Bioaccumulation of microplastic fibres in the gut of Sardinella longiceps (Valenciennes, 1847) collected from Sassoon dock, west coast of Maharashtra.

[1]Priti Singh, [2]Dr. Leena Muralidharan

Dept. of Zoology, Ramniranjan Jhunjhunwala College,
Mumbai 400086. Maharashtra, (India).

Abstract - **Due to anthropogenic activities the marine environment is disturbed and so the organisms living in that habitat. One of the most critical and persistent pollution nowadays is plastic pollution in aquatic ecosystem. Plastic being flexible, durable and inexpensive to produce, utilization of it has become unavoidable which led us in "plastic cage". Present study was conducted to investigate presence of microplastic fibre in the gut of the Sardinella longiceps collected from Sassoon dock, Mumbai. Stereomicroscopy was done for screening and visual inspection of different microplastic fibre from completely digested gut tissue. Identification of found microplastic fibres were done using ATR-FTIR method. Present study provides evidence of presence of microplastic fibres in the gut of the said fish polymers found were polyamide (PA), polyethylene (PE), polypropylene (PP), Polystyrene (PS), & Polycaprolactum (PA-6). Polyamide was found more in number than other type of polymer in gut tissue of studied fish.**

Keywords: **Microplastic, Sardinella longiceps, Sassoon dock, FTIR.**

1. INTRODUCTION

Microplastic pollution is increasing globally and it is one of the great concern today. Plastic being ubiquitous in nature its quantity is enormously growing in environment of marine ecosystem (Ganesan, M, et al,2 019; Gao, F et al,2019; Barnes, D. K. A et al,2009). Anthropogenic activities as industrial effluents, disposal of waste, domestic waste all these leads microplastic entry in the marine ecosystem (Liu et al. 2021; Sutton et al. 2016). Particles varying in size from 0.1 to 5000 μm comes under microplastic category (Alexander et al., 2016). These plastic waste in the environment all together form plastic litter in the environment (Katare et al., 2022). With respect to surface mass area ratio, microplastics may be present in many forms as fragments, pellets, fibres, films or granules (Koelmans et al. 2019). Fish have shown presence of microplastic collected from fresh water as well as marine or estuarine water or even if bought from local markets (Rochman et al. 2015; Wootton et al. 2021b; Wu et al. 2020).

Sardinella longiceps is a pelagic clupeid, commercially valuable fish which is found globally. Sardinella longiceps fish is rich in lipid content (Priti Singh & Leena Muralidharan.,2022). Being most natural and traditional food item, fish is consumed all over the world in all communities. Fish is found to have most protein and other essential vitamins and minerals which is required for better growth and development of living organisms (Kumar et al.,2020). Fish rich diet can reduce the risk of cardiovascular disease (Raatz S.K.,et al, 2013; Torris C, et al 2018).Present study is undertaken to investigate presence of microplastic fibre in the gut of Sardinella longiceps which is collected from Mumbai's one of the famous dock, Sassoon dock.

2. MATERIALS AND METHOD:

Figure 1. Arial view of Sassoon dock on Indias map (Google pic.)

