

ORIGINAL RESEARCH ARTICLE

Preparation and characterization of silver nanoparticles in an environmentally friendly method

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ABSTRACT

Sliver nanoparticles were prepared in an environmentally friendly method. This method is safe and economically inexpensive, as the reducing agents found in the plant work to convert simple primary chemicals into nanomaterials with unique and distinctive properties. They are characterized by their size, which ranges from 10 -100 nm, therefore they are of great importance in all areas of life as they are used in industry, agriculture, medicine, energy, communications and others.

Keywords: biosynthesis; nanoparticles; reducing agents; cinnamomum extract

ARTICLE INFO

Received: 2 March 2026
Accepted: 26 May 2026
Available online: 17 June 2026

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1. Introduction

Nanoparticles are little groups of atoms with one or more dimensions in size from 1 to 100 nanometres. The word "nanoparticles" is derived from the Greek word "nanos" which means dwarf or very little the nanometre is one billionth of a meter or 10^{-9} meters. Nanotechnology is a multidisciplinary field that connects a wide range of science. Including engineering, physics, chemistry, and medicine. A common characteristic is size. At this nanoscale material often exhibit unique and variable physical, chemical and biological phenomena compared to their bulk counterparts they display distinctive properties due to their nanoscale shape and size, distribution, high surface area-to volume ratio, numerous angles with edges, highly reactive surfaces, and high-energy surface defects compared to bulk materials. The small size and scale of these materials have led to behaviours that differ from those of conventional bulk materials exceeding 100 nanometres, resulting in highly distinctive properties that cannot be found together in conventional materials. Nanomaterials are considered the building blocks of the 21st century, Nanoscience is the science concerned with studying and characterizing nanomaterials and determining their chemical, physical and mechanical properties in addition to studding the phenomena associated with them arising from reducing sizes. It goes without saying that reducing the sizes and dimensions of substances to the nanometre level is not an end in itself, but rather an advanced scientific philosophy and a qualitative and a scientific revolution against the classical and constants of physical and chemical theories which aims to produce a new class of materials known as nanomaterials so that their distinctive properties match the requirements of advance technological application in the century and

enhance performance in a unique and unprecedented way^[1]. The fact that a materials behaviour depends on its size allows us to control the engineering of its properties, based on this researchers have concluded that this concept has tremendous technological implication, encompassing a wide and diverse range of fields, Nanoscience (the science of the infinitesimal) deals with the production of materials by precisely controlling their molecules and atoms and directing them to their intended locations to produce materials with specific properties in what is known as molecular manufacturing, for example controlling the orientation of carbon atoms in coal during a reaction may lead to the production of diamonds and arranging sand grains in a specific way may produce computer chips, It is known that traditional methods of manufacturing chemical materials are based on process of mixing and blending the components of the reaction without considering the orientation of the reacting atoms, which produces a chemical substance that is nothing more than a mixture of those reacting substances, however in the world of nanotechnology the resulting materials are more precise, purer, stronger, and more durable due to the ability of the devices used in this technology to direct and arrange the atoms and molecules of materials in selected location to obtain the desired properties, the basis of nanotechnology it is possible to use it medically in diagnosing diseases as an anticipated application using luminous nanoparticles such as silicon or cadmium particles as optical detectors for biological materials in a serious attempt to find an effective solution to those disadvantages and problems that hinder current diagnostic methods using organic dyes where it is hoped that if the particles replace the dyes, they will provide higher sensitivity, accuracy, and ability to differentiate between living tissues and speed in performance which will reduce the time effort and cost spent in diagnosis currently, It is also used in managing and treating infectious diseases such as malaria and others, studies have made promising strides using this technology in creating extremely smooth and hard bone ceramics, which holds great promise for joint replacement and bone regeneration, some researchers have even been able to write gene code within DNA, furthermore medical researchers hope to develop nanotechnology into microscopic robots that can be injected into the body and remotely controlled to perform specific surgical procedures or monitor cellular functions, in addition to these successes in studying tracking and detecting cancerous cells particularly breast cancer using this technology some researchers in the field of science have also made significant progress infection and germ transmission using nanotechnology: coating instrument surface with a thin layer of silver at the nanoscale prevents germs from adhering to them a successful step in reducing hospital – acquired infections, furthermore, medical researchers hope that this technology will enable the rearrangement and distribution of nanoparticles on chips, known as superchips which will lead to updating and manufacturing smaller, faster, and less energy-consuming devices as well as a highly accurate detector that can be attached to cells infected with malignant diseases after coating them with smart, selective biological materials that drive them to search for diseased cells themselves to reveal them during diagnosis so that doctors can track them and send other granules loaded with the drug or substance that kills those malignant tumors while they are still in their infancy as a preventive treatment before the diseases worsens and becomes a malignant tumor with dire consequences, it is know that nanotechnology has a wide use in the world of pharmacy starting from the production of medicine and ending with how to give it to the patient a form that is far superior to current methods through its preservation and storage, this promising technology has also touched on food production and water purification which will bring good and denefit to humanity^[2,3]. The **(Figure 1)** below shows different methods for synthesizing silver nanoparticles

