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Investigation of Microplastics and Mesoplastics in Fish (*Tilapia Guineensis*) from Ilaje River, Ondo State, Nigeria

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ABSTRACT

The investigation of microplastics and mesoplastics in Tilapia guineensis fish from Ilaje River, Ondo State, Nigeria, provides valuable insights into the presence and distribution of these plastic particles in the waterbody. No mesoplastics were found in the fish species. All the plastic particles accounted for were microscopic in nature and were only visible under digital camera microscope. The study found that fiber was the most prevalent form of microplastics, accounting for 43 % of the total count while fragment was the second most abundant type, comprising 32 % of the total count. Film and pellet microplastics each accounted for 12 % and 13 % respectively. The presence of these microplastics in the fish samples suggests potential sources such as industrial activities, plastic wastes, textile manufacturing, fishing activities, and the degradation of fishing gear. The findings emphasize the need for effective measures to mitigate plastic pollution in Ilaje River and protect the health of aquatic organisms. Further research is required to understand the sources and impacts of larger plastic particles and to support future conservation efforts in the region.

Keywords:

Microplastics, Mesoplastics, Fiber, Ilaje River, Fragment, Conservation

Introduction

Plastic pollution has emerged as a global environmental concern. The exponential increase in plastic production vis - a- vis inappropriate waste disposal and management have contributed to the widespread distribution of microplastics and mesoplastics in aquatic ecosystems (Adika et al., 2020). Plastic wastes found in the environment are subjected to environmental factors and are disintegrated into smaller fragments through light, heat, ultraviolet (UV) radiation, mechanical abrasion, ocean current and even under relatively low temperatures. These result into mesoplastics, microplastics and even further degradation into nanoplastics posing significant threats to biodiversity, tourism and fisheries livelihoods even, human health (Merga et al., 2020).

Microplastics are small plastic particles measuring less than 5 mm in size, while mesoplastics are larger plastic fragments ranging from 5 mm to 20 mm and nano (<1 μm). These various sizes of plastics originate from two main sources into the environment; firstly, from the direct emission of microplastic products (e.g. microbeads), and secondly, from breakdown of larger plastic debris (Jambeck et al., 2015;

Adika et al., 2020). Their presence in the environment has created a serious menace and poses a threat to aquatic organisms, including fish. Plastic particles ingestion by fish and other marine organisms is an emerging concern due to the risks such particles pose to the health and functioning of marine ecosystems (Ugwu et al., 2021). Studies have shown that microplastics and mesoplastics can be ingested by fish through various pathways, including direct ingestion of plastic particles or consumption of contaminated prey. Once ingested, these plastic particles can cause physical harm, obstruct the digestive system, and potentially transfer of harmful chemicals to the fish (Auta et al., 2017, Marahana et al., 2020). Fish plays a vital role in aquatic ecosystems as both predator and prey species. They are an essential component of the food web, and any adverse effects caused by plastic particles contamination can disrupt ecosystem dynamics (Lusher et al., 2017). Understanding the presence of plastic particles in fish helps to evaluate the extent of plastic pollution and its potential impacts on the overall health and biodiversity of aquatic ecosystems (Ugwu et al., 2020). Plastic particles have the potential to pose risks to human health through the consumption of contaminated fish. Fish is an important source of protein and essential nutrients for many communities around the world (Samuel et al., 2020). If fish become contaminated with plastic particles, there is a possibility of human exposure to these particles and associated chemical contaminants. Assessing the presence and effects of plastic particles in fish helps to identify potential risks to human health, supporting the development of appropriate measures to ensure the safety and quality of sea and fresh water foods. Thus this study aims at investigating microplastics and mesoplastics occurrence in *Tilapia guineensis* fish from Ilaje River to gain an understanding of plastic pollution of fish in the study area and its potential implications for both ecological and human health.

Materials and methods

The study area

The study area is Ilaje River, Ondo State, Ilaje is a Local Government Area in Ondo State Nigeria, within Latitude 5°50’ N - -6°09’ N and Longitude 4°45’ E - 5°05’ E (Fig.1). The area is chosen for the study as it is one of the locations in Nigeria that could be most impacted by microplastics pollution, due to the prevalence of fishing as the major occupation of the inhabitants as well as domestic and cottage industrial discharges into rivers which are finally emptied into the Atlantic Ocean and the possibility of unabated microplastic levels to adversely affect natural production of the aquatic species.

