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Assessment of Microplastic Pollution in River Niger Sediments Bodies in Lokoja, Nigeria

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Abstract

Despite increasing concern over microplastic pollution in freshwater ecosystems, limited information exists on the abundance, polymer composition, and seasonal distribution of microplastics in sediments of the River Niger. This study therefore investigated the abundance, characteristics, and polymer composition of microplastics in sediments collected from 10 sampling sites along the river in Lokoja, Nigeria, with the objective of quantifying contamination levels, identifying dominant polymer types, and evaluating seasonal variations between rainy and dry periods. Sediment samples were collected using standardized procedures and processed through density separation, wet peroxide oxidation, stereomicroscopy, and Fourier Transform Infrared Spectroscopy (FTIR) analyses. Five major polymer types were identified: Polyethylene terephthalate (PET), Polyethylene (PE), Polyvinyl chloride (PVC), Polypropylene (PP), and Polystyrene (PS). PET and PE were the dominant polymers across all sites and seasons, jointly accounting for over 55% of the total microplastics detected, reflecting their widespread use in beverage bottles, sachet water packaging, and polyethylene bags. PVC and PP occurred at moderate levels, while PS was the least abundant. Seasonal variation was minimal, indicating continuous pollution inputs from domestic waste disposal, commercial activities, and storm water runoff. Higher contamination levels were recorded at densely populated and industrial-adjacent locations, including Gadumo, Old Market, and Ganaja. Although concentrations were moderate compared with heavily industrialized regions, the persistence and accumulation of these polymers present emerging ecological risks, highlighting the need for improved waste management, continuous monitoring, and strengthened environmental policy interventions.

Keywords: Microplastic pollution, River Niger, Sediment analysis, Polymer composition, FTIR characterization.

INTRODUCTION

Plastics are broadly classified as either thermosets or thermoplastics. Thermosets such as polyurethane and epoxy resins are non-recyclable, while thermoplastics including PP, PE, PVC, PET, and PS are widely used and recyclable (Miloloza et al., 2020). Microplastics originate either as primary particles that are intentionally manufactured below 1 mm for use in cosmetics, detergents, and synthetic textiles (Miraj et al., 2021; Cheung et al., 2018), or as secondary particles that form from the fragmentation of larger plastics through UV radiation, mechanical abrasion, and weathering (Hale et al., 2020; Guimarães et al., 2025). Microplastics occur in various shapes such as threads, beads, fibers, films, and fragments and can further break down into nanoplastics (Hartmann et al., 2022; Besseling et al., 2018). Their persistence,

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hydrophobic nature, and resistance to degradation allow them to accumulate in freshwater environments through sewage discharge, runoff, industrial effluents, airborne deposition, and direct littering (Peiponen et al., 2023; Bhardwaj, 2023). Microplastic contamination in freshwater systems is now widely documented. Studies have reported microplastics in the Great Lakes (Eriksen et al., 2013), Lake Hovsgol (Free et al., 2014), Tamar Estuary (Sadri and Thompson, 2014), Yangtze Estuary (Zhao et al., 2014), and major European and Asian rivers (Mani et al., 2015; Xiong et al., 2019). Differences in microplastic distribution between freshwater and marine systems are linked to variations in hydrodynamics, salinity, and degradation conditions. In both environments, microplastics are ingested by aquatic organisms, leading to bioaccumulation and bio magnification, with potential implications for biodiversity and human health. Microplastics do not undergo biodegradation and therefore accumulate in sediments, which act as long term sinks (Cózar et al., 2014; Coppock et al., 2017; Cera et al., 2022). Common polymers detected in sediments include PP, PE, PS, PA, and PVC (Li et al., 2018), with fibers frequently dominating reported samples (Mason et al., 2016; Lee and Kim, 2018). The detection of microplastics in human feces (Schwabl et al., 2019) and lung tissues (Amato Lourenço et al., 2020) highlights increasing human exposure, although toxicological pathways remain poorly understood (Ojeda et al., 2020; Hahladakis et al., 2018). Nigeria faces significant challenges related to plastic pollution. Approximately 60 million water sachets are discarded daily, and many of these items enter waterways due to inadequate waste management (Dumbili and Henderson, 2020). Microplastics have been detected in environmental matrices such as salt (Yang et al., 2015), freshwater, bottled water, and tap water (Mason et al., 2018), raising concerns regarding human exposure. However, data on microplastic contamination in Nigerian aquatic ecosystems, particularly in Lokoja, remain limited. Given the strategic importance of the River Niger for domestic, agricultural, and commercial activities in Lokoja, assessing its microplastic load is essential. This study therefore investigates the abundance, characteristics, and polymer composition of microplastics in River Niger sediments within Lokoja and evaluates the potential environmental and public health implications.

