GREEN SYNTHESIS OF SILVER NANOPARTICLES USING SEED EXTRACT OF MORINGA OLEIFERA MEDICINAL PLANT

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***Abstract :** Nanobiotechnology has emerged as a promising technology to develop new therapeutically active nanomaterials. To avoid the chemical toxicity, biosynthesis (green synthesis) of metal nanoparticles is proposed as a cost-effective and environmental friendly alternative. seed extract of Moringa oleifera is a medicinal agent in this work to prepare silver nanoparticle. From XRD it was found that sample posssess Face Centered Cubic structure and has crystalline size of 22.08 nm. FTIR results proved that the components in Moringa oleifera seeds act as good reductants and stabilizers for the silver nanoparticles.The absorption in the visible region and broad peak at 480 nm was studied by UV studies. The antibacterial activity of bio-synthesized silver nanoparticles were analyzed against E.coli, Klebsiella, Pseudomonous, Staphylococcus bacteria. The results revealed that the seed extract is an excellent bioreductant for the synthesis of silver nanoparticles.*

***Keywords:** Biosynthesis; Ag nanoparticles; XRD; FTIR ; UV-visible ; Antimicrobial activity*

I. INTRODUCTION

Nanotechnology is a broad interdisciplinary area of research, development and industrial activity which has grown very rapidly all over the world for the past decade. Silver nanoparticles (AgNPs) are very important among the most widely used metal nanoparticles. They can be synthesized using different methods including physical and chemical methods [1, 2], electrochemical reduction [3], photochemical reduction [4] and heat evaporation [5]. Most of the methods reported in the literature are extremely expensive and also involve the use of toxic, hazardous chemicals such as stabilizers which may pose potential environmental and biological risks. Because of the increasing environmental concerns by chemical synthesis routes, an environmentally sustainable synthesis process has led to biomimetic approaches, which refers to applying biological principles in materials formation [6].The use of plant extracts to synthesize nanoparticles is receiving attention in recent times because of its simplicity. Also, the processes are readily scalable and may be less expensive. Plant extracts may act both as reducing agents and stabilizing agents in the synthesis of nanoparticles. A number of plant extract mediated synthesis of AgNPs have been reported in the literature.The aim of the current study was synthesis and optimization of AgNPs using seeds extract of *Moringa oleifera*. Characterization of silver nanoparticles using UV–Vis spectroscopy, XRD, FT-IR,and evaluation of the bactericidal activities againstStaphylococcus aureus, Escherichia E-coli andto check their biomedical importance.

II. MATERIALS AND METHODS

*Moringaoleifera*seeds were collected from Tirunelveli District, Tamilnadu, India. The seedswere thoroughly washed thrice with double distilled water to remove dust particles, and made into a fine powder . Then 5 gm of the seeds powder was mixed well with 100 ml of double-distilled water and boiled at 60 ºC for 30 min. Afterboiling, the extract was filtered through filter paper. The supernatant was collected and stored at 4 ºC for further nanoparticles process. 1mM aqueous solution of Silver nitrate (AgNO3) was prepared and used for the synthesis of silver nanoparticles. 1 ml of M.oleifera(*Moringa oleifera*) seeds extract was added into 100 ml of aqueous solution of 1 mM silver nitrate for reduction of Ag+ ions and kept at room temperature for 24 hours. Formation of reddish brown colour confirmed the silver nanoparticles.

III.STRUCTURAL STUDIES

X-ray diffraction (XRD) pattern of green synthesized Ag NPs using seed of MO plant (SMOS) was recorded in the 2θ range 20–80° shown in Fig.1. The XRD pattern shows the face center cubic structure of silver crystal, having diffraction peaks at 38, 44.3, 64, 42 and 77.2° correspond to (111), (200), (220) and (311) planes.. The highest peak intensity of (111) plane with narrow FWHM illustrates the good crystalline nature of synthesized Ag NPs as observed from the XRD images. The average crystallite size of Ag NPs is calculated from well-known Scherrer's formula. Calculated mean crystallite size was found to be 22.08 nm. XRD pattern of present sample (SMOS) coincides with JCPDF file number 43-1038.

