Synthesis of Silver Nanoparticles by Using *Ocimum Sanctum* Leaf Extract and Detection of Antibacterial Activity

Jyoti Boken[1], Monika Sharma[2],Chandrakant Sharma[2], Dinesh Kumar[3]

[1]Deparment of physics, Banasthali Vidyapith-304022, Rajasthan, INDIA
[2]Department of Bioscience and Biotechnology, Banasthali Vidyapith-304022, Rajasthan
[3]Department of Chemistry, Banasthali Vidyapith-304022, Rajasthan, INDIA

ABSTRACT

The field of green nanotechnology is one of the major research interest towards cost effective and ecofriendly method for the biosynthesis of nanoparticles as well as not require sophisticated equipments and toxic chemicals. The paper deals with differently synthesized silver nanoparticles by using Ocimum Sanctum leaf extract. The surface plasmon resonance peak obtained at 431 nm confirmed the silver nanoparticles synthesis. It was also examined that leaf extract can reduce silver ions into silver nanoparticles within 5 min of reaction time. The present analysis explains the fabrication of extremely stable silver nanoparticles by using Ocimum Sanctum of leaf extract. We can also observe their antibacterial activity by these nanoparticles. Formation of silver nanoparticles was characterized by UV-visible spectroscopy, FTIR, XRD and scanning electron microscopy.

Keywords: Silver nanoparticles, Green synthesis, Fresh leaves of Ocimum Sanctum.

1. INTRODUCTION

In recent years, metallic nanoparticles have received great interest due to their unique physicochemical characteristics including optical, catalytic activity, antibacterial, electronic and magnetic properties [1]. Metallic nanoparticles have high surface to volume ratio. Generally, farbrication of nanoparticles carried out by physical and chemical methods. Mostly, these methods are very expensive and require high temperature, high presserure and toxic chemicals [2]. That's why we need to use ecofriendly and environmentally nontoxic methods for the fabrication of metallic nanoparticles. The green synthesis methods are cost effective, ecofriendly and usually lead to the formation of crystalline nanoparticles [3]. Using of these methods, we can produce different shape and size of the particles by varying the parameters such as amount of plant extract, temperature, pH, reaction time as well as most important concentration of metal salts [4]. Plants offer a better platform for nanoparticle fabrication as they are free from toxic chemicals as well as provide natural capping agents and it is also good for the stabily purposes [5]. In this paper, we present cost effective method for developing Ag nanoparticles by using leaves extract of *Ocimum Sanctum* and examines its antibacterial activity. This study chooses for the fabrication of silver nanoparticles which is a novel study, since there is limited information on the use and its stability for processing antibacterial activity.

2. 2. MATERIALS AND METHODS

2.1. Preparation of leaf extract

Ocimum Sanctum leaves were collected from surroundings of the Banasthali University, Rajasthan, India. The fresh leaf of *Ocimum Sanctum* was used for the reduction of Ag^+ ions to Ag^0. 5 gm leaves were prepared in 100 mL distilled water and then boiling the mixture at 80^0 C for 1 h. The extract was filtered and stored at 4^0 C in order to be used for further experiments.

2.2. Synthesis of silver nanoparticles

1mM silver nitrate from Sigma Aldrich was prepared in 100 mL of Milli Q water at room temperature. The aqueous solution was mixed with 5 mL of leaf extract for bio-reduction process at room temperature and observed for change in color.

2.3. Particle characterization

Optical absorption measurements have been carried out using Perkin-Elmer Lambda 750 Spectrometer in the UV-Vis spectrophotometer. The morphology of the nanoparticles have been monitored using Scanning Electron Microscope (SEM). Fourier transformation infrared (FTIR) spectrometer have been used to receive information of element to element bounding or interaction. The crystalline phase of the nanoparticles have determined by X-ray diffraction (XRD) analysis.

