VOLUME 8 ISSUE 1 2022

ISSN 2454-3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 8, No. 1, 401-407 (2022)

International Journal of Zoological Investigations
Contents available at Journals Home Page: www.ijzi.net
Editor-in-Chief: Prof. Ajai Kumar Srivastav
Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

Identification and Characterization of Micro and Mesoplastics Isolated from Commercially Important Marine Fishes of Pulicat Lake, Tamil Nadu, India

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Received: 6th March, 2022; **Accepted:** 28th March, 2022; **Published online:** 8th April, 2022

https://doi.org/10.33745/ijzi.2022.v08i01.044

Abstract: The investigation of microplastics have been carried out among the commercially important marine fishes at Pulicat lake waters. The gastrointestinal tract of fishes were isolated and experimented for further analysis to detect the presence of microplastics. The fishes viz., *Nemipterus japonicus, Mugil cephalus, Scomberomorus guttatus, Terapon puta, Sardinella longiceps, Caranx ignobilis, Stolephorus indicus, Rastrelliger kanagurta, Eleuthronema tetradactylum, Alectis indica, Leiognathus* sp., *Trichiurus lepturus, Trachurus lathamni, Selaroides leptolepis* and *Terapon jarbua* were examined in this study. The microplastics samples were confirmed with Bruker-Alpha FTIR ATR spectrophotometer in order to confirm plastics functional groups. Out of the 16 plastic particles isolated, 8 particles were mesoplastics and the rest of them were microplastics. The FTIR-ATR peaks were confirmed C-H stretching and N- H stretching (polyamide), C-H stretching, O-H stretching or N-H stretching (poly lactic acid), CH group (polythene) and C-H stretching, C=O stretching and C-O stretching (polyester). The presence of microplastics in the fish from the sampling locations may be due to unmonitored dumping of wastes in the water. The presence of microplastics may affect the growth of fish which leads to poor commercial value. The future research should be aimed to evaluate the impact and the risk of microplastics to the fishes, environment as well as human beings and to create awareness among the people, as well as the fishermen.

Keywords: Microplastics, Mesoplastics, Marine fishes, Pulicat lake

Citation: Surya D., Ann Efgin, Thirunavukkarasu N. and Nesakumari C. Sheeba Anitha: Identification and characterization of micro and mesoplastics isolated from commercially important marine fishes of Pulicat lake, Tamil Nadu, India. Intern. J. Zool. Invest. 8(1): 401-407, 2022.
https://doi.org/10.33745/ijzi.2022.v08i01.044

Introduction

Marine pollution changes the physical, chemical and biological characteristics of the oceans, coastal zones and potentially threatens marine organisms, ecosystems and biodiversity which affect the quality and productivity of marine ecosystems. The main contaminants of the ocean include toxic chemicals (e.g., organic compounds, DDT, PCB, metals, pharmaceuticals and gas), solid waste (e.g., plastics and microplastics), increased nutrient (e.g., nitrates and phosphates) and sediment inputs due to human activities (e.g., industry, agriculture, deforestation, sewage discharge and

aquaculture), radioactivity, oil spills and discarded fishing nets. Out of this the plastics and the microplastics form the majority of the pollutants and pose several threats to the organisms living in the ecosystem.

Plastic is a catch-all term used to describe a range of polymer materials that are moulded under specific temperature and pressure and have different properties depending on the requirements of the end-product. Concurrently, improper disposal, accidental loss, and fragmentation of plastic materials have led to an increase in tiny plastic particles and fibres polluting the environment (Cole *et al*., 2011). At least 8 million tons of plastic end up in our oceans every year. Floating plastic debris are currently the most abundant items of marine litter. Waste plastic makes up 80% of all marine debris from surface waters to deep-sea sediments. The present study aimed to investigate the microplastics in the marine fishes at Pulicat lake waters.

