

An examination of the micro and mesoplastics in commercial fish's intestines and gills (*Oreochromis niloticus*) from Ambattur, Korattur and Madhavaram Lake

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Abstract

The most common kind of marine trash in the greater lakes and our ocean is plastic. Plastic waste comes in a variety of forms and sizes, but the term “microplastics” refers to particles that are smaller than five millimeters. Global interest in commercial species polluted with microplastics (MPs) and mesoplastics is growing because of the possible effects on food safety and human health. This study was conducted to study the likelihood of mesoplastic contamination and MPs in *Oreochromis niloticus*, a species that has significant commercial value and was collected from the lakes of Ambattur, Korattur, and Madhavaram. Three hundred fishes were analyzed over a period of six months, from October 2022 to March 2023. It was found that the guts and gills of these fishes possessed more mesoplastics (74), of which 58% were films and fragments, and more MPs (48). Higher levels of MPs pollution were observed in korattur lake. This research has proved that the gut of fish had the highest concentration of MPs. Further in the present study four distinct types of polymers—polythene, polypropylene, polyester, and polyamide—were also identified. These findings made it evident as to how contaminated fish tissues had microplastics in each of the three lakes. In order to minimize plastic pollution in the freshwater environment, extensive efforts are required. MPs present in fish could have negative impacts on environment and human health. These findings would establish a baseline of data regarding the contamination of MPs in freshwater commercial fish species.

Keywords: Microplastics, mesoplastics, *Oreochromis niloticus*, freshwater fishes, Lakes

Introduction

A new epoch known as Anthropocene has developed which describes as to how human development affects earth systems, over the past 50 years as a result of the invention and use of plastics and human industrial progress (Waters *et al.*, 2016). Microplastics are defined as plastics smaller than 5 mm (Thompson *et al.*, 2014). A serious environmental risk is the increased contamination of aquatic habitats with macro- and microplastics. Deep ocean sediments, fish, birds as well as polar waters are contaminated with microplastics. According to the research by (Koelmans *et al.*, 2016) and (Bergmann *et al.*, 2021) [32], they have the capacity to absorb contaminants as well as toxins from the environment and transmit it into the food chain. Depending on its size, the plastic waste is categorized as main or secondary. The main MPs are the microbeads used in sandblasting, medicinal applications, and abrasive cleaning (Kefer *et al.*, 2021). Secondary MPs are created when microplastics are broken down by physical, UV light, and microbiological processes (Barnes *et al.*, 2009 [6, 31]; Browne *et al.*, 2011 [9]; Rochman *et al.*, 2015). Furthermore, because these companies include microplastics into products like toothpaste, resin pellets, and face cleansers, this industry is thought to be a good source of microplastics (Farrell and Nelson 2013 [17, 42]; Sundt *et al.*, 2014; Browne *et al.*, 2011) [9]. Because MPs are buoyant, they spread very fast in aquatic settings. Because the MPs have somewhat lower densities than water, neutral buoyancy is created. This enables them to travel with the wind in the ocean currents or across large areas of land (Wright *et al.*, 2013; MATHALON and Hill, 2014).

6300 million metric tons of plastic waste were produced worldwide in 2015, of which 9% was recycled, 12% was burned, and 79% was disposed of in landfills, according to Geher *et al.* (2017). If these plastic wastes are not disposed

of appropriately, they might damage the ecology. The truth is that plastics break down slowly in the environment for a variety of reasons (Chamas *et al.*, 2020). A variety of elements, such as temperature, UV radiation, oxygen concentrations, wave action, and ocean circulation, contribute to the breakdown of plastics in the water. When plastics break down, they produce oxidative and pathogenic stress, which clogs the digestive tract and prevents those organisms from reproducing (Jovanovic, 2017 [23, 48]; Pandi *et al.*, 2022). The propensity of MPs to inadvertently ingest aquatic life raises the risk to those species.

The water from the lake had been supplied to Chennai residents for a brief period when there was a shortage in the late 1970s. Madhavaram Lake is a freshwater lake located in the northern part of Chennai. It is one of the three interconnected lakes in the region, along with Ambattur Lake and Korattur Lake. The lake is a source of drinking water for the city of Chennai and is also used for fishing and agriculture. These lakes are important for the environment and the people of Chennai. They provide a source of drinking water, support local agriculture and fishing, and are home to a variety of wildlife. The goal of this study was to identify and characterize the types and levels of MPs contamination in *Oreochromis niloticus* caught in Ambattur, Korattur and Madhavaram lake.