2.4. Antibacterial Assay

For the antibacterial activity, we have used well diffusion method against human pathogenic bacteria such as *Escherichia coli*. For cultivation of the bacteria, we have used Nutrient agar. 50 µL of fresh grown culture of the bacteria was spread on petri plates with a hole punched in the media.Then, different amount of nanoparticles was inocultaed in this hole and all the plates were stored at 37^0 C for 24 h. Further, we observed zone of inhibition of silver nanoparticles against *Escherichia coli* bacterial strain.

3. RESULTS AND DISCUSSION

The addition of leaf extract into aqueous solution of silver nitrate resulted in the change in color from light yellow to brown. Silver particles exhibit brown color due to excitation of surface plasmon resonance. We observed the reduction rate and formation of nanoparticles depend on temperature and concentration of silver nitrate as well as leaf extract in the solution.

3.1. Optical Properties analysis

It is well known that silver nanoparticles show yellowish brown color due to the excitation of surface plasmon resonance. Due to addition of leaf extract to aqueous solution of silver nitrate resulted in the color change of the solution. Reduction of silver ions into aqueous solution of silver nanoparticles was observed by UV-Vis spectroscopy. This spectroscopy could be used to examine size and shape of the nanoparticles. We observed that the appearance of a absorbance peak increased in intensity with time. We also observed that the formation of silver nanoparticles within 1 h. UV-Vis absorption spectra monitored at 431 nm as shown in **Figure 1.**

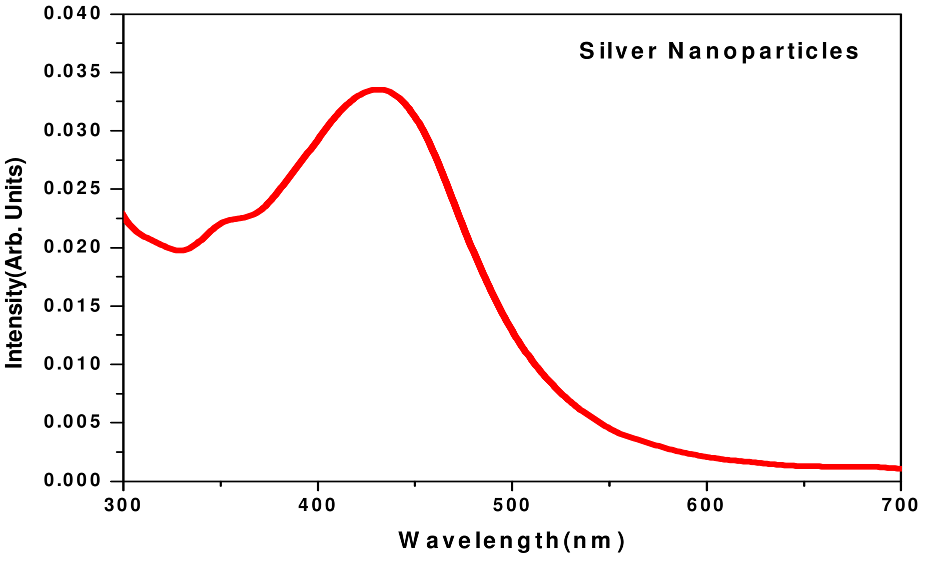

Figure 1: UV-Visible spectra of silver nanoparticles form leaves extract of *Ocimum Sanctum*

3.2. Particle morphology analysis

To determine the morphology of the silver nanoparticles, the sample was measured with scanning electron microscope. This analysis of silver nanoparticles provides the information regarding the dimensions such as shape and size of the particles. The sample was measured by sonicating the sample for 30 mins at room temperature and a small drop was dried on a glass slide and it was coated by gold and monitored by scanning electron microscope. The SEM analysis shows that the silver nanoparticles have spherical in shape and size range from 10-20 nm as shown in **Figure 2**.