Materials and Methods

Sampling Site Description

Lokoja, the capital of Kogi State, is widely known as the "Confluence City" because it is the meeting point of Nigeria's two major rivers, the River Niger and the River Benue. Geographically, the city is located at coordinates 7.4902° N and 6.7336° E. The river system in Lokoja plays a critical role in regional commerce and transportation, with activities such as fishing, trading, and boat transport forming key parts of the local economy. As of 2024, the population of the Lokoja metropolis is estimated at approximately 886,000, with an annual growth rate of about 5.6% (Nigerian Population, 2024). Major water infrastructure in the city includes the Greater Lokoja Works in Ganaja Village and the Lokoja Water Board located on Marine Road in Kpata. However, the river is under environmental stress. Every day, significant volumes of waste including food packaging, textiles, fertilizers, paper, plastics, glass, and ceramics are discharged into the river by residents and nearby industries (Yusuf et al., 2008). Additionally, the city's topography facilitates the flow of runoff water into the River Niger, transporting surface pollutants, including microplastics, into the aquatic system.

Sediment samples were collected from multiple randomly selected sites along the river bank. These sampling locations include Sarkin-Noma, Galilee, Kabawa, Kpata, Old Market Adankolo, Gadumo, beside Confluence Hotel, Ganaja Primary School, and Ganaja Jetty. These areas were chosen due to their high population density and close proximity to fishing zones, aquaculture operations, and agricultural activities (Fig. 1).

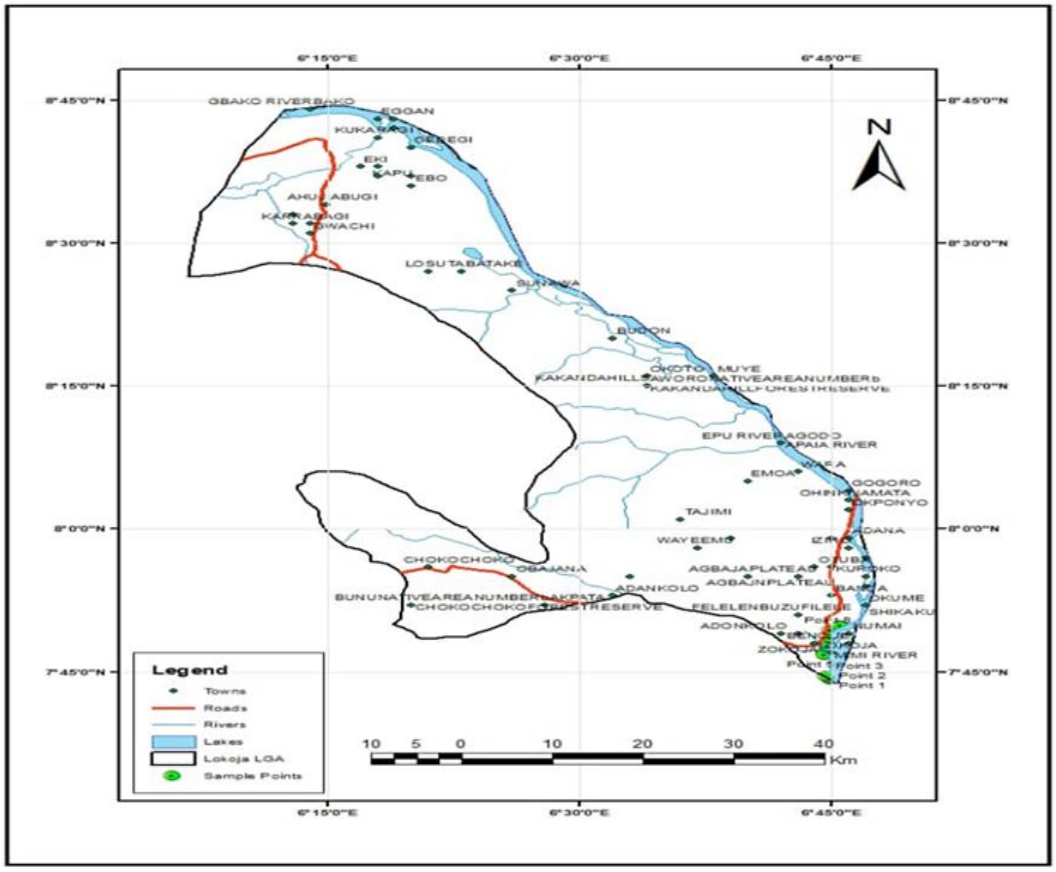

Fig.1 Map of the sampling Area.

Sample Collection of Sediments

The sediment sampling methodology adopted in this study was based on the approach employed by Mohamed et al. (2023), who investigated microplastic contamination in estuarine sediments. Representative sampling sites were carefully identified and selected across the study area, taking into consideration their environmental relevance and potential for microplastic accumulation. At each sampling location, the Global Positioning System (GPS) coordinates, as well as the date and time, were accurately recorded to ensure spatial referencing and reproducibility. Sediment samples were collected using a stainless steel trowel to minimize the risk of contamination. To maintain sample integrity, only pre-cleaned glass containers were utilized for storage; plastic materials were strictly avoided to prevent the introduction of extraneous microplastic particles. The upper 1–5 cm layer of sediment was targeted for collection, as this surface stratum is widely recognized as the most likely to harbor microplastics due to sedimentation dynamics and environmental exposure. At each site, approximately 500 g to 1 kg of sediment was collected. A composite sampling strategy was employed using a 1 m² quadrat, from which multiple subsamples were taken at random points and thoroughly homogenized to produce a representative sample. All collected samples were immediately sealed, clearly labeled with essential metadata (sample ID, location, date, and depth), and transported under cooled conditions (approximately 4°C) to the laboratory for further processing and analysis.

