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A MICROPLASTICS CONTAMINATION IN DONGA RIVER, DONGA LOCAL GOVERNMENT AREA TARABA STATE

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ABSTRACT

Microplastic pollution has emerged as a significant threat to freshwater ecosystems, particularly in regions where baseline data remain scarce. This study investigated the occurrence, distribution, and ecological risks of microplastics in water and sediment samples from Donga River, Taraba State, Nigeria. Different physicochemical parameters namely; conductivity, pH, temperature and dissolved oxygen were analysed according to the standard methods described by UNICEF/WHO, (2017). The microplastics from the water and sediment were extracted as explained by Turhan, (2022). The observation and identification of microplastics in water and sediment samples of petri dishes containing the filter paper were observed using a compound binocular microscope (Motic).Microplastics were detected across all sampling locations, with identified polymers including polyethylene (PE), polyvinyl chloride (PVC), polystyrene (PS), polypropylene (PP), polyamide (PA), and polyethylene terephthalate (PET). Sediment samples exhibited higher concentrations, indicating their role as major sinks for microplastic accumulation. Ecological risk assessment revealed that PE, PVC, PS, and PA posed moderate environmental risks (Level II), whereas PP and PET were associated with lower risk levels (Level I). Variations in physicochemical parameters (Ph,DO, Temperature and conductivity) were found to influence the spatial distribution of microplastics. The widespread contamination observed suggests significant anthropogenic inputs, primarily from improper waste disposal and surface runoff. These findings provide critical baseline data for environmental monitoring and highlight the urgent need for improved waste management strategies and effective regulatory frameworks to protect freshwater ecosystems and public health in the region.

Keywords: Microplastics, Freshwater Pollution, Donga River, Sediment Contamination

INTRODUCTION

Microplastics, defined as plastic particles less than 5 mm in diameter, have emerged as a significant environmental pollutant over the past few decades (Andrady, 2017). They originate from two main sources: primary microplastics, which are manufactured at small sizes for use in personal care products, industrial abrasives, and biomedical applications, and secondary microplastics, which result from the fragmentation of larger plastic debris due to mechanical forces, ultraviolet radiation, and weathering processes (Cole *et al*., 2011; Li *et al*., 2018). These particles are highly persistent in the environment because of their chemical stability, resistance to biodegradation, and ability to adsorb and transport toxic chemicals such as persistent organic pollutants (POPs) and heavy metals.

Freshwater ecosystems, particularly rivers, play a crucial role in the global transport of microplastics. Rivers act as conduits that carry plastic debris from terrestrial sources, including urban settlements, agricultural lands, and industrial zones, to downstream water bodies such as lakes, reservoirs, and the ocean (Eerkes-Medrano *et al*., 2015; Lebreton *et al*., 2017). The presence of microplastics in rivers has been documented worldwide, with studies reporting varying contamination levels depending on proximity to urbanization, industrialization, and waste management practices (Wagner *et al*., 2014; Horton *et al*., 2017). Given the global rise of microplastic pollution and the scarcity of data in the North-East Nigerian context, investigating microplastic contamination in the Donga River is both timely and necessary. Such a study will provide baseline information on the occurrence, distribution, and physicochemical characteristics of microplastics in the river, contribute to understanding their ecological and health implications, and inform policy and environmental management strategies aimed at mitigating freshwater microplastic pollution

MATERIALS AND METHODS

Study Area

Donga is a local Government Area in Taraba State, Nigeria. Its headquarter is in the town of Donga. The Donga River is at 7º 48` 00``N 10º 03` 00``E and 7.71667º 10.05000ºE. It has an area of about 3,420 km^2.

It is a commercial centre which attracts people from many parts of neighbouring local government areas of the state like Takum, Wukari, Bali, Gassol. Not only that, it is also centre for administrative activities. Donga is well connected to the other parts of the state with good transportation networks. These networks also give room for interstate trading in hide and skin especially fish business from River Donga. From 1999 to 2006, population of this area rose from 84,626 and the total population on board was 134,111 at the 2006 census, with overall density of over 43 persons per square kilometers. Soil fertility which is obtained through fallow period has been continuously shortened through increase in population and continuous cropping of the land. Increase in population could generate increased pressure on the sustainability of land resources and environmental condition.