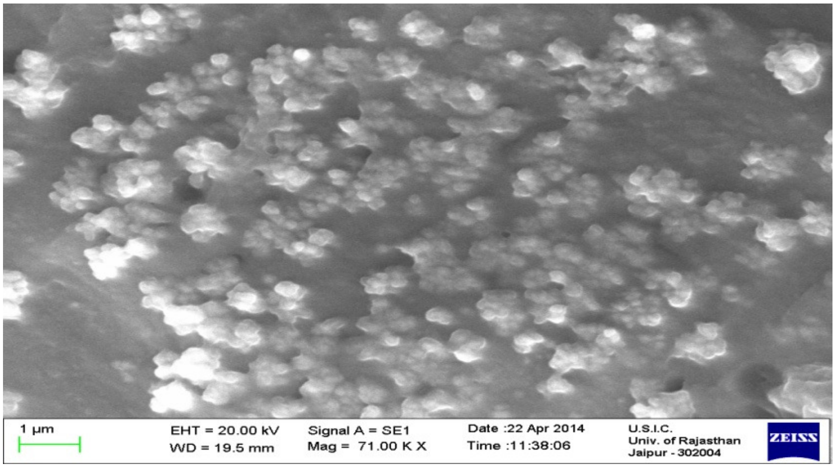

Figure 2: SEM image of synthesized silver nanoparticles using leaves extract of *Ocimum Sanctum*

3.3. Fourier transform infrared spectral analysis

The FTIR analysis of silver nanoparticles showed sharp absorption peaks at 1640 cm^{-1} and 3440 cm^{-1}. The absorption peak at 1640 cm^{-1} may be attributed to the amide I bond of proteins arising due to carbonyl stretch in proteins and peaks at 3440 cm^{1} are assigned due to OH stretching in alcohols and phenolic compounds. These studies confirmed that carbonyl group have strong binding ability with metal nanoparticles and acting as capping agents [6]. These absorption peaks are shown in **Figure 3**.

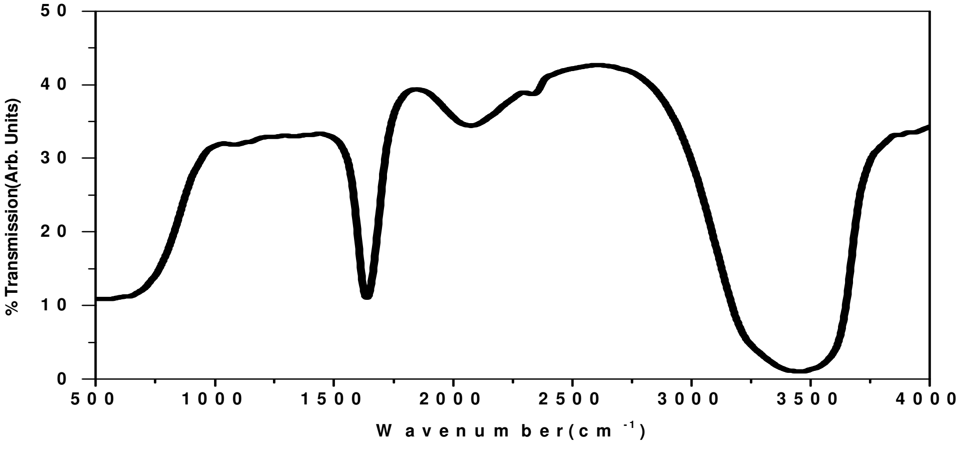

Figure 3: FTIR spectrum of silver nnaoparticles form leaves extract of *Ocimum Sanctum*

3.4. XRD analysis

The XRD pattern of prepared silver nanoparticles in the 2θ range 20^0 to 80^0 is shown in **Figure 4**. Diffraction peaks corresponding to face centered cubic (fcc) structure of silver indicating the amorphous in nature of the sample. Intense peaks can be assigned at 37.74^0, 43.96^0, 64.07^0 and 76.95^0 corresponding to the 111, 200, 220 and 311 facets of the silver crystal, respectively. The broadening of Bragg peaks indicates the formation of nanoparticles. To determine the average particle size, we can used full width half maxima data with Scherrer's formula.