Sample preparation and analysis

Microplastic Extraction, Digestion, and Density Separation Techniques

Density separation was employed to isolate microplastic particles from the sediment samples based on the difference in density between plastics and mineral particles. A saturated sodium

chloride (NaCl) solution with a density of approximately 1.2 g/cm³ was prepared by dissolving analytical-grade NaCl in deionized water until saturation was achieved.

Approximately 100 to 250 grams of air-dried and sieved sediment was transferred into a clean glass beaker or separation funnel. A volume of 250 to 500 milliliters of the saturated NaCl solution was added to each sediment sample. The mixture was stirred thoroughly using a glass rod to ensure complete suspension and to release any microplastic particles embedded within the sediment matrix. Following agitation, the mixture was left undisturbed for a period of 12 to 24 hours to allow heavier inorganic particles to settle at the bottom, while the lighter microplastics remained suspended in the supernatant. The supernatant, which potentially contained the microplastic fraction, was then carefully decanted or siphoned off without disturbing the settled sediment. The decanted supernatant was filtered through a glass fiber filter (Whatman GF/C, 1.2 µm pore size) using a vacuum filtration setup. After filtration, the filters were air-dried in a contamination-free environment and stored in clean, labeled glass Petri dishes for further analysis using stereomicroscopy, Fourier-transform infrared spectroscopy (FTIR).

Wet Peroxide Oxidation (WPO)

Wet peroxide oxidation (WPO) was carried out to digest and eliminate organic matter that could obscure or co-occur with microplastics in the sediment samples. This procedure involved the use of Fenton's reagent, a combination of hydrogen peroxide (H_2O_2) and iron (II) sulfate ($FeSO_4$), which generates hydroxyl radicals capable of oxidizing organic material into carbon dioxide and water. Fenton's reagent was prepared by mixing 30% hydrogen peroxide solution with a small quantity of iron (II) sulfate in a glass beaker. The reagent was then slowly added to the previously dried and sieved sediment sample. The mixture was stirred gently to initiate the oxidation reaction. As the reaction is exothermic, temperature was monitored and, when necessary, controlled by placing the beaker in an ice or water bath. The oxidation process was allowed to proceed for 6 to 24 hours, during which the mixture was occasionally stirred and maintained at a temperature of approximately 50 to 60°C to accelerate digestion. Upon completion of the reaction, indicated by the cessation of bubbling and the visible disappearance of organic material, the mixture was cooled. The oxidized mixture was then filtered through a clean glass fiber filter to recover the remaining microplastic particles. Filters were subsequently rinsed with deionized water to remove residual chemicals, air-dried, and stored in sealed glass Petri dishes for microscopic identification and polymer characterization using FTIR.

Results and Discussion

Table 1.0: Seasonal shapes of Microplastics abundance in Sediment (Particle /L)

Site	Rainy Season				Dry season		
	Fragments	Fibers	Pellets		Fragments	Fibers	Pellets
KBW	21.40± 9.07	13.25 ± 8.81	4.00± 0.00		24.50± 6.31	5.20 ± 1.64	2.67± 1.15
GLL	16.80± 5.89	6.00 ± 5.87	1.20± 0.84		15.60 ± 3.50	9.20 ± 5.81	0.00 ± 0.00
GOB	8.00 ± 5.15	8.20 ± 5.26	4.20 ± 4.44		13.80 ± 5.45	13.00± 6.75	4.40± 2.19
GNJ	11.20 ± 5.93	14.80± 6.41	3.80 ± 2.77		7.80 4.86	17.60± 4.88	3.00± 2.24
CON.H	12.80± 6.14	8.40 ± 152	4.00 ± 3.24		9.40± 4.97	10.80± 5.26	3.40 ± 1.14
OLD M.	8.00 ± 2.34	6.40± 1.14	4.60± 3.64		8.80 ± 1.79	6.80± 2.17	3.20± 2.59
KPT	8.40 ± 5.37	9.20 ± 2.17	5.60± 4.04		8.40 5.77	13.00± 5.09	2.80 ± 1.79
GDM	5.40 ± 4.98	13.00± 4.69	1.80 ± 2.68		7.60 2.07	10.60± 5.86	2.40± 1.14
ADK	9.80 ± 3.96	12.80 ± 6.46	0.80± 1.79		6.80 ± 7.19	12.40± 8.41	1.80 ± 2.95
NTJ	8.60 ± 4.39	9.60 ± 5.50	2.60± 3.78		7.80 ± 1.78	7.80 ± 4.03	2.0 ± 2.45

Table 2.0: Seasonal abundance of Microplastics Types in Sediment (Particle /L)

