International Journal of Chemical Science
www.chemicaljournals.com
Online ISSN: 2523-2843, Print ISSN: 2523-6075
Received: 30-08-2022, Accepted: 15-09-2022, Published: 01-10-2022
Volume 6, Issue 2, 2022, Page No. 40-42

Assessment of microplastic contamination in water from River Niger at Onitsha

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Abstract
In the study, levels of various microplastics were measured in water samples taken from the River Niger in Onitsha. FTIR techniques were used to analyze water samples from the [001], [002], [003], [004], and [005] sample sites. Polyethylene, polyester, polypropylene, styrene ethylene butylenes, and polystyrene were the five microplastic types examined at (<100 um). Their respective mean concentrations (particles L^{-1}) in the water samples fell between the ranges of 6.66 – 12.33, 1.67 – 2.33, 1.33 – 4.33, and 1.66 – 6.33. In all of the water sampling areas, polystyrene and polyester concentrations were found to be highest and lowest, respectively, in accordance with the distribution of plastic types. Polycyclic aromatic hydrocarbons (PAHs) and marine debris were found in the river water, which was the cause of the high concentration of polystyrene that was discovered there.

Keywords: water, microplastics, analyze, pollutants, contamination

Introduction
Water is a highly important natural resource that has many uses in our daily life. Industries rely on it for production-related tasks. Humans also depend on it for residential, agricultural, and food applications (Worm *et al*., 2017) [7]. However, it is well known that water acts as a significant sink for environmental contaminants like microplastics (Tove *et al*., 2010) [6]. Having a maximum size of 5 mm, microplastics are tiny pieces of plastic (Worm *et al*., 2017) [7]. These tiny particles, which are all around us, have been found to be a crucial conduit for the spread of microbes, dangerous chemicals, and microplastics to aquatic life (Browne *et al*., 2007) [1]. As a result of repeated exposure, microplastics pose a number of major health hazards to people as they have the capacity to bioaccumulate in these animals and eventually enter human bodies (Tove *et al*., 2010) [6]. Some inhabitants who live near the River Niger's coast in Onitsha rely on the water for domestic and agricultural needs. Because of this, it is important to measure the amount of microplastics in the river in order to produce baseline data that will aid in identifying the origins of these pollutants and also allow policymakers to set up effective waste disposal management programs for people living in the research region.

Materials and Methods
Description of Study Area
River Niger stretch in Onitsha is the study area. Onitsha, in the state of Anambra in eastern Nigeria, is located between latitudes 5°221 and 6°481 and longitudes 6°321 and 7°201. Onitsha, a city in the Anambra State, is situated on the east bank of the River Niger and has a territory of around 49,000 km^2. It's one of the biggest business hubs in sub-Saharan Africa and is a key transportation center for Nigeria. It is said to be home to one million people. The working force of Onitsha, which includes industries like trading and services, is roughly 75 % of the total. Manufacturing and industrial jobs account for 25 % of all employment.

Sample collection
In this investigation, samples of water were taken during the rainy season at intervals of 2 kilometers (August). Twenty sample points were used to create five composite samples, designated [001], [002], [003], [004], and [005]. The samples were taken at random.

FTIR Analysis of Water Samples
The water samples were examined for the presence of microplastics using a Buck Scientific M530 USA FTIR. This apparatus featured a beam splitter and a deuterated triglycine sulfate detector. The software of the Gram A1 was used to acquire and modify the spectra. After being thoroughly mixed, the samples and 0.5 mL of nujol were added, then added to the salt pellet. During the measurement, FTIR spectra in the frequency bands of 4,000 - 600 cm^{-1} were collected and co-added at 32 scans and 4 cm^{-1} resolution. The FTIR spectra were displayed using transmitter values.