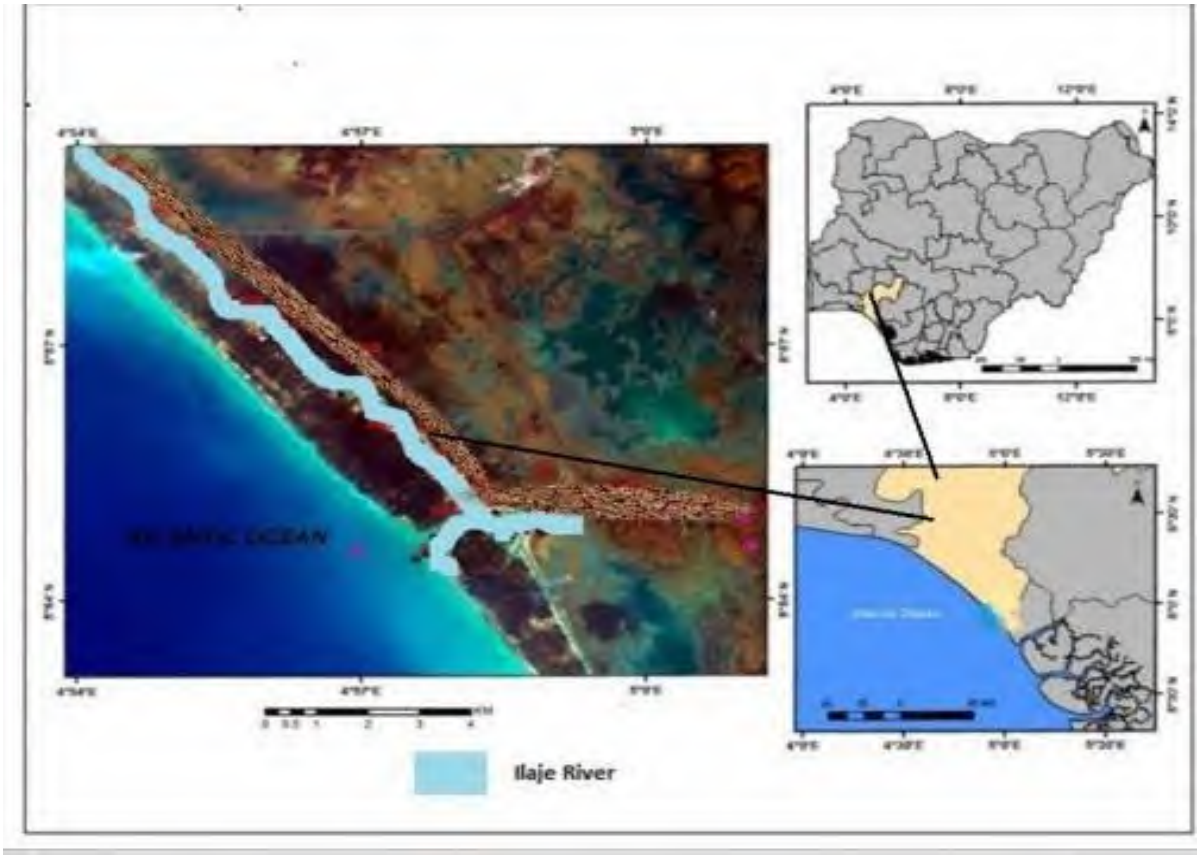

Fig. 1: Map of study area showing the sampling location

Sample collection, extraction and digestion

A total of ten (10) individual *Tilapia guineensis* fish species were purchased directly from the fishermen immediately their boat landed at the fishing harbor. The fish species was selected because it is a source of income for fishermen and is widely consumed by the inhabitants of the area and beyond. The collected fishes were immediately transported in an icebox to the laboratory at Department of Science Laboratory Technology, Federal Polytechnic Ile Oluji and stored at − 20 °C until further analysis. Fish gastrointestinal tracts (GITs) were extracted and digested according to Merga et al. (2020) with slight modifications. All dissecting sets and tweezers were rinsed with pre filtered distilled water before use. Fish samples were also washed with pre filtered distilled water to remove any adhered substances. The morphometric parameters such as total body length in cm and body weight in g were recorded. The fish samples were dissected from the upper part near the gills using the dissecting set (Fig. 2). The excised GITs were weighed on an electronic balance and recorded. Mesoplastics (plastic that are visible to the eyes) were not found in all the samples. 10ml of 10% pre filtered potassium hydroxide was added per gram of the GIT sample. The samples were covered with Aluminum foil and placed on a mechanical shaker for 1 hour and were transferred into incubator at 50°C until digestion was completed. This was followed by the addition of 9ml of 50% H_2O_2 per gram of the GIT and dilution was applied where necessary. Samples were filtered through 0.4 µm membrane filter papers using a vacuum pump and filter papers containing residue were stored in covered petri dishes and placed in a tight sealed desiccator to dry for 48 hrs and to avoid contamination. A blank sample was taken and treated the same way as other samples. The membrane filter papers were then viewed under digital light microscope (Digital