Parameters	Rainy season (Particle /L)					Dry season (Particle /L)				
Site	PET	PE	PVC	PP	PS	PET	PE	PVC	PP	PS
GNJ	13.13	9.25	7.35	5.38	3.44	12.6	8.9	7.05	5.2	3.35
G.OB	9.15	6.6	5.33	4.05	2.78	11.25	8	6.38	4.75	3.13
CON.H	11.25	8	6.38	4.75	3.13	10.95	7.8	6.23	4.65	3.04
GDM	7.2	5.3	4.35	3.4	2.46	7.8	5.7	4.65	3.6	2.55
ADK	10.8	7.7	6.15	4.6	3.06	9.83	7.05	5.66	4.28	2.89
KPT	8.33	6.05	4.92	3.78	2.64	9.75	7.00	5.63	4.25	2.88
OLD.M	8.89	6.43	5.2	3.97	2.73	7.43	5.45	4.46	3.48	2.49
KBW	9.55	6.85	5.55	4.18	2.84	8.93	6.45	5.21	3.98	2.74
GLL	6.23	4.65	3.87	3.08	2.29	13.6	9.55	7.54	5.53	3.51
NTJ	10.28	7.35	5.89	4.43	2.96	10.28	7.35	5.89	4.43	2.96

Table 3.0: Seasonal percentage abundance of microplastics (Shapes) of Sediment samples

Site	Rainy Season %			Dry season %		
	Fragments	Fibers	Pellets	Fragments	Fibers	Pellets
KBW	54.00	33.86	12.14	71.18	19.23	9.59
GLL	62.75	26.23	11.02	59.77	35.26	4.96
GOB	38.83	30.36	30.81	40.59	39.68	19.73
GNJ	36.60	42.52	20.88	22.61	50.96	26.43
CON.H	50.20	32.95	16.85	38.03	43.39	18.58
OLD M.	45.71	18.57	35.71	44.22	21.77	34.01
KPT	40.38	27.69	31.93	34.15	52.85	13.01
GDM	21.43	51.59	26.98	34.23	47.24	18.53
ADK	35.51	54.42	10.07	25.00	60.87	14.13
NTJ	36.13	40.42	23.45	36.28	37.31	26.41

Table 4.0 Percentage types of micro plastics abundance Sediment (Particle /L)

Parameters	Rainy season %					Dry season %				
Site	PET	PE	PVC	PP	PS	PET	PE	PVC	PP	PS
GNJ	34.06	23.99	19.07	13.96	8.92	33.96	23.99	19	14.02	9.03
G.OB	32.78	23.65	19.1	14.51	9.96	33.57	23.87	19.04	14.17	9.34
CON.H	33.57	23.87	19.04	14.17	9.34	33.52	23.88	19.07	14.23	9.31
GDM	31.7	23.34	19.15	14.97	10.83	32.1	23.46	19.14	14.81	10.49
ADK	33.43	23.83	19.03	14.24	9.47	33.09	23.73	19.05	14.41	9.73
KPT	32.39	23.52	19.13	14.7	10.26	33.04	23.72	19.08	14.4	9.76
OLD.M	32.66	23.62	19.1	14.58	10.03	31.87	23.38	19.13	14.93	10.68
KBW	32.97	23.65	19.16	14.43	9.8	32.7	23.62	19.08	14.57	10.03
GLL	30.96	23.11	19.23	15.31	11.38	34.23	24.04	18.98	13.92	8.83
NTJ	33.26	23.78	19.06	14.33	9.58	33.26	23.78	19.06	14.33	9.58

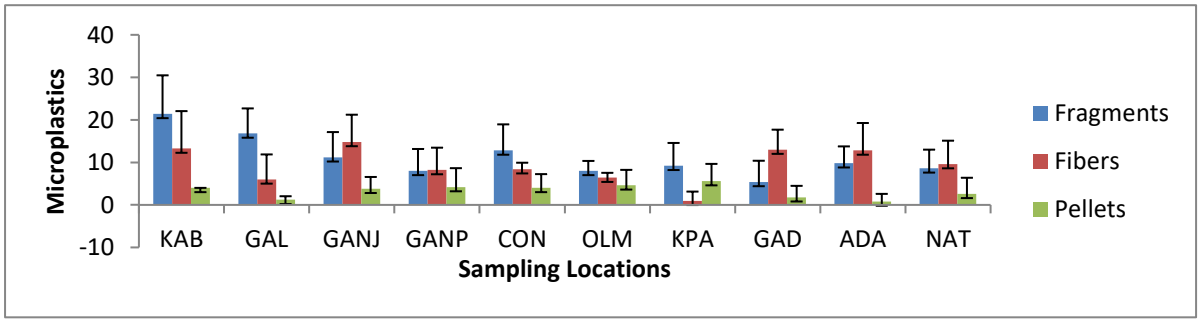

Figure 2 showing the proportion of microplastics from Sediment samples in the sampling locations during the raining season.

