

**Assessment of Heavy Metals and Organic Compounds in Water and Leachate from Aba-
Eku Municipal Solid Waste Site in Ibadan, Oyo State, Nigeria.**

**Morolake Oluwatoyosi AFOLABI
LCU/PG/002246**

**Being a MSc Post-field Presentation Submitted to the Department of Biological
Sciences, Faculty of Natural & Applied Sciences, Lead City University, Ibadan,
Oyo State, Nigeria**

**In Partial Fulfillment of the Requirements for the Award of Masters of Science
Degree (MSc) in Environmental Management and Toxicology**

2023

Certification

This is to certify that **Morolake Oluwatoyosi AFOLABI** with the matriculation number LCU/PG/002246, carried out this research work titled “**Assessment of Heavy Metals and Organic Compounds in Water and Leachate from Aba- Eku Municipal Solid Waste Site in Ibadan, Oyo State, Nigeria.**” in the Department of Biological Sciences, Faculty of Natural & Applied Sciences, Lead City University Ibadan, Oyo State, for the award of Master of Science Degree (MSc) in Environmental Management and Toxicology and this has not been previously submitted.

Dr. Omotayo Sindiku
(Supervisor)

Date

Dr. Felicia Adesina
(Head of Department)

Date

Dedication

This thesis is dedicated to Almighty God, to my husband and family.

Do Not Copy, Lead City University, Nigeria

Acknowledgement

I hereby acknowledged Lead City University and staff members of E-library for their support and well-informed impact.

I truthfully appreciate the efforts and guidance of my supervisor Dr. Omotayo Sindiku, I am grateful for her corrections and advice that made this research work worthwhile. I also acknowledge the effort and support of the Head of Biological Sciences Department, Dr (Mrs) Felicia Adesina, and other lecturers namely Dr. Tinuola Ekanade, Dr. Idowu Ologeh, Dr Bukola Bamkefa and just to mention a few.

I acknowledge my family, all my friends and colleagues who made significant contributions to this study and to my Mr Afolabi Oluwatoyin and Silas Fagbenro. God bless you all.

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

Increase in waste generation, resulting from population growth, has led to a burden on global health. Physico-chemical, organic analysis, and leachate pollution index analysis were conducted on the water samples from Aba Eku dumpsite (latitudes 3°35'N and 4°10'N and longitudes 7°2'E and 7°40'E). Relationships among various parameters were also analysed using correlation coefficients (r) and significance levels (p values). Water samples revealed high concentrations of physico-chemical parameters, heavy metals, also Polyaromatic hydrocarbons (PAHs), and phthalate esters were present. Notably, the dumpsite exhibited highest concentration of naphthalene among all the PAHs. These findings indicate that the landfill site is polluted with PAH and phthalate compounds. Significant relationships among parameters were observed, including a strong negative correlation between pH and both BOD ($r = -0.932$) and dissolved oxygen ($r = -0.912$). Total dissolved solids showed significant positive associations with chloride ($r = 0.977$, $p < 0.05$), total hardness ($r = 0.889$), sulphate ($r = 0.955$, $p < 0.05$), and phosphate ($r = 0.836$). BOD exhibited a strong positive correlation with dissolved oxygen ($r = 0.984$, $p < 0.05$) and NO₃ ($r = 0.742$), while chloride demonstrated significant positive correlations with total hardness ($r = 0.942$), sulphate ($r = 0.994$, $p < 0.01$), and phosphate ($r = 0.796$). Significant differences ($P < 0.001$) were found between leachate and 300m location, leachate and 600m location, as well as leachate and the river location. No significant differences ($P > 0.05$) were detected among other locations. Leachate pollution index (LPI) values of water samples around the dumpsite ranged from 5.558 to 7.683, indicating slight contamination from heavy metals. The pollution from the landfill site, and surface runoff, poses a significant risk to quality of both underground water and river. Urgent remediation, waste management strategies should be implemented to mitigate the pollution.

