



Original Article

Assessment of Microplastic Pollution in Selected River Bodies in Ilorin East Local Government Area, Ilorin, Kwara State, Nigeria

¹Akanbi-Gada, M. A., ¹Ishola H., ¹Oke C.O., ¹Abdulrasheed, A.A., ¹Abdulganiyu, R. O., ¹Abdulraheem, A.F., ¹Abdullahi, H. O., ²Salami, O.O., ²Iyanda, Y.A.

¹Department of Plant and Environmental Biology, Kwara State University, Malete, Nigeria

²Department of Environmental Management and Toxicology, Kwara State University, Malete, Nigeria

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ABSTRACT

This study examined the presence, distribution, and characteristics of microplastics in freshwater systems within Ilorin East Local Government Area, Kwara State, Nigeria. Water, sediment, and aquatic plant samples were collected from Asa, Amule, Abattoir, and Agbadam Rivers using standardized protocols with strict contamination control. Laboratory analysis involved oxidative digestion, density separation, and Fourier Transform Infrared (FTIR) spectroscopy to isolate and identify microplastics and determine polymer types. All rivers contained microplastics, with Asa and Amule showing the highest concentrations, Abattoir moderate levels, and Agbadam the lowest. Fibers were the most abundant morphotype, followed by fragments, foams, films, beads, and pellets. Polypropylene (PP), polyethylene (PE), and polyethylene terephthalate (PET) were the dominant polymers, reflecting common plastic uses in packaging, textiles, and consumer goods. The detection of microplastics in aquatic plants indicates potential bioaccumulation and ecological risks. Findings highlight the influence of urban runoff, waste mismanagement, and human activities on microplastic pollution, underscoring the need for improved waste control, regulation of single-use plastics, and continuous environmental monitoring.

Keywords: Microplastics, Freshwater ecosystems, Morphotypes, Polymer identification,

***Corresponding author's email:** Mariam.gada@kwasu.edu.ng

INTRODUCTION

Plastic pollution has become one of the most persistent and pervasive environmental challenges of the 21st

century. Plastics, primarily composed of synthetic polymers, are valued for their durability, flexibility, and low cost. However, these same properties contribute to their environmental

persistence, particularly in aquatic ecosystems [1]. Since the 1950s, global plastic production has surged reaching approximately 367 million metric tons annually [2], with a significant portion ending up in terrestrial and aquatic environments due to poor waste management practices.

Among the most concerning forms of plastic pollution are microplastics; plastic particles less than 5 mm in diameter. These particles originate either as primary microplastics, intentionally manufactured for use in cosmetics, industrial abrasives and plastic pellets [3], or as secondary microplastics, resulting from the breakdown of larger plastic items due to environmental factors such as UV radiation, mechanical abrasion, and microbial activity [4]. Their small size and chemical resilience allow them to infiltrate ecosystems, posing risks to aquatic organisms, plants and potentially humans [5, 6].

Microplastics are now ubiquitous in marine environments but freshwater systems, especially in developing countries, remain underexplored [7]. In Nigeria, rivers and streams are vital for domestic, agricultural, and recreational use, yet they are increasingly threatened by urban runoff, industrial discharge, and agricultural activities [8, 9]. Studies in Lagos Lagoon and the Ogun River have confirmed the presence of microplastics in water, sediment, and fish tissues, raising concerns about trophic transfer and human exposure [10, 11].

Ilorin East Local Government Area in Kwara State exemplifies this challenge. The region is characterized by rapid urbanization, informal waste disposal, and agricultural dependence, all of which

contribute to microplastic contamination in local rivers such as Asa, Abattoir, Amule, and Agbadam. Asa River, in particular, traverses densely populated zones and receives runoff from residential, commercial, and industrial areas, making it a hotspot for pollution [12, 13]. These rivers serve as critical water sources for surrounding communities, yet they are frequently exposed to untreated wastewater, plastic litter, and sediment-bound contaminants [14].

Recent studies have shown that microplastics can be absorbed by aquatic plants, potentially disrupting photosynthesis and reducing crop yields [15]. This raises concerns about food safety and ecological health, especially in agricultural communities that rely on river water for irrigation. Moreover, the presence of microplastics in sediments and plant tissues suggests long term environmental persistence and bioaccumulation risks.