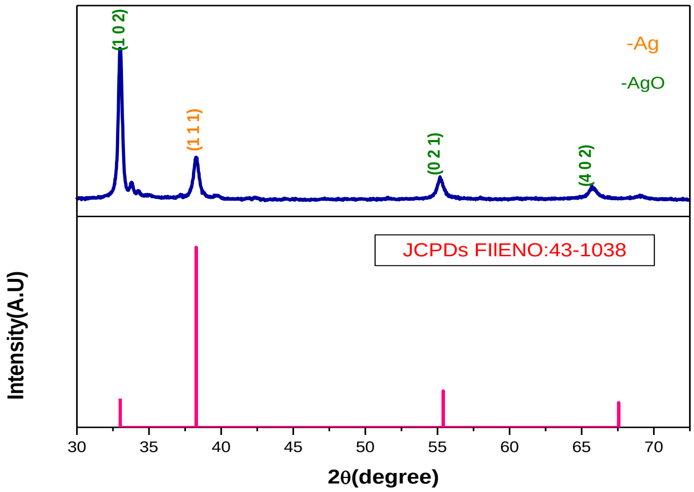

Figure 1: XRD pattern of SMOS sample

II. FTIR SPECTRAL ANALYSIS

FT-IRspectrum of Ag nanoparticles synthesized by *Moringa oleifera* seeds shown in figure 2. From the spectrum the broad absorption peak is observed from 2950 cm^{-1} associated with the stretching vibrations of-C-O, C-H ,C=C,CH_2 and O-H [8].The peak at 1629 cm^{-1} it clearly suggests that the O-H and C=O groups were absorbed on the surface of Ag nanoparticles and involved in the reduction process [9] . The peak at 1458 cm^{-1} due to presence of O-H bending. The absorption peak at 1581 cm-^{1} due to presence of C-OH bending [10].The peak at 1289 cm-^{1} result is functional group of such as –C-C-H, C=0 and –CH. The peak at 1058 cm-^{1} due to presence of amide I [10]. The absorption peak at the 1029 cm^{-1}could be attributed to the presence of C-O stretching and secondary O-H group [12]. The absorption peak at 966 and 981cm-^{1} is due to the presence of silver nanoparticles. The peak at 627 cm^{-1} is due to the presence of C-H bond alkyl stretching. The band recorded at 489 cm^{-1} . Spectra of the synthesized material were assigned to strong COO- Stretching The broad peak at 458 cm^{-1}corresponds to spectra of the synthesized material were assigned to C-H bending and metal [11].

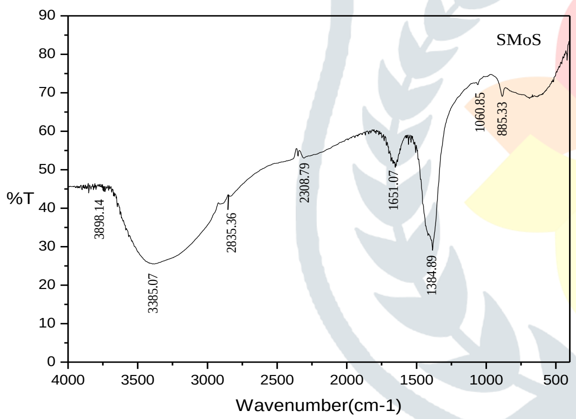

Figure 2: FTIR spectrum of SMOS sample

III. UV–VIS SPECTRAL STUDIES

It is well known that silver nanoparticles exhibit yellowish brown color in aqueous solution due to excitation of surface Plasmon vibrations in silver nanoparticles. The seeds extract was mixed in the aqueous solution of the silver ion complex, it started to change the colour from light green to dark brownish due to reduction of silver ion, which may be the indication of formation AgNP's .The UV-spectrum of Ag-Np's was recorded from the reaction medium. The results showed maximum absorption peak ranging between 310 – 320 nm (Fig.3)