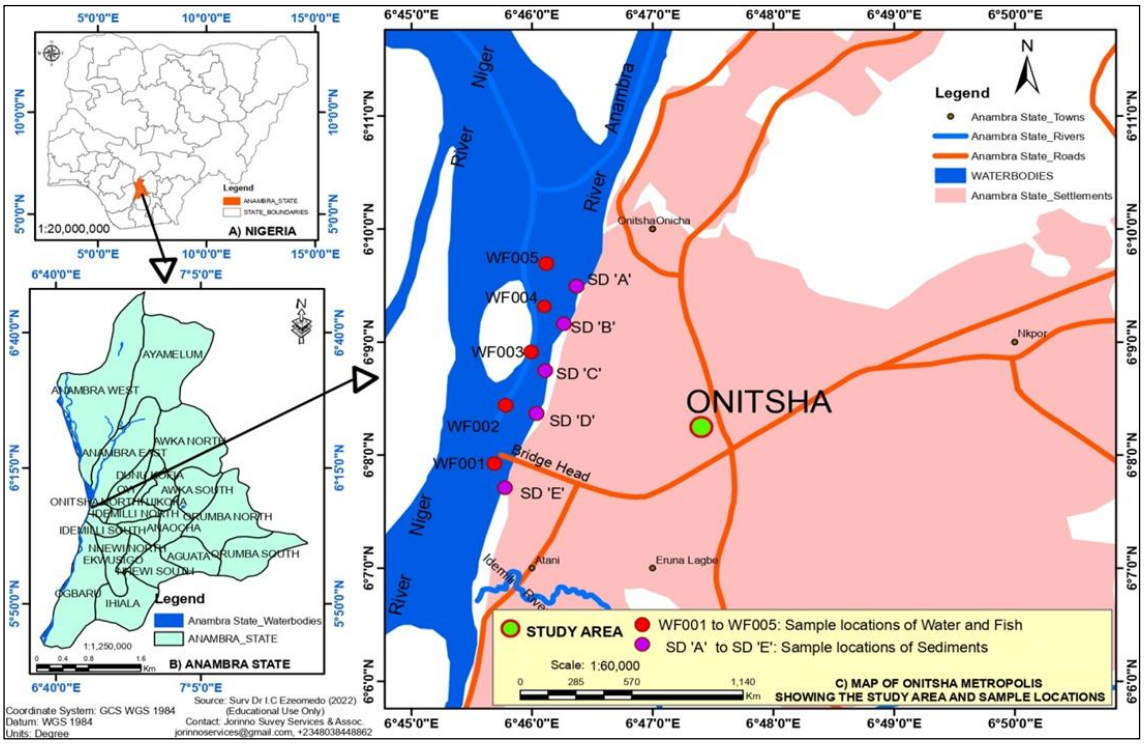

Fig 1: Map of Anambra State Nigeria showing Rivers Niger at Onitsha stretch.

Statistical Quality Control

To check the equipment precision, which is the degree of similarity of results of replicate samples or an indication of the reproducibility of results of replicate samples measured under the same condition, each microplastic estimation was performed in triplicates, with the results reported as mean standard deviation (David, 2000) [3]. The SPSS version 20 software package was used to calculate the mean values from the triplicate results, the standard deviation, analysis of variance (ANOVA) at a value less than 0.05 ($P<0.05$) level of significance, and principal component analysis (PCA) based on the Pearson Correlation matrix analysis.

Results

The distribution of microplastics in water from the River Niger at Onitsha was measured, and the results are shown in Table 1 below.

Table 1: Microplastics in water

Samples	Polystyrene (<100 um)	Polyester (<100 um)	Polypropylene (<100 um)	Styrene ethylene butylenes (<100 um)	Polyethylene (<100 um)
001	12.33	1	2.33	4.33	6.33
002	13	1	1.33	1.67	2.66
003	10.66	1.33	2	1.33	1.66
004	8.66	1.67	2.33	1.67	3
005	6.66	1	1.33	3	1.66

