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Green Synthesis Of Silver Nanoparticles And Its Antibacterial Activity

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Abstract - *An ecofriendly method of obtaining spherical silver nanoparticles (AgNPs) has been synthesized, using Carica papaya fruit extract as reducing agent. The biomolecules present in the extract was responsible for reduction of Ag^+ ions from $AgNO_3$. The prepared nanoparticles were characterized by UV–visible spectroscopy (UV–vis), X-Ray Diffraction pattern (XRD), Transmission Electron Microscopy (TEM) and Energy dispersive spectroscopy (EDS) technique to identify the size and shape of nanoparticles. The prepared AgNPs were monodispersed, spherical in shape with the average particle size of 16 nm and shows surface plasmon resonance (SPR) peak around 429nm. The consequences of the antibacterial studies confirm the superior ability of prepared silver nanoparticles to inhibit the growth of bacteria.*

Key Words: *Carica papaya*, Optical properties, Surface Plasmon Resonance, antibacterial activity.

1.INTRODUCTION

In recent years, microorganisms have developed to become drug resistant by the alterations in their chromosomes/genetic materials. Emergence of the antibiotic resistance pathogens has become a severe healthiness problem and thus, many studies have been reported to develop the present antimicrobial treatments. It is known that over 70% of bacterial infections are resistant to one or more of the antibiotics that are usually used to eliminate the infection. These troubles require the growth of new effectual antibacterial agents against new generation bacteria. A well-organized method to estimate nanotoxicity is to examine the reaction of bacteria exposed to nanoparticles. So it will be helpful, if an easy mechanism can be intended to inhibit the development of various pathogenic bacteria. Antimicrobial agents are of immense significance in numerous industries such as water disinfection, packaging, textiles, construction, medicine and food. The influence of green synthesized metal nanoparticles on bacteria is very important since they constitute the lowest level and hence enter the food chain of the ecosystems. Among the known nanoparticles, silver has been widely studied because of their unique optical, electrical, and photothermal properties. In recent years, green synthesis approach of AgNPs, using plants have received great attention to chemical and physical methods. Recently, extracts of Solanum lycopersicums, Hibiscus cannabinus stem, Hibiscus cannabinus leaf, Ananas comosus, and Hibiscus cannabinus leaf have found appropriate for the green synthesis of nanoparticles [1-5]. Green synthesized AgNPs has been reported to show antibacterial activity against different types of bacteria [3-9].

Carica papaya belongs to family Caricaceae and commonly known as Papaya. It is one of the medicinal plants. The papaya fruits, bark, leaves are being used as medicine to treat various diseases such as warts, corns, constipation, amenorrhoea, general debility, sinuses, eczema, cutaneous tubercles, glandular tumours, blood pressure, dyspepsia, cancer cell growth, diabetes, malaria expel worms and stimulate reproductive organs, syphilis and gonorrhea. Carica papaya fruit extracts are being used to treat dengue fever. Carica papaya extract exerting antioxidant and immune stimulant properties against acrylamide toxicity in rats [10-11]. Major aim of this present study is to synthesize AgNPs using green synthesis method and show its function as an antibacterial agent so that it may be used for biomedical application.

2.EXPERIMENTAL DETAILS

An aqueous solution of $AgNO_3$ (1mM) was added to 2ml of Papaya fruit extract and stirred for 40 min at room temperature. It initially becomes colorless and turned into reddish brown indicating the formation of AgNPs (S1). The dried samples were characterized by XRD using X'Per PRO (PANalytical) X-ray Diffractometer with CuKα radiation λ =1.5406A°, at the scanning rate of 0.05^0. UV study was carried out by using Double Beam UV-vis Spectrophotometer (LMSP UV 1900). Morphology studies were made using a JEOL TEM 2010 High Resolution TEM with an accelerating voltage of 200 kV. A disc diffusion method was used to evaluate the antibacterial action of prepared NPs against bacteria namely Staphylococcus aureus (gram positive).

