GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *Salvadora persica* AS A BIOREACTOR

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ABSTRACT: Silver nanoparticles were synthesised by the interaction of leaf extract of *Salvadora persica* with 1mM silver nitrate solution via Green synthesis. The characterization of the synthesised silver nanoparticles was carried out using techniques such as UV – Visible spectroscopy, FTIR and TEM techniques. The preliminary result was provided by the absorption peak obtained in UV – Visible, while the bio-reduction of silver ion along with various functional groups were observed through FTIR. TEM analysis confirmed the morphology and size of the synthesised silver nanoparticles.

Keywords: **Silver nanoparticles, *Salvadora persica*, Green method, characterization.**

I. INTRODUCTION

Nanotechnology is an emerging field of interdisciplinary research which utilizes the nano – based system [1]. In nanotechnology, a particle with size ranging between 1 to 100 nm and having an interfacial layer is known as nanoparticle. These nanoparticles are known to have many potential applications in different fields of science such as physics, medicine, organic chemistry, surface science, molecular biology, etc. The synthesis of nanoparticles can be carried out by physical and chemical methods. The physical methods generally involve reduction of the material to nanosize dimension by methods like etching, thermal decomposition, etc. On the other hand, chemical methods require construction of the nanoparticles. With the increasing concerns regarding the environment, the chemical methods are more preferred than the physical methods [2, 3]. However, the chemical synthesis methods generally require the usage of toxic chemical reducing reagents. Hence these conventional methods have limitations such as generation of hazardous chemicals, expensive, shortage of raw materials, etc. Therefore, the researchers focused on developing methods that are safe, clean, environmental friendly and cost effective [4-6].

The green synthesis method concentrates more on how to maximize the efficiency of chemical method without compromising the safety concern of the product i.e. working on green chemistry [7]. The biosynthesis of nanoparticles involves the bio - reduction of the metals using organisms as bioreactors. The synthesised nanoparticles are highly stable and well characterized when carried out at controlled conditions such as temperature, pH, substrate concentration, centrifugation, etc. Green synthesis using fungus, micro – organisms [8-10], enzymes [11], and plants [12-14] as bioreactors, has caught attention of various researches and scientists in recent times due to it being eco – friendly, clean and cost effective in nature.

Silver, a noble metal, exhibits highest level of electrical conductivity, thermal conductivity and reflectivity. It is used solar panels, jewellery, ornaments, conductors, etc. Silver shows oligodynamic effect i.e. the silver ions show toxic effect on living cells, algae, molds, spores, fungi, viruses, etc. even in low concentrations. Hence, dilute solutions of silver nitrate ($AgNO_3$) and other silver compounds show antimicrobial activity and are used for various medical applications such as disinfectants, micrbiocides, wound dressing, etc. The green synthesis of silver nanoparticles has been accomplished by using plants, fungi and other living organisms [15]. Silver nanoparticles are applicable in clothing [16], food [17], cosmetics and sunscreens [18, 19], purification of drinking water, degradation of pesticides and killing human pathogenic bacteria [20].

Out of the various bioreactors used in the green synthesis of nanoparticles, plants and plant extracts are more preferable as they are low maintenance and easily acquired. The process involved in synthesising nanoparticles with plant as bioreactors is less elaborate and much cheaper than other organisms. Mangroves are reported to have many uses and possess various types of phytochemicals. The chemical constituents present in mangroves have toxicological, pharmacological and ecological importance [21]. *Salvadora persica* is a mangrove commonly known as Miswak or toothbrush tree, which has been in use for centuries. It is mainly found around coastal regions and creeks and is widely distributed all over the world. *S. persica* is used as natural toothbrush and has been promoted for oral hygiene by World Health Organisation (WHO). The main objective was to carry out the green synthesis of silver nanoparticles, by bio - reduction of the silver ions with the aqueous extract of leaves of *S. persica*. This biogenic process of synthesising silver nanoparticles was cost effective and time saving and hence, an efficient alternative to the conventional methods.

II. MATERIALS AND METHOD

The leaves of *Salvadora persica* are used for the synthesis of silver nanoparticles. The *S. persica* leaves were collected from Naigaon, Mumbai. The identification was carried out at K. B. P College, Sangli.