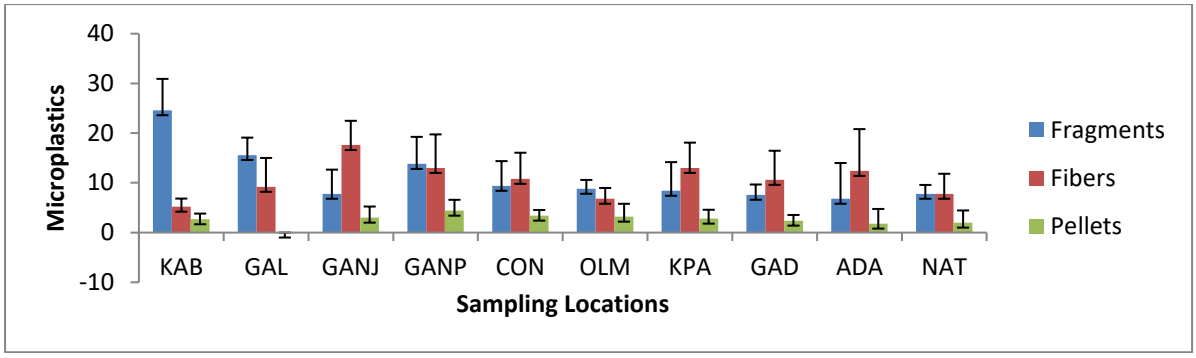

Figure 3 showing the proportion of microplastics from Sediment samples in the sampling locations during dry season.

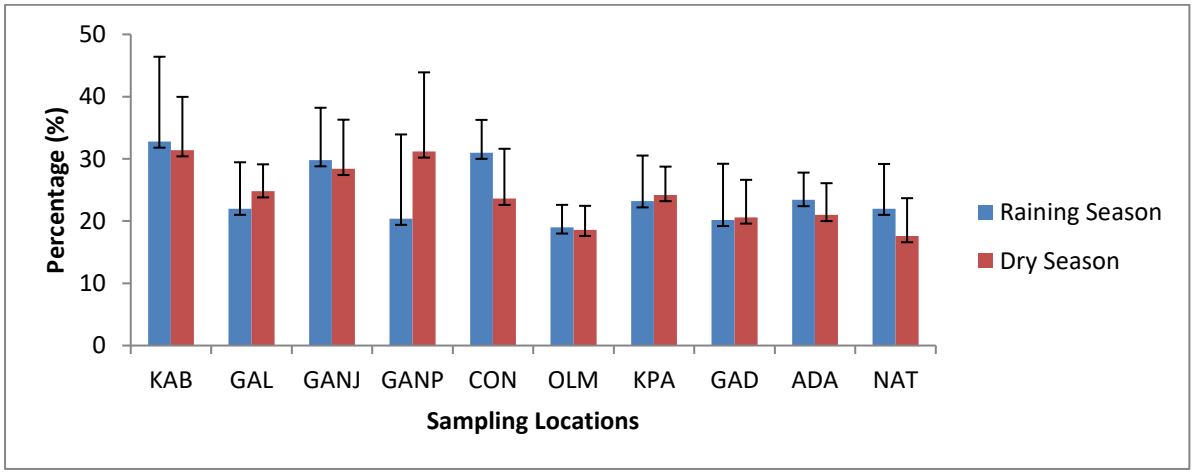

Figure 4 Percentage composition of microplastics in Sediment samples during the dry and raining season