Globally, microplastic pollution has prompted regulatory responses, including bans on microbeads and increased monitoring of wastewater treatment plants [16]. However, in Nigeria, inland freshwater systems remain poorly studied and there is a lack of standardized methods for sampling and analysis. This gap hinders effective policy development and environmental management. The literature also highlights the need for harmonized protocols and robust risk assessments to guide policy and management efforts [17].

This study aims to address that gap by assessing the abundance, distribution, and polymer composition of microplastics in selected rivers within Ilorin East. By analyzing water, sediment, and plant

samples using stereomicroscopy and Fourier Transform Infrared (FTIR) spectroscopy, the research provides baseline data for environmental monitoring and policy development. The findings will inform strategies to mitigate microplastic pollution and protect freshwater resources in the region, contributing to Sustainable Development Goals (SDGs) 6 (Clean Water and Sanitation) and 14 (Life below Water).

MATERIALS AND METHOD

Study Area

The study was conducted in Ilorin East Local Government Area, located within Ilorin, the capital of Kwara State, Nigeria. Geographically, Ilorin lies between latitudes 8°24'N and 8°50'N and longitudes 4°10'E and 4°36'E, covering an estimated area of 100 km² [18]. The city lies within the transitional zone between the forest and savannah ecological belts of Nigeria, making it an area with a blend of both vegetative characteristics [19]. As one of the fastest growing cities in the country, Ilorin has experienced rapid urbanization, industrial development, and population increase, all of which have significantly impacted the city's natural resources particularly its freshwater systems [20]. Among the most important water bodies within the city are the Asa River, Amule River, and Abattoir River, each playing a unique role in the local hydrology and each being subject to varying levels and types of pollution. Asa River (8°29'43.3" N, 4°33'53.6" E), Abattoir River (8°31'42.1" N, 4°33'12.2" E), and Amule River (8°30'52.1" N, 4°34'01.7" E) were selected due to their high exposure to urban runoff and industrial effluents. In contrast, Agbadam River (8°28'29.1" N, 4°35'19.7" E) served as a control site,

representing a less disturbed ecosystem with minimal anthropogenic influence.

Methods of Sample Collection

Water, sediment, and aquatic plant samples were collected from selected rivers in Ilorin East, Kwara State, using modified standard protocols for microplastic monitoring [20,22,23,25]. Water samples were obtained using pre-cleaned glass jars submerged below the surface to capture buoyant particles [22,23]. Sediment samples were collected from the top 5 cm using stainless steel scoops and pooled to reduce spatial heterogeneity [22,23]. Aquatic plants such as *Eichhornia crassipes*, *Ricinus communis*, *Datura stramonium* and *Nuphar lutea* were sampled from littoral zones and wrapped in aluminum foil to prevent contamination [22,25]. All samples were handled using non synthetic materials and stored under controlled conditions [22,24].

Microplastic Recovery

Microplastics were recovered from water, sediment and plant samples using a combination of oxidative digestion, density separation, and filtration techniques. Water samples were treated with 30% hydrogen peroxide for 12 hours to remove organic matter, followed by density separation using NaCl solution (1.5 g/cm³) and filtration through 0.45 µm membrane filter paper [26,20]. Sediment samples were dried, homogenized and manually inspected for visible microplastics [27,28]. Sediment was processed using NaCl based density separation, oxidative digestion, and sequential filtration to maximize recovery [29,30]. Plant samples were rinsed, dried and digested in 10% KOH at 60 °C for 48

hours, followed by NaCl separation and FTIR-based polymer identification [31,32]. All procedures included contamination controls such as non-synthetic lab wear, glass equipment and procedural blanks [32].

Microplastic Observation and Identification

All 0.45 µm membrane filter papers obtained from the water filtration and sediment density separation steps were examined for microplastic particles under a digital stereomicroscope (Andonstar AD246SM, China) offering magnification up to 5,000x. Microplastic identification and classification were conducted following morphological criteria described by [22] and supported by the visual identification protocols outlined by [32]. Particles were examined under controlled lighting conditions to enhance contrast and minimize misidentification. Only particles with uniform coloration, no visible cellular structure, and resistance to breakage or tearing under gentle probe pressure were considered microplastics.