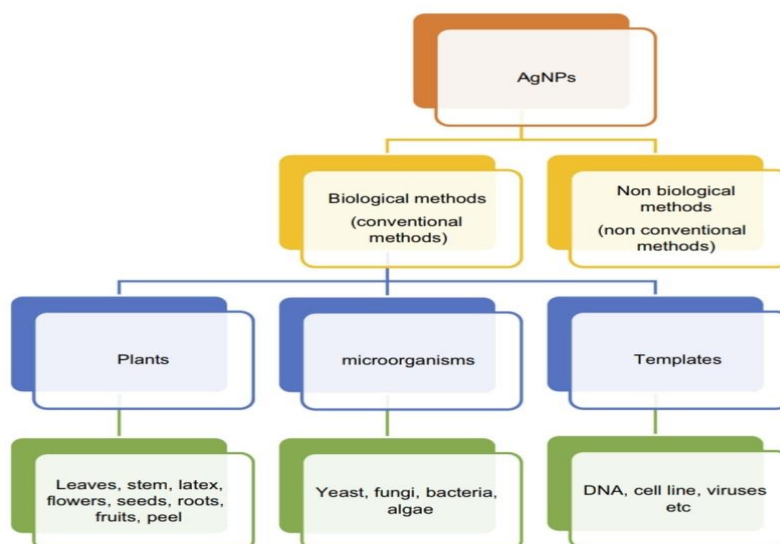


Figure 1. Various approaches to the of synthesis of (Ag NPs)^[4].

1.1. Different Methods for Preparing and Manufacturing Nanoparticles

Studying different methods for synthesizing nanoparticles is essential to obtaining the desired nanoparticles with specific sizes and shapes, these nanoparticles are candidates for commercialization and use in various application, including, imaging, medical application, catalysis, and environmental application. This review focuses mainly on the approaches used to produce nanoparticles and the different methods for synthesizing nanoparticles such as the chemical, physical and biological methods^[5].

1.2. Biological Methods for Nanoparticle Preparation and Synthesis

There are several types of bioreducing agents, safe and environmentally friendly bioreducing factors are distribution into 2 kinds: plant or microorganism based reducing and sugar dissociation based reducing agents, furthermore, the headmost kind of bioreducing agent includes various parts of plants, bacteria, fungi, yeast, amino acid, algae, etc. Among all these plants based reducing agents have many advantages over microorganism based reducing agents due to the age of NTS (Nuclear Substances) resulting from sudden changes, mutation or diseases caused by microorganisms, the second type of reducing agent such as sucrose, starch, fructose and glucose has been considered safe and convenient reducing agents.

1.2.1. Plant Used Synthesis of Composite Nanomaterials

The demand for the synthesis of green nanoparticles has raise to mitigate medium with dangerous normal issues, therefore green synthesis methods primarily consider biological combination, reduction processes centrifugation, boiling, and irradiation techniques offering various feature over previous ordinary methods, the following table presents previously studied report on plant mediated synthesis of various types of nanoparticles, Additionally, this table includes examples of specific plants, showing the plants structure and scientific name a picture of the corresponding reducing agent the plant part used in the preparation and finally the synthesis approach employed in the preparation process.