Keywords: Leachates, Heavy Metals, Leachate Pollution Index, Physicochemical Parameters.

Word Count: 300

Table of Contents

Content	Page
Title Page	i
Certification	ii
Dedication	Iii
Acknowledgement	Iv
Abstract	V
Table of Contents	Vi
List of Tables	Xi
List of Figures	Xii
List of Acronyms	Xiii
Chapter One: Introduction	
1.1 Background to the Study	1
1.2 Statement of Problem	5
1.3 Justification of the Study	5
1.4 Aim and Objectives of the Study	6
1.5 Research Questions	7
1.6 Significance of the Study	7

1.7	Scope of the Study	9
1.8	Limitations of the Study	9
1.9	Operational Definition of Terms	9

	Endnotes	11
--	-----------------	----

Chapter Two: Literature Review

2.1	Solid Wastes	18
2.2	Types of Solid Waste	19
2.2.1	Municipal Solid Waste (MSW)	20
2.2.2	Hazardous Waste	20
2.2.3.	Industrial Waste	20
2.2.4.	Agricultural Waste:	20
2.2.5	Construction and Demolition Waste	20
2.2.6	Biomedical Waste	21
2.2.7	Electronic Waste (e-waste)	21
2.2.8	Radioactive Waste	22
2.2.9	Organic Waste	22
2.2.10	Inorganic Waste	23
2.2.11	Toxic Waste	23
2.3	Leachate	26
2.4	Sanitary Landfill	29
2.5	Toxic Pollutant	31
2.6	Types of Toxic Pollutant	32

2.7	Phthalates Esters	35
2.8	Effects of Phthalates on Human	38
2.9	Environmental Effects of Phthalates	41
2.10	Environmental Sources of Phthalate	41
2.11	Methods of Analyzing Toxic Pollutants	42
2.12	Poly Aromatic Hydrocarbons	44
2.13	Sources of PAH	48
2.14	Atmospheric Transformation and Deposition	50
2.15	Transport and Fate of PAHs in the environment	50
2.16	Risk Management Strategies	54
2.17	Public health effects of landfill leachates	57
2.17.1	Leachate as a Possible Pathogen Source and its Implications for Human Health	58
2.17.2.	Heavy Metal Occurrence in Dumpsite Leachate and Human Exposure	59
2.17.3	Leachate Pollution of Underground Water	60
2.17.4	Leachate Air Contamination	63
2.17.5	Leachate as a Potential Source of Pathogen and Health Implication	63
2.18	Public Health Effects of PAHS	65
2.18.1	Routes of Exposure	65
2.18.2.	Metabolism Exposure to PAHs is Never to Single PAHs.	66
2.18.3	Short-Term Health Effects (Acute)	67
2.18.4	Long-Term Health Effects (Chronic)	68

2.18.5. Carcinogenicity	68
2.18.6. Effects of PAH on the Immune System	69
2.19. Issues with Effective Waste/Leachate Management.	70
Endnotes	72

Chapter Three: Methodology

3.1 Research Design	89
3.2 Study Site	89
3.3 Sample Collection	90
3.4 The Physicochemical Parameters Analysis	91
3.4.1 Determination of Chemical Oxygen Demand (COD)	91
3.4.2 Estimation of Total Hardness	91
3.4.3 Determination of Sulfate	95
3.4.4 Determination of Nitrate	96
3.4.5 Determination of Biological Oxygen Demand (BOD), Dissolved Oxygen and Temperature	96
3.4.6 Determination of pH and TDS	97
3.4.7 Determination of Heavy Metals	97
3.5 Determination of Phthalates Esters	97
3.6 Quality Control and Quality Assurance Protocol	99
3.7 Extraction and Clean-up of Polycyclic Aromatic Hydrocarbons	99
3.7.1 Solvent Extraction	100
3.7.2 Sample Clean-up Procedure	101
3.8 Leachate Pollution Index Calculation	101