camera 1600X RoHS China) for identification according to their morphological characteristics and classified according to their type, color, and size (Turhan, 2022).

Fig. 2: Dissection of fish sample in the laboratory

Result and Discussion

Microplastics in fish species from Ilaje River

The Morphometric properties of the fish species, *Tilapia guineensis* showed an average length of 30.56 cm ± 17.03, body weight (122.55 g ± 36.42) and gastrointestinal tract weight (22.48 g ± 11.68). Microplastics were seen in 100 % of the gastrointestinal tracts (GITs) of the fish samples. A total of 226 MPs and average of 22.60 ± 12.36 MPs per individual were detected in the fish species. The amount of microplastics found in the gut of fish samples increased in individuals as their size (weight) increased. When compared with reports of microplastics in fish species from other regions, microplastic levels found in fishes in this study were higher than those from Chen et al. (2022) who reported an average of 3.20 ± 2.6 microplastics per individual in Nandu river, the largest river in Hainan, China. Hamid et al. (2018) also did a compilation of studies on microplastics in fishes from various European rivers, and reported a maximum concentration of only 0.51 particles/g of fish body.

The MPs were classified into shapes. Determination of various shapes of microplastics in the environment is significant. It provides knowledge to the origin and potential impact on living organisms. The shapes identified were fragments, pellets, fibers and films. Fiber-type microplastics were found to be most abundant in the GITs of all the fishes and fragments were the second abundant (Fig. 3). These fibers come from many sources, such as clothing, fishing, and industrial discharge into water bodies (Bilal et al., 2023). Fragments are unevenly shaped plastic particles and may be more injurious causing laceration on both the external and internal (digestive) parts of an organisms' body because of their coarse edges if ingested (Idowu et al., 2024).

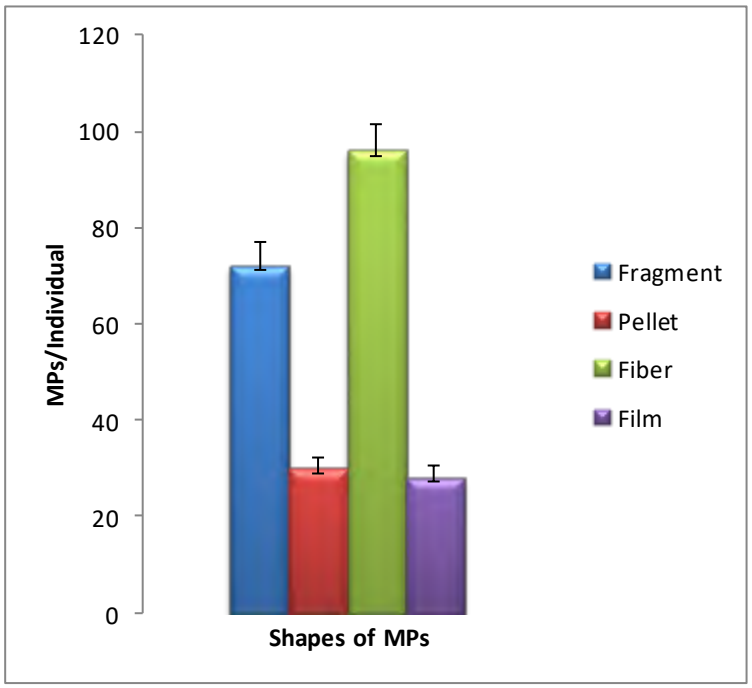

Fig. 3: Concentration of various microplastics shapes in the GITs of fish species

Representative images of the different shapes (fibre, fragment, pellet and films) are shown in Fig. 4 as captured under the digital microscope.

