

Antibiotics 2020: Evaluation of the antibacterial activity of silver (Ag), zinc (Zn) and copper (Cu) nanoparticles from aqueous extract of *Spondias mombin* leaves - Adebowale O. Adeluola - University of Lagos

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Statement of the Problem:

The continued emergence of resistant forms of bacteria at a rate much faster than the rate at which new antibacterial drug compounds are being discovered all over the world, has made it important for researchers to begin to look towards plants and other products of natural origin for solution to this problem. *Spondias mombin* is a fruit-bearing tree and its leaf extracts have been reported to possess antimicrobial properties amongst other therapeutic properties. The fructiferous plant, *Spondias mombin*, which belongs to the flowering plant family, Anacardiaceae, is found in South West Nigeria and other Tropical rain forest regions of the world including the lowland slightly wet forests of the Amazon, Brazil and the West Indies. The leaf extract has been reported to possess antimicrobial activity for treating haemorrhoids, gonorrhoea, urethritis, cystitis, eye and throat inflammations. Other findings have shown some level of antibacterial and antifungal activity in green synthesized nanoparticles of zinc and silver oxide of aqueous extract of some plants. The use of Nanoparticles for Bioactive compounds of plant origin with antibacterial activity have the potential advantage of providing sustained release of the drug compounds with little or no chemical reaction and drug degradation characteristics. It improves the solubility of poorly water soluble antibacterial drug compounds and provides reason for better patient compliance with better therapeutic prospects.

Keywords: synthesis, nanoparticles, FT-IR, UV-visible spectrophotometry, antibacterial activities

Introduction:

Nanotechnology is unfolding as a highly advanced multidisciplinary technology involving chemistry, physics, material science, biology and medicine. The synthesis of nanoparticles (NPs) has been the most important stride in the area of nanotechnology (1). In the subject of biology, NPs have diverse use in drug delivery systems, antibacterial, minerals and many others. There are wide spans of chemical and physical methods being utilized for the synthesis of NPs. Nonetheless, these methods have few limitations such as the use of dangerous solvents, high energy utilization, and dangerous byproducts.

The use of plant extracts in the green synthesis of NPs is attaining significance over chemical synthesis. *Spondias mombin* is a fruit-bearing tree which belongs to the genus *Spondias*, a flowering plant family, Anacardiaceae, home to the

low land slightly wet forest of the Amazon. *S. mombin* emanate gum is used as adhesives, its bark and root decoctions are used as purgatives and medicament for dysentery, diarrhea, and haemorrhoids, while leaf extracts of the tree have been reported to possess anxiolytic, antiepileptic, anathematic, sedative, antipsychotic, antioxidant, and antimicrobial properties. The biomolecules existing in plants can act as capping and reducing agents and thus increase the rate of reduction and stabilization of NPs.

Methodology & Theoretical Orientation:

Metallic (Ag, Zn and Cu) nanoparticles were produced from the leaves of *Spondias mombin* aqueous extracts (SMAE) through green synthesis (8). The agar well diffusion procedure was employed to determine the antimicrobial activity of the Ag, Cu and Zn nanoparticles of the plant extract in comparison with the aqueous plant extract and ciprofloxacin as control. Laboratory stock of Clinical isolates of *Escherichia coli*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* were used as test organisms. Standardized inoculums of the test organisms were adjusted to cell concentrations to match the 0.5 McFarland standards (8). A 100 %, 50 %, 25 % and 12.5 % concentration of the SAME and the different nanoparticle solutions of AgNP (0.02 g/ml, 0.01 g/ml, 0.005 g/ml, 0.0025 g/ml), ZnNP (0.01 g/ml, 0.005 g/ml, 0.0025 g/ml, 0.00125 g/ml) and CuNP (0.02 g/ml, 0.01 g/ml, 0.005 g/ml, 0.0025 g/ml) were used as the concentrations for the sample solutions used for the assay. The zones of inhibition established after 24 hrs were measured with a calibrated ruler in duplicates.

Final concentrations of 0.984375 µg/ml, 1.96875 µg/ml, 3.9375 µg/ml, 7.875 µg/ml, 15.75 µg/ml, 31.5 µg/ml, 63 µg/ml, 126 µg/ml, 255 µg/ml, 510 µg/ml of each of the plant extracts and metallic nanoparticle solutions in the MHA plates, were prepared for MIC determination. Working concentrations of 20 µg/ml, 15 µg/ml, 10 µg/ml and 5 µg/ml of ciprofloxacin were prepared for MIC determination. The least concentration showing no growth of the microorganism was recorded as the MIC after 24 hours.

Findings:

The NPs demonstrated higher antimicrobial activities against *Staphylococcus aureus* than *Pseudomonas aeruginosa* and *Escherichia coli*. The copper NP gave antimicrobial activity higher than those of Ag and Zn NPs, and which were also higher than SMAE. All these conformed to findings of other scientists. The CuNP gave the best results against *Pseudomonas*

aeruginosa, *Staphylococcus aureus* followed by AgNP with *Pseudomonas aeruginosa*.

The MIC results of *Spondias mombin* aqueous extract, AgNP, ZnNP and CuNP of SMAE against *Escherichia coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* was observed to show better activity in Gram-positive bacteria (*Staphylococcus aureus*) than Gram-negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*) and most especially for CuNP. The ciprofloxacin standard gave MIC values well within the CLSI, 2008 breakpoints for susceptibility ($\leq 1\mu\text{g/ml}$) for the isolates used. It is quite noteworthy that all bacterial species tested in this study showed some level of sensitivity towards the green synthesized nanoparticles.

Discussion:

Spondias mombin is a fruit-bearing tree. The leaf extracts have been reported to possess anxiolytic, hypoglycaemic, antiepileptic, antipsychotic, sedative, antioxidant, and antimicrobial properties. In this study, green synthesized metallic NPs were identified by UV-visible and Fourier Transform Infra-Red spectrophotometer. While the generation and steadiness of the reduced metal NPs in the colloidal solution were scanned by UV-visible spectrophotometer, the FT-IR showed the feasible biomolecules for the reduction of metallic NPs.

Metallic NPs are being reported to have desired antibacterial activity because of their large surface area to volume ratio. It is quite noteworthy that all bacterial species tested in this study showed appreciable level of susceptibility towards the green synthesized NPs.

Conclusion & Significance:

From this study, Green synthesized Silver, Zinc and Copper nanoparticles were found to have antibacterial potential against the isolates tested. The findings in this study points to the prospects in the formulation of drug compounds of natural origin into nanoparticles to give hope for better therapeutic outcomes in antimicrobial chemotherapy.

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