

Investigation of Presence of Microplastics in Commercially Edible Fishes and Various Drinking Water Sources

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ABSTRACT

Aims: The objective of this study was to investigate the presence of microplastics in the gastrointestinal tract (stomach and intestine) of commonly consumed commercial edible fishes, namely Labeo rohita, Rastrelliger kanagurta, Oreochromis mossambicus, Pampas argenteus, and Nemipterus virgatus, as well as in different water sources.

Methods: The commercial edible fishes mentioned above were obtained and dissected in the laboratory. The dissection procedure and identification of the gastrointestinal tract parts were conducted following the methodology described by Jennifer Luke et al. (2009).

Results: The study, conducted from June to September 2023, revealed the presence of microplastics in the examined fishes and different water sources. The results showed that Labeo rohita had 36 (20.34%) microplastics, Rastrelliger kanagurta had 32 (18.08%), Oreochromis mossambicus had 28 (15.82%), Pampas argenteus had 48 (27.12%), and Nemipterus virgatus had 33 (18.64%). In terms of water sources, municipal water had 3 microplastics, RO water had 2, canal water had 21, and bottled water had 11. The variations in the number of microplastics could be attributed to differences in food habits, water quality, and the level of microplastic pollution. The presence of microplastic pollution in canal water and bottled water could be due to high pollution sources and improper processing of water bottles.

Conclusion: The study found high levels of microplastic pollution in Pampas argenteus from marine ecosystems, followed by Labeo rohita from freshwater ecosystems. The presence of microplastics in canal water and bottled water indicates a significant level of plastic pollution in both marine and freshwater ecosystems. This highlights the need for awareness and understanding of the extent of plastic pollution that we are exposed to through our food, water, and other means.

Key Words: Microplastics, Fishes, Water samples, Gastro-intestinal tract, Ballari

Mathematical Subject Classification: 62P12

INTRODUCTION

Almost all of the earth's environments, including lakes, rivers, the deep sea, the water column, the ocean, and sediments, are home to microplastics (2017) Boucher and Miller et al. (2017). Plastics have a plethora of advantages, yet it is impossible to ignore the concerns and troubles they generate. The majority of them cannot be destroyed quickly—not even over decades or even centuries (Tiwari et al., 2020).

The discovery that MPs can be discovered in numerous commercial species' edible parts raises serious concerns (Rahman et al., 2022; Wu et al., 2020); this could pose a serious risk to the health of fish consumers. Chronic oxidative stress and inflammation brought on by MP exposure can result in a number of chronic complications, such as diabetes, neuro-inflammation, acute lung injury, chronic kidney disease, and cardiovascular disease (Prata et al., 2020). Furthermore, according to Campanale et al. (2020) and Lu et al. (2019), MPs may be crucial in the carcinogenicity, chemotoxicity, and antimicrobial resistance of the gut microbiota. Nonetheless, the general public's understanding of the health concerns posed by MPs is expanding daily throughout the world. Accordingly, consumer demand and acceptability for cultured fish may be impacted by the mounting evidence of MPs present in farmed fish (Lusher et al., 2017).

Microplastics are encased in algae and fungi, and when ingested by aquatic organisms, they end up in their intestines and tissues, where they cause death as well as disruptions to the food chain and environment (Moore 2008). Microplastics research on MP pollution focused primarily on marine ecosystems until recently (Lambert and Wagen 2018). Given that MP is found in many types of water, it is essential to understand its prevalence in certain edible fish. Such studies in freshwater environments are scarce. In order to ascertain the prevalence and distribution of MP in the stomach and gastrointestinal tract of a few chosen edible fish from both fresh and sea water, the current investigation is being conducted.

MATERIAL AND METHODS

STUDY AREA:

Individuals belonging to various species were gathered at Ballari, Karnataka's fish market. Fresh and marine water fishes includes *Labeo rohita*, *Oreochromis mossambicus*, *Rastrelliger kanagurta*, *Pampas argenteus*, and *Nemipterus virgatus*. Fish placed in a watch glass, with weight noted. A magnetic stirrer bead and 30 ml of 4M KOH were added to the beaker containing the gastrointestinal tract, agitated for one hour at a rate of 350 rpm. Following that, 5 ml of H₂O₂ were added to the beaker, and it was once again swirled for 30 minutes at 350 rpm to remove any remaining contaminants and guarantee that all of the organic matter was finely digested. Left alone for around two hours (Stefan Grigorakis and associates, 2017).

After using sieves to filter and completely wash the undisturbed sample with deionized water, 20 ml of hydrogen peroxide were added. A freshly made solution of ferrous sulphate (FeSO₄) was then added, and the mixture was agitated for 30 minutes. Once more, the samples were strained. The sieve was used to examine the strained sample in order to look for microplastics. (Grofakis, Stefan, and others, 2017).

The stereo microscope was used to identify the Microplastics Samples (Micro Aim 48 MP). The microplastics were counted and documented, exhibiting a variety of shapes, sizes, and colors.

Microplastics in water

The different water samples have been collected from various water resources and were examined for the microplastics (Nurain Saipolbahri et al., 2020).

1. The canal water sample:

A 10-liter water sample was gathered from various sources including municipal tap, RO, canal water and packaged water. The samples were filtered on-site using a sieve placed in a sterilized container. The filtered sample was then transported to the laboratory for examination under a stereo microscope. Microplastics of varying colors and sizes were detected on the monitor screen connected to the microscope. The same procedure was followed for collecting RO water sample near the girl's hostel at VSK University and bottled water sample.