Figure 1: Map of Donga Local Government Area of Taraba State, Nigeria
Source: Ministry of Land and Survey, Taraba State (2019)

Sample Collection

The water and sediment samples were aseptically collected in pre-cleaned sterile sample bottles from the middle of the river in triplicate from the River in Donga town, Donga Local Government Area, Taraba State, Nigeria. The collected samples were tagged appropriately and placed inside an ice-cold cooler and transported to Biology laboratory, Federal University Wukari for analysis of microplastics.

Microplastic Extraction from Water and Sediment Samples

The microplastics from the water and sediment were extracted as explained by Turhan, (2022). Twelve (12) water and sediment samples (2 from the inflow, 2 from the mid-point and 2 from the outflow of the water and sediment samples) underwent filtration using fiber filter papers. After the filtration, 9ml of hydrogen peroxide (H_2O_2) solution was added to each 1 litre of the water and sediment samples to digest organic materials and the samples were kept away from light for 48 hrs at room temperature. Subsequently, the digested water and sediment samples were transferred into a separating funnel containing an aqueous potassium formate solution of 300ml. Water and sediment samples were then filtered sequentially through a fibre filter paper with a pore size of 2.7 µm to extract the microplastics. Each filter paper after the microplastics extraction was placed in a glass petri dish and placed in a desiccator under room temperature. Observation and Identification of Microplastic.

The observation and identification of microplastics in water and sediment samples of petri dishes containing the filter paper were observed using a compound binocular microscope (Motic). Photo micrographs of the viewed microplastic particles were captured and categorized as fibers and fragments. The microplastic particles from the inflow, mid-point and outflow were pooled together, after which identification and characterization of the microplastics detected were conducted with a UV-Visible spectrophotometer (T60U) at a wavelength of 300nm.

The polymer types were identified by matching the wavelength data with those obtained from previous literature (Jung *et al*., 2018). Throughout the entire analysis, filter papers were covered properly to prevent contamination from airborne fibers when they were not under the microscope.

Contamination Control

All the glasswares used were properly washed and rinsed twice using sterile distilled water and sterilized in an oven at 100^0c for 1hr. The samples were kept covered inside glassware whenever possible or under analysis to avoid external microplastics contamination. Polyester-type clothing was avoided to prevent contamination of microplastics in the samples and during handling, cotton- made laboratory lab were used. All non-plastic sieves were washed properly, before and after use. All microplastic samples in filter paper were kept in petri dishes and appropriately covered with aluminum foil and all petri dishes were placed in a glass desiccator to avoid airborne microplastic contamination following the method described by Rakib *et al*. (2022).

Physicochemical Analysis

Different physicochemical parameters namely; conductivity, pH, temperature and dissolved oxygen were analyzed according to the standard methods described by UNICEF/WHO, (2017).

Determination of pH of Water and Sediment Samples

A digital pH meter (Model: HI 2214) was used to determine the pH of the water and sediment samples. The pH meter was calibrated using different buffer solutions of pH 12.1, 7.0 and 4.0. The pH electrode was immersed in the water and sediment samples and the steady value of Ph read. Readings were taken in duplicates and average values record.

Determination of Temperature of Water and Sediment Samples

A digital temperature meter was used to measure the temperature of the water and sediment samples. The temperature probe was immersed in the water and sediment samples and the steady value of temperature read.

Determination of Conductivity of Water and Sediment Samples

The electrical conductivity of the water and sediment samples were determined using a digital conductivity meter (Model: DDS-307A). The conductivity meter was calibrated by standardizing with distilled water and conductivity meter electrode immersed inside the water and sediment samples. The read/enter key was pressed and the value of conductivity read directly in S/m. The test was performed twice on each water sample and the average values recorded.

Determination of Dissolved Oxygen of Water and Sediment Samples

The dissolved oxygen (DO) of the water and sediment samples was determined using a dissolved oxygen (DO) meter (Model: 407510A). The DO meter probe was rinsed with distilled water followed by the water and sediment samples tested. The rinsed probe was allowed to stabilize in the water and sediment samples for 1 min after which the DO value was read directly in mg/L.