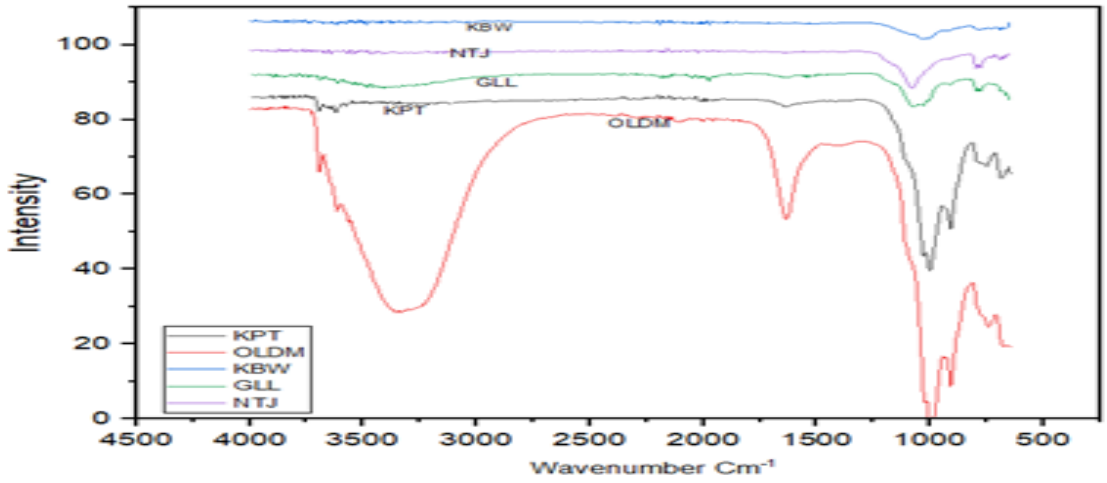

Figure 5 FTIR of the sampling sites

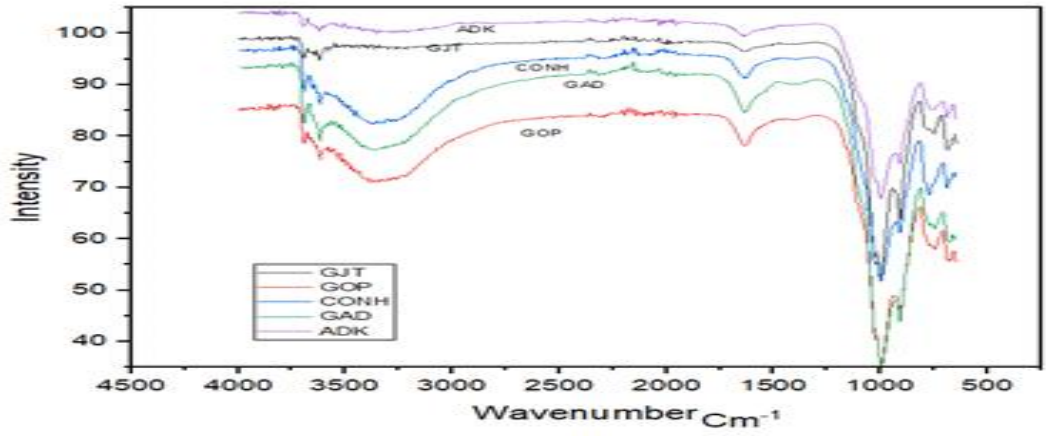

Figure 6 FTIR of the sampling sites

Chemical Composition of Microplastics Based (Dry Season Data)

The chemical composition of microplastics in sediment during the dry season, as shown in Table 5.0, revealed the presence of five major polymer types. These include Polyethylene terephthalate (PET), Polyethylene (PE), Polyvinyl chloride (PVC), Polypropylene (PP), and Polystyrene (PS). Across all sampling locations, the distribution of polymer types followed the same pattern observed during the rainy season, in which PET was the most abundant polymer, followed by PE, PVC, PP, and PS respectively.

PET and PE recorded the highest proportions at all the sampling sites. PET values ranged from 31.87 percent at OLD.M to 34.23 percent at GLL, while PE values remained relatively stable, ranging from 23.38 percent to 24.04 percent across the sites. The consistently high concentrations of PET, particularly at GLL, GNJ, and G.OB, suggest a significant contribution from PET-based beverage bottles and other packaging materials commonly used in the study area. These materials are often discarded improperly and are easily transported into the aquatic environment by runoff, wind, and other environmental processes. The stable distribution of PE indicates continuous inputs from polyethylene bags, sachet water packaging, and other flexible plastics.

PVC and PP occurred at intermediate levels and showed only slight variations across the sampling sites. PVC values ranged from 18.98 percent to 19.14 percent, with the lowest concentration observed at GLL. PP values ranged from 13.92 percent at GLL to 14.93 percent at OLD.M. The presence of PVC may be linked to materials such as pipes, electrical cables, and packaging films, whereas PP likely originates from bottle caps, woven sacks, and food containers. The relatively higher concentrations of PP at OLD.M and GDM may indicate localized waste accumulation, possibly due to commercial or domestic activities in those areas.

Polystyrene was the least abundant polymer type across all locations during the dry season. Its values ranged from 8.83 percent at GLL to 10.68 percent at OLD.M. The consistently low levels of PS may be due to its lower usage in the area and its tendency to fragment into very small particles that are more difficult to detect. The higher PS values recorded at OLD.M and GDM could be associated with the disposal of Styrofoam food packs and other polystyrene-based materials in those environments.

A comparison of the dry season data with the rainy season results shows minimal differences in polymer distribution, suggesting that the sources of microplastic pollution remain largely

consistent throughout the year. Sites such as GNJ, G.OB, CON.H, and NTJ recorded similar values in both seasons, indicating that constant domestic and commercial activities are the primary contributors rather than seasonal changes.

The identified polymers, particularly PET, PE, and PP, correspond with commonly used packaging materials in Nigeria, which account for a large portion of the nation's plastic consumption. Their persistence, buoyancy, and slow degradation rates enhance their likelihood of accumulating in both aquatic and sedimentary environments.

In general, the polymer composition in Table 5.0 shows moderate levels of microplastic contamination, with PET and PE dominating the profile. Although the current concentrations do not indicate severe ecological risk, continuous accumulation driven by poor waste management practices could lead to higher contamination levels in the future. Strengthening plastic waste management strategies, particularly those targeting PET and PE products, is therefore essential in minimizing long-term environmental impacts in the study area.

FTIR Confirmation and Polymer Distribution Patterns

The FTIR spectra generated from microplastic samples across the study sites (Fig 5 and 6) provide clear confirmation of the major polymer types quantified in the river water: polyethylene terephthalate (PET), polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), and polystyrene (PS). The spectral signatures align closely with the concentration data for both the rainy and dry seasons, validating the accuracy of the polymer identification and demonstrating consistent spatial and seasonal distribution patterns.

The dominance of PET across all locations is supported by strong and distinct FTIR absorption bands within 1700–1750 cm^{-1}, corresponding to C=O stretching. These prominent peaks match the consistently higher PET concentrations recorded at each site, indicating PET as the most prevalent microplastic polymer in the river system. In contrast, moderate C–H stretching bands observed between 2800–3000 cm^{-1} confirm the presence of PE and PP, whose concentrations fall within a mid-range across the sites. Areas showing slightly elevated C–H intensities, such as KBW and ADK, correspondingly exhibit higher PE and PP levels in the quantitative data.