Materials and Methods

Pulicat beach is located in Pulicat town, a Chennai suburb in Thiruvallur district of Tamil Nadu, India. This beach was formed by the confluence of backwaters, Pulicat lake and Buckingham canal (13º 25'11" N Latitude and 80º 16'06"E Longitude) were selected for fish sampling (Fig. 1).

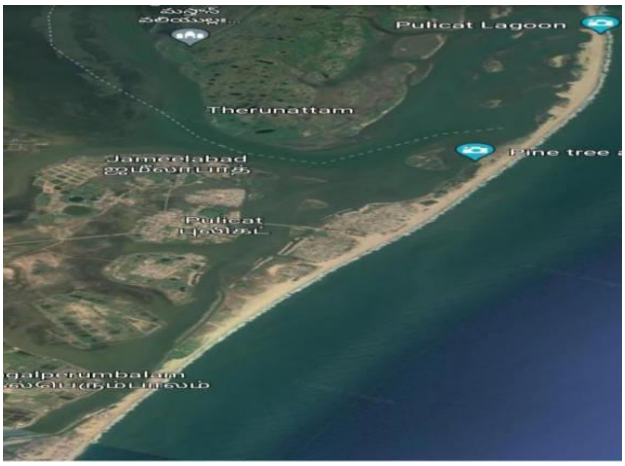


Fig. 1: Pulicat Lake.

A total of 345 fishes belonging to 21 commercially important species were collected from the Pulicat fish market. The collected fishes were identified by FAO identification keys. The gastro-intestinal (GI) tracts of fishes were isolated and kept in separate sterilised zip lock covers and stored at -20 C. The GI tracts of the fishes were thawed and brought to room temperature. The tracts were cut open and examined under a dissection microscope. Particles which do not resemble natural prey were collected and kept for further analysis. The tracts and other organs were homogenized with the help of an autoclaved mortar and pestle. For digesting the rest of the organic material, Alkaline digestion were followed. In the case of alkaline mode of digestion, methods proposed by Lusher *et al.* (2015), Karthik *et al.* (2018) and Kumar *et al.* (2018) were followed in which aqueous Potassium hydroxide is used.

The digested material was filtered through two sets of filters of mesh size 1mm and 125 µm, respectively using filtered tap water. The remnants of the digested material were checked for the presence of micro-plastics. Suspected particles were isolated and kept for further analysis. Once passing the primary confirmation test, the particles were isolated, photographed and its diameter was measured. Then the particles were classified based on its size and colour. Then the IR spectrum was recorded with the help of Bruker – Alpha FTIR ATR spectrophotometer in order to confirm polymer functional groups (Mirabella, 1993).

Results and Discussion

Plastic accumulation in the oceans has increased a lot in last century due to the increasing demand for plastics. There are reports regarding the occurrence, sources, physical effects, biological interactions, bioaccumulation and biomagni-fication (Lusher *et al.*, 2017). The occurrence of microplastics in aquatic organisms have been carried out by Lusher *et al*. (2015), Collard *et al.* (2017), Karthik *et al.* (2018) and Kumar *et al.* (2018).

Out of the 16 plastic particles isolated, 8 particles were mesoplastics and the rest of them were microplastics. The diameter of the plastics is

shown in Table 1. The IR spectrums of the isolated plastics were recorded with the help of Bruker FTIR-ATR Spectrophotometer. Based on the peaks formed the functional groups were identified with the help of standardcharacteristic IR frequencies. Depending upon the peaks formed, the functional groups of each and every plastic were identified.