RESULTS AND ANALYSIS

The occurrence microplastics in the fresh and marine water fishes were studied, and found the various size, shape and quantity/number of microplastics particle fiber, fragment and filament in different fishes. Although its ubiquity in organisms the entry of MP in fishes has many ways but its knowledge and information is scanty. Hence, Fishes were analyzed for morphometric characteristics (Table 1), dissected, and examined under a stereomicroscope to detect microplastics on a monthly basis from June to September 2023.

SL NO	Name of the fish	Total body weight (gm)	Total body length (cm)	Pre orbital length (cm)	Post orbital length (cm)	Body depth (cm)	Stomach weight(g m)	Intestine weight (gm)
1	<i>Labeo rohita</i>	255.7	35.4	3.2	2.8	8.9	6.92	9.55
2	<i>Rastrelliger kanagurta</i>	125.9	25.4	2.5	1.9	8.9	3.2	6.8
3	<i>Oreochromis mossambicus</i>	128.23	24.5	3.5	4	10.5	2.6	10.2
4	<i>Pampas argenteus</i>	128.33	20.4	2.3	1.9	10	1.85	4.41
5	<i>Nemipterus virgatus</i>	169.24	25.7	4	2.4	6.8	1.69	1.46

TABLE 1: Showing the morphometric details of different freshwater and marine water fishes

Morphometric details of the fishes are being studied and presented in table 1. which is indicating highest body weight and length recorded in *Labeo rohita*, pre and post orbital length highest observed in *Oreochromis mossambicus*, maximum stomach weight in *Labeo rohita* intestine weight in *Oreochromis mossambicus* respectively.

SL NO	Name of the fish	No.of microplastics				
		June	July	August	September	Total
1	<i>Labeo rohita</i>	12	8	6	10	36
2	<i>Rastrelliger kanagurta</i>	9	5	7	11	32
3	<i>Oreochromis mossambicus</i>	7	9	5	7	28
4	<i>Pampas argenteus</i>	18	12	8	10	48
5	<i>Nemipterus virgatus</i>	5	9	7	12	33

TABLE 2: Showing number of Microplastic found in Gastro-intestinal tract of different freshwater and marine water fishes

Table 2. depicts the presence of microplastics in five different fish species which were investigated for microplastics in their gastrointestinal tracts, specifically in the stomach and intestine from both marine and freshwater environments. The fish species examined were *Pampus argenteus* (marine water), *Nemipterus virgatus* (marine water), *Rastrelliger kanagurta* (marine water), *Labeo rohita* (freshwater) and *Oreochromis mossambicus* (freshwater). *Pampus argenteus* had 48 microplastics, *Nemipterus virgatus* had 33, *Rastrelliger kanagurta* had 32, *Labeo rohita* had 36 and *Oreochromis mossambicus* had 28 microplastics. Highest number of MP found in *Pampus argenteus* and *Labeo rohita*. And lower *Oreochromis mossambicus* and *Rastrelliger kanagurta*. During the month of June and September it was 51 MP and 50 MP respectively in the month of August 33 lowest. Comparatively marine water fish *Pampus argenteus* has shown more MP in its GI tract.

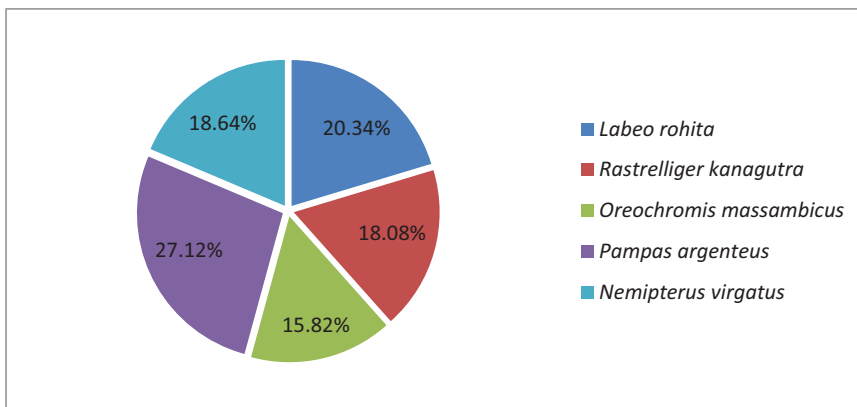


Fig. 1. Order of percentage of microplastics

The microplastics found in different fishes have been recorded and presented in table 2 and Order of MP percentage observed highest found in 27.12 % *Pampus argenteus* >20.34% *Labeo rohita*

> 18.64% *Nemipterus virgatus* > 18.08% *Rastrelliger kanagutra* > 15.82% *Oreochromis massambicus* (Fig.1).

SL No.	Name of the water sample	No. of microplastics
1	Municipal water	3
2	RO Water	2
3	Canal Water	21
4	Bottled Water	11

TABLE 3: Showing the order of number of microplastics found in

Number of microplastics recorded in different water samples are presented in table 3 depicting the canal water 21> Bottled water 11> Municipal water 3> and RO water 2. Higher number found in canal water and lower in municipal and RO water. Although water is filtered and purified the contamination of MP is noticed.

