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Bio Synthesis and Characterization of Silver Nanoparticles by Leaf Extract of Bamboo Leaf and Their Antibacterial Activity

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ABSTRACT

Silver nanoparticles (AgNps) have a number of applications in medical domain. Since these nanoparticles have been used for infection, prevention in the medical science. The plant leaves extract is used in biosynthesis of nanostructure materials can be non-toxic and cost effective, it may be more relevant to reduce their size. A green rapid biogenic synthesis of silver nanoparticles using Bamboo leaf. The obtained AgNps were synthesized using Bamboo leaf extract have been characterized by x-ray diffraction (XRD) analysis shows that particles overage size 28.45 nano meter, Fourier transform infrared spectroscopy (FTIR) studies suggest that the present of function group, Energy dispersive x-ray spectroscopy (EDS) results showed the compositional mass ratio, UV-visible spectrum reveals that resonance band at 420nm. Scanning electron microscope (SEM) shows that the morphology of AgNps can be controlled by using leaf extracts. The bacterial activity was evaluated using E-coli and S. aureus from the disc diffusion results, the synthesized AgNps shows as excellent antibacterial property.

Keywords: *Silver nanoparticles, Bamboo leaf, Green synthesis, FTIR, XRO.*

1. Introduction

Nanotechnology is a branch of science, which deals with creation of materials, devices by controlled manipulation of size and shape of materials at the nano-meter scale. The nano-meter scale is commonly indicated as1-100nm. Nanoparticles can be broadly grouped into two namely organic nanoparticles which includes carbon nanoparticles, while some of the inorganic nanoparticles include magnetic nanoparticles and semiconductor nanoparticles. The metallic nanoparticles have various categories such as gold, Ag, Alloy, Zinc and others.

Ag is a magnetic nanoparticle. Nano silver has biological properties which are significant for consumer products, food technology, textile/ fabrics and medical applications. In addition, nano silver has unique optical and physical properties that are claimed to have great potential for medical applications. In recent years, the synthesis of AgNp5 plays an important role in biomedicine, particle size, high surface area and applications in various fields such as antibacterial activity, catalysis. There are many techniques have been used for synthesis of AgNp5, including electrochemical, thermal decomposition, hydrothermal, green chemistry methods. Green synthesis provides advancement over chemical and physical method as it is cost effective, environment friendly, easily scaled up large scale synthesis and by this method there is no need to use high pressure, energy, temperature and toxic chemicals. Bio-synthesis of AgNps is a bottom -up approach that mostly involves reduction/ oxidation reactions.

In the present study has aimed to synthesis of AgNp5 using Indian herbal plants such as bamboo leaf extract.

2. Experimental Procedure

2.1. Materials

Silver nitrate ($AgNO_3$) was obtained from SRL and as received. Fresh leaves of bamboo were collected from local market. All glass wares were washed with sulphuric acid (H_2SO_4) and de-ionized water then dried in hot air oven.

2.2. Preparation of leaf extracts and 0.1m $AgN0_3$

All leaves were surface cleaned with running tap water. Then this was continued by distilled water to remove the dust and unwanted visible particles 20g of the leaves were taken in 250ml beaker, and boiler with 100ml of distilled water 80C for 20 minutes. The leaves extracts were filtered through Whatman no.1 filter paper to remove particulate matter, get clear solutions. A stock solution of $AgNO_3$ $1*10^{-1}$ M was prepared by dissolving 1.52g/100ml distilled water.

2.3. Synthesis of silver nanoparticle

For the synthesis of the silver nanoparticles, 100ml of 0.1m aqueous solution of silver nitrate was taken in 500ml beaker. Then 10ml of plant extract were added to it at room temperature. The solution was stirred for 20 min. when the reaction started by the colour change of the solution from yellow to brownish-yellow to deep brown colour is obtained. Once the reaction mixture had reached a brown colour, then centrifuged technique was used to separate the nanoparticles from the solution (AgNo3+ plant extract). The solution was centrifuged at 3000rpm for 10 min. The final product of silver nanoparticles is dried at 110C for 3 hours.