Materials and Methods

1. Sampling Area

Three different sampling locations were taken for the study in Chennai, Tamil Nadu, India namely Ambattur (Lat.13.10°N and Long. 80.14°E), Korattur (Lat. 13.12330°N and Long. 80.18047°E) and Madhavaram (Lat. 13°17'55"N and Long. 80°10'40"E). All these three lakes are interconnected.

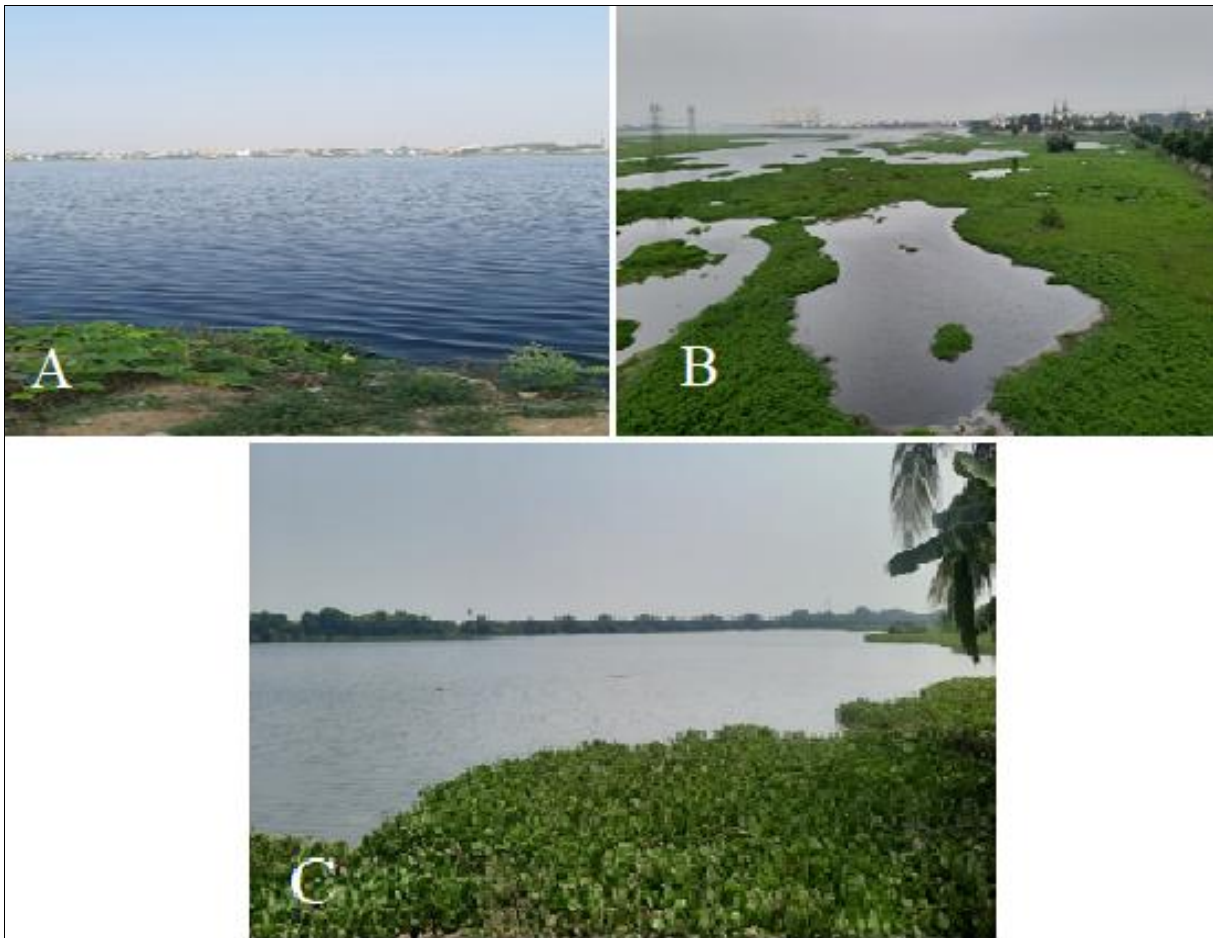


Fig 1: Study area (A) Ambattur lake, (B) Korattur lake, (C) Madhavaram lake.