Plastic fibre obtained from *Nemipterus japonicas, Stolephorus indicus, Sardinella longiceps, Terapon puta* and *Trachurus lathami* showed predominant peaks at wave numbers 2914, 3431, 1456 and 1378 cm^{-1}. Based on the standard absorption IR spectrum, there is C-H stretching and N- H stretching. Thus the functional groups are alkane andamine. Hence, the polymer is Polyamide (Fig. 2). Plastic obtained from *Nemipterus japonicas, Selaroides leptolepis, Alectis indica, Rastrelliger kanagurta* and *Terapon jarbua* showed predominant peaks at wave numbers 2911, 1574, 3378, 1377, 1012 and 716 cm^{-1}. Based on the standard absorption IR spectrum, there is C-H stretching, O-H stretching or N-H stretching. Thus, the functional groups are alkane and amine or hydroxyl group. Hence, the polymer may be Poly Lactic acid (Fig. 3).

Plastic obtained from *Mugil cephalus, Scomberomorrus guttatus* and *Leognathus* sp. Showed predominant peaks at wave numbers 2910, 2845, 1464 and 717cm^{-1}. Based on the standard absorption IR spectrum, there is C-H stretching. Thus, there is only CH group and there is only a single peak at 1464. Hence, the polymer is polythene (Fig. 4). Plastic obtained from *Trichurus lepturus, Eleutheronemate tradactylum* and *Caranx ignobilis* showed predominant peaks at wave numbers 2963, 1729, 1455, 1160 and 1376cm^{-1}. Based on the standard absorption IR spectrum, there is C-H stretching, C=O stretching and C-O stretching. Thus, the polymer is polyester (Fig. 5).

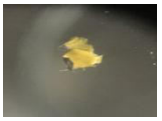
FT-IR analysis confirmed presence of polythene, polyester and polyamide in the fish intestine. The presence of polythene was determined through the appearance of characteristic wave numbers in the range from 1461 to 1400 cm^{-1} showing C-H bending and 2960–2926 cm^{-1} showing C-H stretching. The presence of polyamide was determined by the presence of a broad peak at 3400-3500 cm^{-1} which confirms N-H stretching and peaks at different ranges corresponding to C-H bending and C-H stretching. The presence of polyester was determined by the presence of a single predominant peak around 1730 which corresponds to C=O stretching and a peak at 1160 which corresponds to C-O stretching.

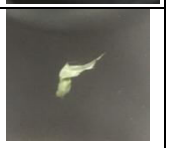
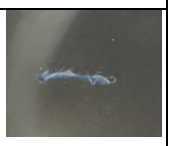
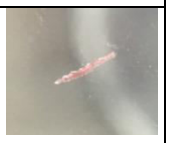
In the case of polymer obtained from *T. puta*, peaks were formed at 3371, 2915 and 1572 which indicated N-H stretching, C-H stretching and N-H bending, respectively. However, the peak formed at 1372, may be either S=O stretching or C-H bending. There is a high chance of this plastic to be polyamide. There was also a peak which corresponds to the presence of O-H group. In the case of polymer obtained from *R. kanagurta*, there were peaks corresponding to N- H stretching, O-H stretching, C-H stretching and C-H bending. There is a chance of this plastic to be poly lactic acid. But, confirmation can be done only after performing NMR spectroscopic analysis (Kumar *et al*., 2018).

Out of the 345 fishes sampled, microplastics were found only in 16 individuals. One reason may be due to the rapid gut evacuation in the fishes. Fishermen usually spend about three weeks in the sea, to collect as many fishes as possible. Gut evacuation occurs within hours after the death of the fish. Thus, in order to preserve the gut contents, fishes have to be put in ice, as soon as they are caught. Though the presence of microplastics in the fish gut is a matter of significant environmental pollution, the main concern is about its transfer to edible parts of the fishes. There are reports regarding the translocation of the microplastics from the GI tract to other parts in the fishes (Collard *et al.,* 2017).

