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Microplastics in the edible and inedible tissues of *Mugil cephalus* from Ashtamudi Lake, a Ramsar site in Kollam, Kerala, India

Gayathry S.[1], Pathissery John Sarlin[1*], Jeniffer Ann Thomas[1], Ashly Augustine[1], Darshitha S.[1] and Sancia Morris[2]

[1*] PG and Research Department of Zoology, Fatima Mata National College (Autonomous), University of Kerala, Kollam, India.
[2]Institute of Chemical Technology Mumbai, IOC Bhuvneshwar Odisha, India.

ABSTRACT

Microplastics are considered as an emerging global issue due to its detrimental effects on natural ecosystem. These microplastics have ill-effects on aquatic biota and possible hazards to human health. Contamination of fish by microplastics is a major hazard that requires special focus. We examined the presence of Microplastics in edible and inedible tissues of *Mugil cephalus* (Mullet) from Ashtamudi Lake, a RAMSAR site. 53.33% of the sampled 60 fishes had ingested plastic particles. The average abundance of microplastics was 0.08 ± 0.009 and 0.31 ± 0.016 items/fish respectively in the edible and inedible tissues. The most commonly found MPs were fibre (70.83%). Red and black coloured microplastics were the most commonly ingested particle. Fourier Transform Infra-Red spectroscopy characterisations of the debris revealed, polyethylene as the most abundant polymer type in both edible and inedible tissue. The results point to the possibility of small-scale human ingestion of microplastics through the consumption of filter feeders from this lake.

Key words: *Microplastics, FT-IR, Ingestion, Mullet, Polyethylene, Polypropylene.*

Introduction

Microplastics are plastic particles less than 5mm in size (Thompson, 2004) that are ubiquitously found in aquatic and terrestrial systems.They have been reported worldwide in marine (Browne *et al*., 2011; Van Cauwenberghe *et al*., 2013), as well as in freshwater environment (Dris *et al*., 2015; Zhang *et al*., 2016; Wang *et al*., 2017; Sruthy and Ramasamy 2017). Since microplastics are similar in size to plankton, they are easily misinterpreted by aquatic animals and are accumulated in wide range of marine organisms (Lusher *et al*., 2013; Jabeen *et al*., 2017). When ingested by animals, plastic provides a feasible pathway for the transfer of attached pollutants and additive chemicals into their tissues (Teuten *et al*., 2009; Rochman *et al*., 2013) at concentrations sufficient to disrupt ecophysiological functions linked to health and biodiversity (Browne *et al*., 2013).

Microplastic particles were found in many aquatic biotas, such as fishes, mussels, oysters, zooplanktons, shrimps, crabs, jellyfishes etc. (Avio *et al*., 2015; Santana *et al*., 2016; Scherer *et al*., 2017; Nelms *et al*., 2018; Zhang *et al*., 2020; Wang *et al*., 2021). Fishes are continuously exposed to the microplastics present in water, soil and sediments. Recently studies on the ingestion of microplastics by fishes in marine and freshwater regions have been reported in various parts of the country (Kumar *et* *al*., 2018; Naidu *et al*., 2018; Daniel *et al*., 2020; Devi S.S 2020; Nikki *et al*., 2021).

Ashtamudi Lake (Ramsar site No. 1204), the second largest wetland ecosystems of Kerala, is a brackish water lake in Kollam district, located between $8^0 50'$ N to $9^0 5'$ N and $76^0 30'$ E to $76^0 40'$ E. It has been negatively harmed by the uncontrolled dumping of solid waste and sewage from homes and business firms. Mullets are caught along the sea coast, in the lagoons and the adjoining brackish-water lakes, and in the estuaries. As they are caught almost throughout the year, they are a valuable source of food-fish during the off-season of the other commercial fisheries (Luther, G 1973). Ashtamudi Lake contributes to the grey mullet fishery resources of India throughout the year. Naidoo *et al* 2016 used *Mugil cephalus* as a sentinel species to investigate the ingestion of plastics in the heavily industrialised Durban Harbour. Considering the importance, in the present study, an attempt has been made to investigate the presence of microplastics in the edible and inedible parts of the *Mugil cephalus* from Ashtamudi Lake and to characterize the detected micro plastics.