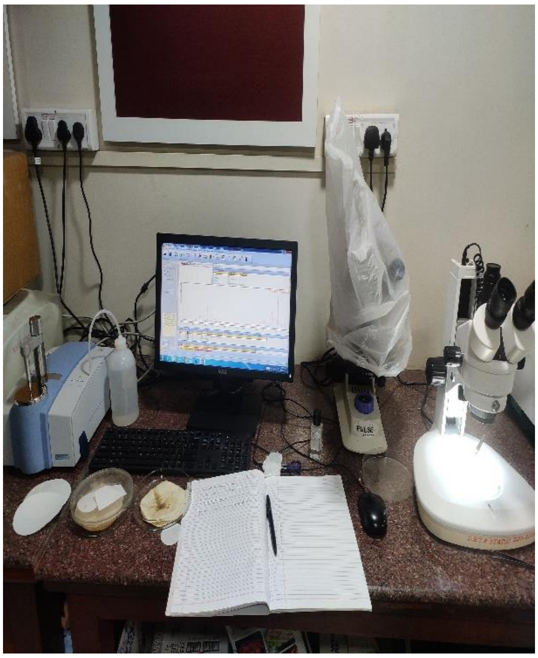

Figure 2. Experimental setup of ATR-FTIR

2.1 Sample collection

Fresh fish samples of Sardinella longiceps (Valeciennes, 1847) were collected from the sampling site, Sassoon dock, Mumbai (Fig. 1). With the help of local fisherman fishes of 18-21 cm in length and 75 to 95 gms in weight were taken and kept in ice box transported to the lab for microplastic examination. Sassoon dock is one of the famous dock in Mumbai which is located between latitude 18°54'37.692" N and longitude 72°49'2.172"E from where fresh fishes and other sea food items are exported in all part of Mumbai and to other part of world.

2.2 Extraction of microplastic

Fishes were dissected in sterile condition taking care to avoid any false reading. Gut of the fish were removed carefully after dissection and digested completely with the help of 10% KOH solution (Rochman,C., et al. 2015). Tissue to chemical solution volume was kept 1:3 and it is kept at 60 °C overnight for effective digestion. After complete digestion tissue filtrate is filtered on whatman filter paper with pore size of 11 micron meter and it was oven dried. After complete digestion of organic and inorganic material the filter paper is inspected in stereomicroscope for microplastic morphology and characteristic feature. The microplastic fibre found on stereomicroscope is then analysed on ATR-FTIR (Fig.2) and with the help of inbuilt library type of microplastic fibres were identified.

2.3 Contamination control

To minimize false positive result from airborne plastic, the whole experiment was done under sterile condition wearing 100% cotton lab coat, nitrile gloves cleaning surface area with 70 % alocohol and taking precautionary measures. All glassware in used was wash with distilled water and oven dried prior to use every time.

3. RESULT AND DISCUSSION:

Present work showed varying size, shape and colour of microplastic fibre in the gut of Sardinella longiceps. The size of microplastic found was 0.1 mm to 2.5 mm. It has been found that most frequent size found in marine organism is 100-1000 micronmeter (Rochman et al., 2015; Vendel et al., 2017; Pazos et al., 2017; Barboza et al., 2020; Bessa et al., 2018; Abbasi et al., 2018). Shape found in our research varied from slender body to comma shape to curve of different angle. The different shape of microplastic fibre may be due to rejection capacity of body tissue to expel it out. The impact of microplastic to the biological system is affected by the varying size of microplastic (Hamed et al., 2022). In our study we found polyamide(PA), polyethylene(PE), polypropylene(PP), Polystyrene(PS), & Polycaprolactum (PA-6) as microplastic fibre under ATR-FTIR spectroscopy.