Identified microplastics were categorized by shape into fragments, fibers, pellets, films, foams, and beads. For water samples, the total microplastic abundance was determined by counting the number of particles retained on each filter paper and normalizing it to the volume of water filtered. Results were expressed as particles per liter (particles/L). For sediment samples, the number of microplastics particles identified from each filter was normalized against the dry weight of the sediment processed, and results were reported as particles per kilogram of dry sediment (particles/kg dw).

Microplastics Chemical Composition Identification by FTIR analysis

The identification of polymer types of microplastics recovered from water, sediment, and plant samples was carried out using Fourier Transform Infrared (FTIR) spectroscopy, a widely accepted analytical technique for characterizing the chemical composition of plastic particles based on their vibration spectra, as adopted by [32]. FTIR analysis was employed to confirm the synthetic polymer nature of the particles initially identified through physical and visual inspection.

Data Analysis

Statistical analyses were performed using the Statistical Package for the Social Sciences SPSS where Microplastic abundance data were summarized as mean values \pm standard error (SE) for each site and sample matrix (water, sediment, and plants) to account for variability within replicates. One-way Analysis of Variance (ANOVA) was employed to test significant differences in microplastic concentrations among the four river sites. Where the ANOVA indicated significant variation, Duncan's multiple range test was applied as a post hoc procedure to identify specific site-to-site differences. Statistical significance was determined at $p < 0.05$.

RESULT

Abundance and Morphotypes of Microplastics in Water and Sediment Samples

Table 1: Microplastic Abundance in Water Samples (particles/L)

Shapes/ Sample location	Beads	Fibre	Film	Foam	Fragment	Pellets
	Mean \pm SE					
Asa	22.33 \pm 3.18 ^a	44.67 \pm 5.78 ^a	8.67 \pm 2.03 ^a	9.67 \pm 2.73 ^b	37.33 \pm 2.60 ^a	13.33 \pm 4.91 ^a
Abattoir	10.00 \pm 1.53 ^b	19.33 \pm 3.17 ^b	7.67 \pm 1.20 ^b	5.33 \pm 1.86 ^b	36.00 \pm 5.68 ^a	6.67 \pm 2.73 ^b
Amule	21.67 \pm 8.19 ^a	56.00 \pm 3.79 ^a	11.00 \pm 1.73 ^a	20.67 \pm 4.85 ^a	22.33 \pm 2.40 ^b	11.00 \pm 3.21 ^a
Agbadam(Control)	3.67 \pm 2.33 ^b	11.67 \pm 2.40 ^b	3.00 \pm 1.53 ^b	1.00 \pm 0.58 ^b	7.67 \pm 2.40 ^c	0.67 \pm 0.33 ^b

Note: Values are Mean \pm Standard error (n=12 samples), values with the same superscript are not statistically different along the column(p<0.05)

Microplastics were detected in all water samples, with concentrations ranging from 0.67 \pm 0.33 to 46.00 \pm 5.29 particles/L. Asa River recorded the highest abundance, followed by Amule and Abattoir. Agbadam, the control site, showed significantly lower levels.

Sediment samples revealed even higher microplastic concentrations than water. Amule River had the highest sediment contamination (56.00 \pm 3.79 particles/kg), followed by Asa and Abattoir. Agbadam had the lowest (Table 1,2).

Table 2: Microplastic Abundance in Sediment Samples (particles/kg)

Note: Values are Mean \pm Standard error(n=12 samples), values with the same superscript are not statistically different along the column(p<0.05)

Correlation Analysis of Microplastic Types

Correlation analysis revealed strong positive relationships among microplastic types. In water samples, beads and fragments ($r = 0.98$), and pellets and fragments ($r = 0.96$) showed high correlation. In sediment, beads and pellets ($r = 0.97$), and fibers and foams ($r = 0.94$) were strongly associated (Fig. 1,2).

