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MICROPLASTICS IN SILVER CATFISH (*Chrysichthys nigrodigitatus*) FROM NEW CALABAR RIVER IN NIGER DELTA, NIGERIA

I. Ilechukwu, G. I. Ndukwe*, B. E. Ehigiator, C. S. Ezeh & S. L. Asogwa
(I. I. & S. L. A.: Environmental Chemistry Unit, Department of Industrial Chemistry, Madonna University, Elele Campus, Rivers State, Nigeria; G. I. N.: Department of Chemistry, Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Rivers State, Nigeria; B. E. E. & C. S. E.: Department of Pharmacology and Toxicology, Madonna University, Elele Campus Rivers State, Nigeria).
**Corresponding author's email: gloria.ndukwe@ust.edu.ng*

ABSTRACT

This study investigated the ingestion of microplastics by silver catfish (*Chrysichthys nigrodigitatus*) from New Calabar River in Niger Delta, Nigeria. Microplastics from the guts of 45 fish were examined with microscope after dissolution with potassium hydroxide. Microplastics, mostly fragments were found in about 56% of the samples at an average of 3.87±5.97 particles per fish. This study highlights the consequences of plastic pollution in freshwater environment and the potential risk to aquatic and human life. This also shows a potential threat to public health and therefore needs attention from health and environmental policy makers.

Keywords: Microplastic, fish, freshwater, Niger-Delta, Nigeria.

Introduction

Microplastics are plastic particles whose longest diameter is less than 5 mm (Gamarro *et al.,* 2020; Wagener & Lambert, 2018). In most cases, they are seen under the microscopy (Andrady, 2011). They are ubiquitous in the different spheres of the environment, including seas, freshwater lakes, rivers, terrestrial environments, and atmospheric fallout (Ilechukwu *et al.,* 2019; Moore, 2011). Microplastics in aquatic environment have been of concern in recent years because they are not only a source of toxic chemicals added as ingredients during plastic manufacturing but also a sink for toxic chemicals such as hydrophobic organic pollutants and metals from the surrounding environment (Wang *et al.,* 2017; Taniguchi *et al.,* 2016; Lithner *et al.,* 2011). There are two types of microplastics: secondary and primary microplastics (Costa *et al.,* 2010). While primary microplastics are manufactured to be of microscopic size, secondary microplastics break out from large plastic materials due to diverse environmental processes (Boucher & Friot, 2017). Physical, biological and chemical processes can reduce the structural integrity of plastic materials resulting in fragmentation (Browne *et al.,* 2007).

Sources of microplastic contamination into the environment include passage through waste water treatment plants (WWTPs), either from microplastic use in personal care products or release of fibres from textiles during the washing and wear of clothes, application of biosolids from waste water treatment plants (WWTPs) to agricultural lands, storm water overflow, incidental release (e.g. during tyre wear), release from industrial products or processes, and atmospheric deposition (Crossman *et al.,* 2020; Liu *et al.,* 2019; Napper & Thompson, 2016). Fishes, snails, marine turtles, water birds, earthworms, lobsters, shrimps, clams and bivalves have been shown to ingest microplastics (Duncan *et al.,* 2019; Hossain *et al.,* 2019; Wang *et al.,* 2019; Cheung *et al.,* 2018; Courtene-Jones *et al.,* 2018; Reynolds & Ryan, 2018; Li *et al.,* 2015). Effects of aquatic organism exposure to microplastics include altered reproduction, immobilization and disturbed antioxidant system (Cong *et al.,* 2019; Wang *et al.,* 2019; Deng *et al.,* 2017; Cole *et al.,* 2011). Toxicity may be from exposure to additives used for plastic production and organic contaminants adsorbed onto plastics (Ma *et al.,* 2019; Galloway, 2015).