Leaves of *Salvadora persica*

Tree of *Salvadora persica*

2.1. Preparation of plant extract

The leaves of *S. persica* were thoroughly washed and shadow dried. The dried leaves were then grinded into a fine powder using an electric blender. 10 grams of powdered *S. persica* leaves was then mixed with 100 ml of distilled water and boiled for 20 minutes. After boiling, the decoction was filtered through Whatmann filter paper no. 1 and allowed to cool. The required volume of the plant extract was used for the nanoparticle synthesis, while the remaining extract was stored in the refrigerator at 4°C.

2.2. Preparation of 1mM $AgNO_3$ solution

Silver nitrate solution was used in the synthesis of nanoparticles. The concentration of the solution was 1mM and 0.169g of silver nitrate was weighed and dissolved in 1000 ml of distilled water.

1000 cm^3 of 1M $AgNO_3$ = 169.87g

1000 cm^3 of 0.001M (1mM) $AgNO_3$ = 0.169g

2.3. Synthesis of Silver nanoparticles

10 ml of the plant extract was mixed with 100 ml of 1mM silver nitrate solution at the room temperature. On addition of $AgNO_3$ solution, the colour change of plant extract was observed. On exposure to sunlight, the intensity of the colour increased. This colour change was observed for 30 minutes with a time period of 5 minutes, with constant shaking and exposure to sunlight.

III. CHARACTERIZATION OF AgNPS

The silver nanoparticle solution was sonicated for 3 minutes before the analysis.

The plant extract, 1mM $AgNO_3$ solution and silver nanoparticle solution was monitored using UV - Visible spectrophotometer. The analysis was carried out in the range of wavelength between 200 to 600nm. The analysis showed the absorbance peak in the range of 390nm to 400nm.

The Fourier Transform Infra-Red spectroscopy (FTIR) of *Salvadora persica* plant extract, 1mM $AgNO_3$ solution and silver nanoparticles was carried out for determining the changes and different functional groups that are present in the nanoparticle solution.

The morphology and size of the silver nanoparticles was confirmed by Transmission Electron Microscopy (TEM).

IV. RESULT AND DISCUSSION

4.1. UV – Visible spectrophotometer – Silver nitrate (1mM), when mixed with plant extract at room temperature, showed colour change in the solution. This solution was analyzed at different time periods in order to observe the gradual changes that take place in this solution. The absorbance peak was observed at 393nm. The colour changes were due to the excitation of surface plasmons and this indicated the presence of silver nanoparticles in their respective solutions. Also, the exposure to sunlight increased the intensity of colour which is caused due to the excitation of silver ions.