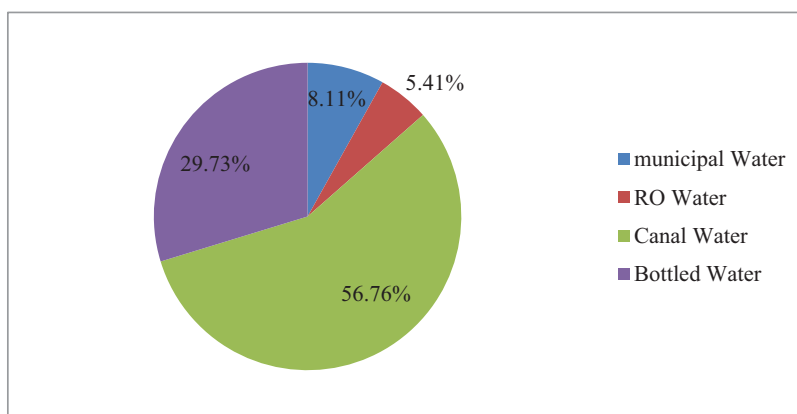


Fig 2. Order of percentage of Microplastics found in different water samples.

Percentage of concentration/number of microplastics in different water samples have been analysed and depicted in Fig 2. i.e. 56.76% in canal water> 29.75% in bottled water>8% municipal water> 5.41% RO water. Maximum was noticed in canal water and bottled and minimum in Municipal and RO water.

The microplastics observed in GI tract of different fresh and marine water fishes are presented as below. In Plate-1 *Labeo rohita*, Plate-2 *Rastrelliger kanagutra*, Plate-3 *Oreochromis mossambicus*, Plate-4 *Pampas argenteus*, Plate-5, *Nemipterus virgatus*, Plate-6 Municipal water, Plate-7 RO water, Plate-8 Canal water and Plate-9 Bottled water.

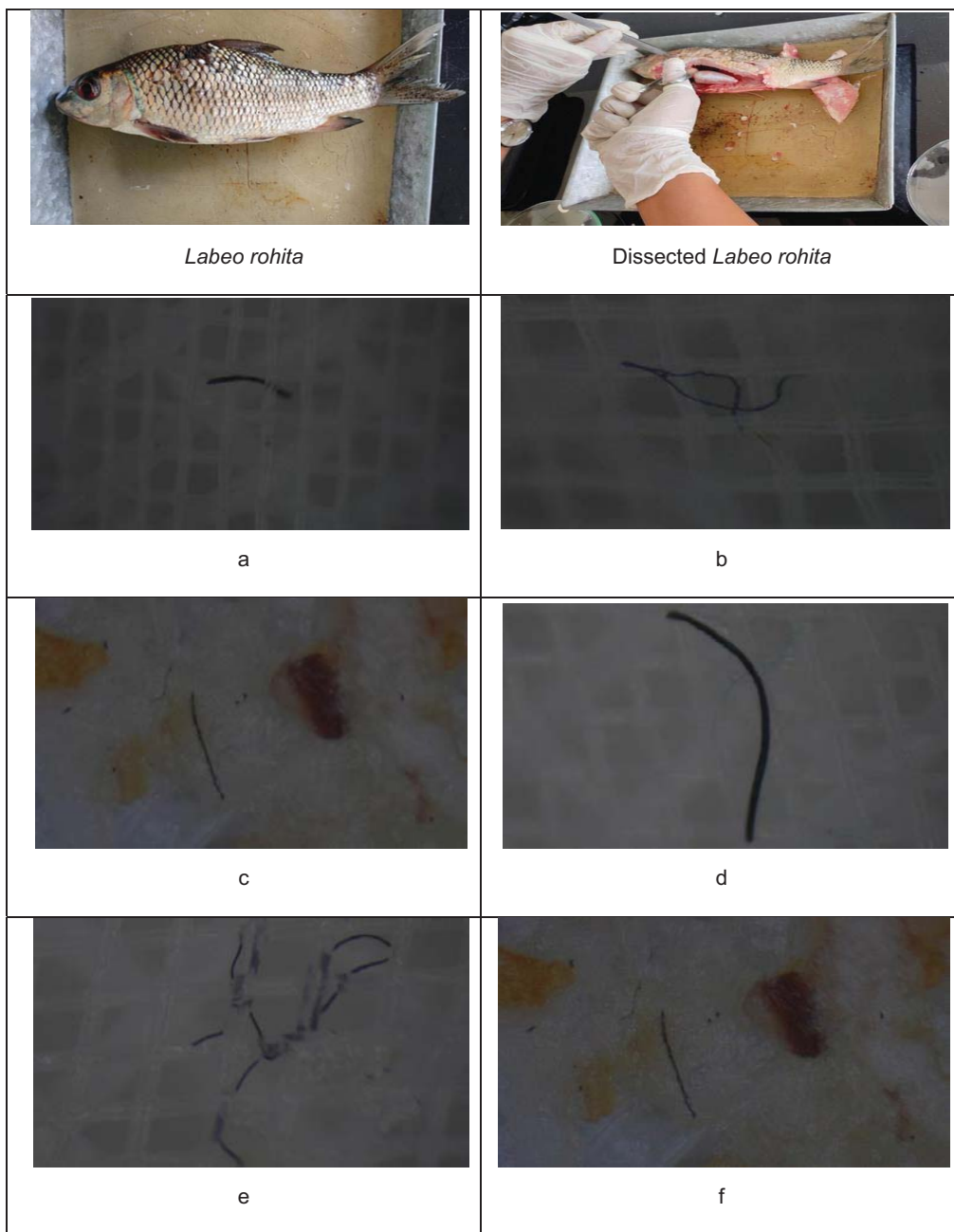


PLATE-1: a-f Pictures of microplastics found in the GI tract of fish *Labio rohita*