3. Characterization of Silver Nanoparticles

X-ray powder diffraction (XRD) is mostly used for the identification of unknown crystalline materials (example: minerals, inorganic compounds). Data interpretation is relatively straight forward. The SEM is used to generate high -resolution image of shapes of objects and identify phases based on qualitative chemical analysis/or crystalline structure. EDS spectrum analysis the relative concentrations in weight, oxide, or atomic formula percentage in sample. FTIR analysis can be applied to minute quantities of materials, whether solid, liquid, or gaseous. Each absorption peaks correspond to frequency of vibration between bonds of the atoms, no two compounds produce the exact same infrared spectrum. Ultraviolet-visible spectrophotometry (UV-V is or UV/V is) refers to absorption spectroscopy or reflectance spectroscopy in the ultraviolet-visible spectral region. An absorption spectrum shows a antibiotic method is carried out a test of the antibiotic sensitivity of bacteria. It uses antibiotic impregnated wafers to test the extent to which bacteria are affected by those antibiotics.

4. Results and Discussion

4.1. FTIR Analysis

The FTIR study is used to analysis the functional group. The FTIR spectrum was out the result of bamboo leaf extract of Ag nanoparticles showed three sharp absorption peaks at $1379cm^{-1}$,$1759cm^{-1}$, $1360cm^{-1}$Including the possible interaction between proteins and silver nanoparticles. In FTIR stabilized Ag nanoparticles showed their vibration spectrum at $2924cm^{-1}$ (CH stretching), $2360cm^{-1}$ (NH_2^- asymmetric stretching and NH_2^+ symmetric

stretching),1579cm^{-1} (NO_2 symmetric stretching), 1759cm^{-1} (coupled C=O),830cm^{-1} (C-4 out of plane bending), 790cm^{-1} (C-H out of plane bending), 674cm^{-1} (OCN deformation) of individual protein were measured respectively.

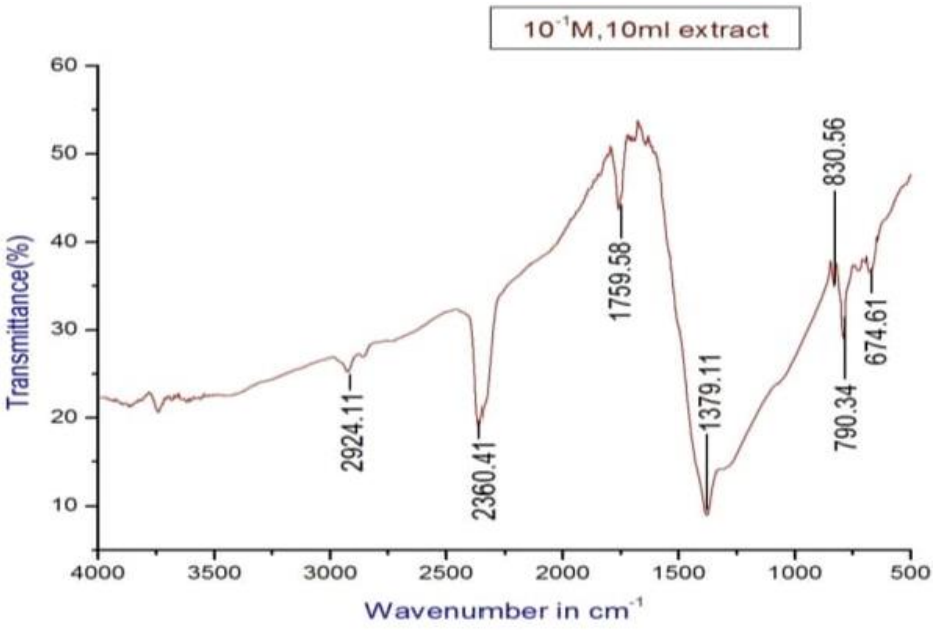


Fig.1. FTIR analysis of bamboo leaf extract

Table 1. FTIR analysis of bamboo leaf extract

S.No	Wave Number cm^{-1}	Type of Vibration	Intensity
1	2924.11	C-H Stretching	Medium
2	2360.41	NH_2^+ asymmetric and NH_2^+ symmetric stretching	Strong
3	1379.11	NO_2 symmetric stretching	Strong
4	1759.58	Coupled C=O	Strong
5	830.360	C-H out-to- plane bending	Strong
6	790.34	C-H out-to- plane bending	Strong
7	674.61	OCN deformation	Medium