2. Sample collection

The three sampling areas were evaluated from the month of October 2022 to March 2023. From each sampling areas 100 fishes (*Oreochromis niloticus*) (Fig. 2.) were collected using fishing nets to identify the presence of Micro and mesoplastics. A total of 300 fishes were evaluated for this study. The samples were frozen, coated with aluminum foil, moved to the lab, and kept at -20°C in order to determine whether MPs were present in the gut and gill contents. According to the procedure described by Lusher *et al.* (2013), the material is thawed at room temperature prior to examination.



Fig 2: Image of a sample *Oreochromis niloticus*.

3. Sample setup

Fish morphometric parameters, including length (cm), weight (g), and sex, were noted. The fish's digestive systems were removed and preserved for microscopic analysis in

glass jars. The gastrointestinal tracts and gills were examined using the techniques outlined by Boerger *et al.*, 2010^[33] and Davison *et al.*, 2011^[40, 15]. After that, this was examined to eliminate any ingested fragments that did not resemble real prey. After drying on a filter paper, this was sealed and put back on the paper.

4. Extraction of microplastics

The MPs were extracted by immersing fish gut and gills in a 10% w/v KOH solution for an whole night at 60°C (Rochman *et al.*, 2015). In between successive tests, the equipment was repeatedly cleaned with separate water to prevent sample contamination. To find plastic debris, the contents of the gut were counted, examined, and sorted by kind and color using a stereoscopic microscope that was attached to a digital camera. The non-plastic parts were manually sorted under a stereomicroscope and then extracted using forceps from each sample. Using the technique described by Free *et al.* (2014), the MPs were identified by their shape. There were found to be four distinct kinds. Foam, film, fragments, and fiber/line are the first four. Six distinct hues were used to identify the MPs in the sample: yellow, black, blue, red, green, and translucent. Because MPs are compounds with a certain degree of flexibility, the suspected MPs were outfitted with iron tweezers to remove any broken or damaged pieces (Young and Elliott, 2016). The fiber is a long, continuous strip that cannot split at the end and has a constant thickness and color throughout (Karthik *et al.*, 2018). There were found to be microplastics (less than 5 mm) and mesoplastics (more than 5 mm).

5. SEM Analysis

Most of the time, MPs were identified visually prior to the identification of a polymer type. We could observe them as tiny particles in naked eye using SEM. Using SEM, the sample morphology and any additional particles adhering to the MPs were identified, and pictures were taken.

6. MPs are analyzed using Fourier Transform Infrared Spectroscopy (FT-IR)

Fourier Transform Infrared Spectroscopy (FT-IR) was utilized to examine MPs particles extracted from fish intestines, in accordance with the methodology obtained from Alomar *et al.* (2017) [3, 28]. With the use of an Attenuated Total Reflectance (ATR) accessory and a single reflection diamond, the infrared spectra were acquired using an FT-IR spectrometer.

7. Statistical analysis

An analysis using SPSS 20.0 was carried out to confirm the significance in the MPs particle counts between sampling intervals. The graph was generated using MS Excel.

Results and Discussion

A total of 300 fishes were collected from all the three locations (Ambattur, Korattur, Madhavaram) out of which 122 micro and mesoplastics were isolated (Fig. 5). Microplastic presence and dispersion can be attributed to a number of causes, including meteorology, hydrological processes, trash dumping along the shoreline, and plastic material degradation (Cole *et al.*, 2011 [12, 37]; Ballent *et al.*, 2012 [4, 29]; Kukulka *et al.*, 2012; Zhao *et al.*, 2014). When compared to the other two lakes, Korattur lake had a higher concentration of microplastics. The sewage from residential areas and waste outlets surrounds the reservoir's outlet. According to Liu *et al.*, 2019, the microplastic may have been spread by wind activity as well. So, it's possible that it contributed to the high level of microplastics found in the korattur lake.