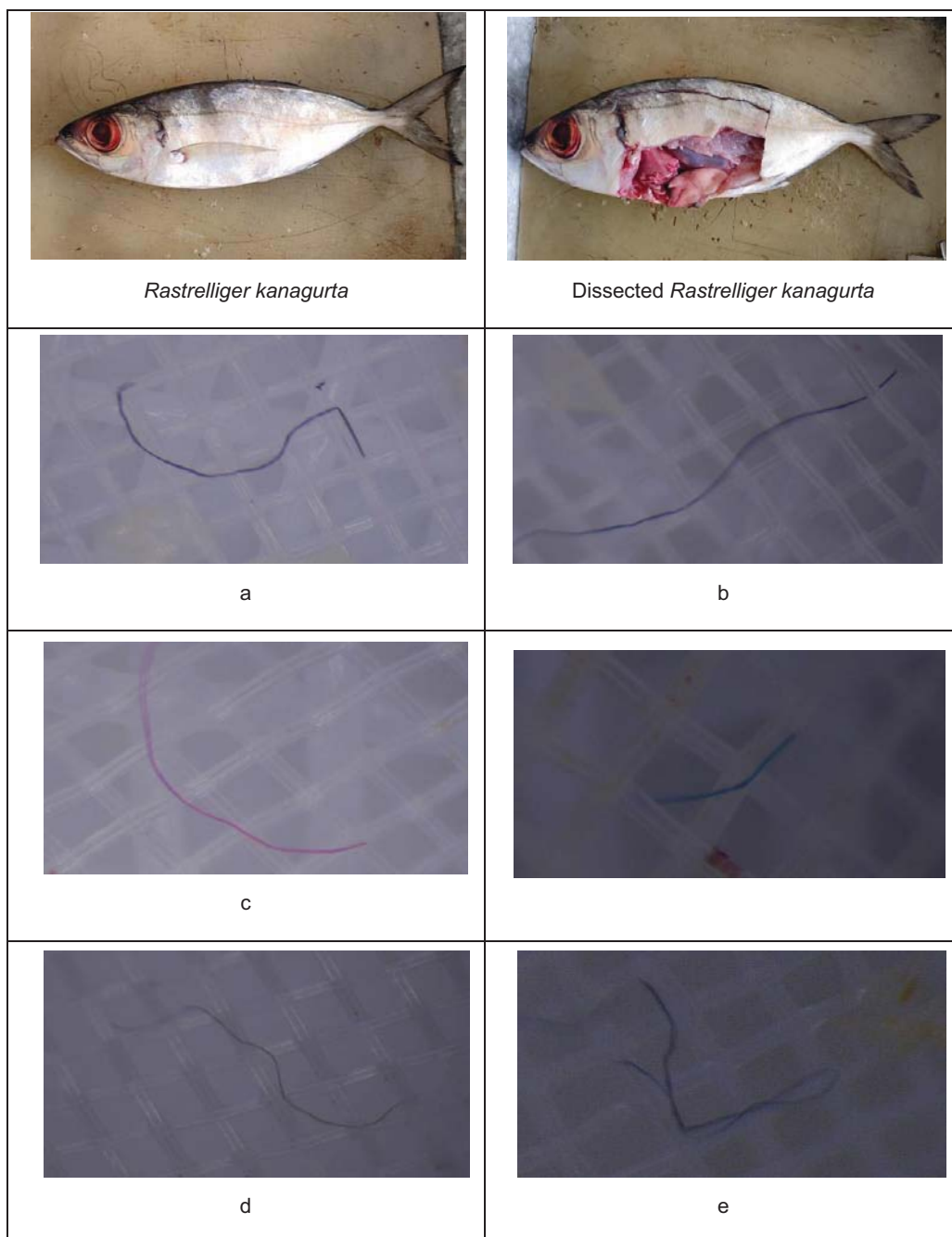


PLATE-2: a-e Pictures of microplastics found in the GI tract of fish *Rastrelliger kanagurta*