1.2.2. Biosynthesis of Nanoparticles Using Bacteria

Biosynthesis of nanoparticles using bacteria involves microorganisms such as bacteria, fungi, and viruses act as efficient biofactories for the production of metallic nanoparticles like Ag, Au, Pd, with cadmium sulphide, the utilize of microorganisms for nanomaterial synthesis has emerged as a novel method due to the their inherent detoxification metabolism, which involves the reduction of metal ions by biomineralization biosorption bioaccumulation or rainwater accumulation, Among microorganisms, bacteria can synthesis

inorganic metallic nanoparticles intracellularly or extracellularly. The extracellular technique involves the biosorption of metal ions either onto the cell wall surface or into the surrounding medium, while the intracellular method involves the synthesis of nanoparticles within the bacterial cell, some bacteria can grow and survive in environments with high concentration of metal ions due to their resistance to metals, mechanisms of resistance include reflux altered toxicity through enzymatic reduction or oxidation adsorption accumulation and finally the accumulation of rainwater on metals.

1.2.3. Biosynthesis of Nanoparticles Using Yeasts

Many researches have record on the formation of mineral nanomaterial using yeast, the synthesis of silver nanoparticles using baker's yeast has been demonstrated, it was reported that a silver tolerant yeast species was used to synthesize silver nanoparticles ranging in size from 2 to 5 nm.







1.2.4. Biosynthesis of Nanoparticles Using Fungi






Fung have been found be efficient in the biosynthesis of mineral based nanomaterial because the secretion of a large amount of fungal protein increases the ability to bind to metal ions in the intracellular space, using cells to from nanoparticles is faster and easier to maintain and cultivation and well-defined molecules can be synthesized on a large scale compared to other biological methods.

1.2.5. Biosynthesis of Nanoparticles Using Microorganisms

Microbiologically based nanoparticles manufacturing is slow with low productivity and nanoparticles recovery requires sophisticated downstream processing, Among environmentally friendly biological approaches plant inspired manufacturing has advantages over microbial methods because it eliminates technical labor reduces long bio cup time eliminates the need to microbial culture and sterile conditions throughout the process and has simple downstream process steps, It also exhibits a dual functional nature as reducing with stabilizing factors in a single batch, the biological synthesis of mineral oxide and metal nanomaterial using plant materials consists of (3) major procedures inclusive (1) Selection of solvent medium, (2) Selection of nontoxic reducing agents (3) Selection of environmentally friendly materials for stabilizing the nanomaterials. Below is a list containing nanomaterials synthesized using reducing agents found in various plants.

Table 1. List of nanoparticles synthesis using reducing agents^[5].

S. No	المؤلف وسنة التقرير	اسم النبات العلمي	الاسم العام للنبات	صورة عامل اختزال أخضر	جزء من المصنع	تحضير جسيمات النانوية
1 [11]	Tavakoli et al. 2013	<i>Punicanote granatum</i>	Pomegranate		Seeds	Copper iodide
2 [12]	Siddhiprada Shete et al. 2014	<i>Rosa macdub</i>	Rose		Petals	Silver chloride
3 [13]	Jayanta Kumar Patra et al. 2016	<i>Allium cepa</i>	Onion		Peel	Gold
4 [14]	Kokila et al.	<i>Carica Papaya</i>	Papaya		Peel	Silver
5 [15]	Balashanmugam et al.	<i>Citrus aurantium</i>	Orange		Peel	Silver
6 [16]	Kumaravel Palanisamy et al. 2014	<i>Emblica Officinalis</i>	Amla		Leaf	Silver

7 [17]	Prasanta Sutradhar et al. 2014	<i>Camellia sinensis</i> <i>Coffea arabica</i>	Tea, coffee		tea leaf coffee powd er	Copper oxide
8 [18]	Yuvasravana et al. 2018	<i>Punica granatum</i>	Pomegra nate		Peel	Copper oxide, zinc oxide
9 [19]	Padma S. Vankar et al. 2012	<i>Citrus limon</i>	Lemon		Leave s	Silver
10 [20]	Priya Pokale et al.	<i>Mimuso ps elengi</i>	Spanis h cherry		Bark	Calcium phosphate
11 [21]	Mallikarjuna et al. 2011	<i>Ocimum</i>	Tulsi		Leave s	Silver

2. Materials and Methods

2.1. Chemicals

Sliver nitrate (AgNO_3) purity 99.9%, its molecular weight is 169.87 g/mol, its density is 4.35 g/cm³, silver nitrate (AgNO_3) was Purchased from Sigma Aldrich, Cinnamomum plants, Filer paper, absolute ethanol was buy from Merck (KGaA, Germany) and (DDW) is used the work.