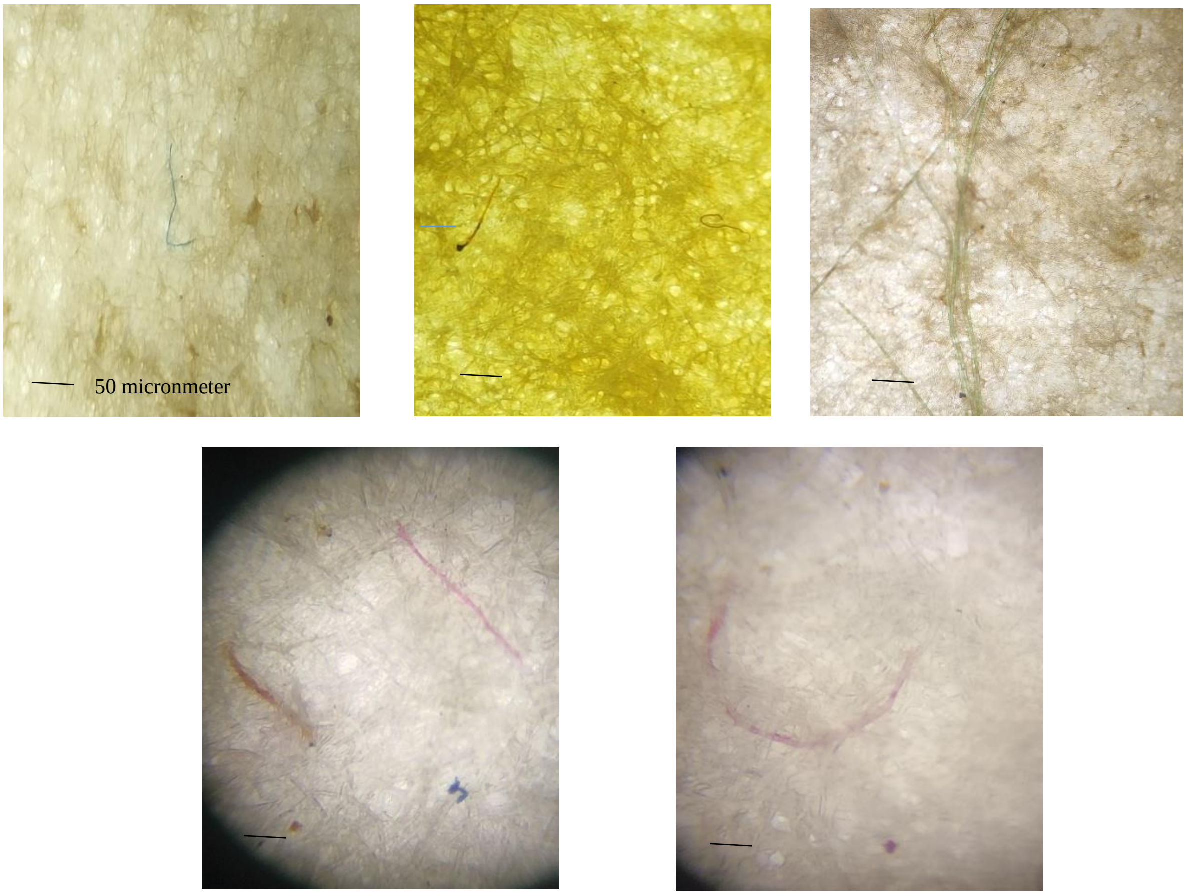

Figure 3. Colourful microplastic fibre from gut of Sardinella longiceps under optical microscope.Bar length represents 50 µm length.

Figure 4. ATR-FTIR library indicating presence of polyamide microplastic in the gut sample of said fish

Polyamide was found more frequently (Fig.4). Our findings of microplastic fibre is in concordance with earlier studies as they also got polystyrene, polypropylene, and polyethylene from gut of their studied organism (Kezia James et al.,2022; Mohammad Javad Nematollahi et al.,2021; Cassola et al., 2019). Blue, green, red, yellow, brown, black colour of different fibre were present in studied fish (Fig.3). It has been shown in studies that blue and black colours are more frequently present in marine organisms (Morgana et al., 2018; Wieczorek et al., 2018; de Vries et al., 2020). Microplastic fibre has high specific surface area and it has prevalence in sludge and agricultural soil due to this it is one of the important category of microplastic (H. Frost et al.,2022).

4. CONCLUSION:

The present study showed bioaccumulation of microplastic fibre in the gut of commonly edible commercial fish sardinella longiceps collected from Sassoon dock, Mumbai. Microplastic found more frequently were blue and red in colour and size was 0.1mm-2.5

mm. The shape and size of polymer found was not similar in each fish and capacity of ingestion of microplastic fibre also varies. Our study will add evidence on microplastic ingestion in experimental fish suggesting urge of plastic waste management for betterment of our future as plastic ingestion could be potentially hazardous to living organisms. This work is done to add on data to fill the gap of plastic knowledge in marine environment. The knowledge gap in plastics is available to plastics researchers.

5. ACKNOWLEDGEMENT:
We are greatful to our principal Dr.Himanshu Dawda sir for providing ATR-FTIR laboratory facility and motivating us throughout the experimental period.

