Microplastic and Phthalate Esters Occurrences in *Oreochromis niloticus* and *Clarias gariepinus* Obtained from Lagos and Epe Lagoons

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Being a PhD Thesis Submitted to the Department of Biological Sciences, Faculty of Natural and Applied Sciences, Lead City University,
Ibadan, Oyo State, Nigeria

In Partial Fulfilment of the Requirements for the Award of the Doctor of Philosophy Degree (PhD) in Environmental Biology

2025

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Certification

This is to certify that **Nkechinyere Veronica OTU-EKUMA** with matriculation number **LCU/PG/003012** carried out this research work titled "**Microplastic and Pthalate Esters Occurence in *Oreochromis niloticus* and *Clarias gariepinus* from The Lagos and Epe Lagoons**" in the Department of Biological Sciences, Faculty of Natural and Applied Sciences, Lead City University, Ibadan, Oyo State, for the award of **Doctor of Philosophy (PhD) Degree in Environmental Biology** and that this has not been previously submitted.

_____ _____

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(Supervisor)

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(Head of Department)

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Dedication

This research work is dedicated to God Almighty and to the memory of my late Mother, Mrs Chienye Otu-Ekuma, and late sister, Ucha Joy Otu-Ekuma, who are forever my greatest source of inspiration on my weary days.

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Completing this degree means a lot to me and I appreciate my friends (Elizabeth, Oluchi, Pwandayakai, Agbo and Favour), colleagues and all the readers of this work for their contributions in making this research a success. May God bless you all.

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

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Abstract

Microplastics are increasingly found in aquatic environments, yet data on their distribution and effects in Nigeria's lagoons remain limited. This study assessed the occurrence of microplastics and phthalate esters in two commercially important fish species (*Oreochromis niloticus* and *Clarias gariepinus*) and heavy metals in surface and benthic waters from Makoko, Ikorodu, and Epe. Sampling occurred during four seasonal cycles (March, May, August, and November). Microplastics were isolated by density separation and identified via FTIR; phthalates were analyzed using GC-MS, and heavy metals analysed using standard method. The study recorded widespread contamination in all sample types and sites, with seasonal and spatial variations. Microplastic counts in *Oreochromis niloticus* ranged from 8.7±2.3 particles/fish (Epe, August) to 22.3±5.7 (Makoko, November), and in *Clarias gariepinus* from 7.6±1.9 (Epe, August) to 19.4±4.8 (Makoko, November). Fibers made up 58%, fragments 35%, films 5%, and pellets 2% of total particles. The most abundant polymers were PE (42%), PP (26%), PS (17%), and PET (15%), indicating mixed urban and household plastic sources. Phthalate esters occurred in all fish tissue samples, showing seasonal and spatial variation. The highest concentration (55.0 ± 5.4 mg/kg) was observed in C. gariepinus from Ikorodu in March, and the lowest (28.7 ± 3.2 mg/kg) in August, while *Oreochromis niloticus* from Makoko contained 49.3±4.1 mg/kg. Diethyl phthalate (DEP) and di(2-ethylhexyl) phthalate (DEHP) were the most abundant esters detected. Heavy metal concentrations exceeded WHO limits in all water samples. Notably, in November, Pb in Makoko benthic water reached 6.77 mg/L, Ni 14.66 mg/L, Cd 2.84 mg/L, Cr 3.15 mg/L, and Cu 2.61 mg/L. Seasonal variations were evident across parameters: for instance, Pb in surface water at Ikorodu declined from 3.74 mg/L in May to 1.21 mg/L in August before rising again to 4.68 mg/L in November. Similar seasonal trends were observed for Ni, Cd, Cr, and Cu, reflecting the influence of rainfall, mixing, and anthropogenic inputs. Morphometric analysis showed clear spatial and seasonal differences in *Oreochromis niloticus* and *Clarias gariepinus*. Epe consistently recorded the largest specimens, with *O. niloticus* reaching a mean standard length of 13.80 ± 1.56 cm and weight of 175.00 ± 31.31 g in November, while Makoko recorded the smallest (13.00 ± 1.12 cm; 155.00 ± 33.54 g). For *C. gariepinus*, Epe weights peaked at 390.00 ± 78.26 g, compared to 350.00 ± 67.08 g at Makoko. Physicochemical parameters varied seasonally; for example, dissolved oxygen was highest in August (6.24 mg/L surface water at Epe) during peak rainfall, while conductivity and TDS were elevated in March and November, with benthic conductivity reaching 329.50 µS/cm at Makoko. Turbidity also peaked in November, with surface water values up to 42.40 NTU at Ikorodu, reflecting increased runoff and anthropogenic input. These findings demonstrate that microplastics, phthalates, and heavy metals co-occur at ecologically concerning levels in Lagos and Epe lagoons, with site- and season-specific patterns. Targeted interventions—particularly improved waste management, focused monitoring in high-risk areas such as Makoko, and seasonal pollution control—are essential to safeguard aquatic ecosystems and food security.

Keywords: Microplastic, Phthalate, Heavy Metals, Pollution, Aquatic Ecosystems

Word Count: 457

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List of Acronyms

Abbreviation	**Meaning**
AAS	Atomic absorption spectroscopy
ANOVA	Analysis of Variance
ABS	Acrylonitrile butadiene styrene

COD	Chemical Oxygen Demand
DBP	Dibutyl Phthalate
DEHP	Diethylhexyl Phthalate
DEP	Diethyl Phthlate
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
EIA	Environmental Impact Assessment
EPR	Extended Producer Responsibility
EU	European Union
FMENV	Federal Ministry of Environment
FTIR	Fourier Transform Infrared Spectroscopy
GC-MS	Gas Chromatography-Mass Spectrometry
GIS	Geographic Information System
HDPE	High Density Polyethylene
HIPS	High Impact Polystyrene
IMO	International Maritime Organization
MbR	Membrane Reactor
MP	Microplastic
NESREA	National Environmental Standards and Regulation Enforcement Agency
NGO	Non-Governmental Organisation
NTU	Nephelometric Turbidity Unit
PA	Polyamide
PAE	Phthalate Esters
PAH	Poly Aromatic Hydrocarbon

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PBAT	Polybutylene Adipate-co-Terephthalate
PC	Polycarbonate
PCB	Polychlorinated Biphenyls
PE	Polyethylene
PET	Polyethylene Terephthalate
pH	Potential of Hydrogen
PLA	Polylactic Acid
PP	Polypropylene
PS	Polystyrene
PVC	Polyvinyl Chloride
PYr-GCMS	Pyrolysis-Gas Chromatography Mass Spectrometry
RSD	Relative Standard Deviation
SPE	Solid Phase Extraction
SPSS	Statistical Package for Social Sciences
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UNEA	United Nations Environmental Association
UNEP	United Nations Environmental Program
USEPA	United Nations Environmental Protection Agency
UV	Ultra Violet
VOCs	Volatile Organic Compound
WHO	World Health Organization
WWTP	Waste Water Treatment Plant

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