2.2. Instruments

X – ray diffraction (Xrd – 6000 Japan), Field Emission - Scanning electron microscope (FE-SEM), (JEOL JSM-6515L V Japan), Atomic force microscope (AFM) (AA300, Angstrom Advanced Inc, USA), Transmission Electron Microscope (TEM) (912AB, Germany), Furnace (K – MFO3 K&K Scientific, Korea), Ultrasound path (405 power sonic, Hwashin, koura), Hot plate stirrer (KMS-1003 Labtech, Korea).

2.3. Preparation of extract

Prepared Cinnamomum extract by collected dried plants were carefully washed with distilled water and dried in air. Then, the dried plants were divided into short parts (250) g adding 2L of deionized water. Then

heating at 60 °C for 15 minutes at room temperature, then prepared extract was filtered using whatman filter paper^[6].

2.4. Synthesis of Ag nanoparticles

Silver nanoparticles were prepared by adding 0.1g from AgNO₃ into 50 ml from Cinnamomum extract which was previously prepared and left at room temperature until color changed to beige, reference the consistence of nanomaterials of silver.

3. Result and Discussion

3.1. X-ray Diffraction pattern (XRD)

X-ray diffraction is a good method to diagnosis the crystalline normal of the substance. If a substance is crystalline, fine specific peaks are observed, whereas amorphous or non-crystalline systems appear a hollow than of fine specific peak. The sliver nanoparticles XRD emission appeared four clear peaks at the 2 Θ of 38.2°, 44.24°, 64.38°, 77.35°. And the XRD scheme of AgNPs is as exhibit in **(Figure 2)** the diffraction summits of AgNPs shown face-centered cubic (fc). The size of the silver nanoparticles was calculated based on the following equation^[7-10].

$$D=K \lambda/\beta\cos \Theta \quad (1)$$

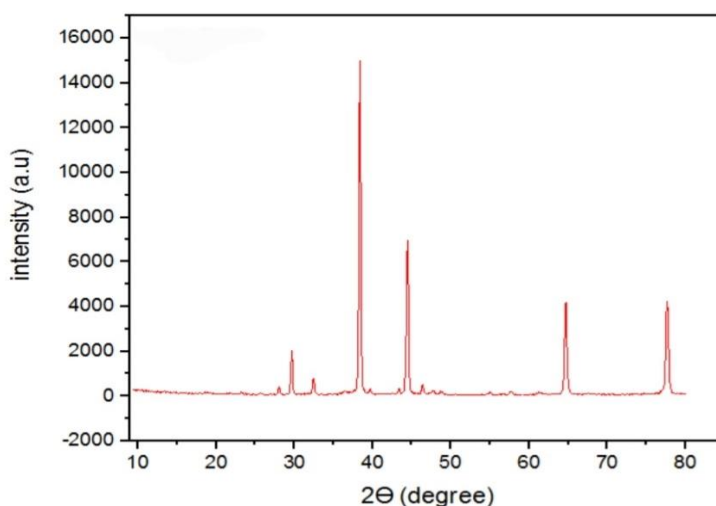


Figure 2. XRD patterns of synthesized (Ag NPs).

3.2. Field Emission- Scanning Electron Microscopy (FE-SEM)

Technique Field Emission-Scanning Electron Microscopy was utilized to diagnosis the morphology surface, figure, size and arrangement of the nanomaterials formed. **(Figure 3)** exhibit the particles are uniformly hexagonal and spherical crystal homogeneity higher quality with the diameter of Ag nanoparticles was in the range of 1-100 nm. Observed no potential figure irregularities or deform^[11-14].