4.2. XRD Analysis

The XRD pattern of prepared $AgNO_3$ shown in the figure. The spectra of XRD indicate that the synthesized Ag nanoparticles using bamboo leaf extracts is crystalline in nature. The XRD spectrum which confirms the presence of three major peaks at 20 values 32.5459,37.9144,44.5507,47.5507,67.2721 respectively are attributed the solely to the structure and these peaks corresponding to the five d-spacing (JCPDS card No.04-0783, 76-1489). The remaining minor peaks are reflection of crystalline organic molecules of adsorbed on the surface of the Ag nanoparticles. To determine the crystallite size of the Ag nanoparticles, the Debye-Scherrer formula was used,

$D = K \lambda / \beta \cos\theta$

Where,

- **β** is full width half maxima of the peak in XRD pattern
- **θ** is peak obtained angle
- **λ** is X-ray wavelength
- **K** is the constant of 0.9

According to Debye-Scherrer equation the average crystallite size of the particles is calculated as 28.45nm.

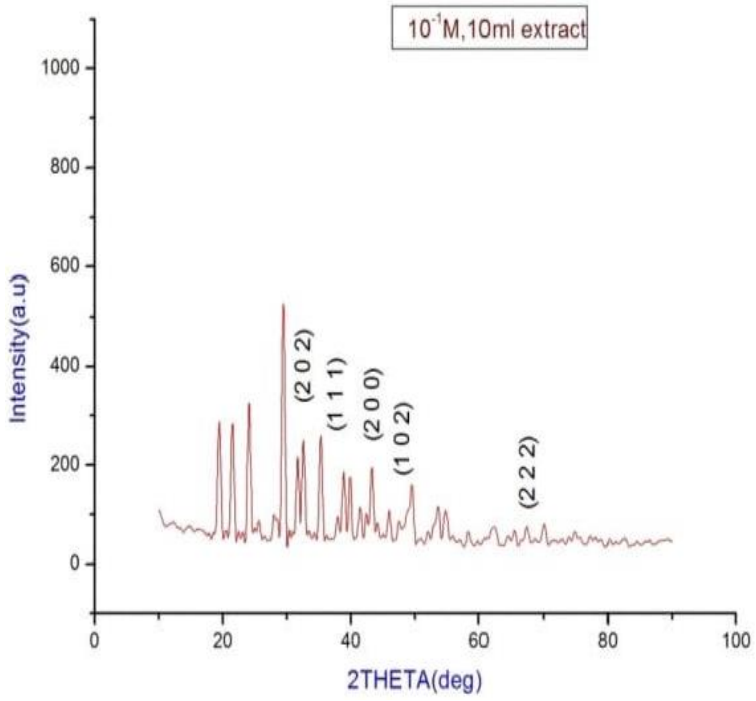


Fig.2. X-ray diffraction spectra

Table 2. X-ray diffraction spectra of Bamboo leaf extract

2 Theta (deg)	d Spacing(deg)	FWHM (deg)	h k l value	Crystallite Size D(nm)	Average Crystallite size D(nm)
47.5507	1.91070	0.29990	102	28.63	28.45
32.5459	2.74897	0.25980	202	30.24	
67.2721	1.39065	0.38430	222	24.55	
37.9144	2.31116	0.28770	111	28.87	
44.0712	2.0533	0.28250	200	30.00	

4.3. UV Analysis

In the UV spectrum wavelength lies between 200-800nm. The band gap energy is determined based on the numerical derivative of the optical absorption coefficient. The fundamental absorption method refers to band to band transition by using energy relation,

$E = h \nu$

Where,

- h is the Planck's constant
- v is the frequency (**c**/ **λ**)
- c is the speed of light.

The UV spectra of the Silver Oxide Ag nanoparticles from bamboo leaf extract are shown in the figure graph. From this analysis absorbance peak found at 420nm. Which was specific for Ag nanoparticles based on UV-V is spectra the sharpness of the absorption peak was found to be dependent on the concentration ratio of the leaf extract.