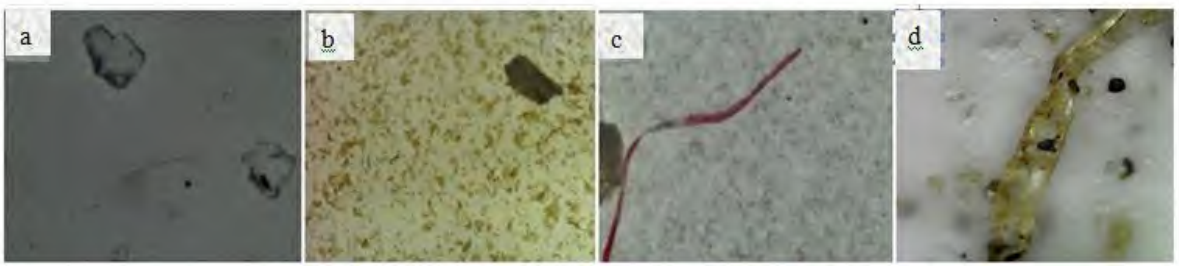

Fig. 4: Typical images of MPs found in the GITs of fish samples; a) fragment, b) pellet, c) fiber, d) film.

Microplastics belonging to four different colours were observed in the fish samples. They are brown, black, yellow and blue (Fig.5). Consumption of tiny plastic items by aquatic organisms may be influenced significantly by their colours. A report by Zhao et al. 2022 revealed that aquatic animals that are visual predators (e.g. gobies) are prone to ingesting microplastics with colours resembling their preys. Microplastics with black colours dominated the fish species with 80 %. Black microplastics may have come from objects like car tyres, which wear gradually over a period of time and then resulting into tiny particles which are carried through run-offs into the drainages and the water bodies. The fact that black microplastics were predominant in this study area is in agreement with the relative positioning of the communities (the inland region) which are easily accessible to motor vehicles. Automobile tyre wears may have contributed to the level of black microplastics observed at this particular location. The other contribution to the black MPs generally would be the breakdown of black-coloured single-used packaging bags (polythene and nylon), which are very widely used and discarded indiscriminately in the country (Idowu et al., 2024). The fish species investigated in this study is commercially important

and is a delicacy for many people in Ilaje area and beyond. The detection of microplastics in them, thus, indicates a potential risk for consumers.

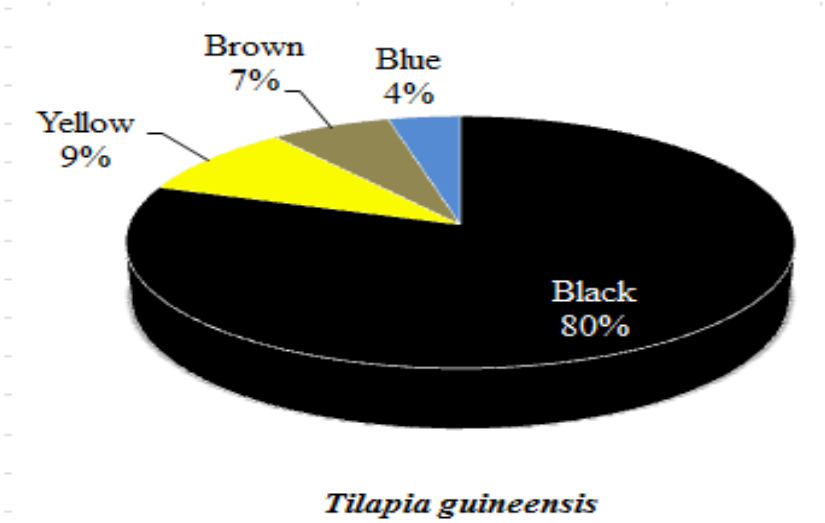

Fig. 5: Composition of different coloured microplastics found in the gastro-intestinal tract (GIT) of *Tilapia guineensis* from Ilaje River, Ondo state

Conclusion

The assessment of microplastics and mesoplastics in *Tilapia guineensis* from Ilaje River, Ondo State, Nigeria, revealed the presence of microplastics pollution in the aquatic ecosystem. No mesoplastics (plastic particles >5 mm <20 mm) were found in the fish species under investigation. The detection of microplastics (< 5 mm) in the fish suggests that they have been exposed to microplastics contamination through water pollution or ingestion of prey containing microplastics. This finding raises concerns about the ecological and health implications for both the fish and the wider ecosystem. Further research and monitoring efforts are recommended to understand the extent and sources of plastic pollution while public awareness and education initiatives should be implemented to promote responsible waste management practices and mitigate the impacts of plastic pollution on the environment and human health.