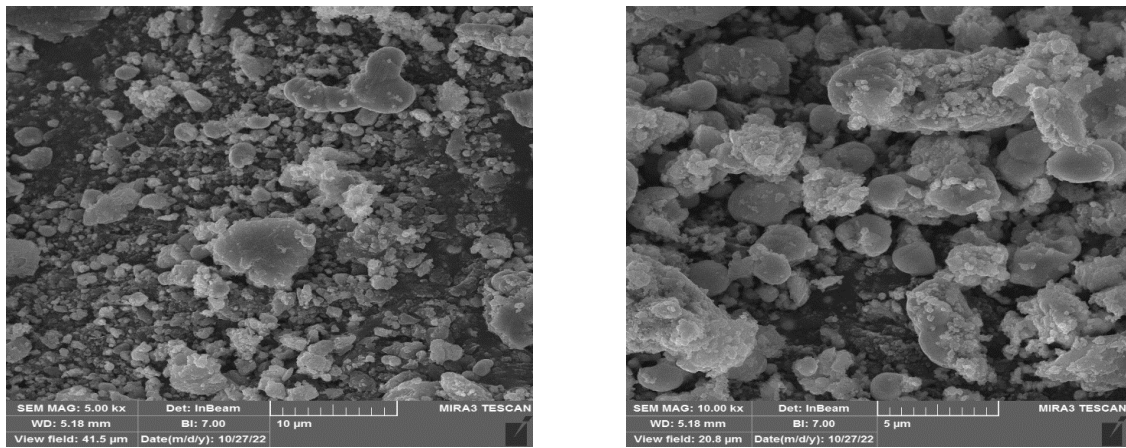


Figure 3. FE-SEM images of synthesized (Ag NPs).

3.3. Atomic Force Microscopy (AFM)

Utilizing eco-friendly ways, the (FAM) was used to determine the structure morphology of the Ag NPs, the (FAM) of silver nanoparticles (Figure 4) exhibits both two-dimensional (2D) and three-dimensional (3D) image of the Ag NPs show rhomboid bipyramid shape and were formation with perfect crystallinity and keen brink homogeneity and regularity with surface leveling 0%. Observed when increases concentration of Ag NPs, that can result increase probability of conglomerate in the array^[15-17].

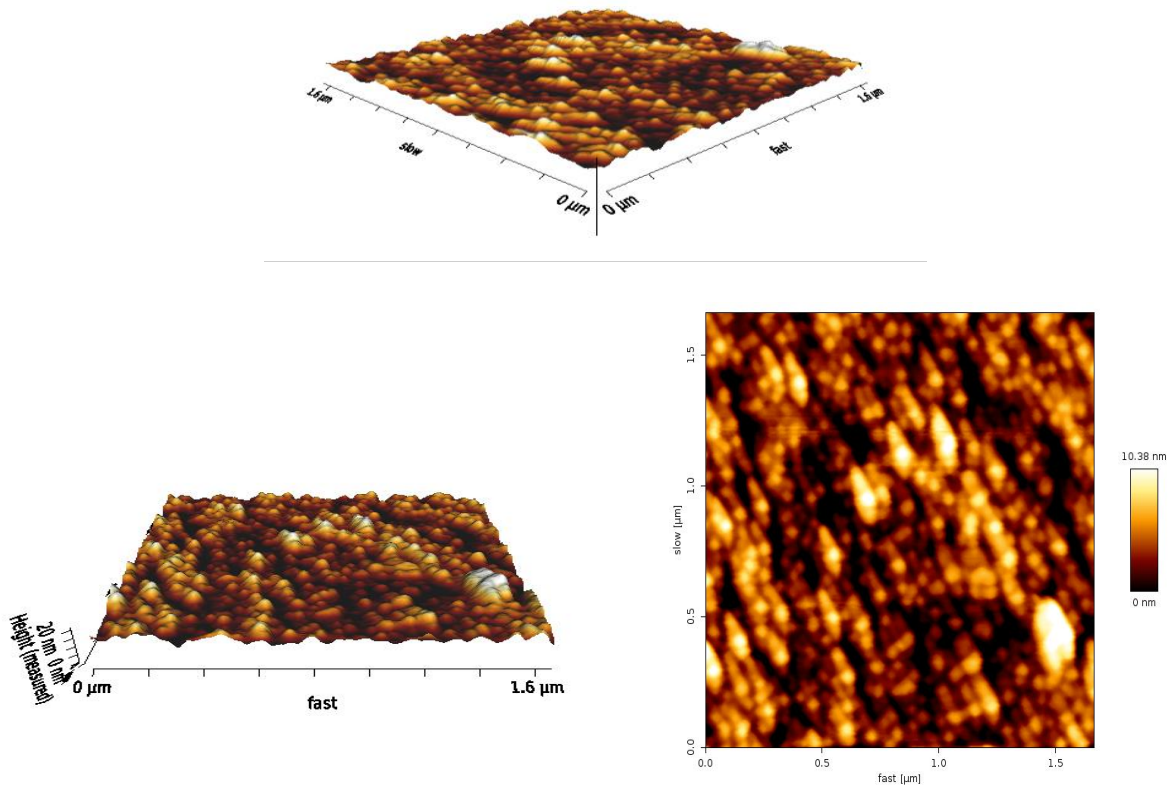


Figure 4. Images AFM of synthesized (Ag NPs).