In most of the places, fish sellers usually remove the digestive tract prior to selling, but in the case of dry fish, the entire fish is dried in the sun. In this case, these edible dry fishes were overlooked for the presence of plastics. Thus

Table 1: Plastics isolated from the GI tract of fishes

Species name	Colour	Collection site	Diameter (mm)	Image
Nemipterus japonicus	Yellow	Pulicat	3.5 (Micro) 4.4 (Micro)	 
Mugil cephalus	Black	Pulicat	4.7 (Micro)	
Scomberomorus guttatus	Transparent	Pulicat	3.3 (Micro)	
Terapon puta	Translucent	Pulicat	5.2 (Meso)	
Sardinella longiceps	Blue	Pulicat	7.1 (Meso)	
Caranx ignobilis	Transparent	Pulicat	3.6 (Micro)	
Stolephorus indicus	Transparent	Pulicat	2.1 (Micro)	
Rastrelliger kanagurta	Green	Pulicat	9.3 (Meso)	

Eleuthronema tetradactylum	Translucent	Pulicat	1.8 (Micro)	
Alectis indica	Translucent	Pulicat	6.2 (Meso)	
Leiognathus sp.	Yellow	Pulicat	9.1 (Meso)	
Trichiurus lepturus	Blue	Pulicat	7.6 (Meso)	
Trachurus lathami	Brown	Pulicat	5.4 (Meso)	
Selaroides leptolepis	Translucent	Pulicat	6.8 (Meso)	
Terapon jarbua	Translucent	Pulicat	2.1 (Micro)	

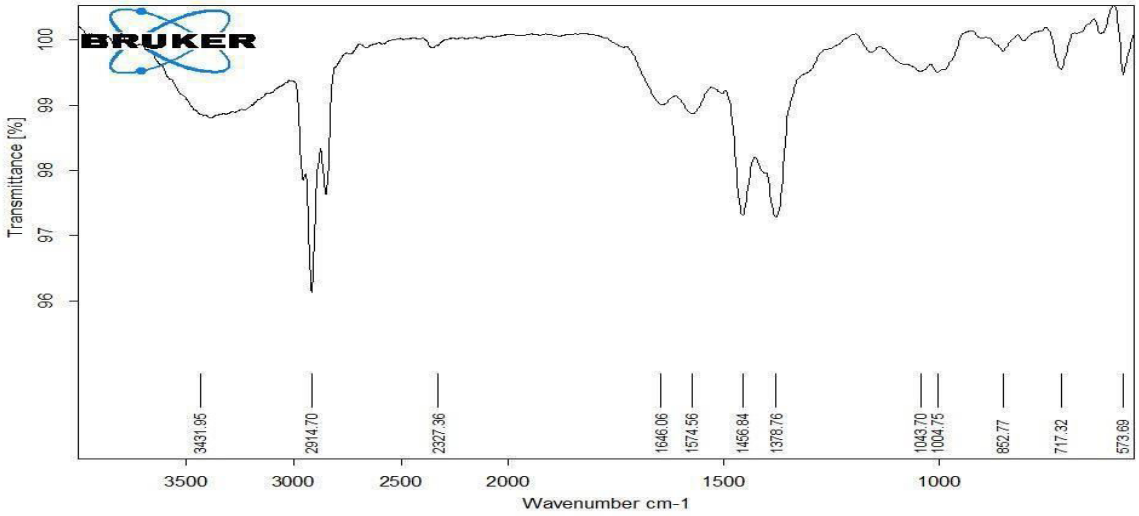


Fig. 2: Showing the FTIR – ATR of polyamide.