3.RESULTS AND DISCUSSION

Fig.1 (i) shows the optical absorption spectra of prepared silver nanoparticles. It shows that the biomolecules present in the papaya extract plays a vital part in the formation of AgNPs, revealed by the intensity of SPR band around 429 nm. This indicates the formation of large number of AgNPs which can be observed in TEM images. The TEM images of the prepared AgNPs are shown in Fig.2(a). In the present case the smaller sized AgNPs also observed in TEM images. When adding 2 ml of papaya extract, more carotenes, vitamin C, flavonoids, minerals and fiber and phenolic compounds are available to reduce silver ion and to form large number of small nanoparticles, which give rise to intense SPR. This was also evident from TEM images in Fig. 2(a). It shows monodispersed spherical and smaller nanoparticles of average size of 16 nm with diameter ranging from 7 to 25 nm. There is no obvious absorption in the range of 455-800nm, which indicates that negligible aggregation occurs in this reactive system is further confirmed by the TEM images. Fig. 2(b) shows the EDS spectra of Carica papaya assisted silver nanoparticles. It confirms the formation of AgNPs and reveals higher counts at 3keV. It was due to SPR of metallic silver nanocrystals as shown in optical absorption spectra.

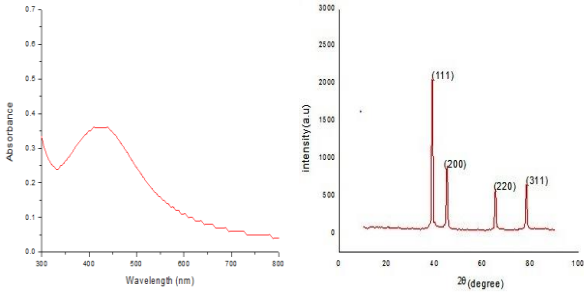

Fig – 1: Optical absorption spectra and (ii) XRD pattern of prepared silver nanoparticles.

Fig. 1(ii) shows the XRD pattern of prepared nanoparticles. The four broad diffraction peaks observed at 38.08°, 44.29°, 64.4° and 77.33° in the 2θ range can be indexed to the (1 1 1), (2 0 0), (2 2 0), and (3 1 1) reflections of FCC structure of metallic silver nanopowers. All these peaks are well corresponding to the standard JCPDS file no. 04-0783. It can be seen that broadening in peaks occur due to the smaller particle size, which reflect the effects of the experimental conditions on the nucleation and growth of the crystal nuclei [5]. The average crystallite size of the nanoparticles was estimated by the Scherrer equation with the width of the (111) peak is 18 nm. The calculated cell volume is around 68 $Å^3$. The lattice parameter for this powder works out to be a = 4.0863Å which is in very good agreement in the standard data file JCPDS no.04-0783.

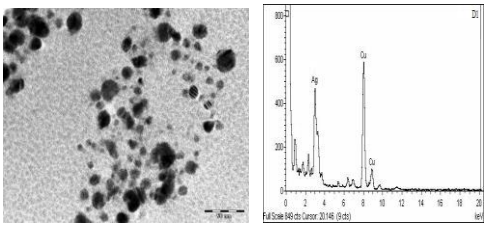

Fig-2: TEM micrograph (a), TEM micrograph (b) EDX spectrum of prepared silver nanoparticles.

Fig.3 shows the antibacterial activity of prepared silver nanoparticles against Staphylococcus aureus. The prepared silver nanoparticles display best activity in Staphylococcus aureus (14 mm). The disparity in the sensitivity or resistance to both pathogens could be due to the variations in the cell structure, physiology, metabolism,

Fig-3: Zone of inhibition of prepared nanoparticles for S.aureus.

or degree of contact of organisms with nanoparticles. The effective interaction against gram-positive S. aureus was also due to absence of outer membrane in the cell wall. The antibacterial activity of prepared silver nanoparticles was more because smaller particles having bigger surface area, which can enhance the capability to go through cell membrane and provide more bactericidal effect.

4. CONCLUSIONS

In present study, Carica papaya assisted silver nanoparticles were obtained by green synthesis method and characterized by XRD, UV-vis, and TEM. XRD pattern showed that the fine created nanoparticles and has FCC structure. TEM proved the creation of 16 nm sized nanoparticles. UV–

vis spectra of the prepared nanoparticles specify the formation of silver nanoparticles. The prepared nanoparticles revealed efficient antibacterial activity. This approach will be extremely useful for the synthesis of nanostructures in various valuable industrial applications for inhibiting the growth of bacteria.

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