3.4. Transmission Electron Microscopy (TEM)

Transmission Electron Microscopy analysis was used to determine particles dimension and scale procedure on a small of 100 nm. The photo (**Figure 5**) of silver nanomaterials shows shapes spheroidal, there is a fair amount appear the form small aggregate, multiple disperse, untidy deposition^[18-20].

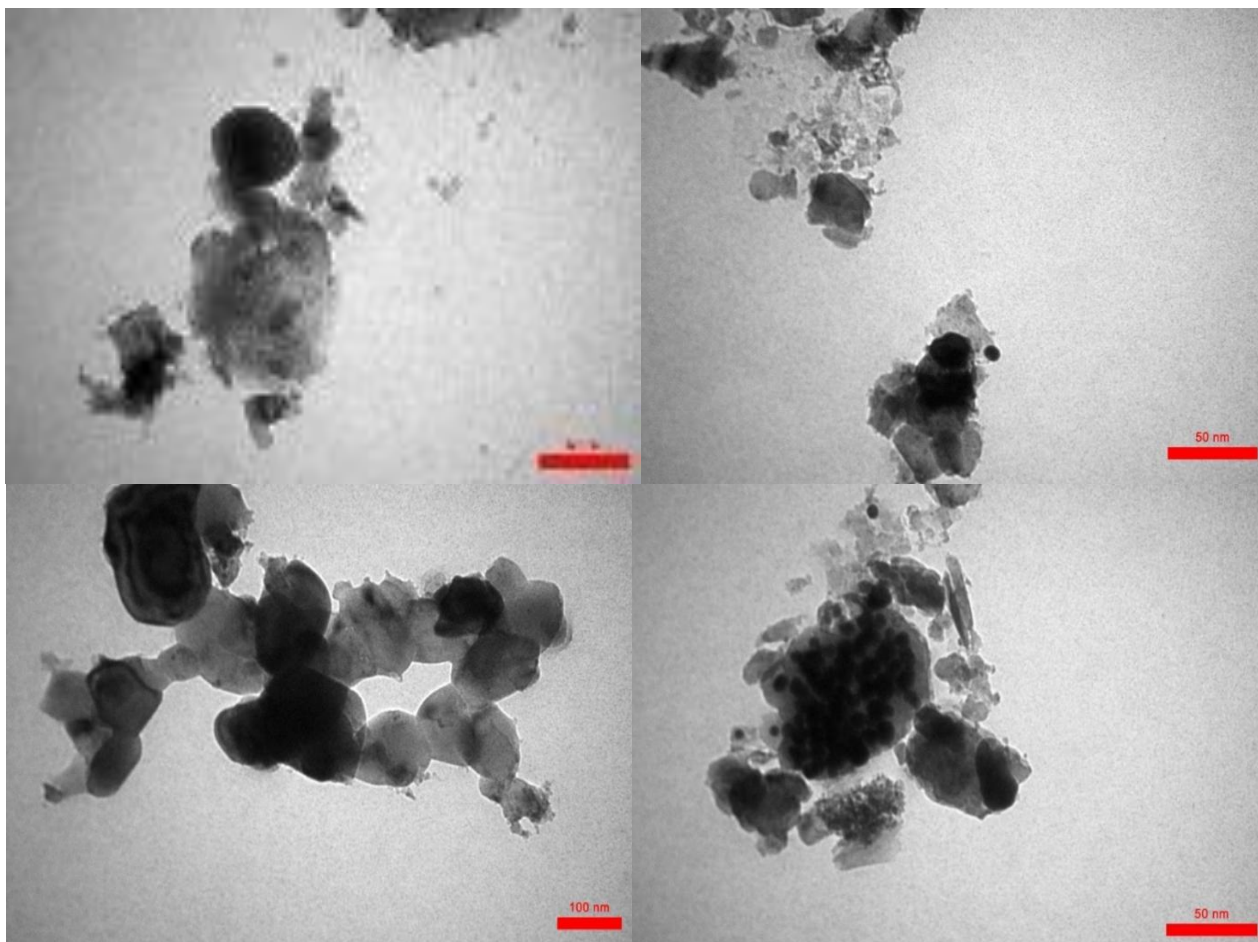


Figure 5. TEM images of synthesized (Ag NPs).

Conflict of interest

The authors declare no conflict of interest.

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