According to Horton *et al.*, 2017a [21, 46], 2 mm-sized mesoparticles predominate, followed by 1 mm-sized mesoparticles. Fishing activities, garbage buildup around reservoirs, and waste burning close to lakes may be major

sources of microplastic pollution. These sources are the principal causes of microplastic contamination in these lakes. Fishing activities, trash dumps close to the dam outflow, dry deposition, and flow of raw sewage from residential development near the lake bed are the sources of microplastics in these lakes. From the samples collected, the most prevalent kinds of microplastics were fibers (28), fragments (40), films (31), and foam (23).

Fishing nets and the weathering process, which breaks down plastic objects, are the primary sources of microplastics. These processes also significantly contribute to the amount of microplastics found in water and sediments (Derraik 2002 [16, 41]; Obbard *et al.*, 2014; Zhang *et al.*, 2015). Dry deposition caused by wind transport is another potential route for microplastics to travel. Microplastic may be transported by dust, such as that released by vehicle exhaust and tyres, which can also deposit and disperse in the atmosphere, on land, and in water (Cai *et al.*, 2017) [10, 35]. The color, size, and content of the microplastics found in fish gills and guts were also categorized. The primary color particles included in the samples were transparent (31), blue (24), black (20), yellow (19), green (15), and red (13). Large plastic pieces that may have gotten into the lake as a result of nearby urbanization and wind-borne dry deposition are the causes of the colorful material's existence. (Wright *et al.*, 2013; Nobre *et al.*, 2015; Anderson *et al.*, 2016 [11]; Camarero *et al.*, 2017 [36, 11]; Shaw and Day, 1994; GESAMP 2016).

Both colorful and uncolored microplastics are a serious environmental threat because they are consumed by fish, plankton, and other species that cannot tell them apart from prey. Because they are so widely available, zooplankton eat a large amount of microplastics. Therefore, more research is needed to understand the effects of microplastic biotoxicity and the health risks to the organism in this freshwater environment, both for fish and even people. This happens because the higher trophic levels devour the zooplankton.

The Chemical Make-Up of Microplastics– FTIR

Microplastics were chosen at random and identified with SEM pictures (Fig. 3)

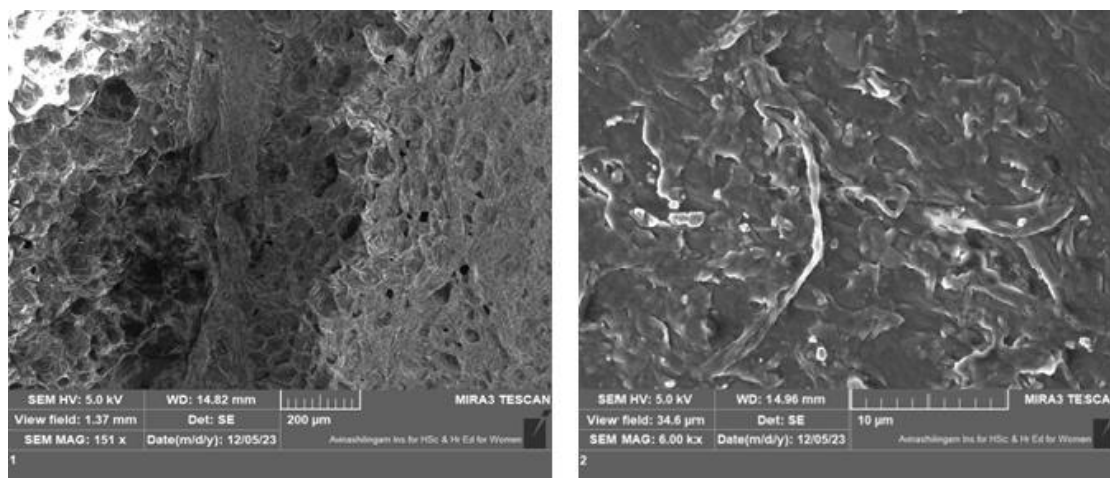


Fig 3: SEM of micro and mesoplastic samples collected from the sampling area.