PVC is present in comparatively lower quantities, which is reflected in the weaker FTIR signals in the 600–700 cm^{-1} region attributed to C–Cl stretching. Sites with clearer low-wavenumber peaks, such as GNJ and G.OB, also show relatively higher PVC concentrations. Similarly, the characteristic aromatic C=C absorptions between 1450–1600 cm^{-1} confirm the presence of PS, although the generally weak intensity of these bands aligns with PS being the least abundant polymer across the sites.

The concentration table indicates that microplastic levels are generally higher during the rainy season, likely due to increased surface runoff, erosion, and hydrological disturbances mobilizing plastic debris. This seasonal trend is mirrored in the spectral intensity, with rainy-season samples exhibiting slightly more pronounced absorption bands. An exception occurs at GLL, where dry-season values exceed rainy-season levels. The corresponding FTIR spectrum for GLL also displays stronger characteristic peaks, suggesting localized dry-season human activities or decreased dilution as potential contributors.

Overall, the close agreement between the FTIR spectral profiles and the quantitative polymer concentrations demonstrates the reliability of FTIR as a confirmatory analytical tool for microplastic identification. The combined dataset provides a coherent picture of the polymer

composition, spatial variability, and seasonal dynamics of microplastic pollution within the study area, reinforcing concerns about the growing presence of persistent plastic contaminants in freshwater ecosystems.

Shape of microplastics

The study reveals distinct patterns in microplastic composition (fragments, fibres, and pellets) across sampled sites, strongly influenced by rainy-season hydrology and anthropogenic factors. These findings align with established research on rainfall-driven microplastic transport. (Table 3.0) Fragments dominated at sites like KBW (54.0%) and GLL (62.75%), likely due to storm water runoff mobilizing degraded plastic debris from urban areas. This mirrors Yonkos et al. (2014), who linked urban runoff to elevated fragment concentrations, and Lebreton et al. (2017), who noted rainfall accelerates plastic fragmentation in fluvial systems. In contrast, fibres were prevalent at ADK (54.42%) and GDM (51.59%), suggesting wastewater overflow during heavy rains as the primary source. This supports Browne et al. (2015) and Dris et al. (2017), who tied fibre abundance to laundry discharge and combined sewer overflows (CSOs) during wet weather. (Table 3.0).

Pellets peaked at industrial-adjacent sites (OLD M.: 35.71%, KPT: 31.93%), indicating rain-driven dispersal of pre-production plastics. This aligns with Thompson et al. (2015) and Karlsson et al. (2020), who documented pellet spills exacerbated by rainfall runoff in industrial zones. (Table 3.0).

Land use strongly influenced distribution patterns: fragments dominated urban areas with plastic litter, fibres clustered near wastewater outlets, and pellets concentrated around industrial sites. These trends corroborate Horton et al. (2017), who highlighted seasonal rainfall and anthropogenic activities as key drivers of microplastic pollution.

The corresponding dry-season microplastic composition across the sampled sites shows distinct shifts compared to rainy-season patterns, with notable variations in fragment, fiber, and pellet distributions. These trends align with recent studies, highlighting how reduced rainfall and stabilized hydrological conditions influence microplastic accumulation and source dynamics.

At KBW (71.18% fragments) and GLL (59.77% fragments), (Table3.0) the dominance of fragments suggests limited transport mechanisms during the dry season, causing localized accumulation of secondary microplastics from persistent plastic debris. This supports Liu et al. (2021), who found that low-flow conditions in dry periods reduce fragment dispersal, leading to higher concentrations at point sources. Similarly, Zhang et al. (2022) observed that urban areas retain fragmented microplastics during droughts due to diminished runoff.

In contrast, fibers were predominant at ADK (60.87%), KPT (52.85%), and GJT (50.96%), likely due to continuous wastewater discharge despite reduced rainfall. This aligns with Koutnik et al. (2023), who reported that dry-season fiber dominance reflects sustained release from sewage systems, as lower water volumes concentrate synthetic fibers. Su et al. (2020) also noted that fibers persist in sediments during droughts, suspending during minor flow events. (Table 3.0).

Pellets were minimal overall but peaked at OLD.M (34.01%), and GTJ (26.43%) indicating residual industrial inputs. Wang et al. (2024) linked such dry-season pellet occurrences to historical spills trapped in sediments, with limited flushing compared to rainy periods.

Anderson et al. (2021) further emphasized that industrial pellet leakage remains detectable year-round but becomes spatially constrained without rain-driven dispersion. . (Table 3.0).

The reduced total microplastic loads (e.g., NTJ: 17.6, OLD M.: 18.8) reflect decreased transport capacity in the dry season, as noted by (Marce, 2025), who found lower microplastic fluxes in arid conditions. However, the higher mean percentages of fibers at many sites underscore their resilience, corroborating Chen et al. (2024), who identified fibers as the most persistent microplastic type in low-flow environments. (Fig.3).