Materials and Methods

Mullet samples (n= 60) were collected in iceboxes, from the local fisherman at various landing sites of Ashtamudi lake from December 2021 to June 2022 and transported to the laboratory. The fishes were dissected, gut contents (non-edible) and edible muscular component were separated for microplastic analysis while following the standard protocol (Avio *et al*., 2015). Microplastic extraction was done by wet peroxidation method according to the protocol of Li *et al*., (2016). After the complete digestion of tissues, density separation of plastics particles by saline (NaCl) solution, as suggested by Jabeen *et al.*, (2017) was employed. Glass microfiber filter paper was used for filtration. After filtration, the filters were examined under stereomicroscope (SZ1145, Olympus), and plastic particles were observed, visually sorted and categorized based on the physical features stated by Hidalgo-Ruz *et al*., (2012). The size, shape and colours of the identified plastics were recorded. Identified plastics items with various physical features were randomly sampled and tested by a Fourier transform Infra-Red (FT-IR) spectrometer instrumentation supported by CLIF, University of Kerala.

Results and Discussion

About 32(53.33%) individuals of the collected samples were found to ingest microplastics. Out of the 60 fishes examined, microplastics were found in 79.17% of the inedible part while the edible part contains 20.83%. The average abundance of microplastics in edible tissue was 0.08±0.009 item/fish and in inedible part 0.31±0.016 item/fish. (Figure 1). The occurrence of microplastic ingestion found in this study is similar to the studies done in mullets from Durban Harbour KwaZulu-Natal; South Africa (73% with a mean of 3.8 particles per fish *Mugil cephalus* in (SD 4.7) (Naidoo *et al*., 2016) and from the eastern coast of Hong Kong (60% of grey mullets with a mean 4.3 items per mullet) (Cheung *et al*., 2018). In the present study, the results suggest that microplastics in the inedible tissues were approximately four times that of microplastics present in the edible tissues.

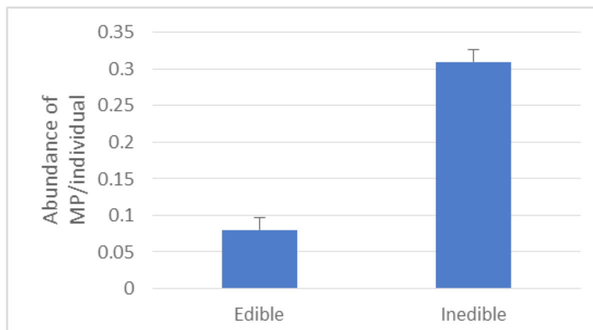

Fig. 1. Abundance of microplastics (Mean ± SE) in edible and inedible tissue of *M.cephalus* (Items/individual).

Three different morphotypes of microplastics were found, in which the most common one is fibre followed by fragment and pellet. Edible part contained 60% fibres and inedible part contained 73.68% fibres and 21.05% fragments were found in inedible tissue, and 20% pellets in both edible and inedible tissue, were observed in sampled individuals of Mullet. According to Jabeen *et al.*, 2017, fibres were the most abundant (50%), followed by fragment (18.8%), and pellet (1%). Fibres were the most common morphotypes of plastics in the present study, which is similar to the results reported in previous studies (Lusher *et al*., 2013; Nadal *et al*., 2016; Naidoo, 2016; Jabeen *et al*., 2017). Mullets are a polychaeta-preying species; it is possible for them to mistake fibres for polychaetas (Bellas *et al.*, 2016).