The New Calabar River is an essential water source in the Niger Delta. It has been reported to be contaminated with organic pollutants and heavy metals (Ilechukwu *et al.,* 2018; Mgbemena *et al.,* 2017). These contaminants adsorb to microplastics and may be transferred to organisms that ingest them. The ubiquitous nature of plastics and its ability to break into micro and nano fragments has made it a concern for environmental health. These microplastics may be transferred to higher animals including humans on consumption of aquatic organisms (Li *et al.,* 2015). Seafood products including fishes are sources of dietary intake of microplastics apart from drinking water (Lusher *et al.,* 2017). It is important therefore to examine fishes from local aquatic sources for microplastic ingestion. Only few studies have investigated microplastics ingestion by fishes in African aquatic environment and most of the studies from other regions focused on marine environment. This represents a knowledge gap on the effects of plastic pollution on African freshwater resources. This study, therefore, aimed at investigating the occurrence of microplastics in locally consumed fish from New Calabar River in Niger Delta, Nigeria.

Experimental

Study area

New Calabar River (Fig. 1) is located between Longitude 6.9962 – 7.0333° E and Latitude 4.4167 – 4.4983° N in the Niger Delta area of Nigeria and empties into the Atlantic Ocean. It is among the important water resources in the region. The river serves as agricultural, recreational, and sometimes, domestic water supplies for the locals in the area. Silver catfish is available throughout the year and heavily consumed by locals in the region.

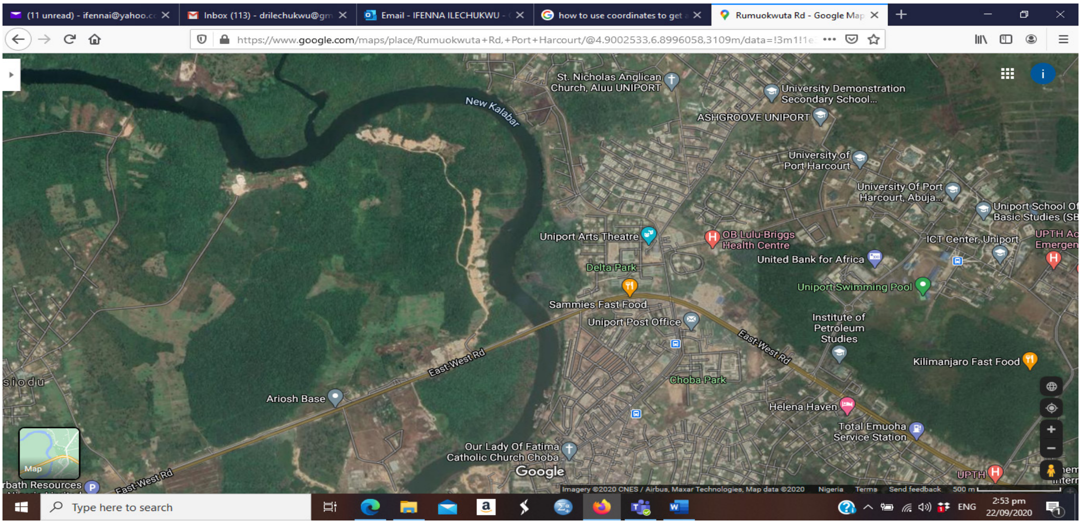

Fig. 1. New Calabar River.

Sampling

Fish samples were collected with metallic traps and transported to the laboratory, washed with double-distilled water to remove external debris, labelled, and their length and weight recorded. Forty-five (45) fish samples were collected between November 2018 and April 2019.

Sample treatment for microplastic analysis

Fish guts were obtained according to the method described by Lusher & Hernandez-Milian (2018). The guts of the fish samples were removed by ventral dissection. After weighing, the guts were placed into clean beakers and digested with 10% KOH three times the volume of the content. This was incubated at 40 °C for 48 hours to dissolve all organic tissues. The solution was filtered with vacuum pump once it was clear and the filtrate was discarded while the residue which contained the microplastics was dried in the oven at 60 °C and stored in glass Petri dishes (Lusher & Hernandez-Milian, 2018).

