ANALYSIS OF MICROPLASTICS OF BILIH FISH *(Mystacoleucus padangensis)* IN LAKE SINGKARAK, WEST SUMATRA USING FT-IR SPECTROSCOPY

Calysta Deli Ad'hani*, Zulkarnaini Zulkarnaini *, Shinta Silvia*, Fitri Yuranda*
**Department of Environmental Engineering, Andalas University, Padang, Indonesia, calystadeliadhani@gmail.com, zulkarnaini@eng.unand.ac.id, shintasilvia2476@gmail.com, fitriyuranda@gmail.com*

Email Correspondence : zulkarnaini@eng.unand.ac.id

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Abstract: Microplastics have become a global concern due to their wide distribution and ecological effects. Understanding the interactions between microplastics and ecosystems is important for environmental risk assessment. This study analyzed the abundance and distribution of microplastics in Lake Singkarak. Substantial microplastic research is still lacking for freshwater biota, so a study was conducted to determine the level of microplastic pollution in bilih fish tissue. The fish's size, weight, and sampling point were studied about microplastic uptake through two channels, digestion and respiration. From the results, the types of polymers identified in this study were polyethylene, polyvinyl chloride, and polyethylene terephthalate. Overall, 7.14% - 23.53% (average = 11.48%) of microplastics were identified in the D tract of bilih fish from sixteen different sampling points. While 7.69% - 17.39% (average = 11.85%) of microplastics were identified in the respiration of bilih fish. The highest percentage of the abundance of microplastic forms in the digestions identified was fiber at 70.42% and 66.82% in the digestions. At the same time, The lowest percentage identified was fragmented, with an average abundance of 29.58% in digestion and 33.32% in respiration. In conclusion, this study reveals the presence and impact of microplastics in Lake Singkarak, West Sumatra, on the bilih fish *(Mystacoleucus padangensis)*. By examining the fish's digestive and respiratory systems and using FT-IR Spectroscopy, the research highlights the ecological and economic implications of microplastic pollution. These findings emphasize the need for targeted conservation and management strategies.
Keywords: Microplastics; Digestion; Respiration; Bilih Fish

Abstrak: Mikroplastik telah menjadi perhatian global karena distribusinya yang luas dan efek ekologisnya. Pemahaman tentang interaksi antara mikroplastik dengan ekosistem dinilai penting untuk penilaian risiko lingkungannya. Penelitian ini menganalisis kelimpahan dan distribusi mikroplastik di Danau Singkarak. Penelitian mikroplastik secara substansial masih sedikit untuk biota air tawar maka dilakukan penelitian untuk menentukan tingkat polusi mikroplastik pada jaringan ikan bilih. Ukuran, berat, dan titik sampling ikan diteliti dalam kaitannya dengan jerapan mikroplastik melalui dua saluran, yaitu digestif (pencernaan) dan respirasi (pernapasan). Dari hasil penelitian, jenis polimer yang teridentifikasi dalam penelitian ini adalah jenis polietilen, polivinil klorida, dan polietilen tereftalat. Secara keseluruhan 7,14% - 23,53% (rata-rata = 11,48%) mikroplastik teridentifikasi pada digestif ikan bilih dari enam belas titik sampling yang berbeda. Sementara 7,69% - 17,39% (rata-rata = 11,85%) mikroplastik teridentifikasi pada respirasi ikan bilih. Persentase kelimpahan bentuk mikroplastik tertinggi pada

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digestif yang diidentifikasi adalah *fiber* sebesar 70,42% dan 66,82% pada digestif. Sementara persentase terendah yang diidentifikasi adalah *fragment* dengan rata-rata kelimpahan sebesar 29,58% di digestif dan 33,32% di respirasi. Sebagai kesimpulan, penelitian ini mengungkap keberadaan dan dampak mikroplastik di Danau Singkarak, Sumatera Barat, pada ikan bilih *(Mystacoleucus padangensis)*. Dengan memeriksa sistem pencernaan dan pernapasan ikan serta menggunakan Spektroskopi FT-IR, studi ini menunjukkan implikasi ekologis dan ekonomi dari polusi mikroplastik. Temuan ini menekankan perlunya strategi konservasi dan pengelolaan yang terarah.
Kata kunci: Mikroplastik; Digestif; Respirasi; Ikan bilih