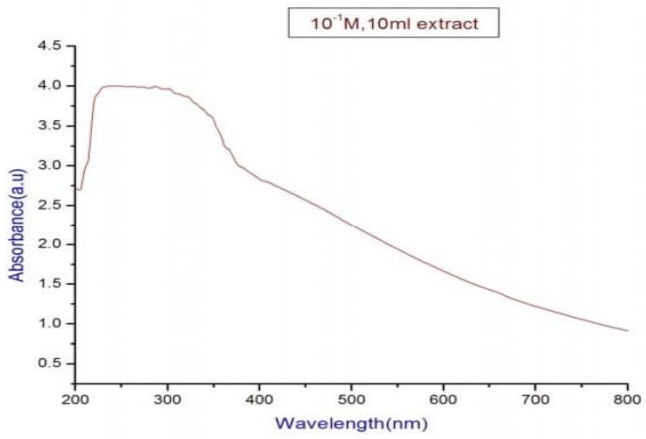


Fig.3. Ultraviolet spectra of Bamboo leaf extract

4.4. SEM Analysis

Scanning electron microscopy was used to investigate the morphologies structure and particles size of (bamboo leaf) Ag nanoparticles. Figure shows the SEM image of the synthesized leaves extracts. It clearly reveals that spherical, rod structure. The presence of agglomerated nanoparticles with an average particle sizes varied from (76.93nm).

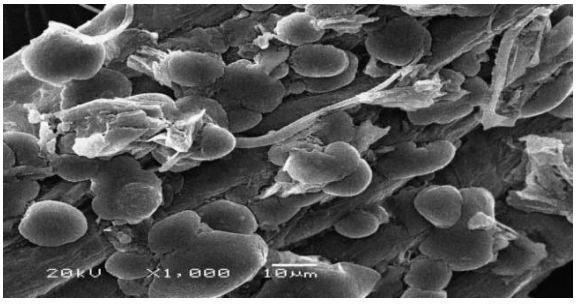


Fig.4. SEM image of silver Nanoparticle

4.5. EDS Analysis

The synthesized Ag nanoparticles from leaf extract analysis using EDS showed high silver content of percentage. The spectrum showed the present O and Ag of 70.05% and 29.95% respectively.

Table 3. EDS data of Bamboo leaf extract

Element	App. Conc.	Intensity Corrn.	Weight%	Weight% Sigma	Atomic%
O K	6.16	0.3459	25.76	2.30	70.05
Ag L	48.33	0.9410	74.24	2.30	29.95
Total			**100**		

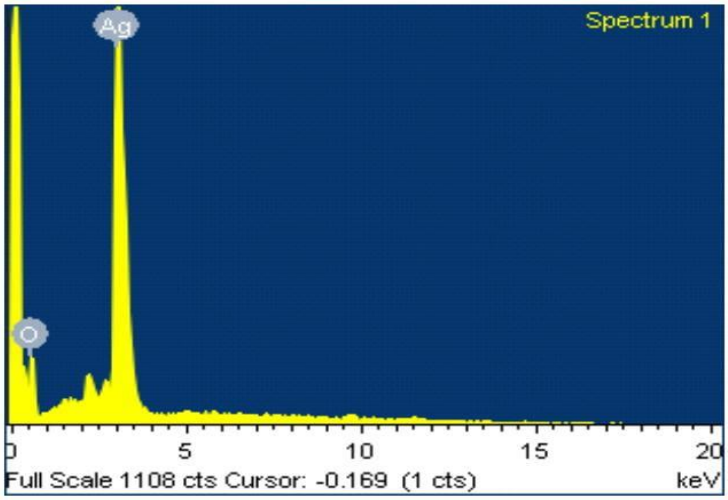


Fig.5. EDS Analysis of Bamboo leaf

4.6. Antimicrobial Analysis

The antibacterial efficiency of Ag nanoparticles against both gram positive and negative strains. The disc diffusion studies demonstrated large inhibition zones. Based on the various sizes (in nm) of zone of inhibitions results compare to the different leaf extracts.

