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 average 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. aureas 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 as 1-100nm. 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 (AgNO₃) was obtained from SRL and as received. Fresh leaves of bamboo were collected from local market. All glass wares were washed with sulphuric acid (H₂SO₄) and de-ionized water then dried in hot air oven.

2.2. Preparation of leaf extracts and 0.1m AgNO₃

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 80°C 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 AgNO₃ 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 110°C 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 (NH₂ asymmetric stretching and NH₂⁺ symmetric
stretching), 1579 cm$^{-1}$ (NO$_2$ symmetric stretching), 1759 cm$^{-1}$ (coupled C=O), 830 cm$^{-1}$ (C=H out of plane bending), 790 cm$^{-1}$ (C-H out of plane bending), 674 cm$^{-1}$ (OCN deformation) of individual protein were measured respectively.

![FTIR analysis of bamboo leaf extract](image)

**Fig.1.** FTIR analysis of bamboo leaf extract

**Table 1.** FTIR analysis of bamboo leaf extract

<table>
<thead>
<tr>
<th>S.No</th>
<th>Wave Number cm$^{-1}$</th>
<th>Type of Vibration</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2924.11</td>
<td>C-H Stretching</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>2360.41</td>
<td>NH$_2^+$ asymmetric and NH$_2^+$ symmetric stretching</td>
<td>Strong</td>
</tr>
<tr>
<td>3</td>
<td>1379.11</td>
<td>NO$_2$ symmetric stretching</td>
<td>Strong</td>
</tr>
<tr>
<td>4</td>
<td>1759.58</td>
<td>Coupled C=O</td>
<td>Strong</td>
</tr>
<tr>
<td>5</td>
<td>830.360</td>
<td>C-H out-of-plane bending</td>
<td>Strong</td>
</tr>
<tr>
<td>6</td>
<td>790.34</td>
<td>C-H out-of-plane bending</td>
<td>Strong</td>
</tr>
<tr>
<td>7</td>
<td>674.61</td>
<td>OCN deformation</td>
<td>Medium</td>
</tr>
</tbody>
</table>

**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,

- \beta is full width half maxima of the peak in XRD pattern
- \theta is peak obtained angle
- \lambda 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

<table>
<thead>
<tr>
<th>2 Theta (deg)</th>
<th>d Spacing(deg)</th>
<th>FWHM (deg)</th>
<th>h k l value</th>
<th>Crystallite Size D(nm)</th>
<th>Average Crystallite size D(nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>47.5507</td>
<td>1.91070</td>
<td>0.29990</td>
<td>102</td>
<td>28.63</td>
<td></td>
</tr>
<tr>
<td>32.5459</td>
<td>2.74897</td>
<td>0.25980</td>
<td>202</td>
<td>30.24</td>
<td></td>
</tr>
<tr>
<td>67.2721</td>
<td>1.39065</td>
<td>0.38430</td>
<td>222</td>
<td>24.55</td>
<td></td>
</tr>
<tr>
<td>37.9144</td>
<td>2.31116</td>
<td>0.28770</td>
<td>111</td>
<td>28.87</td>
<td></td>
</tr>
<tr>
<td>44.0712</td>
<td>2.0533</td>
<td>0.28250</td>
<td>200</td>
<td>30.00</td>
<td></td>
</tr>
</tbody>
</table>
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
- \( \nu \) is the frequency (\( c/\lambda \))
- \( c \) 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

<table>
<thead>
<tr>
<th>Element</th>
<th>App. Conc.</th>
<th>Intensity Corn.</th>
<th>Weight%</th>
<th>Weight% Sigma</th>
<th>Atomic%</th>
</tr>
</thead>
<tbody>
<tr>
<td>O K</td>
<td>6.16</td>
<td>0.3459</td>
<td>25.76</td>
<td>2.30</td>
<td>70.05</td>
</tr>
<tr>
<td>Ag L</td>
<td>48.33</td>
<td>0.9410</td>
<td>74.24</td>
<td>2.30</td>
<td>29.95</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>S.No</th>
<th>Organisms</th>
<th>Zone of Inhibition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>STD</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIPROFLOXA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CIN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10μg/disc)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Samples</td>
</tr>
<tr>
<td>1.</td>
<td>E. Coli</td>
<td>32</td>
</tr>
<tr>
<td>2.</td>
<td>S. aureus</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 5. Properties, Uses of Bamboo leaves

<table>
<thead>
<tr>
<th>Leaf extract</th>
<th>Medical Uses</th>
<th>Temperature</th>
<th>Yield of sample</th>
<th>Solubles</th>
<th>Colour Change</th>
<th>SEM Shapes</th>
<th>Particle Size</th>
<th>Anti-Microbial E.Coli</th>
<th>Anti-Microbial S.Aureus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bamboo</td>
<td>Ulcers, Wounds, Diarrhoea, Control BP</td>
<td>Room Temperature</td>
<td>0.21 Water</td>
<td>Yellow to Brownish to Deep Brown</td>
<td>Spherical</td>
<td>76.93 20</td>
<td>21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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...
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 AgNO₃ 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 Ag²⁺ and Ag nanoparticles. In UV-V 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 biosynthesised 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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