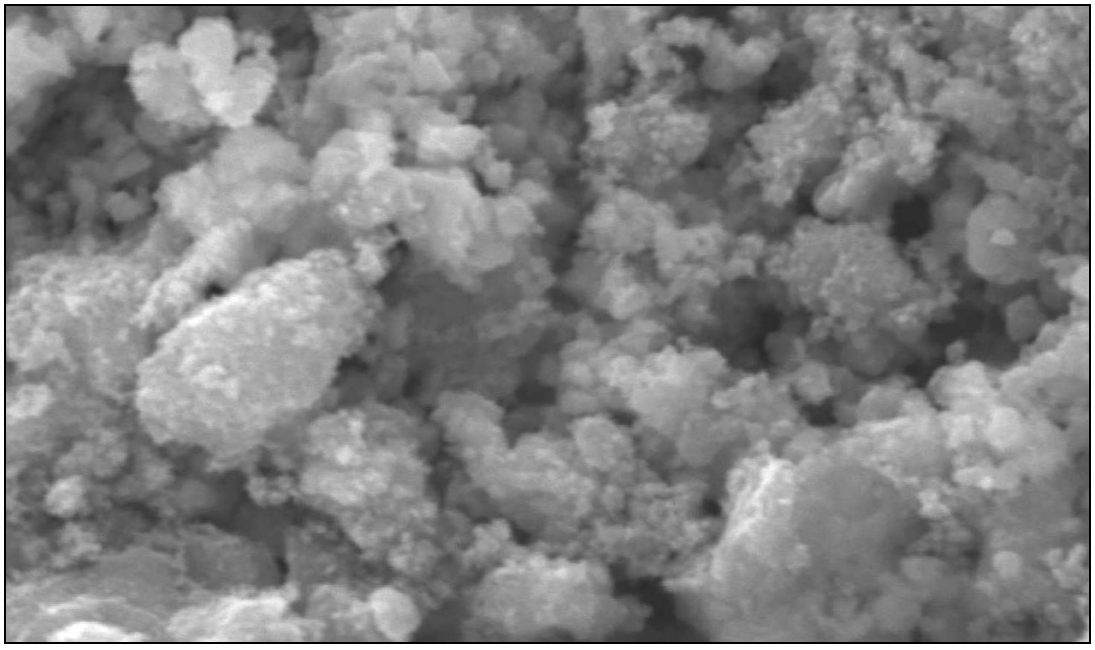

**Fig 1:** SEM image of silver nanoparticles.

**2. TEM Examination**

The size, shape, and morphology of nanoparticles have been determined using transmission electron microscopy (TEM). The organic layer appeared to separate the TEM pictures, which were not physically in contact with each other. As a result, TEM pictures clearly show that Ag nanoparticles are coated with an organic layer. Several poly phenolic components, such as flavonoids and terpenoids, aided in the reduction of Ag ions while also stabilising the surface of the resulting Ag nanoparticles. It demonstrates that the silver nanoparticles are well disseminated and mostly spherical in shape, with some NPs having irregular shape structures, as seen in Figure 1 The average particle size is roughly 50 nanometers.

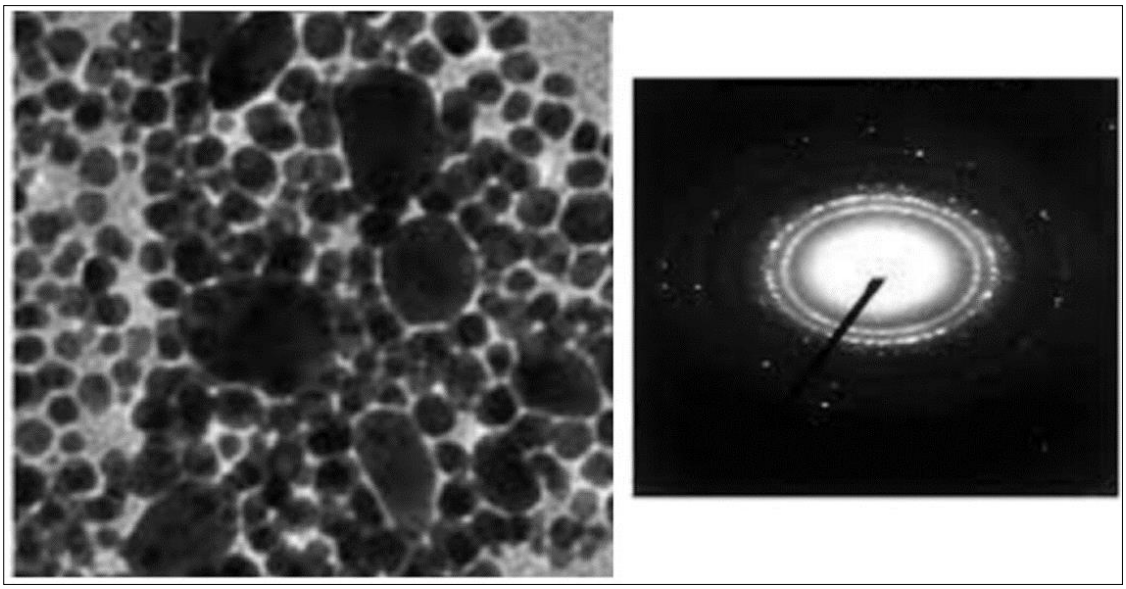

**Fig 2:** TEM image of silver nanoparticles.

Data on the average size of Ag nanoparticles produced with Azadirachta Indica backed up this claim. Previous research has shown that the small size of Ag nanoparticles makes it easier for them to penetrate bacteria's outer walls, enter the body, damage the respiratory chain, and therefore limit cell respiration, resulting in bacterial death.

**Conclusion**

Medicinal herbs, namely aqueous extracts of fresh Ocimumtenuiflorum leaves, can be employed as bioreduction agents to create Ag nanoparticles. The colour shift of Ocimumtenuiflorum extract into green extract into yellow brown colour indicated the development of Ag nanoparticles in the extract. The appearance of colour shifts indicates the formation of Ag particles. Because of the higher concentration of AgNO3 solution, the size of the Ag particles produced increased, but the average size remained in the 50 nm range. The use of silver nanoparticles and surface coating or impregnation of nanomaterials as antibiofilmagents is one of these possible techniques. Furthermore, silver nanoparticles are the most researched and used nanoparticles in the treatment of a variety of ailments, including cancer, wound healing, dental implants, and other therapies including modifying biological activities. TEM observations revealed two types of morphology in the produced NPs smaller spherical and bigger truncated octahedral forms.

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