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Antimicrobial Property of *Dalbergia latifolia* Silver Nanoparticle

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ABSTRACT

The biosynthesis of nanoparticles is an ecological substitute to the chemical route which is accompanied by the discharge of harmful byproducts. Methanol extract of *Dalbergia latifolia* was used to prepare metallic silver nanoparticles (AgNPs). Optimization of the reduction was done at different operational parameters and measured using a UV-Vis Spectrophotometer. Characterization was done using spectroscopic techniques (UV, X-ray Diffraction and FTIR) and Scanning Electron Microscope. The antimicrobial efficacy of the AgNPs was determined using pathogenic microorganisms. The study, showed that the rate of production of the AgNPs increased proportionally to the time of reaction while the optimum ratio of plant extract to $AgNO_3$ solution was 1:2. The nanoparticles demonstrated activity against tested pathogens.

KEYWORDS: Silver nanoparticles, Biosynthesis, *Dalbergia latifolia*, antimicrobial activity.

1. INTRODUCTION

Metallic nanoparticles are nanomaterials with structure components of size dimensions less than 100 nanometers[1]. The high surface area to volume ratio in nanoparticles permits interaction with other particles easily[2,3] which encourages easy diffusion. In recent years, there has been increase research attention on nanoparticles owing to their outstanding qualities which have unlocked many new pathways in nanotechnology. Metal nanoparticles' optical properties are an important factor because of the localized surface Plasmon which resonance frequency within the visible region [4-6] Nanoparticle synthesis is in three major ways, namely, physical, chemical and green synthesis. Chemical reduction of metal lacks precise control over the size distribution of the colloidal particles [7] coupled with the production of damaging by-products.

Green synthesis which combines plant extracts and microorganisms is acceptable method because of its low cost and less time-consuming and also does not produce any toxic chemicals [8,9]. Applications of nanoparticles include diagnosis and management of human diseases, drugs, and fluorescent biological labels, bio-detection of pathogens[10], gene delivery agents, tissue engineering[11,12], tumour destruction[13] and dietary supplements for delivering biologically active substances. Nanoparticles are used in agriculture, cosmetics, the environment, food, home appliances, medicine, sport and fitness, and many other industrial sectors[14].
Metallic nanomaterials of Mg, Cu, Pt, Ti, Zn, Ag and Au and their corresponding oxides and sulfides have been synthesized but Ag nanoparticles have demonstrated higher efficacy against bacteria, viruses and other micro-organisms[15-18].

Dalbergia latifolia Roxb. (Bombay Blackwood or Indian rosewood) is a member of the family Fabaceae. Ethnobotanical usage includes treatment for body pain, leprosy, diarrhoea and obesity; additionally, the plant is adapted as bitter tonic, anthelmintic and for stomach ache. The bark contains tannins which is used to treat diarrhoea, worms, indigestion, and leprosy[19,20]. Antibiotic resistance is a major challenge facing infectious disease management. In the present study, the agar well diffusion technique was used to determine the antimicrobial properties of *D. latifolia* nanoparticles against ten human pathogens.

2. MATERIALS AND METHODS

2.1. Extract preparation and synthesis of AgNPs

Dalbergia latifolia leaves were obtained from the University of Ibadan, Nigeria. Identification was done at the Forest Research Institute Herbarium, Ibadan. 70 g of dried ground leaves were boiled in 40% ethanol to obtain the leaf extract. A mixture of plant extract and aqueous solution of silver nitrate was heated on a hotplate at 70°C for 30 minutes. The production of silver nanoparticles was established by spectrophotometric methods.

2.2. Optimization of bioreduction Process

Synthesis of AgNPs were carried out at different operational parameters such as (i) concentration of $AgNO_3$ (1, 2, 3mM), (ii) time (0-60mins), (iii) volume ratio of plant extract to $AgNO_3$ and (iv) pH to determine their effects on the yield and properties of the synthesized nanoparticle.

2.3. Characterization of synthesized nanoparticles

UV/Vis spectral analysis was done using the Lambda 25 UV/Vis Spectrometer scanned from 300 to 900 nm. FT Infra-red spectrometer (Perkin-Elmer LS-55- Luminescence spectrometer) was used to determine the different functional groups present. The structure of synthesized silver nanoparticles was determined by X-ray diffraction spectroscopy (Rigaku D/ Max-IIIC) while the shapes and size were studied using the scanning electron microscope (JEOL JSM -7600F).