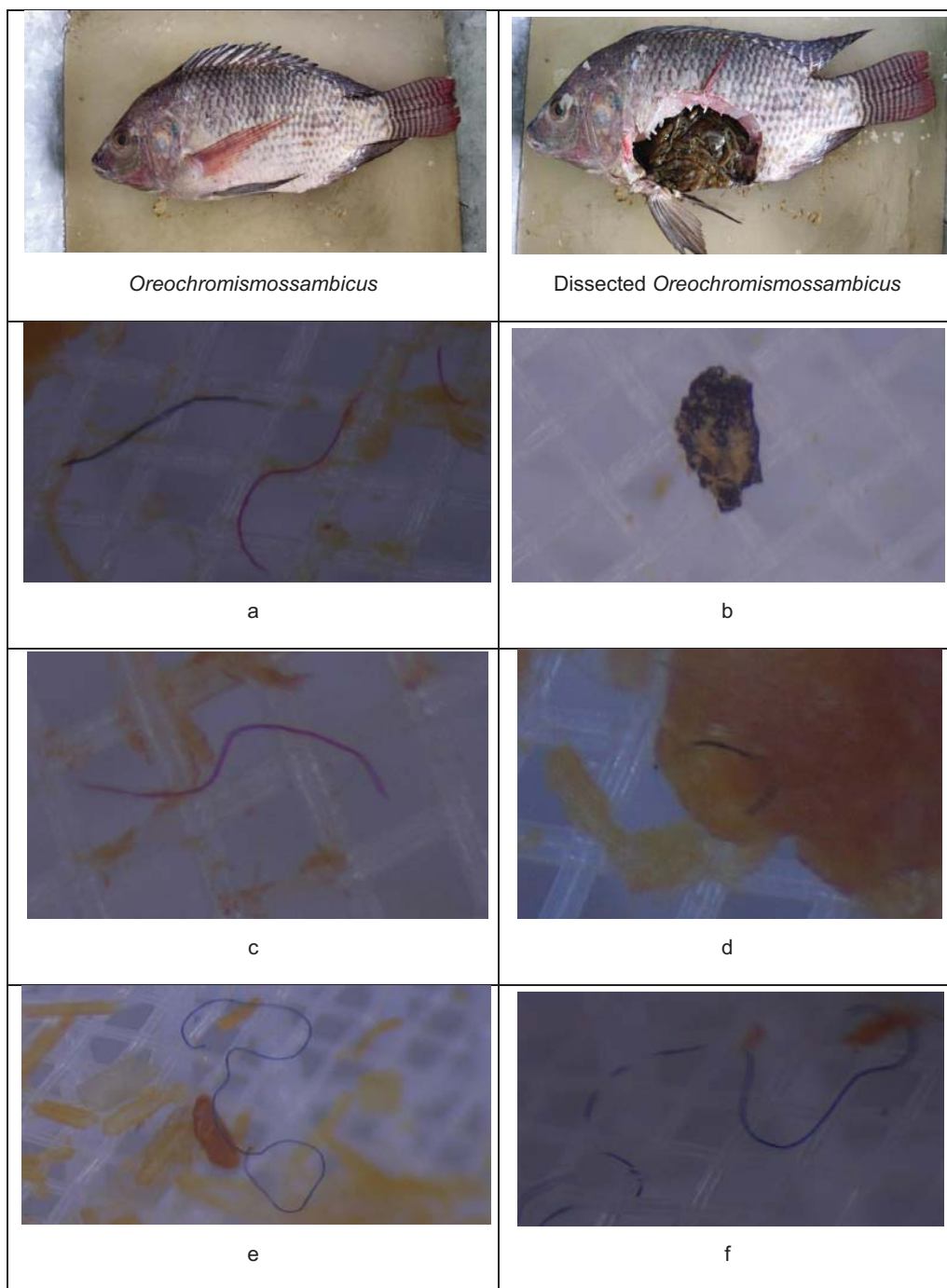


PLATE-3:a-f Pictures of microplastics found in the GI tract of fish *Oreochromis mossambicus*

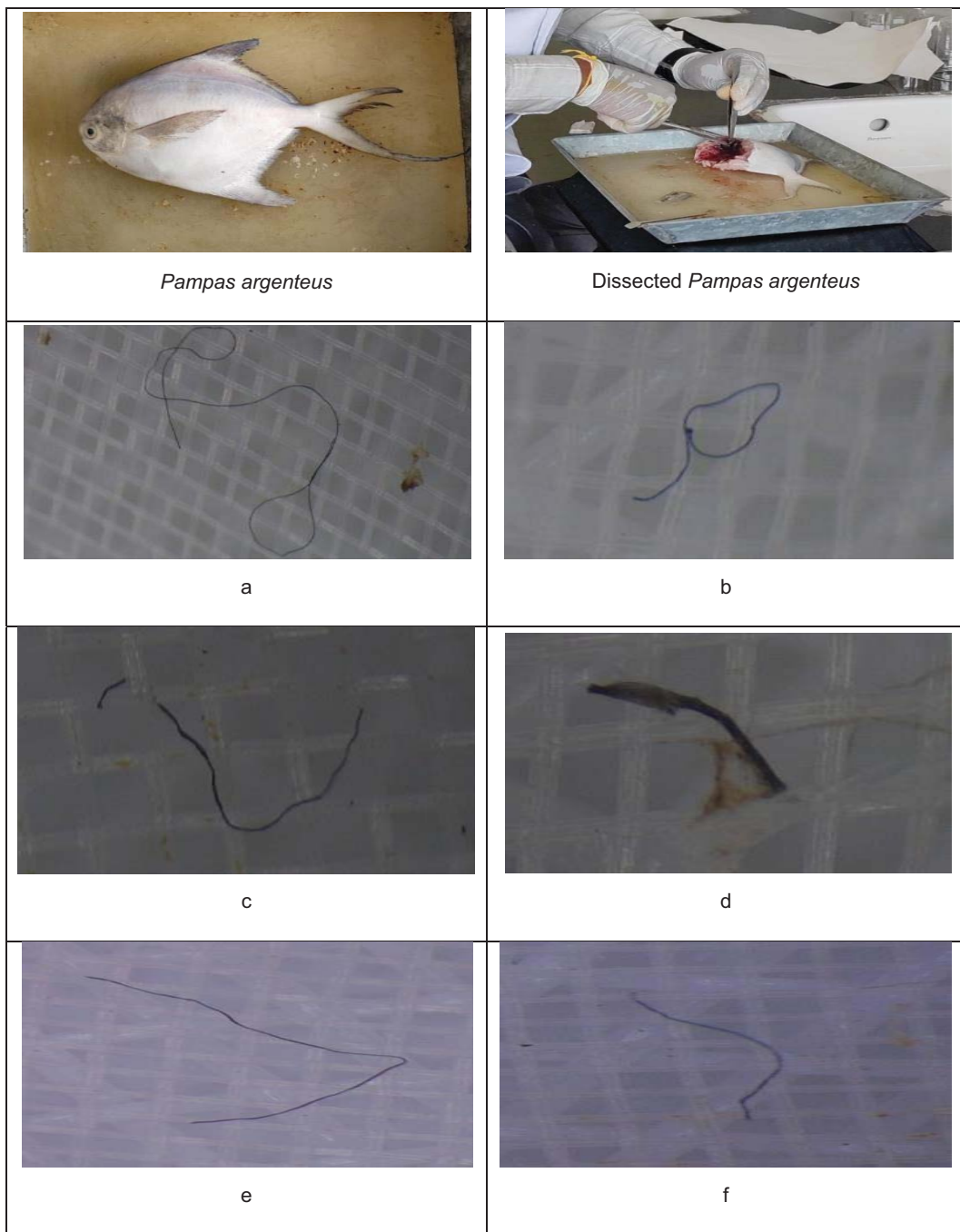


PLATE-4: a-f Pictures of microplastics found in the GI tract of fish *Pampus argenteus*