Polyethylene (PE), polypropylene (PP), polyamide (PA), and polyester (PET) were the key constituents of the chosen

microplastics (Fig. 4). PE dominated in our sampling locations, which has consistent with past environmental

studies conducted in diverse aquatic contexts and could be attributed to the widespread use as a packaging material

(Frere *et al.*, 2017; Plastics Europe, 2016).

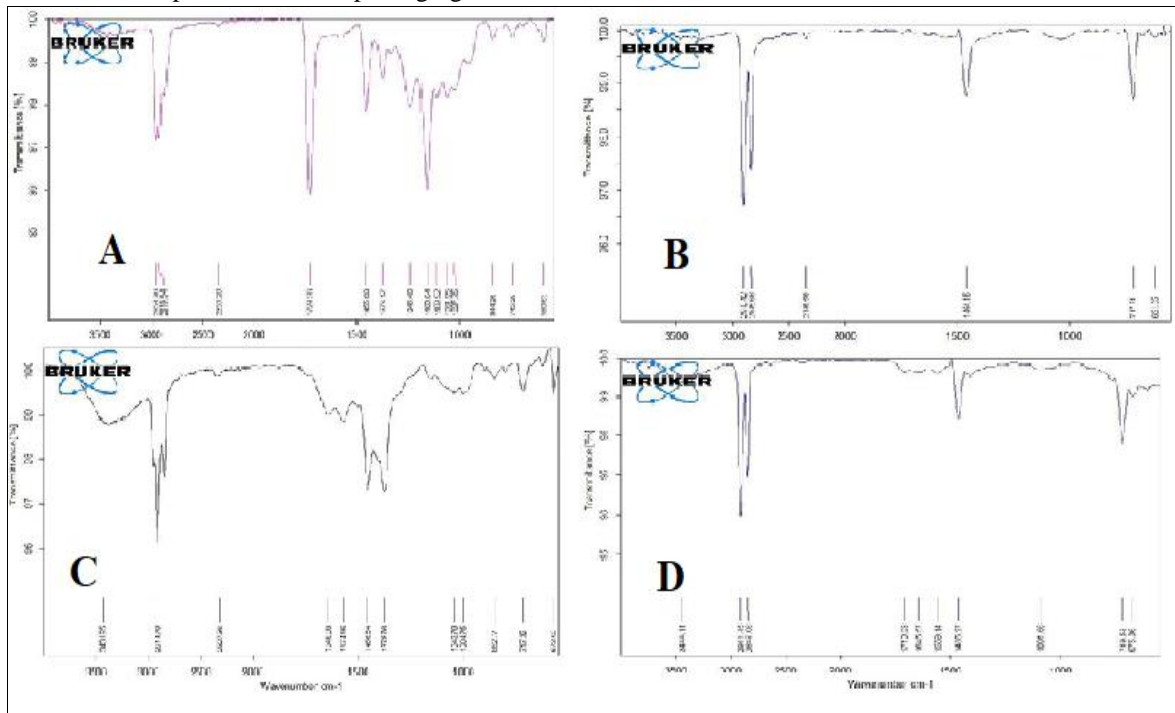


Fig 4: FTIR images of micro and mesoplastics extracted from the fish samples collected from all the sampling locations (A) Polyethylene, (B) Polypropylene, (C) Polyamide and (D) Polyester.

The presence of sizable amounts of PA and PE fibers in the intestines of commercial fish suggests that plastic additives with a high potential for toxicity are being leached and are accumulated in the environment. Due to the presence of PA, it was possible to confirm that intensive fishing operations and massive depositions of nylon from fishing nets could have influenced the findings. Fish play a crucial role in the

food chain. If people eat commercial fish that has been polluted, MPs would probably accumulate in their bodies. The health of the population would be affected by this. It is crucial to employ a common and commercial fish as a monitoring organism for the contamination of fish MPs. MPs contamination in processed fish meals is not attended to.