2.4. Antimicrobial assay

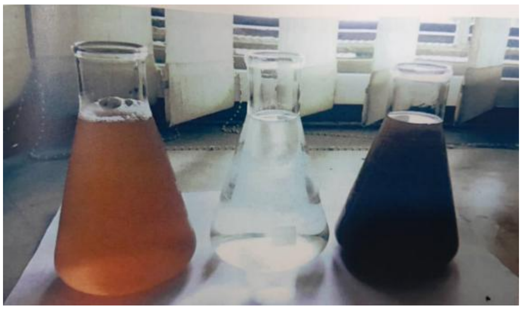
Ten pathogenic organisms which include six bacteria *Pseudomonas aeruginosa, Staphylococcus aureus*, *Bacillus subtilis*, *Klebsiella pneumonia, Salmonella typhi, Escherichia coli* and four fungi *Candida albicans*, *Penicillium notatum, Rhizobium stolomite* and *Aspergillus niger* were used in the antimicrobial assay.

3. RESULTS AND DISCUSSION

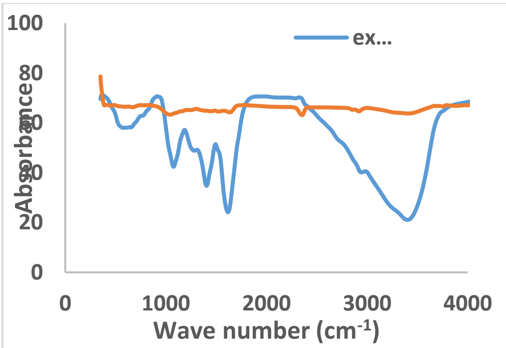
3.1 Synthesis of Ag Nanoparticles

The colour intensity of the plant extracts increased (chocolate brown) with time (Figure 1a). This is due to the excitation of surface plasmon resonance (SPR). The green synthesized nanoparticles showed a maximum peak at 450 nm which is characteristic of the SPR band for metallic silver nanoparticles. Generally the absorption peak shows around 412–470 nm [21,22] .

The effect of various operational parameters showed that the excellent surface Plasmon resonance at a ratio of 1:1 at a concentation of 10^{-1} M for optimization. The best reaction time for optimization is 60 minutes while the effect of change in pH of the reaction time on formation of AgNPs is optimized in acidic conditions (Figures 2a-d).



a)



b)

Figure 1a: Solutions of leaf extract, silver nitrate, and silver nanoparticles; 1b: Graph of FTIR analysis on TD extract and AgNPs

FTIR spectra of the *D. latifolia* -AgNPS (Figure 1b) showed peaks around 1400, 1040, 3474,1700, cm^{-1} assigned to C-C, C–O–H, C=O and O-H, groups absorption bands as the possible stabilizing and capping groups[23]. The XRD result (Figure 3) confirmed the elemental silver signal. It showed characteristic peaks corresponding to metallic silver, confirming the successful synthesis of AgNPs. Energy peak at 3.0-3.8 KeV were consistent with known diffraction patterns for silver, indicating the purity and crystalline nature of the nanoparticles. SEM revealed the morphology showing the formation of uniformly distributed quasi spherical shape AgNPs (Figure 4).