Microplastic Enumeration and Identification

Suspected microplastic particles were examined under the microscope (Olympus CX31RTSF) at 40x according to the criteria used by Qui *et al.* (2016). Photographs of suspected particles were directly taken on the filters stained with eosin red using Olympus E330ADU1.2X6K1338 camera.

Quality assurance

All solvents were redistilled and filtered before use to ensure no contamination (Ilechukwu *et al.,* 2019). Glassware used for sample preparation and extraction were rinsed with double distilled water and dried in the oven before use (Mgbemena *et al.,* 2017). Working surfaces were cleaned with ethanol prior to start of work. Samples were covered when not in use and filters were carefully handled to ensure non-contamination by air-borne particles. Sample blanks were also extracted alongside the samples to ensure non-contamination.

Results and discussion

The results of microplastics abundance in silver catfish (*Chrysichthys nigrodigitatus*) from New Calabar River is presented in Table 1. Lengths of the fish samples ranged from 11.00 - 32.50 cm while the weights ranged from 26.00 - 200.50 g. Microplastics were in the guts of twenty-five (25) samples (56 %) out of forty-five examined.

TABLE 1

Observed parameters of the fish samples

Fish sample	Fish weight (g)	Fish length (cm)	Gut weight (g)	Microplastic items
1	37.20	16.00	1.38	0
2	79.90	18.00	10.00	0
3	86.80	21.00	3.50	0
4	100.00	24.00	11.00	0
5	86.60	19.50	7.00	0
6	121.10	23.00	10.70	0
7	107.58	21.50	12.42	5
8	120.53	25.30	22.76	0
9	148.88	26.50	6.39	0
10	120.48	22.70	5.95	2
11	117.97	25.00	12.24	0
12	30.58	13.50	4.80	0
13	29.66	14.00	1.41	1
14	42.00	16.20	1.38	0
15	50.51	16.40	1.93	1
16	36.65	15.50	1.36	2
17	45.68	15.00	6.48	3
18	46.17	16.50	2.13	2
19	47.99	17.00	2.62	0
20	54.76	17.50	2.71	0
21	79.19	20.00	10.11	1
22	69.41	18.50	2.63	0
23	68.89	18.00	3.49	0
24	61.90	17.50	3.06	0
25	71.03	17.00	4.72	1
26	168.50	28.50	50.50	13
27	171.20	29.80	45.80	6
28	151.20	24.50	32.40	0
29	146.50	24.30	20.50	0
30	120.50	20.50	18.50	7
31	75.00	18.00	10.50	23
32	82.00	20.00	9.20	4
33	200.50	32.50	49.50	0
34	60.50	13.00	9.50	6
35	100.20	17.00	11.10	7
36	145.60	28.00	46.40	11
37	88.50	16.00	4.40	5
38	56.50	13.00	9.10	7
39	85.50	18.00	7.60	2
40	130.20	20.00	16.50	23
41	26.00	11.00	1.30	0
42	85.50	16.00	17.20	20
43	70.20	17.50	4.10	6
44	90.50	21.00	20.40	13
45	50.50	16.00	3.30	3

A total of 174 microplastics were found at an average number of 3.87±5.97 particles per fish. The observed microplastics include irregularly shaped fragments (87.93%), fibres (10.92%) and pellets (1.15%) (Fig. 2).

Microplastics have been shown to transport organic pollutants like hydrocarbons, pesticides, additives used in manufacturing plastics and in some cases, heavy metals (Wang *et al.,* 2017). Consumers of fishes from the river especially smaller fishes that are consumed whole are at risk of ingesting microplastics and accompanying health risks that go with it such as consumption of leached plastic additives and adsorbed pollutants (Gamarro *et al.,* 2020; Smith *et al.,* 2018). Pearson correlation showed weak positive correlation between the number of microplastic particles and fish weight (+0.20), length (+0.03) and guts (+0.32) indicating that all sizes of fishes are susceptible to microplastics ingestion (Table 2). Reasons why aquatic organisms ingest microplastics include microplastics resemblance of food, accidental intake during feeding and transfer from food chain. These are influenced by factors such as microplastic concentration in the aquatic environment, fish size and foraging behaviour (Roch *et al.,* 2020).