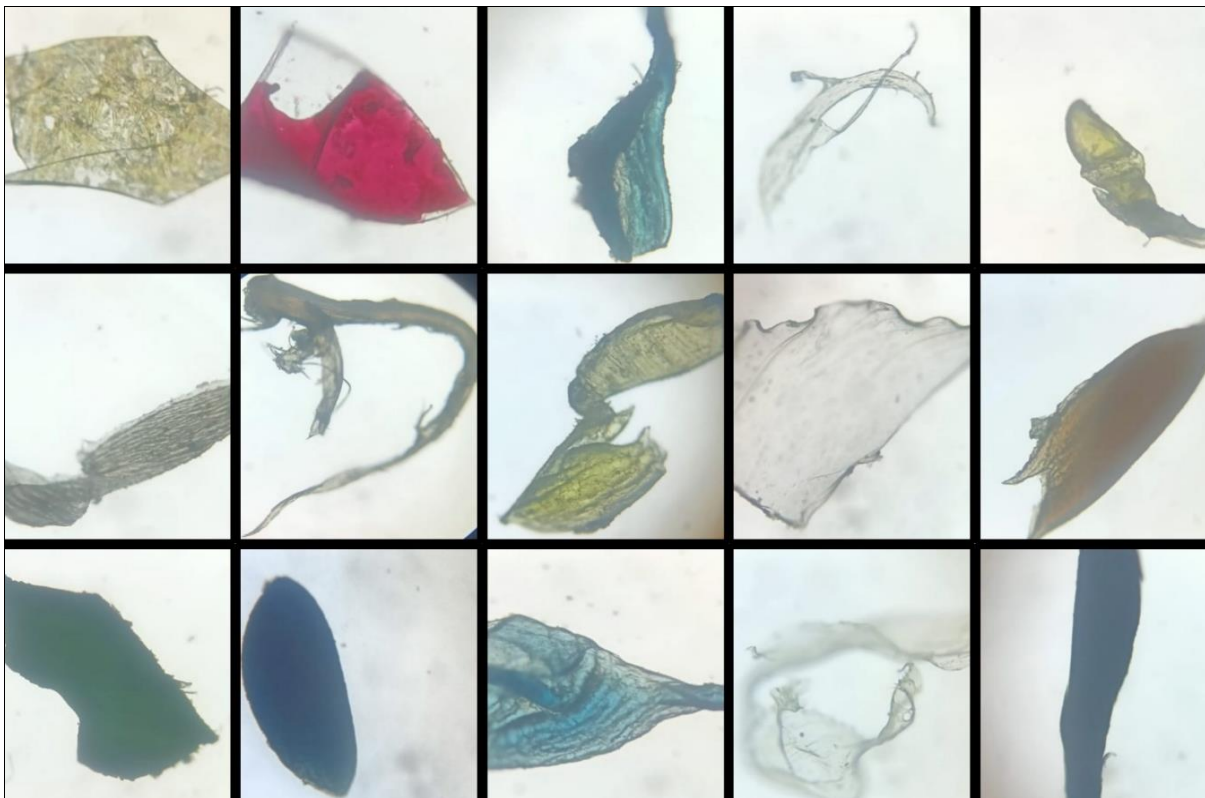


Fig 5: Picture showing the various forms of microplastics found in fish samples taken from each of the three lakes.

Rapid action would require to prevent MPs contamination in watershed areas because the fish species indicated here are edible and more readily available for customers. In order to help the government create rules to address the pollution by MPs in commercial fish in the near future, this study presents the basic information on the potential dangers to food safety posed by MPs pollution in commercial fish. The current study reveals that there is accumulation of MPs in fish population in all the three lakes. The Korattur lake is more contaminated than the other two lakes, and has been widely documented.

Conclusion

The commercial fish examined from the lakes of Ambattur, Korattur, and Madhavaram were found to have MPs, as this study has revealed. The abundance of MP in relation to fish habitat and eating habits was also examined in this study. Microscopic MPs (0.5 mm), transparent MPs, and fragments with fragments and films accounting for 40 and 31 of the total MPs, respectively, were the three types of MPs that were most prevalent in these fish. The majority of fish species obtained from the three sampling locations had greater MP levels, and all the samples showed an excess of secondary MPs. FTIR measurements led to the discovery of four main polymer kinds, with PE being the most common. This discovery thus adds to the pervasive plastic particle pollution of lakes, which is harmful to the freshwater biota. Adopting efficient management techniques is necessary to stop MP from ever entering freshwater habitats. In order to more precisely determine the danger to human health, future studies should compare the MP contamination in the biota. It is necessary to regulate or avoid the buildup of MPs in aquatic environments by taking into account the health of aquatic creatures.

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