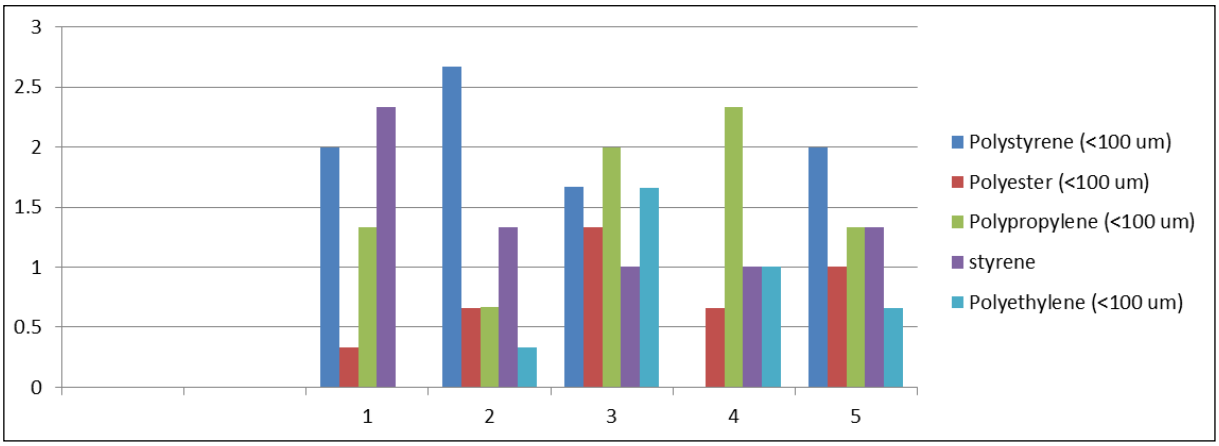

Fig 1: Microplastics in water

Discussion

Polystyrene (<100 um), polyester (<100 um), polypropylene (<100 um), styrene ethylene butylenes (<100 um), and polyethylene (<100 um) were the five microplastic types examined. Their respective mean concentrations (particles L^{-1}) in the water samples ranged from 6.66 – 12.33, 1.67 – 2.33, 1.33 – 4.33, and 1.66 – 6.33. According to the distribution of plastic types, polystyrene and polyester concentrations were found to be highest and lowest, respectively, in all of the water sampling areas. The accumulation of PAHs and marine debris in the river water was the cause of the high amount of polystyrene (Enyoh *et al*., 2019) [4].

The levels of microplastics found in this study are considerably low when compared to other studies. Finding from the study carried out by Chae *et al*. (2015) [2] on the levels of microplastics in surface seawaters of the Incheon/Kyeonggi Coastal Region of South Korea, the concentrations of microplastic ranged from 1602 ± 1274 to 152,688 ± 92,384 particles/m^3. They came to the conclusion that the sampling technique and spatiality had an impact on the amount of microplastics. Similar results were obtained in other studies (Zhao, 2014, Xu, 2018; Li *et al*., 2020) [9, 8, 5]. So it seems that the amount of microplastics found in this study doesn't pose much of a threat to people.

Table 2: Pearson's correlation coefficient for Microplastics in water

	Polystyrene	Polyester	Polypropylene	Styrene ethylene butylene	Polyethylene
Polystyrene	1				
Polyester	-0.30046	1			
Polypropylene	0.138194	0.59021	1		
styrene ethylene butylene	0.043714	-0.56115	0.190351	1	
Polyethylene	0.508677	-0.21928	0.582958	0.757374	1

Correlation Analysis

The correlation study of the microplastics in the river water samples (Table 2) showed a substantial and positive correlation between polypropylene/polyester, polyethylene/polystyrene, polyethylene/polypropylene, and polyethylene/styrene ethylene butylene (r=0.59021 at p>0.05). The correlation between styrene, ethylene, and polyester, on the other hand, was very strong, negative, and inverse (r= -0.56115 at p > 0.05). This finding shows that the sources of the microplastic kinds with strong and positive correlations are similar. Additionally, the negative correlation between styrene ethylene butylenes and polyester shows that a drop in polyester concentration results from a rise in styrene ethylene butylenes concentration and vice versa.

Conclusion

The quantity of microplastics found in the river water has been measured. Polystyrene and polyester concentrations among the five types of microplastics examined were discovered to be greatest and lowest, respectively, across all sampling stations (001 – 005). PAHs and marine debris in the river water were blamed for the high concentration of polystyrene. The majority of the microplastics discovered were from sources that were generally of similar origin, according to correlation analysis.

Acknowledgments

We are incredibly appreciative of everyone who helped make this study a reality.

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