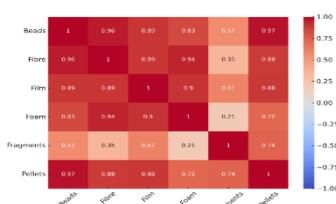


Fig.1: Corelation heat map of water samples



Fig2: Correlation heatmap of sediment samples

for polyethylene (PE). Fig. 4 shows FTIR spectrum of microplastic from Abattoir River, which is a typical pattern for Polypropylene (PP). Fig. 5 shows FTIR spectra of microplastic from Amule River which is a typical pattern for polypropylene (PP). Fig. 6 shows FTIR spectrum of microplastic from Agbadam(control site) which is a typical pattern for polyethylene terephthalate (PET),Fig.7 shows FTIR spectrum of microplastic from Asa River which is a typical pattern for Polypropylene (PP) Fig.8 shows FTIR spectrum of microplastic from Abattoir River, which is a typical pattern for Polypropylene (PP). Fig.9 shows FTIR spectra of microplastic from Amule River which is a typical pattern for polypropylene (PP). Fig. 10 shows FTIR spectrum of microplastic from Agbadam(control site) which is a typical pattern for polypropylene (PP). Fig. 11 shows FTIR spectrum of microplastic from Asa River which is a typical pattern for Polypropylene (PP). Fig. 12 shows FTIR spectrum of microplastic from Abattoir river, which is a typical pattern for Polypropylene (PP). Fig. 13 shows FTIR

Shapes/ Sample location	Beads	Fibre	Film	Foam	Fragment	Pellets
	Mean ± SE					
Asa	10.33 ± 3.71 ^a	26.67 ± 4.48 ^a	26.00 ± 3.21 ^a	13.33 ± 7.83 ^a	46.00 ± 5.29 ^a	19.66 ± 7.31 ^a
Abbattoir	5.00 ± 1.00 ^a	40.00 ± 3.60 ^a	40.00 ± 4.37 ^a	7.33 ± 1.45 ^a	32.67 ± 2.40 ^a	7.67 ± 2.90 ^a
Amule	9.00 ± 4.16 ^a	36.33 ± 6.98 ^a	36.33 ± 5.84 ^a	5.00 ± 0.57 ^a	40.00 ± 6.92 ^a	11.67 ± 4.05 ^a
Agbadam(Contro)	0.67 ± 0.33 ^a	1.67 ± 0.67 ^b	1.67 ± 1.67 ^b	1.67 ± 1.67 ^a	13.67 ± 3.71 ^b	0.00 ± 0.00 ^b

Polymer Composition via Fourier Transform Infrared Spectroscopy (FTIR)

Fig.3 shows FTIR spectrum of microplastic from Asa River which is a typical pattern

spectra of microplastic from Amule River which is a typical pattern for polypropylene (PP). Fig. 14 shows FTIR spectrum of microplastic from

Agbadam(control site) which is a typical pattern for polypropylene (PP).