Endnotes	102
Chapter Four: Results and Discussion of Findings	
4.1 Results	103
4.2 Results of Physico-Chemical Analysis	103
4.2 Qualitative Analysis for Physicochemical Parameters of the Groundwater Samples	103
4.3 The Correlation Coefficients (R) and Significance Levels (P Values) for the Various Parameters Studied	103
4.4 Two-way Analysis of Differences of Water Quality Parameters in different Locations.	106
4.5 Results of Phthalate Analysis	109
4.6 Results of PAH Analysis	109
4.7 Results of LPI Analysis	109
Endnotes	117
Chapter Five: Conclusion	
5.1 Summary of Findings	118
5.2 Conclusion	119
5.3 Recommendations	120
5.4 Contribution to Knowledge	121
5.5 Suggested Areas for Further Research	121
Bibliography	122
Appendices	148
Bio-data	159
The University Compliance Certification	162

List of Tables

Table	Title	Page
2.1	Waste Composition in Different Region	24
3.1	AAS Modeled AA990 PG Working Conditions	98
4.1	Concentration of Physic-chemical Parameters in the Samples	104
4.2	Summary Statistics for Concentration of Physicochemical Parameters, with Comparison to National Standards.	105
4.3	Pearson's Correlation Analysis of the Physicochemical Parameters and Heavy Metals among all Water Quality	107
4.4	Analysis of Differences of Water Quality Parameters in Different Locations using Two Way ANOVA at a 95% Confidence Interval	108
4.5	Summary Statistics for Concentration of Phthalate Compounds	110
4.6	Summary Statistics for the Concentration of PAH compounds	112
4.7	The LPI of Aba-Eku Water Sample	114

List of Figures

Figure	Title	Page
2.1	Theoretical Framework of the Review: Source of contamination due to Solid Waste management	27
2.2	Composition and Classification (by material) of MSW Generated by the United States in 2013	28
2.3	Effects of BPA and Phthalates on the Development and Function of the Male Reproductive Tract. Abbreviations: polychlorinated biphenyls (PCB), Persistent Organic Pollutants (POP), Polyfluoroalkyl Acids (PFAS), Perfluorooctanoic Acid (PFOA)	39
2.4	Polycyclic Aromatic Hydrocarbons: Sources, Importance and Fate in the Atmospheric Environment.	46
2.5	Natural and Anthropogenic Sources of Polycyclic Aromatic Hydrocarbons (PAHs)	51
2.6	Flow Chart Showing Short- and Long-Term Health Effects of Exposure to PAHs	53
3.1	A Cross-section of Aba-Eku Dumpsite	92
3.2	The Map of Aba-Eku Municipal Dumpsite in Ibadan	93

List of Acronyms

Abbreviation	Meaning
AAS	Atomic Absorption Spectroscopy
USEPA	United States Environmental Protection Agency
ANOVA	Analysis of Variance
GC	Gas Chromatography
GC-MS	Gas Chromatography Coupled to Mass Spectrometry
HPLC	High Performance Liquid Chromatography
PAHs	Polycyclic Aromatic Hydrocarbons
LPI	Leachate Pollution Index
MSW	Municipal Solid Waste
PAEs	Phthalate Esters
DEHP	Di (2-ethylhexyl) Phthalate
EPA	Environmental Protection Agency
USA	United States of America
APEs	Alkylphenol Polyethoxylates
PFCs	Perfluorinated Compounds
VOC	Volatile Organic Compounds
PCBs	Polychlorinated Biphenyls
POP	Persistent Organic Pollutants
DDT	Dichlorodiphenyltrichloroethane
PVC	Polyvinyl Chloride
PET	Polyethylene Terephthalate

OECD	Organization for Economic Cooperation and Development
EDCs	Endocrine Disruptive Chemical
SWM	Solid Waste Managements
BPA	Bis-Phenol

Do Not Copy, Lead City University, Nigeria

Do Not Copy, Lead City University, Nigeria