Reference

Adika S.A., Mahu E., Crane R., Marchant R., Montford J., Folorunsho R., Gordon C. (2020). Microplastic ingestion by pelagic and demersal fish species from the Eastern Central Atlantic Ocean, off the Coast of Ghana. *Marine Pollut. Bull.* (153) 110998.

Auta, H.S., Emenike, C.U., Fauziah, S.H, (2017). Distribution and Important of Microplastics in the marine environment: A review of the sources, fates, effects, and potential solutions. *Environment International*, 102, 165-176.

Bilal, M., Ul Hassan, H., Siddique, M.A.M., Khan, W., Gabol, K., Ullah, I., Sultana, S., Abdali, U., Mahboob, S., Khan, M.S. (2023). Microplastics in the Surface Water and Gastrointestinal Tract of *Salmo trutta* from the Mahodand Lake, Kalam Swat in Pakistan. *Toxics*, *11*, 3. https://doi.org/10.3390/ toxics11010003.

Chen, Y., Shen, Z., Li, G., Wang, K., Cai, X., Xiong, X., Wu, C., (2022). Factors affecting microplastic accumulation by wild fih: a case study in the Nandu River, South China. Sci. Total Environ. 847, 157486.

Hamid, F.S., Bhatti, M.S., Anuar, N., Anuar, N., Mohan, P., Periathamby, A., (2018). Worldwide distribution and abundance of microplastic: how dire is the situation? Waste Manag. Res. 36 (10), 873–897. https://doi.org/10.1177/ 0734242X18785730.

Idowu, G.A., Oriji, A.Y., Olorunfemi, K.O., Sunday, M.O., Sogbanmu, T.O., Bodunwa, O.K., Shokunbi, O. S., Aiyesanmi, A.F. (2024). Why Nigeria should ban single-use plastics: Excessive microplastic pollution of the water, sediments and fish species in Osun River, Nigeria. *Journal of Hazardous Materials Adv.* (13) 100409.

Jambeck**,** J.R, Geyer, R., Wilcox, C., Siegler, T.R,, Perryman, M., Andrady, A., Narayan, R., Law, K.L. (2015). Plastic waste inputs from land into the ocean. *Science* 347:768 DOI 10.1126/science.1260352.

Lusher, A.L., Hollman, P.C.H., Mendoza-Hill, J.J. (2017). Microplastics in fisheries and aquaculture: status of knowledge on their occurrence and implications for aquatic organisms and food safety. *FAO Fisheries and Aquaculture Technical Paper*. No. 615. Rome, Italy.

Maharana, D., Saha M., Dar J.Y., Rathore C., Sreepada R.A., Xu X.-R., Koongolla J. B., Li H. X.(2020). Assessment of micro and macroplastics along the west coast of India: Abundance, distribution, polymer type and toxicity. *Chemosphere* vol 246, 125708.

Merga, L.B., Redondo-Hasselerharm, P.E., Van den Brink, P.J., Koelmans, A.A. (2020). Distribution of microplastic and small macroplastic particles across four fish species and sediment in an African lake. *Sci. Total Environ.*, *741*, 14052

Turhan DÖ (2022). Evaluation of Microplastics in the Surface Water, Sediment and Fish of Sürgü Dam Reservoir (Malatya) in Turkey. Turkish Journal of Fisheries and Aquatic Sciences.22(SI), TRJFAS20157. http://doi.org/10.4194/TRJFAS20157

Ugwu, K., Herrera, A., & G´omez, M. (2021). Microplastics in marine biota: A review. *Marine Pollut Bull.* 169 (2021) 112540.

Olanipekun, O. S., Gbadamosi, O.K., Adegbenro, M, Agbona, A. I., and S. L. Adebisi, S. L. (2020). Ameliorative Effects of Dietary *Ocimum gratissimum* Leafmeal on African Catfish, *Clarias gariepinus* Subjected to Pathogenic and Transportation Induced Stress. *Journal of Applied Life Sciences International 23(12): 67-75, 2020; Article no.JALSI.64449 ISSN: 2394-1103.*

Zhao, X., Wang, J., Leung, K.M.Y and Wu, F. (2022). Color: An Important but Overlooked Factor for Plastic Photoaging and Microplastic Formation. *Environ. Sci. Technol.*, 56, 9161 −9163.