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Introduction

According to the National Waste Management Information System (SIPSN), Indonesia will produce 28.4 thousand tons of plastic waste daily in 2021, accounting for 15.6% of all waste generated. Based on the Ministry of Environment and Forestry assumptions, the Indonesian population produces 0.8 kg of waste per person daily, resulting in a total waste production of 189 thousand tons daily. With 28.4 thousand tons of plastic waste generated each day, this plastic waste poses a threat to human survival and pollutes the seas, marine life, and freshwater bodies such as lakes and rivers (Dzihninafira et al., 2023). Microplastics are currently considered a pollution problem, and various global efforts are being made to locate their presence in the environment. Most information regarding the presence of microplastics in terrestrial and freshwater environments is considered only as sources and transport pathways of microplastics to the oceans. In addition, microplastics can also be released into the air by various sources, including synthetic textiles, abrasion of materials (e.g. car tires, buildings), and re-absorption of microplastics on surfaces (Prata et al., 2020). Unmanaged waste will be disposed of on land and eventually enter water bodies. Improper handling and unacceptable degradation of plastic waste can cause environmental pollution. Debris, including plastic waste, accumulates in the aquatic environment and will negatively affect it over time. Exposure to plastic debris can damage the aesthetic appearance of aquatic ecosystems and the biota that inhabit them, cause various diseases, affect food webs, and reduce the productivity of fish caught (Rohaningsih et al., 2022).

In addition, microplastics that accumulate in the food web can impact humans who consume contaminated aquatic biota (L. Su et al., 2019). Microplastics are widespread contaminants. The human body is exposed to microplastics through the consumption of food containing microplastics, inhalation of airborne microplastics, and skin contact with these particles found in products, textiles, or dust (Prata et al., 2020). Aquatic organisms can be contaminated by microplastics either through contaminated water or by feeding on other organisms, and can thereby become a source of exposure to humans. Additionally, fish can be contaminated after capture during storage and transportation in fragile polystyrene plastic containers (Revel et al., 2018). Another study revealed the adverse effects of microplastics on human kidney and liver cells, indicating that ingesting microplastics can cause toxicological problems in cell metabolism and cell-cell interactions. Since exposure of human kidney and liver cells to microplastics causes changes in morphology, metabolism, proliferation, and cellular stress, these results highlight the potential undesirable effects of microplastics on human health (Goodman et al., 2022). Using animals as indicators is necessary for assessing the ecological impact of anthropogenic activities on aquatic environments down to the xenobiotic level, meaning not only in water but also in animal tissues (Nousheen et al., 2022). Fish are one of the most commonly used species as bioindicators in water quality pollution monitoring because of their sensitivity to pollution and wide distribution (Husamah & Rahardjanto, 2019). Ingested microplastics can migrate to other internal organs, such as the kidneys and liver, causing labor effects at the cellular level (Goodman et al., 2022). In another case, microplastics were found in commercial salt from 128 brands from 38 countries (Peixoto & Pinheiro, 2019). In the same object and different studies, microplastics were also found in 21 samples of salt analyzed (Syamsu et al., 2024). Almost all humans use this commercial salt daily. Therefore, salt is a long-term microplastic exposure pathway for people, similar to fish. Finally, from an economic point of view, microplastics identified in bilih fish could have an impact on the level of fish consumption and distribution in the community as it affects consumers image and preference for bilih fish, resulting in decreased market demand.