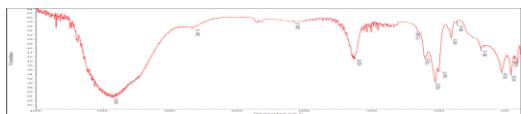


Fig. 3. Water FTIR spectrum of microplastic from Asa river



Fig. 4. Water FTIR spectrum of microplastic from Abbatoir



Fig. 5. Water FTIR spectrum of microplastic from Amule

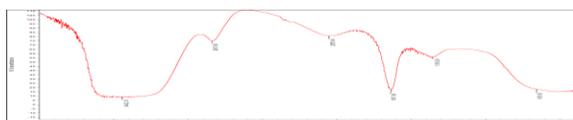


Fig. 6. Water FTIR spectrum of microplastic from Agbadam

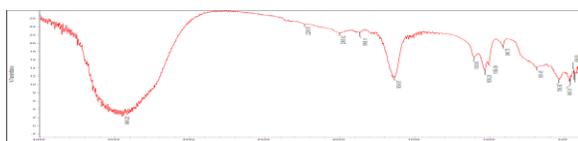


Fig. 7. Sediment FTIR spectrum of microplastic from Asa river



Fig. 8. Sediment FTIR spectrum of microplastic from Abbatoir



Fig. 9. Sediment FTIR spectrum of microplastic from Amule river



Fig. 10. Sediment FTIR spectrum of microplastic from Agbadam



Fig. 11. Plant FTIR spectrum of microplastic from Asa

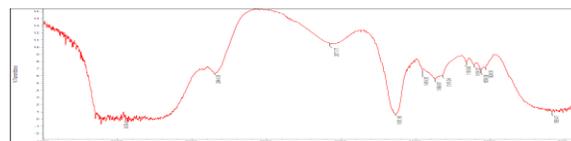


Fig. 12. Plant FTIR spectrum of microplastic from Abbatoir

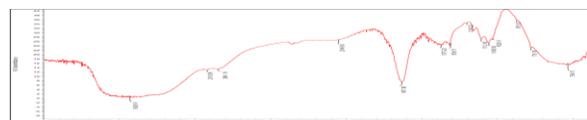


Fig. 13. Plant FTIR spectrum of microplastic from Amule



Fig. 14. Plant FTIR spectrum of microplastic from Agbadam

DISCUSSIONS

This study confirms the pervasive presence of microplastics in freshwater systems across Ilorin East Local Government Area. All four sampled rivers contained measurable levels of microplastics in water, sediment and plant samples. The spatial distribution revealed a clear pollution gradient, with Asa and Amule Rivers exhibiting the highest concentrations, followed by Abattoir, while Agbadam, the control site, recorded the lowest levels. Asa River, which flows through densely populated neighborhoods such as Amilengbe and Unity Road, is heavily impacted by urban runoff, market refuse, and poorly managed waste disposal. Akanbi-Gada *et al.* (2021) investigated microplastic contamination in aquatic ecosystems of Kwara State and highlighted the influence of urbanization and poor waste infrastructure on microplastic accumulation, which aligns with the findings of this study. Amule River, similarly affected by shops, markets, and residential waste, showed elevated levels of foam and film particles. These morphotypes are typically associated with expanded polystyrene (EPS) food containers and plastic bags, which are common in roadside trading and domestic use [33]. The presence of microplastics in Amule's aquatic plants further suggests that these particles are not only suspended in water but also interacting with biological systems, potentially entering the food chain [31]. Abattoir River's moderate contamination appears to stem from a mix of slaughterhouse waste, agricultural runoff and domestic effluents [21]. Meanwhile, Agbadam's relatively low microplastic levels support the hypothesis that less disturbed ecosystems with minimal human interference tend to have cleaner water bodies [9].

Across all sites, fibers emerged as the most dominant microplastic type. These likely originate from synthetic textiles shed during laundry, airborne deposition and degraded fishing gear [6]. Their presence even in Agbadam highlights the mobility of microplastics, which can travel long distances via wind and water currents. Fragments, the second most abundant type, result from the breakdown of larger plastic items such as bottles and containers [21]. Foams and films were also detected particularly in Amule and Abattoir Rivers linked to food packaging and agricultural plastics [34]. Beads and pellets, though less common, were found in multiple samples and are associated with personal care products and industrial processes [3].

FTIR analysis confirmed the presence of three dominant polymers: polypropylene (PP), polyethylene (PE), and polyethylene terephthalate (PET). PP was most prevalent especially in sediment and plant samples reflecting its widespread use in packaging and woven sacks [35]. PE, common in water samples, is linked to carrier bags and agricultural mulch films [36]. PET, found primarily in water and sediment originates from beverage bottles and synthetic textiles [37]. These polymers are known for their durability and resistance to degradation, contributing to their environmental persistence and ecological impact.

The detection of microplastics in aquatic plants such as *Eichhornia crassipes*, *Ricinus communis*, and *Datura stramonium* suggests uptake through root systems and biofilms [31]. This raises concerns about trophic transfer especially in agricultural communities that rely on river water for irrigation. Correlation analysis revealed strong associations

among several microplastic types, particularly between beads and pellets, and fibers and films. These relationships suggest shared pollution sources such as domestic packaging, market refuse and industrial runoff [33]. Fragments showed weaker correlations, indicating more diverse origins from environmental degradation [38].

In a broader context, the pollution levels observed in Ilorin East are comparable to moderately impacted systems like Dongting Lake in China and Lagos Lagoon in Nigeria but lower than heavily industrialized rivers such as the Huangpu and Rhine [39, 40]. This places Ilorin East's freshwater systems in a moderate to high pollution category, signaling the need for ongoing environmental monitoring and stronger waste management strategies.

In light of these findings, several practical recommendations are proposed. Firstly, improving urban waste management is essential to reduce plastic input into rivers. This includes better collection systems and public awareness campaigns. Also, regulating single use plastics, especially polystyrene food containers and plastic bags, can help limit the most common sources of microplastic pollution. In addition, community led river cleanups and educational outreach can foster environmental responsibility and reduce littering. Lastly, establishing microplastic monitoring programs in collaboration with local universities and environmental agencies will support long-term data collection and policy development.

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