RESULTS AND DISCUSSION

Table 1: Absorbance Peak and Functional Groups of Polymers Identified in Donga River Water and Sediment Samples

Sample	Absorbance peak Polymer Type	Functional Group Source
Donga pond inflow water sample	1430, 1461 and 1475	CH_2, CH_2, CH_2
bend	PVC, PE, PE	Shiue *et al*. 2021
Donga pond inflow sediment sample	1586, 1514 and 1464	C=C stretch, CH_2
bend	PS, PS, PE	Jipa *et al*. 2012
Donga pond mid-point water sample	1520, 1493 and 1659	C=C stretch, C=C, C=O
	PS, PS, PP	Jipa *et al*. 2012
Donga pond mid-point sediment sample	1584, 1540 and 1601	C=C, NH, C=C
	PS, PE, PS	Jipa *et al*. 2012
Donga pond outflow water sample	1572, 1583 and 1599	NH, C=C stretch, C=C
	PA, PS, PS	Jipa *et al*. 2012
Donga pond outflow sediment sample	1514, 1487 and 1522	C=C, C=C, C=C
	PET, PS, PS	Jipa *et al*. 2012

Key: PVC, Polyvinyl Chloride, PE = Polyethylene, PS = Polystyrene, PP = Polypropylene, PA = Polyamide, PET = Polyethylene Terephthalate

Table 2: Risk Index of Polymers in Donga River Water and Sediment Samples

Sample	PE PP	PVC PA	PS PET
Donga river inflow water sample	11.0	47.1	-
	-	-	-
Donga pond inflow sediment sample	10.9	-	29.7
	-	-	-
			28.4
Donga pond mid-point water sample	-	-	28.5
	0.9	-	-
			27.9
Donga pond mid-point sediment sample	11.1	-	29.7
	-	-	-
			30.0
Donga pond outflow water sample	-	-	29.7
	-	22.1	-
			29.9
Donga pond outflow sediment sample	-	-	27.9
	-	-	4.0
			28.5
Risk level	II	II	II
	I	II	I

Key: PE = Polyethylene, PVC = Polyvinyl Chloride, PS = Polystyrene, PP = Polypropylene, PA = Polyamide, PET = Polyethylene Terephthalate. Note: I = Low Risk < 10, II = Medium Risk 10 – 100, III = High Risk 100 – 1000, IV = Extremely High Risk > 1000 (Yahaya *et al*., 2022)

Table 3: Physicochemical Analysis of Water and Sediment Samples from Donga River

Parameter	INW OUS	INS WHO	MIDW SON	MIDS	OUW
pH	8.6	9.1	9.1	10.2	7.8
	8.9	6.5-8.5	6.5-8.5		
Temperature	32.3^{o}C	32.5^{o}C	32.5^{o}C	32.5^{0}C	
	31.70C	32.10C	29^{o}C		
Dissolvedoxygen, Mg/L	67.9	68.3	69.0	67.3	67.7
	65.2	6.5-8	6.5-8		
Conductivity, S/m	5.6	5.6	5.2	6.7	8.2
	8.5	1000	1500		

Key: INW = Inflow water, INS = Inflow sediment, MIDW = Mid-point water, MIDS = Mid-point sediment, OUW = Outflow water, OUS = Outflow sediment. World Health Organization (WHO) Standard Guidelines (2011) and Standard Organization of Nigeria (SON) Standard Guidelines (2007).

Discussions

The present study revealed the occurrence of microplastics in both water and sediment samples collected from Donga Pond in Donga Local Government Area of Taraba State. Several polymer types were identified including polyethylene (PE), polyvinyl chloride (PVC), polystyrene (PS), polypropylene (PP), polyamide (PA), and polyethylene terephthalate (PET). The presence of these polymers across the inflow, mid-point, and outflow sampling locations indicates that microplastic contamination is already established within the aquatic ecosystem. The occurrence of these particles suggests that anthropogenic activities such as improper disposal of plastic waste, domestic activities, and agricultural runoff may be contributing significantly to the contamination of the pond. Similar observations were reported by Li *et al*. (2021), who detected polyethylene, polypropylene, and polystyrene as dominant microplastic polymers in freshwater environments in Zhijin county, located in mdwest of Guizhou China. Likewise, Oyekunle *et al*. (2022) reported the presence of microplastics in Nigerian freshwater bodies such as Lagos Lagoon and Ogun River, confirming that plastic contamination of aquatic ecosystems is becoming increasingly widespread.