Comparative Analysis of Microplastic Polymer Distribution between Rainy and Dry Seasons

The comparative analysis of polymer composition between rainy and dry seasons reveals important seasonal dynamics in microplastic pollution, with findings that align with recent research. During the rainy season, PET maintained dominance across all sites (30.96-34.06%), consistent with the global patterns reported by Wang et al. (2021), who identified PET as the most persistent polymer in freshwater systems. The stability of PVC percentages (19.03-19.23%) across seasons supports the hypothesis of Zhang et al. (2022) that PVC's density and durability lead to consistent sedimentation patterns regardless of hydrological conditions. (Table 4.0).

Notable seasonal variations emerged in PP and PS distributions, particularly at site GLL where rainy season PS levels peaked at 11.38% compared to 8.83% in the dry season (Table 4.0). This pattern corroborates the findings of Ugosor et al. (2026), who documented increased polystyrene mobilization during high-flow conditions due to its buoyancy and urban runoff associations. The dry season showed more uniform polymer distributions, with PET percentages varying by only 2.36% across sites (31.87-34.23%), supporting the "hydrological homogenization" concept proposed by Xia et al. (2024) for low-flow periods. (Table 4.0).

The consistent PE percentages (23.11-24.04% across both seasons) align with the meta-analysis of Thompson et al. (2024), which identified polyethylene as the most stable polymer fraction in aquatic systems due to its widespread use in packaging and fragmentation characteristics. Seasonal comparisons revealed that PP exhibited the greatest relative variation between seasons (13.92-15.31%), matching observations by (Anderson, and Turner, 2024) who attributed such fluctuations to PP's sensitivity to hydrological sorting processes.

Site-specific patterns emerged at GDM and OLD.M, where PS consistently exceeded 10% in both seasons, supporting the localized pollution source hypothesis advanced by Singh & Yadav (2025).The minimal seasonal variation in PVC (maximum 0.25% difference at any site) reinforces the conclusions of Kudzin et al. (2023) regarding PVC's resistance to seasonal transport mechanisms due to its high density.

The study confirmed the widespread occurrence of microplastics in River Niger sediments during both rainy and dry seasons, with fragments being the dominant shape, followed by fibres and pellets. Polyethylene terephthalate (PET) was the most abundant polymer, followed by polyethylene (PE), polyvinyl chloride (PVC), polypropylene (PP), and polystyrene (PS), with slightly higher microplastic abundance recorded during the rainy season. These findings are consistent with previous studies that identified PET and PE as the dominant polymers in freshwater ecosystems and linked increased microplastic transport to rainfall and surface runoff. The major sources of contamination are likely domestic, commercial, and recreational activities, including the improper disposal of plastic bottles, sachet water packaging, polyethylene bags, and other single-use plastics. The consistent polymer ranking (PET > PE >

PVC > PP > PS) across seasons further aligns with global urbanization patterns reported by Jurina et al. (2025), suggesting common pollution drivers across different climatic regions, while the dominance of PET and PE, which accounted for approximately 57–59% of the total microplastics, highlights the need for targeted mitigation measures as recommended by Wilson (2023). Continuous accumulation of these polymers in river sediments may pose ecological risks to aquatic organisms and potential public health concerns through food-chain transfer, emphasizing the importance of season-specific monitoring strategies as proposed by Ruffell et al. (2025). Although FTIR analysis successfully identified the major polymer types, the study was limited by its spatial and temporal coverage and did not assess nanoplastics or biological impacts; therefore, improved waste management, regular environmental monitoring, public awareness programmes, and further research on microplastic toxicity, bioaccumulation, the hydrological sensitivity of PP, and the environmental stability of PVC are recommended.

CONCLUSION

This study confirms the pervasive presence of microplastics in the River Niger across both rainy and dry seasons. Fragments dominated the microplastic forms, followed by fibers and pellets, indicating strong contributions from packaging waste and anthropogenic activities. Polyethylene terephthalate (PET) was the most prevalent polymer, while polystyrene (PS) was least common. Although concentrations were relatively low compared with other international studies, the findings highlight the emerging ecological and public health risks associated with microplastic pollution. Urgent measures are needed, including effective waste management, public awareness initiatives, and the adoption of sustainable alternatives to single-use plastics, to mitigate microplastic contamination in freshwater systems.

The study confirmed the widespread occurrence of microplastics in River Niger sediments during both rainy and dry seasons, with fragments being the dominant shape, followed by fibres and pellets. Polyethylene terephthalate (PET) was the most abundant polymer, followed by polyethylene (PE), polyvinyl chloride (PVC), polypropylene (PP), and polystyrene (PS), with slightly higher microplastic abundance recorded during the rainy season. These findings agree with previous studies that reported PET and PE as the dominant polymers in freshwater ecosystems and linked increased microplastic transport to rainfall and surface runoff. The major sources of contamination are likely domestic, commercial, and recreational activities, including the improper disposal of plastic bottles, sachet water packaging, polyethylene bags, and other single-use plastics. Continuous accumulation of microplastics in sediments may pose ecological risks to aquatic organisms and potential public health concerns through food chain transfer. Although FTIR analysis successfully identified the major polymer types, the study was limited by its spatial and temporal coverage and did not assess nanoplastics or biological impacts. Therefore, improved waste management, regular environmental monitoring, public awareness programmes, and further research on microplastic toxicity and bioaccumulation are recommended.

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