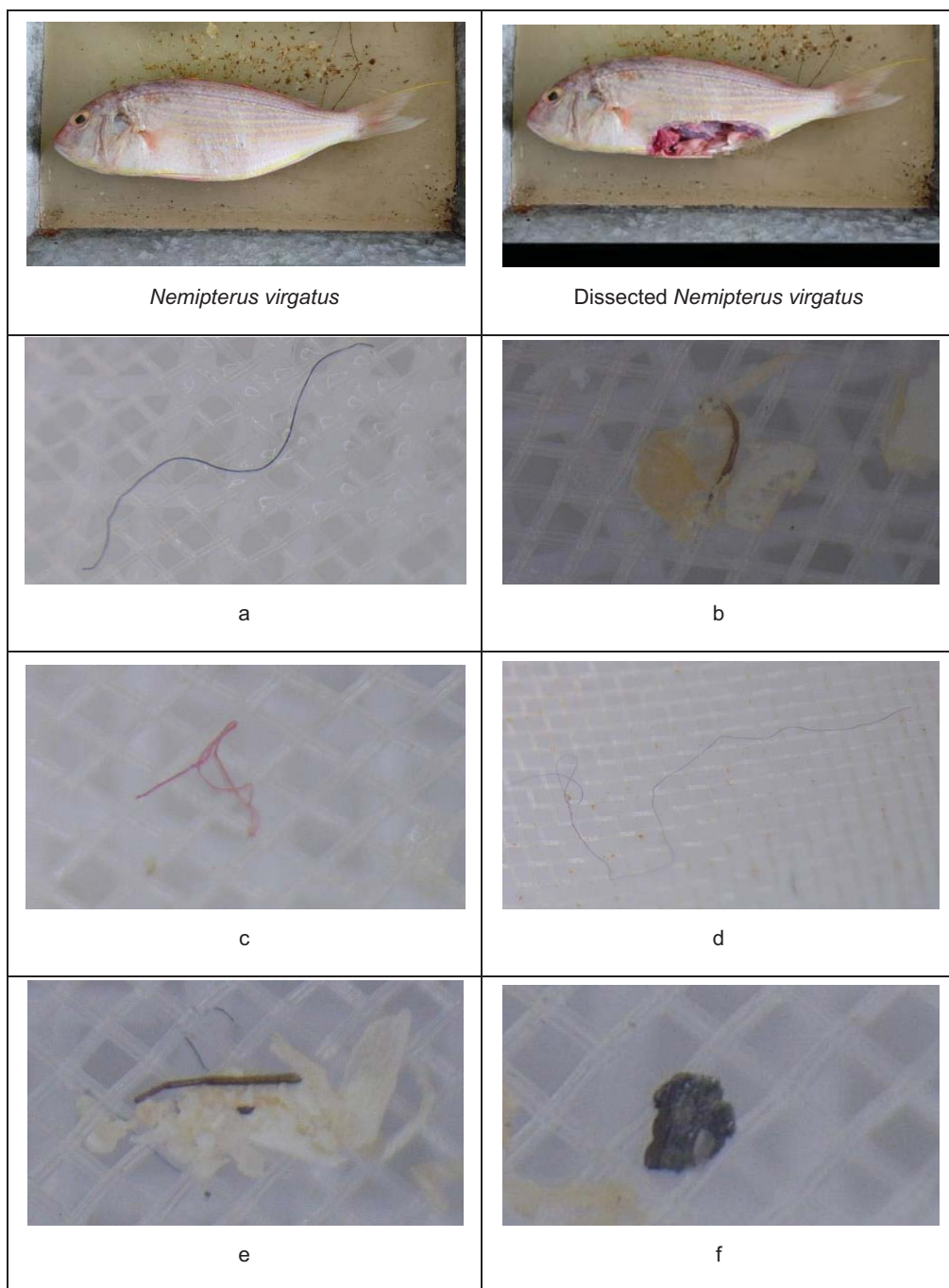


PLATE-5: a-f Pictures of microplastics found in the GI tract of fish *Nemipterus virgatus*

