ANTIMICROBIAL AND TOXICITY EVALUATION OF SILVER-COBALT NANOPARTICLES USING *Annona muricata* LEAF EXTRACT

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M.Sc.) DEGREE IN INDUSTRIAL CHEMISTRY IN THE DEPARTMENT OF CHEMISTRY, COLLEGE OF SCIENCE AND TECHNOLOGY, COVENANT UNIVERSITY.

JULY, 2022

ACCEPTANCE

This is to attest that this dissertation has been accepted in partial fulfilment of the requirement for the award of the degree of Master of Science in Industrial Chemistry in the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Ogun State.

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(Dean, School of Postgraduate Studies) **Signature and Date**

DECLARATION

I, **ODAUDU, RUTH OPIOTU (20PCC02187),** declare that this dissertation is a representation of my work, and is written and implemented by me under the supervision of Dr. Anuoluwa Abimbola Akinsiku of the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Nigeria. I attest that this dissertation has in no way been submitted either wholly or partially to any other university or institution of higher learning for the award of a masters' degree. All information cited from published and unpublished literature has been duly referenced.

ODAUDU, OPIOTU RUTH

Signature and Date

CERTIFICATION

This certify that the dissertation titled **"ANTIMICROBIAL AND TOXICITY EVALUATION OF SILVER-COBALT NANOPARTICLES USING *ANNONA MURICATA* LEAF EXTRACT"** is the original research carried out by **ODAUDU, RUTH OPIOTU (20PCC02187)** in the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Ogun State, Nigeria, under the supervision of Dr. Anuoluwa Abimbola Akinsiku. We have examined and found the work acceptable as part of the requirement for the award of the degree of Master of Science (M.Sc.) in Industrial Chemistry.

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DEDICATION

This dissertation is dedicated to God Almighty, my lovely parents and my family. None of this would have been possible without you.

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LIST OF ACRONYMS AND ABBREVIATIONS

Ag NPs	Silver nanoparticle
Ag-Co NPs	Silver-cobalt nanoparticles
Au-NPs	Gold Nanoparticles
BSA	Bovine Serum Albumin
FTIR	Fourier Transform Infra-Red
MBC	Minimum Bactericidal Concentration
MIC	Minimum Inhibitory Concentration
MFC	Minimum Fungicidal Concentration
nm	Nano Metre
NPs	Nanoparticles
PBS	Phosphate Buffered Saline
ROS	Reactive Oxygen Species
SEM	Scanning Electron Microscopy
SPR	Surface Plasmon Resonance
TEM	Transmission Electron Microscopy
UV-Vis	Ultraviolet-Visible
XRD	X-ray diffraction
XPS	X-ray Photoelectron Spectroscopy

ABSTRACT

Globally, the health sector needs to take advantage of nanotechnology as nanotoxicology is gaining interest. More so, there is a need to check the drug resistance of the disease-causing microbes and find alternative cancer drug treatments in humans. However, the safety of human health and the environment is a major concern as some nanoparticles were reported to be toxic due to their fabrication methods. Thus, these challenges lead to the quest for a safer choice of synthetic routes. While the search for contextualization of the harmful effects of nanoparticles is ongoing, a green approach method that makes use of biodiversity plants instead of toxic chemicals is considered primarily for biomedical applications. This research evaluated the antimicrobial, toxicity, and cytotoxicity of the green synthesized silver-cobalt nanoparticles (Ag-Co NPs). Aqueous extract of *Annona muricata* leaf prepared via hot maceration was utilised as a reducing agent. Progress of the reaction was monitored by a UV-Visible spectrophotometer. The biomolecules responsible for reducing and capping the particles were analysed qualitatively. SEM and TEM were used to investigate the morphological characteristics of the particles and further characterization by X-Ray Diffraction (XRD) and zeta sizer. Furthermore, antimicrobial activity of the Ag-Co NPs was carried out using 6 test organisms, two gram-positive: *Staphylococcus aureus*, *Streptococcus pneumoniae* and three gram-negative, *Escherichia coli*, *Klebsiella sp*, and *Salmonella sp* and one fungus, *Candida albicans*. The cytotoxic effect of the Ag-Co NPs was tested on a cancer cell line. *In vivo* toxicity assessment was done using *Drosophila melanogaster* as the assessment model. The characteristic absorption wavelength of the as-prepared nanoparticles was observed with a broad peak around 400-450 nm, indicating that the nanocluster formed was silver enriched. The FTIR showed the functional groups present in the plant extract and the Ag-Co NPs. In the plant extract, the following absorption bands occurred at 3322, 1585, and 1277 cm^{-1}, stretches assigned to O-H, N-H, and C-N, respectively, while peaks occurred at 1649 cm^{-1} and (N-H) 1163 cm^{-1} in the corresponding Ag-Co NPs. Both the extract and Ag-Co NPs possessed antimicrobial activities against the test organisms moderately, compared to the control (antibiotics). Moreover, there were no significant toxicity observations on the two developmental stages and locomotive assessment of *Drosophila melanogaster*. The finding in this study indicates that the *Annona muricata*-based Ag-Co NPs synthetic route is an excellent alternative technique to the conventional method. Also, the nanoparticles demonstrated little or no toxicity that indicated them as potential candidates for drug development as they exhibited promising antimicrobial activity with no significant toxic effect, as shown in the *Drosophilla melanogasta in vivo* model.

Keywords: ***Ag-Co nanoparticle, toxicity, cytotoxicity, green chemistry, Sustainability Developmental Goals (SDG), antimicrobial.***