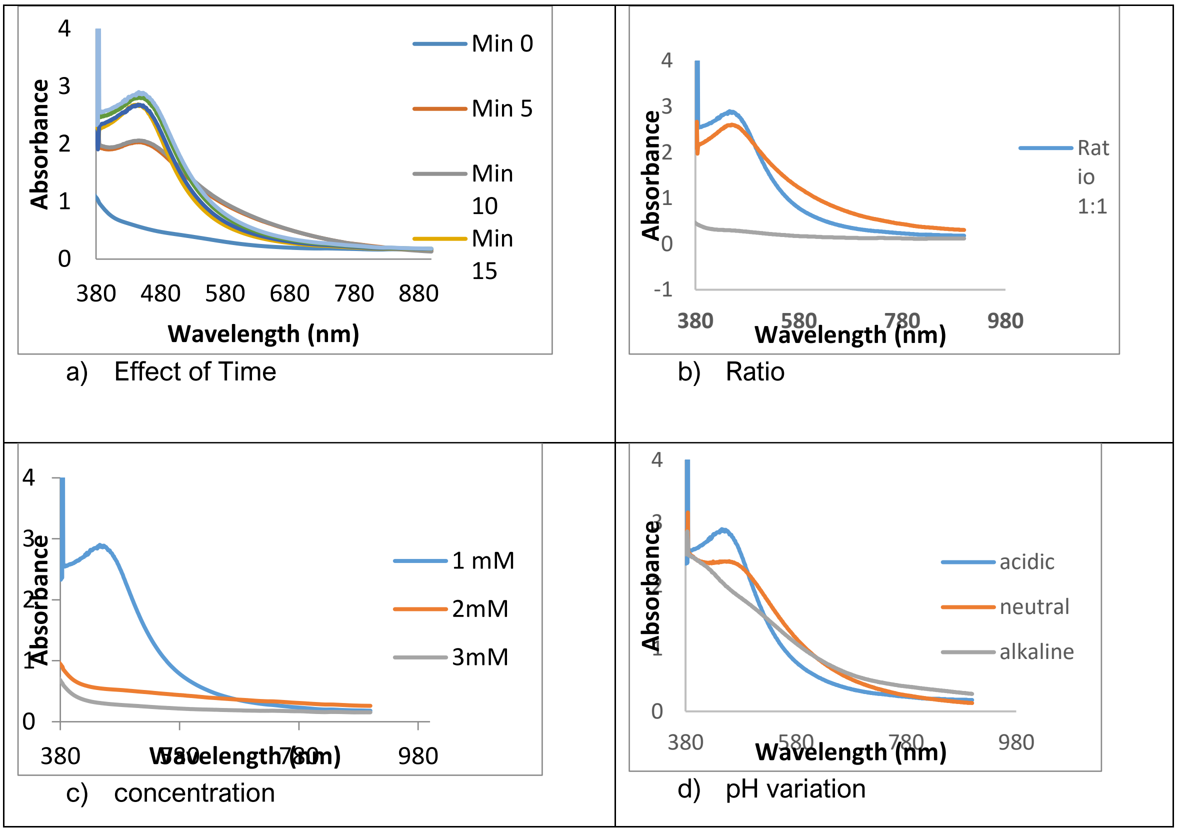


Figure 2a-d: Graphs of the effect of Varying Operational parameters in the formation of Silver Nanoparticles

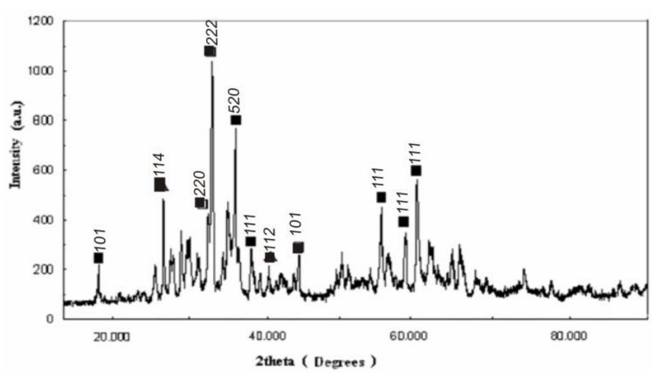


Figure 3: XRD peaks for AgNPs from *Dalbergia latifolia*

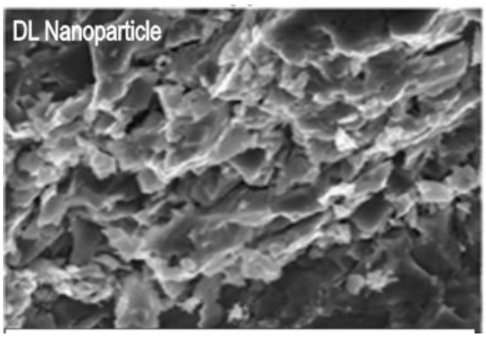


Figure 4: SEM image of *Dalbergia Latifolia* AgNPs

3.2. Antimicrobial studies

D. latifolia nanosilver showed concentration dependent zone of inhibition against all the tested microorganism. Of all the bacteria screened the gram negative, *P. aeruginosa* and *E. coli* were the most susceptible organisms while the highest activity was demonstrated against *A. niger* for fungi (Table 1). This could be because gram negative pathogens mostly contain only one single peptidoglycan coat, thus making the permeation of Ag^{+} ions into the cytoplasm easy therefore causes cell lysis [24]. In all assays, the synthesized AgNPs demonstrated lower activities than the reference drugs.

Table 1: Zones of Inhibition of Green-synthesized *D. latifolia* AgNPs against Strains of microorganisms

	Zones of inhibition				
Organisms/ concentration	100 mg/mL	50 mg/mL	25 mg/mL	12.5mg/mL	6.25 mg/mL
S. aureus	20	18	16	14	10
E. coli	22	18	16	14	10
B. substilis	18	16	14	10	-
P. aeruginosa	22	18	16	14	10
K. pneumonia	18	16	14	12	10
S. typhi	16	14	12	10	-
C. albicans	18	16	14	10	-
A. niger	18	16	14	12	10
P. notatum	16	14	12	10	-
R. stolonifer	16	14	12	10	-

*Gentamicin= 38.0 mm; Tioconazole= 26.0 mm, Methanol= no inhibition

4. CONCLUSION

Green-synthesized AgNPs from *D. latifolia* exhibit promising antimicrobial properties, particularly against gram-negative bacteria and fungi. This method offers a sustainable alternative to chemical synthesis, reducing environmental impact**.** Furthermore, *D. latifolia* AgNPs could be used in combination therapies to enhance antimicrobial efficacy.

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