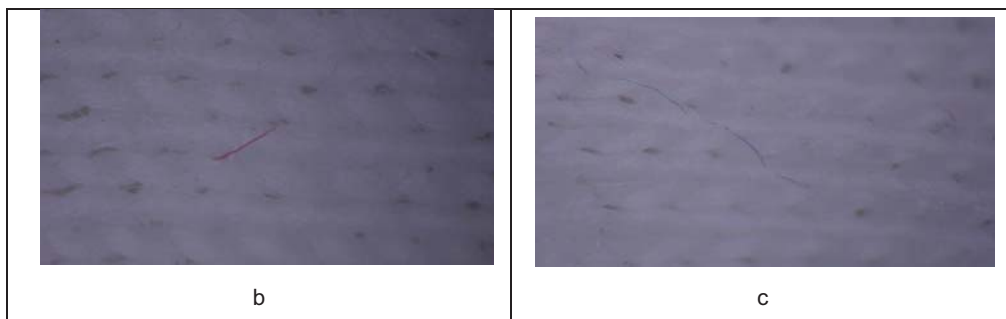


Plate 6: b-d Pictures of microplastics in Municipal water sample

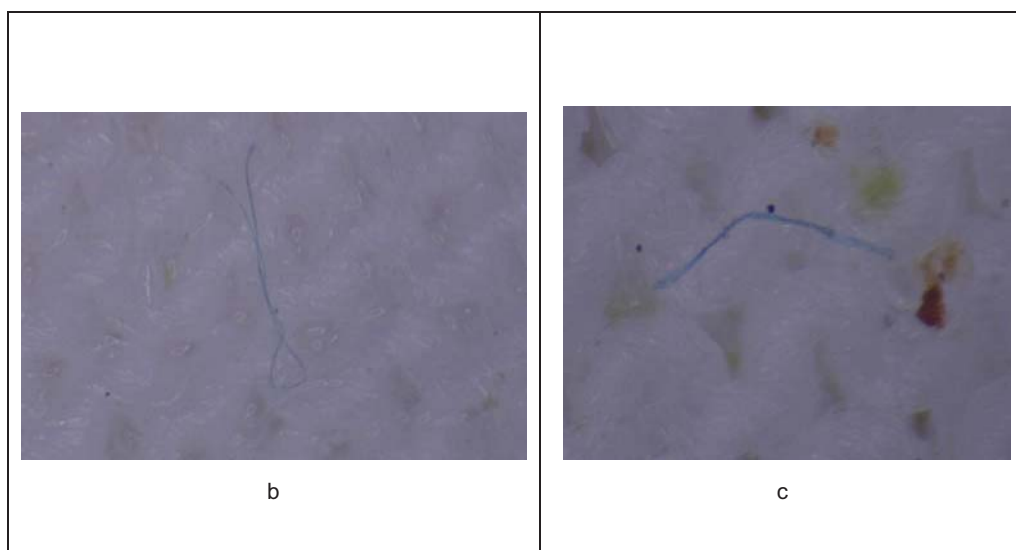


Plate 7: b-c Pictures of microplastics found in RO (REVERSE OSMOSIS) waters sample

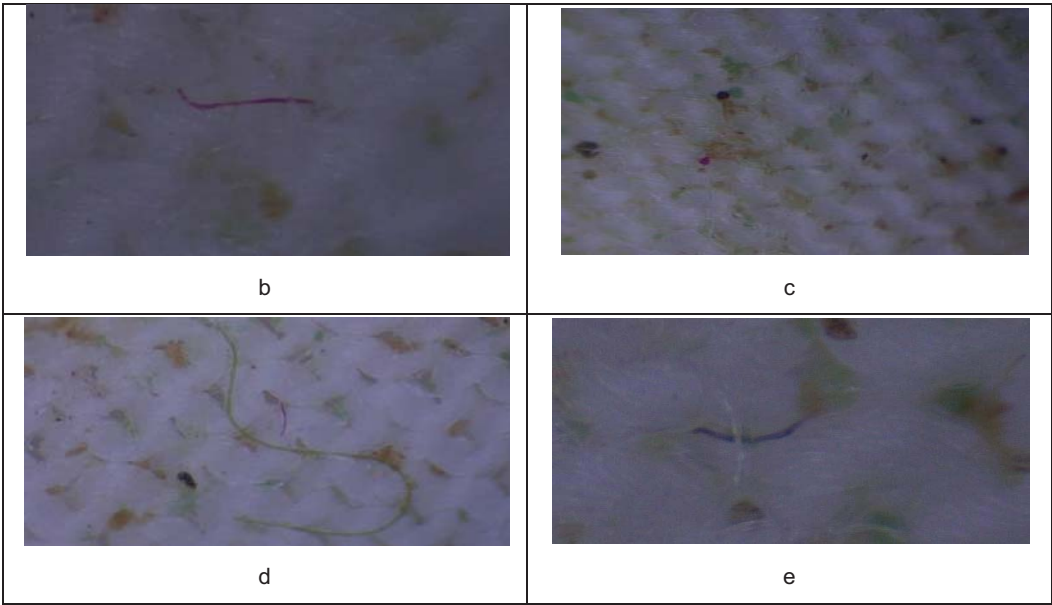
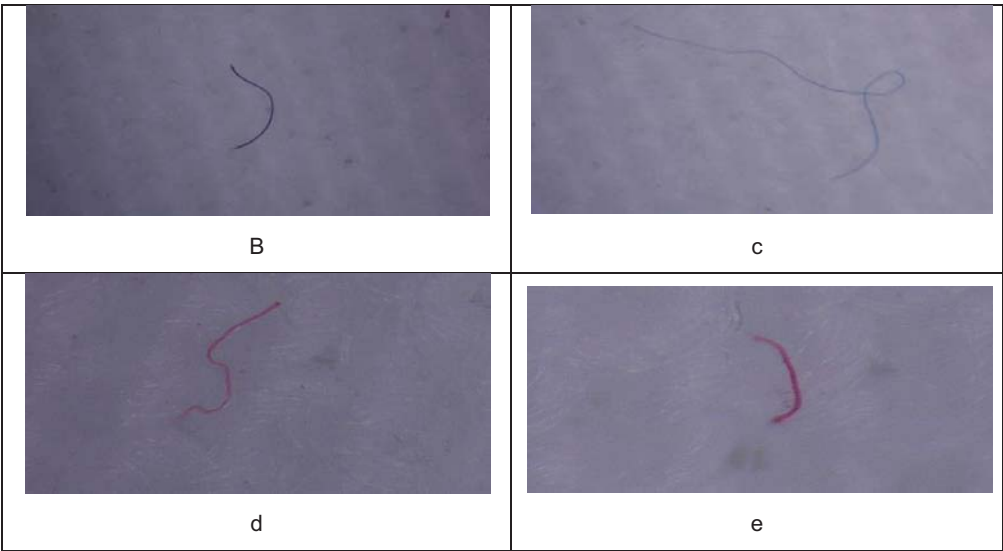