Microplastics of four different colours – red (62.5%), blue (4.16%), black (20.83%), and colourless (12.5%) were observed in both edible and inedible tissues. Most of the particles were red colored (63.15% in inedible and 60% in edible tissue). Blue coloured particle was only found in inedible part (20%). The most common plastic items were fibres that were green in colour and small in size (Cheung *et al*., 2018). Dark-coloured plastic items were frequently identified in the digestive systems of mullet, as the sizes and colours of these plastic items were similar to those of plankton in the marine environment, it is possible that these fishes might have mistakenly ate them as food (Lusher *et al*., 2013).

All the 24 suspected microplastics were validated using FT - IR analysis. The polymer types identified using FTIR, include polyethylene and polypropylene. (Figure 2). From the 24 particles analysed, 18 were polyethylene and 6 were polypropylene. Tsang *et al*., (2017) claimed that, polypropylene and polyethylene constituted more than 60% of plastic production. PE and PP might be derived from the abrasion of fishing tools, since they are widely used in fishery activities around theworld. The possible sources of polypropylene include the widespread usage of polypropylene rope, which is used for the attachment and in predator exclusion netting. Polyethylene is common in plastic packaging materials, such as plastic bags and sheets. PE and PP are less dense polymers that will usually float on the surface of the water and are likely to be ingested by pelagic species (Lim *et al.*, 2022).

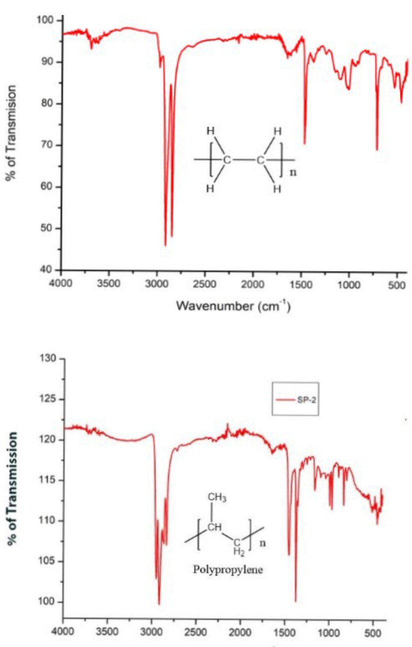

Fig. 2. FT-IR spectra of microplastics from *Mugilcephalus* (a) The FT- IR spectra of Polyethylene – characteristic peak located at 2914 cm^{-1}, 2847 cm^{-1}, 1471cm^{-1} and 717cm^{-1} (b) The FT- IR spectra of Polypropylene- characteristic peak at 2950cm^{-1}, 2916cm^{-1}, 2867cm^{-1} 1375 and 1452 cm^{-1}

Conclusion

The present study provides the evidences for the first time, of microplastic contamination of grey mullet *Mugil cephalus,* in Ashtamudi Lake. We have detected the presence of microplastics in edible and inedible parts of the fish from Ashtamudi Lake; FTIR analysis has revealed Polyethylene and Polypropylene as the prominent microplastic debris in the fishes. The results suggest that microplastics in the inedible tissues were approximately four times that of microplastics present in the edible tissues. No significant correlation was obtained between the length and weight of the fish and the number of MPs.

This lake serves as the centre of livelihood of thousands of marginalized fisher folks and is a rich source of this invaluable delicacy. As the fishing resources from the Ashtamudi Lake are widely utilised by the local population, further study is needed to determine whether the fish is chemically contaminated. The additives in MPs and the adsorbent pollutants might affect human health when they consume these plastic ingested fish (Rochman *et al.*, 2015). Much detailed studies are needed to draw conclusions on how these MPs impact the biota of Ashtamudi brackishwater lake that is rich in fishery resources.

The study concludes that the presence of microplastics in the *Mugil cephalus* can be considered as an indication of the increasing microplastics pollution in Ashtamudi brackish water lake.

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Conflict of Interest

The authors declare no conflict of interest.

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