Concentration and Exposure Assessment of Antibiotics and Heavy Metals in Groundwater Sources in Two Rural Communities in Nigeria

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Certification

This is to certify that Adesola Olubunmi, ADEDEJI with Matric Number LCU/PG/002183 carried out this research work titled "Concentration and Exposure Assessment of Antibiotics and Heavy metals in Groundwater sources in Two Rural Communities in Oyo and Ogun States in Nigeria" in the Department of Chemical Sciences (Chemistry Unit), Faculty of Natural and Applied Sciences, Lead City University, Ibadan, Oyo State, for the award of Master Degree (M.Sc) in Chemistry and that this work has not been previously submitted.

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Dedication

This study is dedicated to the Almighty God, the creator of heaven and earth who granted me the grace to complete this work against all odds. Blessed be His holy name forever.

Acknowledgement

I want to appreciate the Lead City University, Ibadan, Oyo state, Nigeria for the opportunity given to me that led to the discovery of the inherent potentials in me through a well-guided academic training.

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Even though the above-mentioned institutions and persons have assisted in the process of this research work, I alone stand responsible for the errors, if any found in the work.

Abstract

In most rural communities in Nigeria, access to potable water is of great concern. Likewise, several studies have linked heavy metals to the co-selection of antibiotic resistance, and Antibiotic Resistant Genes (ARGs). However, co-occurrence and exposure assessment data for antibiotics and heavy metals are scarce and when available are limited to urban areas. Hence, this study aims to investigate the occurrence, source, concentration and risk associated with antibiotic chemical residues and heavy metals in groundwater sources. A total of 30 groundwater samples from two rural communities were assessed for physicochemical parameters (pH, Temperature, Total Dissolved Solids (TDS), Electrical Conductivity (EC), and Dissolved Oxygen (DO)), heavy metals (B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Se, and Zn) and common antibiotics (ampicillin, chloramphenicol, ciprofloxacin and metronidazole). Samples for elemental analysis were digested using HNO_3 and those for antibiotics analysis were extracted using Solid Phase Extraction (SPE). Elemental and antibiotics quantifications were done using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES) and high-performance liquid chromatography-UV/Visible (HPLC-UV) systems respectively. All calibration curves exhibited $r^2 > 0.999$ and relative recovery experiments were within the acceptable range. Concentration data obtained were subjected to descriptive, inferential and multivariate analyses. The average concentrations of all heavy metals in groundwater samples were below the WHO permissible limit for drinking water except for Cr, Ni and Pb at 0.05, 0.02 and 0.10 mg L^{-1} respectively. Although Ampicillin and Chloramphenicol concentrations were below the limit of detection, Ciprofloxacin (76 to 1137 µg L^{-1}) and Metronidazole (1191 to 7846 µg L^{-1}) detection ranged between 30-60% in all groundwater samples. Data from this study indicated that Cr, Ni and Pb contamination in groundwater and may pose a potential health risk to the local inhabitants who depend on well water for consumption and other domestic uses.

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List of Acronyms

Abbreviation	Meaning
PPCPs	Pharmaceuticals and Personal Care Products
DDD	Defined Daily Dose
ARB	Antibiotic Resistance Bacteria
ARG	Antibiotic Resistance Gene
AR	Antibiotic Resistance
PNEC	Predicted No Effective Concentration
MEC	Measured Environmental Concentration
WWTP	Waste Water Treatment Plants
PWS	Public Water Supply
RQ	Risk Quotient
HM	Heavy Metals
HHRA	Human Health Risk Assessment
Rfd	Reference Dose

ED	Exposure Duration
BW	Body Weight
PHQ	Potential Hazard Quotient
CDI	Chronic Daily Intake
ADI	Acceptable Daily Intake
THQ	Target Hazard Quotient
HQ	Hazard Quotient indices
TCR	Target Carcinogenic Risk
SF	Slope Factor
HI	Health Index
FEPA	Federal Environmental Protection Agency
USEPA	United State Environmental Protection Agency
WHO	World Health Organization
IUPAC	International Union of Pure and Applied Chemistry
NAFDAC	National Agency for Food and Drug Administrative Control
LOD	Limit of Detection
LOQ	Limit of Quantification
SPE	Solid Phase Extraction
HPLC-UV	High Performance Liquid Chromatography- Ultraviolet Detection
ICP-OES	Inductively Coupled Plasma-Optical Emission Spectrometry.

ANOVA	Analysis of Variance
PTE	Potentially Toxic Element.