Plate 8: b-e Pictures of microplastics found in Canal water sample



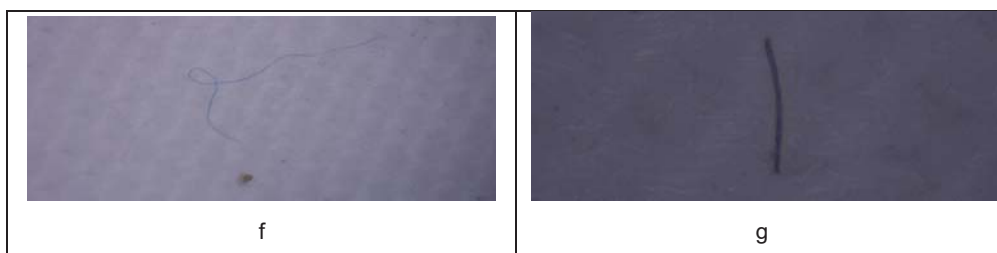


Plate 9: b-g Pictures of microplastics found in Bottled water sample

DISCUSSION

The occurrence of MP in fresh and marine water is similar (Roch et al 2019, Lusher et al 2013), Although the mechanism of ingestion is indistinguishable (Roch et al 2020). Microplastic contamination in aquatic environments has been increasingly highlighted in recent years. Research findings indicate the presence, abundance and distribution of microplastics in both fishes and samples of fresh and marine water.

The highest percentages of microplastics were recorded in the following order: 27% in *Pampus argenteus*, 20% in *Labeo rohita*, 18.6% in *Nemipterus virgatus*, 18.08% in *Rastrelliger kanagurta*, and 15.82% in *Oreochromis mossambicus* (Fig 1) and Plate N0. 1-9 depicts the images taken from microscope respectively. The elevated levels in *Pampus argenteus* and *Labeo rohita* may be attributed to significant microplastic pollution in marine ecosystems, with a rising trend in freshwater ecosystems as well. Conversely, lower levels of microplastics were found in *Oreochromis mossambicus* and *Rastrelliger kanagurta*. These variations in microplastic concentrations are influenced by geographic location, fish feeding habits and the level of microplastic pollution in a specific region. Fish may experience anorexia and false satiety after consuming microplastics, even though it may not lead to histopathological changes as suggested by De Sales-Ribeiro et al. (2020). Wardrop et al. (2016) warn that along with microplastics, dangerous pollutants such as heavy metals may also be ingested. The long-term accumulation and continuous transfer of microplastics in the food chain are concerning issues. Rate of deposited MP may increase the risks and its also depends the translocation rate of the MP (Stock et al., 2019) that sequentially decided by size, shape, properties as well, and in-situ conditions experimental set up too (Lusher et al 2001).

Higher number of MP in marine water fishes may be due to more amount of consumption of water than fresh water. Short exposure to MP will have less impact on the organism Roch et al (2020). Discrepancies in microplastic prevalence among different fish species may be attributed to varying environmental characteristics and features (Aina Et al 2020), as well as anthropogenic pressures on water bodies, supported by the fact that 80% of microplastic litter is found on land (Andrady 2011). The higher concentration of microplastics in certain fish species may be linked to their increased interaction with microplastics and lower population numbers. This could be influenced by their habitat preferences, feeding habits as piscivores and reduced likelihood of exposure to microplastics through filter feeding

(Aina 2020). Similar research has been conducted in various ecosystems by Li et al. (2016), Guven et al. (2017), and Bour et al. (2018).

Syafitri et al. (2021) and Hastuti et al. (2019) observed that the highest concentration of microplastics were present in canal water, with 21 microplastics per 10 liters of water sample, while the lowest concentration was found in RO water, with only 2 microplastics (Table 3 and Fig 2). The elevated levels of microplastics in canal water and bottled water samples can be attributed to extensive plastic waste disposal in dams and the use of packaging materials, respectively. Interestingly, even the filtered water from the RO plant contained microplastics. This finding aligns with the results reported by Koelmans et al. (2019) and Eamrat et al. (2022).

CONCLUSION

All most all the aquatic organism are adversely affected by microplastics and human being as well. Plastics have difficult degradation character due to that it deposits in the environment and biota, resulting into effect on organism including the endocrine disruption, cancer, impact on physiological pathways etc. Although, many of the flora and fauna do adapt to polluted environment only few can change and adapt swiftly. *Pampus argenteus* and *Labeo rohita* have been observed to have the highest number of MP as a result of the rise in pollution activities. Likewise, the packed drinking water and canal water also exhibit the highest number of MP due to inadequate bottle processing and pollution from human activities. There is need of production of biodegradable plastics which has less impact on environment and biota. Ultimately the understanding of the lack of awareness and its impact on organisms is not well comprehended by the general public, and even those who are aware do not take it seriously.

RECOMMENDATIONS

1. It is imperative to cease the dumping of plastics into water bodies.
2. We should transition to using non-plastic materials for our daily activities.
3. The most effective solution is to utilize biodegradable plastics.
4. It is crucial to refrain from conducting religious rituals in water bodies.
5. Manufacturing industries must ensure proper processing of bottled water.
6. The use of tap filters can significantly reduce the influx of microplastics into our drinking water.
7. Regular maintenance and cleaning of RO filters is essential.
8. Each individual should take personal responsibility.
9. It is advisable to avoid drinking water from reusable plastic bottles, as they tend to have the highest average microplastic particle counts.

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