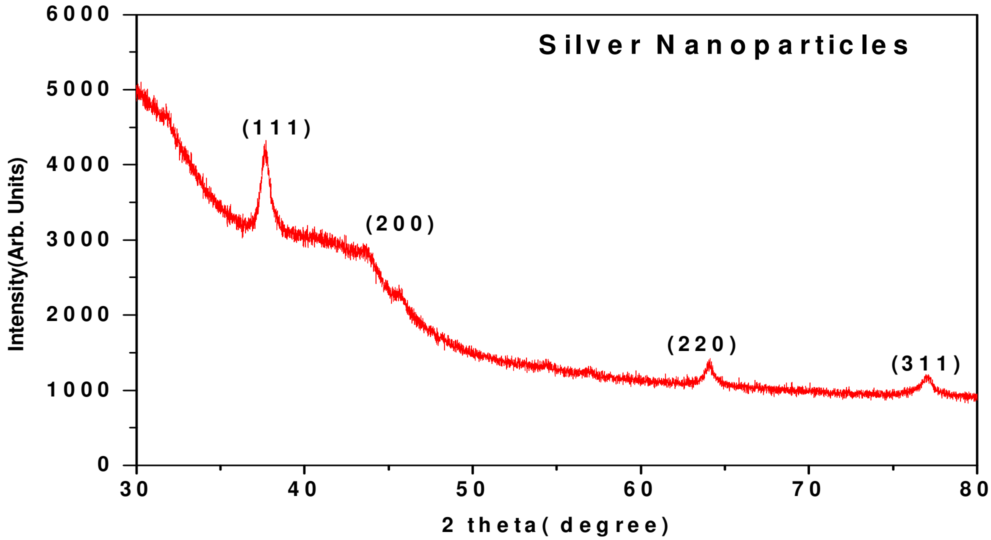

Figure 4: XRD pattern of silver nanoparticles using *Ocimum Sanctum* leaf extract

3.5. Antibacterial activity analysis

Antibacterial activity of silver nanoparticles synthesized by using green synthesis method and was observed against *Escherichia coli* bacteria which are present in the drinking water. Then, we observed zone of inhibition. The results indicates that silver nanoparticles synthesized from *Ocimum Sanctum* leaf extract revealed effective antibacterial activity. The antibacterial activity was examined using disc diffusion method, which is used to identify the sensitivity of bacterial strains towards antibiotics with a zone of inhibition towards antiboitics. The mean diameter of zone of inhibition in mm are given in **Table 1**. This results revealed that synthesized silver nanoparticles using *Ocimum Sanctum* leaf extract showed good inhibition against *Escherichia coli* bacterial strains [7].

Table 1: Antibacterial activity of synthesized siliver nanoparticles using *Ocimum Sanctum* leaf extract.

Name of microorganism	Zone of Inhibition in mm		
	Gentamicin(10μg/disc)	Concentration of silver Nanoparticles (μL)	Silver Nanoparticles
Escherichia Coli	30	5	0.5
	30	10	0.9
	30	20	1.0
	30	30	1.5
	30	40	2.3

4. CONCLUSION

By using green chemistry, the silver nanoparticles have prepared using *Ocimum Sanctum* leaf extract which is a non toxic. The synthesized silver nanoparticles using leaf extract exhibit good stability as well as good antibacterial activity against *Escherichia coli* bacterial strain. We can be used effectively these particles more than one month. Due to good stability, silver nanoparticles could be used for biomedical as well as sensor applications. Thus, we can be concluded that plant extract could be used in various fields due to good stability, cost effective and ecofriendly method for the biosynthesis of nanoparticles as well as not require sophisticated equipments and toxic chemicals in the reactions.

5. ACKNOWLEDGEMENTS

One author (Jyoti Boken) is thankful to Department of Science and Technology (DST), New Delhi for its financial assistance, grant no F. No.SR/WOS-A/PS-35/2010. We are also thankful to Professor Aditya Shastri, Vice Chancellor of Banasthali Vidyapith for kindly extending the facilities of ''Banasthali Centre for Education and Research in Basic Sciences" sanctioned under CURIE programme of the Department of Science and Technology, New Delhi.

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