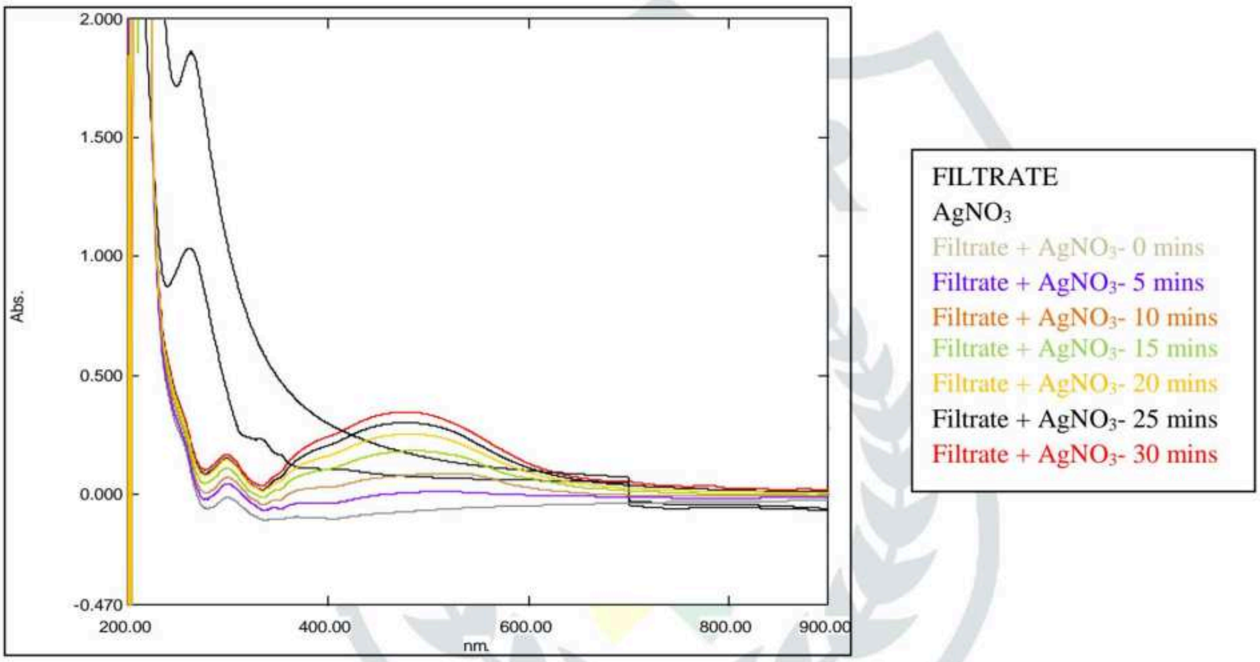


Figure no. 1: UV - Visible of *Salvadora persica* extract, 1mM $AgNO_3$ solution and Silver nanoparticle solution