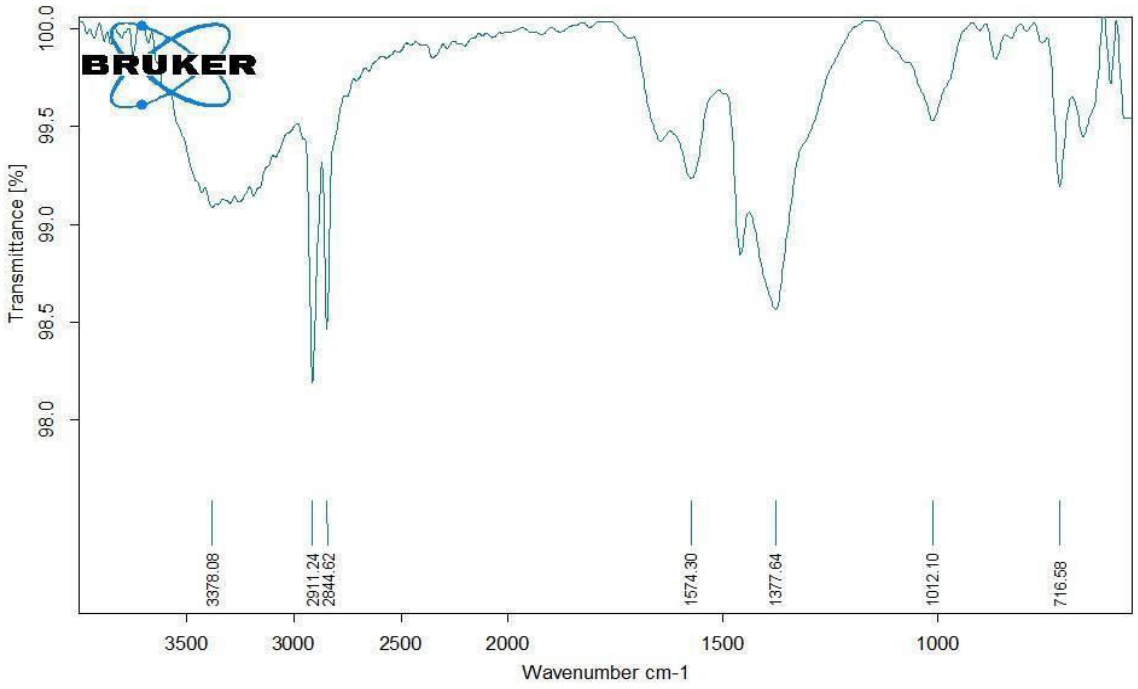


Fig. 3: Showing the FTIR – ATR of poly lactic acid.