REFERENCES:

1. Abbasi, S., Soltani, N., Keshavarzi, B., Moore, F., Turner, A., Hassanaghaei, M., (2018). Microplastics in different tissues of fish and prawn from the Musa Estuary, Persian Gulf. Chemosphere 205, 80–87.
2. Alexander, J., Barregard, L., Bignami, M., Ceccatelli, S., Cottrill, B., Dinovi, M., Edler, L.,Grasl-Kraupp, B., Hogstrand, C., Hoogenboom, L., Knutsen, H.K., Nebbia, C.S.,Oswald, I., Petersen, A., Rogiers, V.M., Rose, M., Roudot, A.-C., Schwerdtle, T.,Vleminckx, C., Vollmer, G., Wallace, H., Chain, E.P.C.F., (2016). Presence of micro-plastics and nanoplastics in food, with particular focus on seafood. EFSA J. 14.
3. Barboza, L.G.A., Lopes, C., Oliveira, P., Bessa, F., Otero, V., Henriques, B., Raimundo, J., Caetano, M., Vale, C., Guilhermino, L., (2020). Microplastics in wild fish from North East Atlantic Ocean and its potential for causing neurotoxic effects, lipid oxidative damage, and human health risks associated with ingestion exposure. Sci. Total Environ. 717, 134625.
4. Barnes, D. K. A., Galgani, F., Thompson, R. C., and Barlaz, M., (2009). Accumulation and fragmentation of plastic debris in global environments. Philos. Trans. R. Soc. B Biol. Sci. 364, 1985–1998.
5. Bessa, F., Barría, P., Neto, J.M., Frias, J.P., Otero, V., Sobral, P., Marques, J.C., (2018). Occurrence of microplastics in commercial fish from a natural estuarine environment. Mar. Pollut. Bull. 128, 575–584.
6. Besseling ,E., Foekema,E.M., Van Franeker, J.A., Leopold, M.F., Kuhn, S., Bravo Rebolledo, E.L., Hesse, E., Mielke, L., Ijzer,J., Kamminga, P., Koelmans, A.A., (2015). Microplastic in a macro filter feeder: Humpback whale Megaptera novaeangliae. Mar Pollut Bull 95:248–252.
7. Cassola, E., Zadjelovic, C, Gibson, V, Christie-Oleza, M, Joseph., (2019). Distribution of plastic polymer types in the marine environment; a meta-analysis. J. Hazard. Mater. 369, 691–698.
8. De Vries, A.N., Govoni, D., Arnason, ´ S.H., Carlsson, P., (2020). Microplastic ingestion by fish: body size, condition factor and gut fullness are not related to the amount of plastics consumed. Mar. Pollut. Bull. 151, 110827.
9. Ganesan, M., Nallathambi, G., Srinivasalu, S.,(2019). Fate and transport of microplastics from water sources. Current Sci. 117 (11), 1879–1885.
10. Gao, F., Li, J., Sun, C., Zhang, L., Jiang, F., Cao, W., Zheng, L., (2019). Study on the capability and characteristics of heavy metals enriched on microplastics in marine environment. Mar. Pollut. Bull. 144, 61–67.
11. H. Frost., T. Bond., T. Sizmur., M. Felipe-Sotelo., (2022). A review of microplastic fibres: generation, transport, and vectors for metal(loid)s in terrestrial environments : Environ. Sci.: Processes Impacts, 2022, 24, 504.
12. Hamed, M., Monteiro, C.E., Sayed, A.E.-D.H., (2022). Investigation of the impact caused by different sizes of polyethylene plastics (nano, micro, and macro) in common carp juveniles, Cyprinus carpio L., using multi-biomarkers. Sci. Total Environ. 803, 149921.
13. Katare, Y., Singh, P., Sankhla, M.S., Singhal, M., Jadhav, E.B., Parihar, K., Nikalje, B.T., Trpathi, A., Bhardwaj, L., (2022). Microplastics in aquatic environments: sources, ecotoxicity, detection & remediation. Biointerface Res. Appl. Chem. 12, 3407–3428.
14. Keziya James., Kripa Vasanta ., Shelton Paduaa ., Vineetha Gopinatha. , Abilash K.S., Jeyabaskaran R. , Akhil Babua , Seban Johna.,(2020). An assessment of microplastics in the ecosystem and selected commercially important fishes off Kochi, south eastern Arabian Sea, India. Marine Pollution Bulletin, Volume 154,111027.
15. Koelmans AA, Nor NHM, Hermsen E, Kooi M, Mintenig SM, De France J (2019) Microplastics in freshwaters and 123 198 Rev Environ Sci Biotechnol (2022). drinking water: Critical review and assessment of data quality. Water Res 155:410–422. 21:169–203.
16. Kumar A, Bajpeyee AK, Yadav CB. (2020). Effects of Dietary vitamin-C on Biochemical and Morphometric parameters of Labeorohita. International Journal of Biological Innovations. 2(2):174-177.
17. Lund E.K., (2013). Health benefits of seafood; Is it just the fatty acids? Food Chem 140, 413–420.
18. Liu Q., Li L., Zhao X., Song K., (2021) An evaluation of the effects of nanoplastics on the removal of activated-sludge nutrients and production of short chain fatty acid. Process Saf Environ Prot 148:1070–107.
19. Mohammad Javad Nematollahi. , Behnam Keshavarzi a. , Farid Moore . , Hamid Reza Esmaeili ., Hassan Nasrollahzadeh Saravi . , Armin Sorooshian .,(2021). Microplastic fibers in the gut of highly consumed fish species from the southern Caspian Sea. Marine Pollution Bulletin 168 112461
20. Morgana, S., Ghigliotti, L., Est´evez-Calvar, N., Stifanese, R., Wieckzorek, A., Doyle, T., Christiansen, J.S., Faimali, M., Garaventa, F., (2018). Microplastics in the Arctic: a case study with sub-surface water and fish samples off Northeast Greenland. Environ. Pollut. 242, 1078–1086.
21. Pazos, R.S., Maiztegui, T., Colautti, D.C., Paracampo, A.H., Gomez, N., (2017). Microplastics in gut contents of coastal freshwater fish from Rio de la Plata estuary. Mar. Pollut. Bull. 122, 85e90