TABLE 2

Pearson correlation of the observed parameters of the fish samples

Parameter	Fish weight	Fish length	Gut weight	Microplastics
Fish weight	1			
Fish length	0.92343722	1		
Gut weight	0.82816935	0.79050545	1	
Microplastics	0.19683383	0.025479798	0.32398769	1

The higher number of fragments in the samples suggests the breakdown of larger plastic items into secondary microplastics as the major source of microplastics in the river (Neves *et al.,* 2015).

Ingestion of microplastics by fishes has also been studied by researchers in other different regions. The percentage of fishes with ingested microplastics in other studies compared with the result of this study are outlined in Table 3. This present study provides the first record of microplastics ingestion by fish in the Niger Delta aquatic environment. Another study from Eleleye Lake in southwestern Nigeria recorded 69.7% of fish samples with ingested microplastic at the average of 1 - 6 microplastic particles per individual species (Adeogun *et al.,* 2020). Compared with the average of 3.87±5.97 per fish in this study, it shows the high degree of plastic pollution in Nigeria freshwater and the effects on aquatic organisms. A recent report identified three rivers in Niger Delta, Nigeria among the first twenty rivers polluting world oceans with plastics (Ilechukwu, 2020).

TABLE 3

Percentage of fish samples with ingested microplastics in different regions

Number of individual samples	Percentage of samples with ingested microplastics	Location	Reference
45	55.6	New Calabar River, Niger Delta Nigeria	This study
109	69.7	Eleleye Lake, South-western Nigeria	Adeogun *et al.,* 2020
150	49.0	Northeast Atlantic Ocean	Barboza *et al.,* 2020
140	5.71	Western Arabian Gulf	Baalkhuyur *et al.,* 2020
40	30.0	Tuticorin, Southeast Indian Coast	Kumar *et al.,* 2018
504	36.5	English Channel, Plymouth, UK	Lusher *et al.,* 2013
263	19.8	Portuguese Coast	Neves *et al.,* 2015
233	73.0	Northwest Atlantic, Ireland	Wieczorek *et al.,* 2018
120	38.0	Mondego River, Portugal	Bessa *et al.,* 2018
337	68.0	Baleric Island (Mediterranean Sea)	Nadal *et al.,* 2016

The nature of microplastics ingested by fishes are similar to the microplastics in the aquatic environment (Neves *et al.,* 2015). The New Calabar River also serves as drain for floods and storm water in the area. Considering the poor waste management system in Nigeria, it is no surprise that microplastics found in the fishes were dominated by fragments since solid wastes emptying into the river are usually household and municipal wastes.

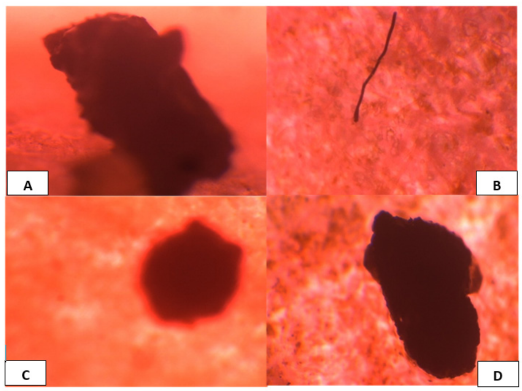

Fig. 2. Selected fibre and fragments of microplastics present in the fish samples: A-Fragment, B-Fibre, C-Pellet, D-Fragment.

Conclusion

Microplastics were found in more than half of the guts of fish samples from New Calabar River in Niger Delta, Nigeria. The result of this study is an indication of the plastic pollution status of the river. It also shows that freshwaters are sinks for plastics and serve as plastic channels into the marine environment. In view of this, proper management of plastic wastes to prevent drainage into aquatic environment is recommended.

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