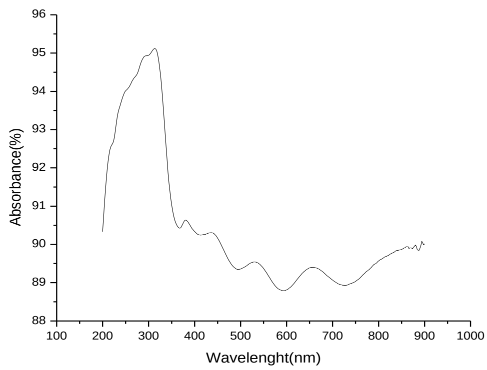

Figure 3: Uv-Visible absorption spectrum of SMOS sample

IV. ANTIMICROBIAL ACTIVITY

Synthesized Ag NPs were examined about their antibacterial activity against the bacterial strains of *Escherichia coli (E. coli)* and *Staphylococcus aureus (S. aureus)* using well diffusion technique. The zone of inhibition around the well is shown in figure 4. From Figure 4, it is noted that synthesized Ag NPs show significant impact on the growth of bacteria around the well. No inhibition zone was observed for control, prepared by the stack solution taken in well without Ag NPs. The antibacterial activity of Ag NPs increases gradually as the stack solution increases from 50 to 200 µL. The antibacterial activity of Ag NPs should be associated with several mechanisms including (i) generation of Reactive Oxygen Species (ROS) like super oxide anions (O_2^-) and hydroxyl radicals ($OH^\bullet$), (ii) the presence of Ag^+ ions in Ag NPs are making bond with sulphhydryl groups which direct to de-naturation of proteins in the bacteria [12] and (iii) release of Ag^+ ions from the Ag NPs which simply penetrate into the cell wall and cause severe damage to the bacteria and kill them. Moreover, nanosized Ag NPs were attached to the bacteria and disturb the usual function of bacteria and hence damage severely to outer surface of the bacteria such as DNA, lipids and proteins. From Figure 4, it is found that Ag NPs have robust antibacterial activity on *E. coli* (Gram negative) than *S. aureus* (Gram positive) bacteria. This greater antibacterial activity against gram negative bacteria is ascribed to the variation in cell wall membrane of these bacteria. The gram negative bacteria such as *E. coli* consist of a very thin layer cell wall membrane; its thickness ranged 13 nm and made up of peptidoglycans and lipopolysaccharides [13]. On the other hand, the gram positive *S. aureus* bacteria have a very thick cell wall membrane, its thickness ranged from 12 nm and made up of large number of mucopeptides, lipoteichoic and acids murein[14]. In addition, *S. aureus* has an antioxidant enzyme and shows a strong oxidant resistance.

Figure 4: Antibacterial activity of Ag NP's against *E. coli* and *S. aureus* bacteria

V. CONCLUSION

In this study the presence of phenolic compounds in association with silver nanoparticles are reported which indicate their possible role in the bioreduction mechanism. These bioreduced silver nanoparticles were found to be stable for 3 months which is a major advantage of using biological approach for nanoparticle synthesis. From FTIR spectra it was found that biomolecules responsible for capping and stabilization of silver nanoparticles are proteins present in the extract. This study also showed that biosynthesized silver nanoparticles using seed extract of *Moringa oleifera*have potent antimicrobial activities against E. coli and S. aureus cells. The slight variation in the number of cell deaths in case of E. coli and S. aureus is due to the fact that E. coli being a gram negative bacterium which has higher amount of membranes as a barrier to be disrupted by Ag nanoparticles compared to that of S. aureus. Thus, this approach can be applied for rapid, cost effective and ecofriendly green synthesis of silver nanoparticle for industrial and medical application.

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