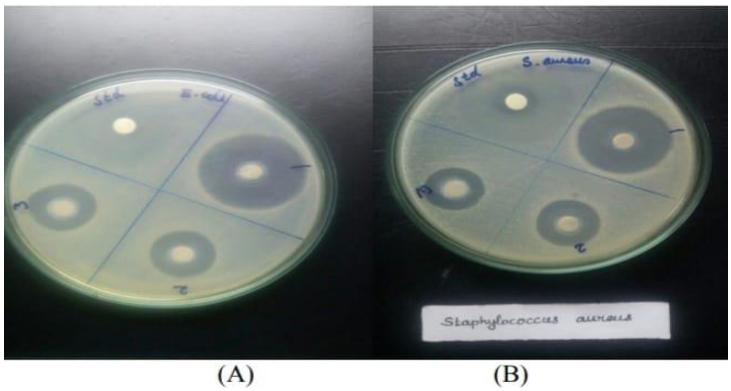


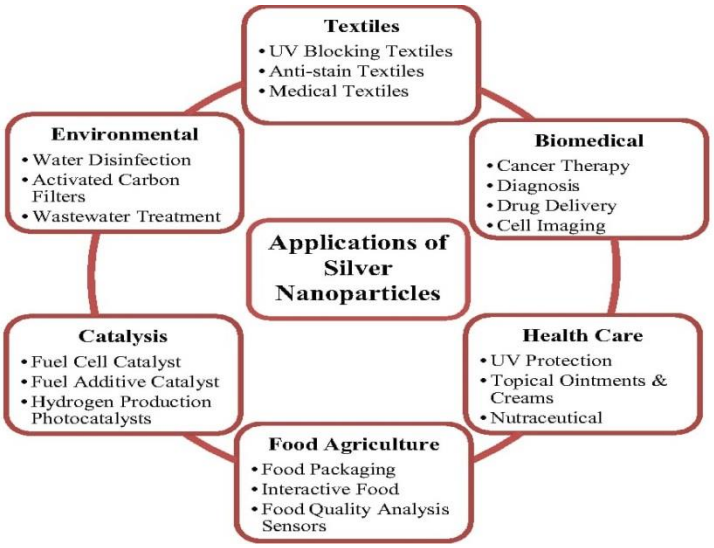
Fig.6. (A) E. coli (B) S. aureus

Table 4. Antimicrobial Analysis of Bamboo leaf extract

S.No	Organisms	Zone of Inhibition	
		STD CIPROFLOXACIN (10µg/disc)	Samples Bamboo
1.	E. Coli	32	20
2.	S. aureus	36	21

Table 5. Properties, Uses of Bamboo leaves

Leaf extract	Medical Uses	Tempera-ture	Yield of sample	Solubles	Colour Change	SEM Shapes	Particle Size	Anti-Microbial E.Coli	Anti-Microbial S.Aureus
Bamboo	Ulcers, Wounds, Diarrhoea, Control BP	Room Tempera-ture	0.21	Water	Yellow to Brownish to Deep Brown	Spherical	76.93	20	21



5. Conclusion

In the presence study, the leaves of plant extracts were good source for the synthesis of Ag nanoparticles and have many medical advantages. The Silver nanoparticles prepared in variety of extracts as Bamboo leaf for metal

nanoparticles. The synthesized Ag nanoparticles were analysed using XRD, SEM, EDS, FTIR, UV and Antimicrobial test. Powder XRD pattern of Ag nanoparticles for Bamboo leaf extract, confirms pure natural and nano crystallite size around 30nm. The morphological analysis was performed by using SEM. The particle sizes are varied from (43-76) nm, (12-950) nm and has an agglomerated Spherical shape are different for Indica (neem) leaf, Bamboo leaf extracts respectively. EDS data gave the elemental percentage and atomic percentage in the mixed $AgNO_3$ nanoparticles. It shows the presence of Ag and O. the FTIR measurement for Bamboo leaf extract to identify the presence of various function group in bio reduction of Ag^{2+} and Ag nanoparticles. In UV-V is spectrum was absorbed the absorption peak of (420nm) which confirmed the synthesis of silver nanoparticles. The antibacterial efficiency of Ag nanoparticles against E-coli (gram positive) and S. aureus (gram negative) bacteria. The zone of inhibition (mm) is compared to the different leaf extracts. Bamboo leaf extract of Ag nanoparticles are required to fully characterize the non-toxicity mechanism of biosynthesized Ag nanoparticles for, suitable in lower blood sugar medical application.

Declarations

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Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Consent to participate

Not Applicable

Consent for publication

We declare that we consented for the publication of this research work.

Availability of data and material

Authors are willing to share data and material according to the relevant needs.

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