4.2 FTIR analysis –

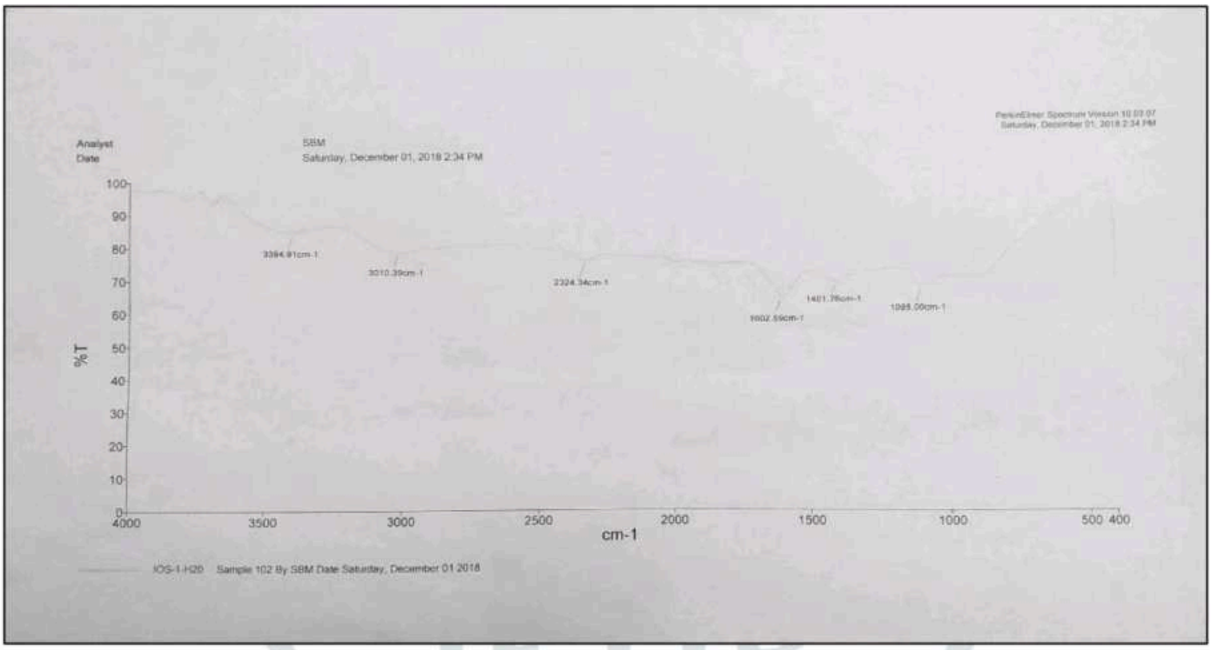


Figure no. 2: FTIR of *Salvadora persica* extract

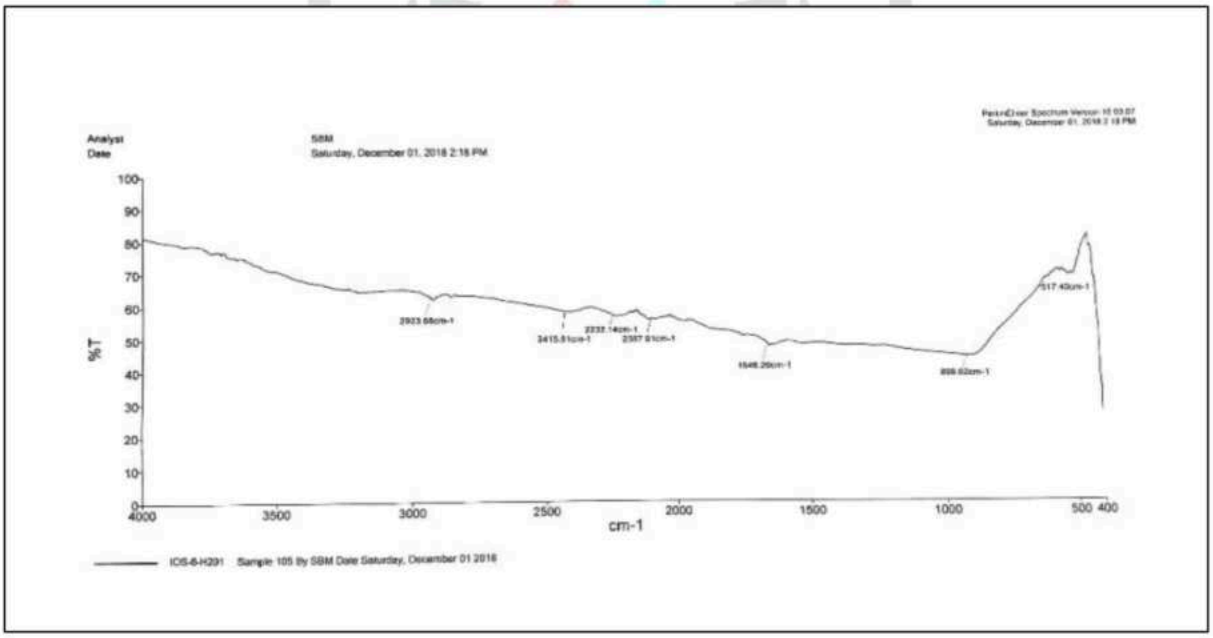


Figure No. 3: FTIR of 1mM $AgNO_3$ solution

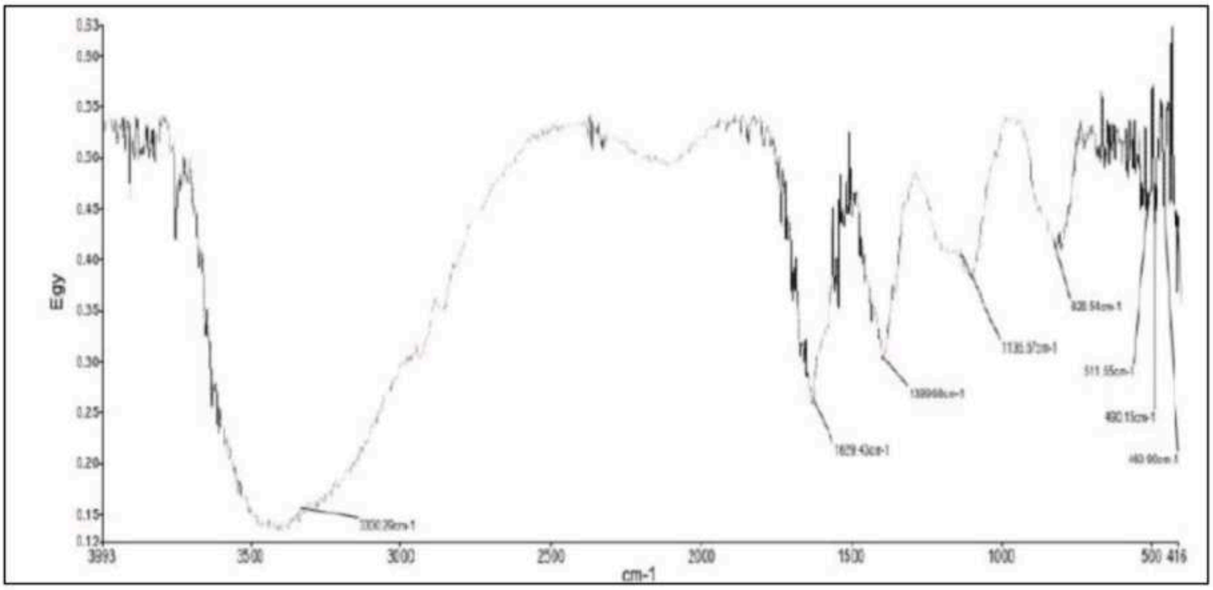
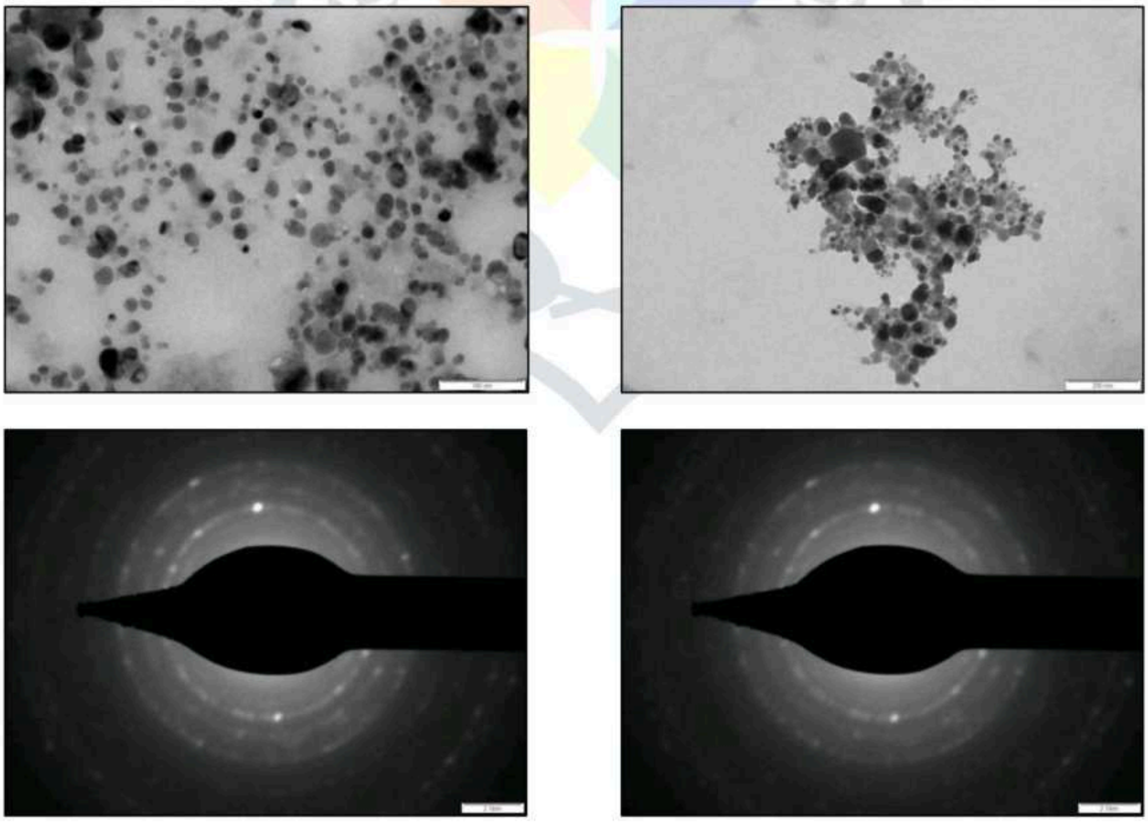


Figure No. 4: FTIR of Silver nanoparticles

In Figure no. 4, the broad peak at 3330.29 cm^{-1} corresponds to O – H stretching H- bonded alcohols and phenols. The peak at 1629.43 cm^{-1} corresponds to C=O carbonyl stretching of carbonyl group. While 1399.68 cm^{-1} corresponds to CH_2 and CH_3 deformation, the peak at 1136.67 cm^{-1} corresponds to C – O stretching of secondary alcohol. Thus the nanoparticles synthesized were surrounded by proteins and metabolites having functional groups such as phenols, aldehydes, ketones, alcohols, etc. The phenolic group has more affinity to bind with the metal ion and may be acting as a capping agent, thereby reducing agglomeration. This suggests that the biological groups can play a dual role for formation and stabilization of the nanoparticles.

4.3. TEM analysis – The TEM analysis confirmed the formation of silver nanoparticles from *Salvadora persica* leaves extract. The nanoparticles were observed to be spherical in shape and the size ranged from 20 to 50 nm, with the average size of 44nm.



V. CONLUSION

Due to the recent times, it has become necessary to develop methods that are not only beneficial, but also eco – friendly. The method to synthesize silver nanoparticles using *Salvadora persica* as a precursor is simple, inexpensive and time saving. They can be further studied for their antimicrobial potential and applications.

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