The detection of polyethylene and polyvinyl chloride in the inflow water samples suggests that the pond receives plastic contaminants from surrounding land-based sources. Polyethylene is widely used in plastic bags, packaging materials, and household products, while polyvinyl chloride is commonly used in construction materials, pipes, and plastic containers. Their presence at the inflow region therefore indicates contamination arising from domestic waste disposal and environmental runoff from nearby settlements. Similar findings were reported by Wagner *et al*. (2019), who noted that polyethylene and polyvinyl chloride are among the most frequently detected polymers in freshwater systems due to their extensive industrial and domestic applications. Andrady (2017) also explained that environmental factors such as sunlight exposure, temperature, and mechanical abrasion contribute to the fragmentation of larger plastic materials into smaller microplastic particles that are eventually transported into rivers and ponds.

The study also revealed the presence of polystyrene and polyethylene in sediment samples, indicating that sediments can serve as important sinks for microplastic accumulation. Due to differences in density and hydrodynamic conditions, microplastics can settle at the bottom of aquatic environments where they accumulate over time. This observation agrees with Prata *et al*. (2020), who reported that freshwater sediments often contain high concentrations of microplastics because particles gradually settle and persist for long periods due to their resistance to biodegradation. Similarly, Zhou *et al*. (2022) reported significant microplastic accumulation in river sediments, emphasizing that benthic environments can act as reservoirs for plastic particles. The accumulation of microplastics in sediments may pose ecological risks since benthic organisms can ingest these particles, thereby introducing them into the aquatic food chain.

The distribution of microplastics across the inflow, mid-point, and outflow sampling locations suggests that plastic particles are transported within the pond through water movement and hydrodynamic processes. The detection of polystyrene and polypropylene in the mid-point samples indicates that microplastics remain suspended within the water column and can spread throughout the aquatic system. Horton *et al*. (2017) reported that microplastics can remain suspended in freshwater systems for extended periods, enabling them to disperse across different sections of rivers and lakes. Similarly, Lebreton *et al*. (2018) observed that freshwater bodies act as important pathways that transport microplastics from terrestrial environments to downstream aquatic ecosystems. The presence of polyamide and polyethylene terephthalate in the outflow samples therefore suggests that the pond may contribute to the movement of microplastics into surrounding water bodies.

The risk index analysis further revealed that polyethylene, polyvinyl chloride, polystyrene, and polyamide exhibited medium environmental risk levels, while polypropylene and polyethylene terephthalate exhibited relatively lower risk levels. Although some polymers showed lower risk levels, the presence of medium-risk polymers suggests potential environmental concerns. Lithner *et al*. (2018) reported that certain polymers such as polystyrene and polyvinyl chloride contain chemical additives that may pose ecological hazards to aquatic organisms. Furthermore, Smith *et al*. (2020) noted that microplastics can adsorb toxic substances such as heavy metals and persistent organic pollutants, thereby increasing their harmful effects when ingested by aquatic organisms. The physicochemical parameters measured in this study, including pH, temperature, dissolved oxygen, and conductivity, also indicate environmental conditions that may influence microplastic behavior and distribution in the pond. For instance, variations in pH and temperature can affect the interaction between microplastics and pollutants in aquatic systems (Zhou *et al*., 2022).

CONCLUSION

This study investigated the occurrence and distribution of microplastics in water and sediment samples from Donga Pond in Donga Local Government Area of Taraba State. The findings confirmed the presence of several microplastic polymers, including polyethylene, polyvinyl chloride, polystyrene, polypropylene, polyamide, and polyethylene terephthalate across the different sampling locations. This finding is indicating that the pond is already affected by plastic contamination originating from human activities such as improper waste disposal and environmental runoff. The distribution of these microplastics across the inflow, mid-point, and outflow sections of the river suggests that water movement contributes to their transport and accumulation within the aquatic environment. The risk index assessment further revealed that some of the detected polymers pose moderate environmental risks, particularly due to their persistence and potential to adsorb toxic substances that may harm aquatic organisms.

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