22. Priti Singh & Leena Muralidharan (2022). Proximate Analysis of Sardinella Longiceps (Valenciennes,1847) Collected From Sassoon Dock West Coast of Maharashtra,India. IJSART 8(7) 505-508.
23. Raatz S.K., Silverstein JT, Jahns L, et al. (2013) Issues of fish consumption for cardiovascular disease risk reduction. Nutrients 5, 1081–1097.
24. Rochman C.M., Tahir A., Williams S.L., Baxa D.V., Lam R., Miller J.T., Teh F.C., Werorilangi S., Teh S.J., (2015) Anthropogenic debris in seafood: plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Sci Rep 5:14340.
25. Sutton R., Mason S.A., Stanek S.K., Willis-Norton E., Wren I.F., Box C., (2016). Microplastic contamination in the San Francisco Bay, California, USA. Mar Pollut Bull 109(1):230–235.
26. Torris C, Smastuen MC., Molin M (2018). Nutrients in fish and possible associations with cardiovascular disease risk factors in metabolic syndrome. Nutrients 10, 952.
27. Vendel, A.L., Bessa, F., Alves, V.E.N., Amorim, A.L.A., Patrício, J., Palma, A.R.T., (2017). Widespread microplastic ingestion by fish assemblages in tropical estuaries subjected to anthropogenic pressures. Mar. Pollut. Bull. 117 (1–2), 448–455.
28. Wieczorek, A.M., Morrison, L., Croot, P.L., Allcock, A.L., MacLoughlin, E., Savard, O., Brownlow, H., Doyle, T.K.,(2018). Frequency of microplastics in mesopelagic fishes from the Northwest Atlantic. Front. Mar. Sci. 5, 1–9.
29. Wootton, N., Ferreira, M., Reis-Santos, P., Gillanders, B.M., (2021b). A comparison of microplastic in fish from Australia and Fiji. Front Mar Sci.690991.
30. Wu, F, Wang, Y, Leung, J.Y.S., Huang, W., Zeng, J., Tang, Y., Chen, J., Shi ,A., Yu, X., Xu ,X., Zhang ,H., Cao, L., (2020) .Accumulation of microplastics in typical commercial aquatic species: a case study at a productive aquaculture site in China. Sci Total Environ. 135432.