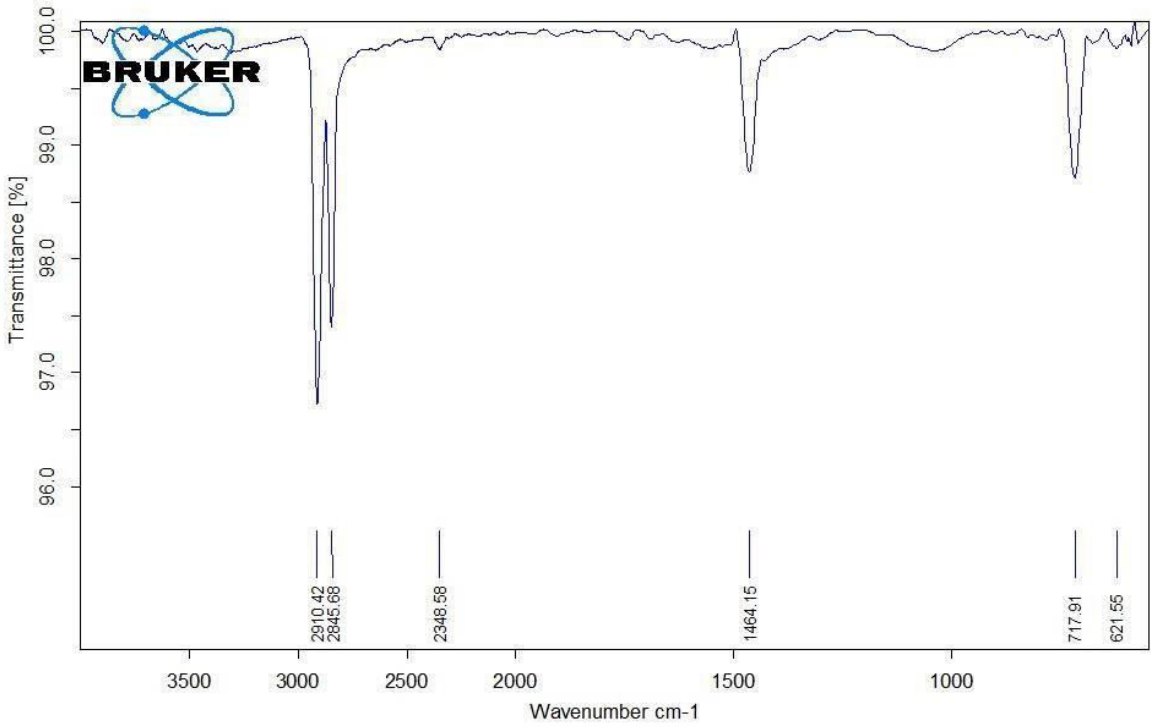


Fig. 4: Showing the FTIR – ATR of polythene.

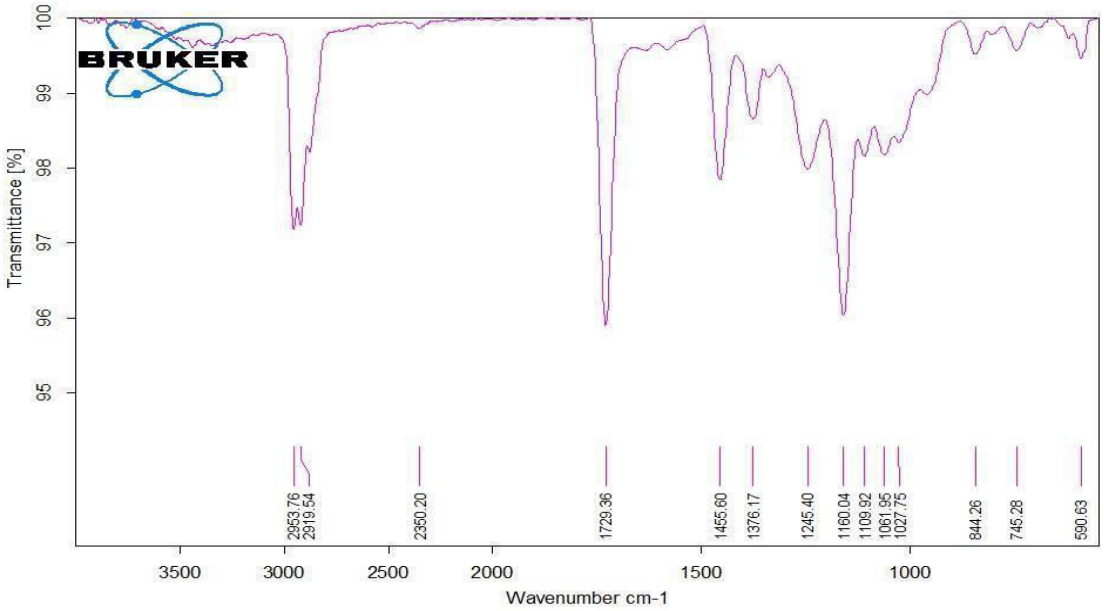


Fig. 5: Showing the FTIR – ATR of polyester.

awareness should be created about the presence of plastics in fishes to the fishermen and fish sellers. Fishes must be cleaned properly prior to selling otherwise plastics may also enter the human body. This study was primarily aimed at detecting microplastics and raising attention to the issue of the rising plastic pollution in Pulicat of Tamil Nadu coast. The future research should be aimed to evaluate the impact and the risk of microplastics to the fishes, environment as well as human beings and to create awareness among the people, as well as the fishermen.

Acknowledgements

The authors are thankful to Authorities of Madras Christian College (Autonomous), Tambaram, Chennai for providing necessary facilities.

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