Fishing location also affects microplastic; according to research (Nousheen et al., 2022), tributary areas, and boating or fishing areas have a higher abundance of microplastics than residential areas. This proves that human activities are closely related to the abundance of microplastics in the environment. These activities include tourist activities, considering that many lakes are used as tourist areas, followed by household activities of residents around the lake who produce household waste and are directly discharged into the lake. Then, it can also be from residents' agricultural, livestock, and trade activities around the lake. On the other hand, with a smaller population around the lake, it may be more affected by tourism activities (Xiong et al., 2022). As the largest natural freshwater lake in West Sumatra, Lake Singkarak is a suitable place to study the abundance of microplastics in the environment. The lake is dependent on local human activities and tourism activities (Henny et al., 2022). This is closely related to the type of fish used in this study, namely Bilih fish that live in Lake Singkarak. This fish lives in a lake that is the source of life for the surrounding community. Bilih fishing locations are narrowed by prioritizing lake areas with high human activity. This is also the background of the choice of Bilih fish and Lake Singkarak in this study.

Bilih fish (*Mystacoleucus padangensis*) is an endemic fish of Lake Singkarak, its presence in the lake is more than other fish species in the lake, and because it is an endemic fish, the attractiveness of outside consumers to buy and consume this fish is higher than other species in the lake. this certainly makes it easier for researchers to obtain the fish because of its availability. In addition, the high consumer interest is also the basis for why Bilih fish needs to be studied because there is a possibility of contamination of consumers who eat it. Based on the scope of fish, several previous studies have been conducted to determine the abundance and characteristics of microplastics in fish, including biomonitoring in urban wetlands of Melbourne, Australia using eastern mosquito fish (*Gambusia holbrooki*); the results showed an average abundance of microplastics in the body of 19.4% and 7.2% in the head (L. Su et al., 2019). Another study by (Saad et al., 2022) also conducted biomonitoring of microplastic pollution in goldfish (*Cyprinus carpio*), the results showed that microplastics were detected in twenty-six fish studied as many as 682 particles and dominated by the type of fiber by 69%.

Therefore, this study will analyze the abundance and distribution of microplastics in Lake Singkarak. Since microplastic research is still substantially lacking for freshwater biota, a study was conducted to determine the level of microplastic pollution in bilih fish tissue. Fish size, weight, and sampling points about microplastic uptake were studied through two channels, namely digestion and respiration. Microplastics are present in Lake Singkarak, West Sumatra, and they have a significant impact on the endemic bilih fish *(Mystacoleucus padangensis),* affecting both their digestive and respiratory systems. By examining both the digestion and respiratory systems of the fish and employing FT-IR Spectroscopy to identify polymer types, this study offers a comprehensive understanding of microplastic contamination. These findings contribute valuable data on the ecological and economic implications of microplastic pollution in a unique freshwater ecosystem, highlighting the need for targeted conservation and management strategies.

Materials and Methods

Materials

The research tools and materials used in this study are bilih fish, FT-IR Perkin Elmer Frontier C90704, optics B-350 microscope, aquadest, hydrogen peroxide (H_2O_2) p.a (Sigma-Aldrich), sodium hydroxide (NaOH) p.a (Sigma-Aldrich), filter paper Whatman no. 42, aluminum foil, analytical balance (PW 254, ADAM Equipment) with readability of 0.0001 g, ArcMap 10.3 software, SPSS IBM Statistic 29 software, moticplus software, and spectrum IR Version 10.6.1 software.

Method

Location

Lake Singkarak, located in West Sumatra, Indonesia, is a tectonically formed lake shaped by the Sumatran Fault System. It is the second-largest lake in Sumatra, with an area of 107.8 square kilometers, a depth of 296 meters, and significant ecological and economic importance (Rohaningsih et al., 2022).

Bilih fish sampling was conducted in areas near the inlet river of Lake Singkarak, adjacent to residential and tourist areas. Based on these criteria, the sampling location was chosen to be in Jorong Mutiara, Nagari Batu Taba, South Batipuh District, Tanah Datar Regency. Bilih fish (Mystacoleucus padangensis) were collected from sixteen points, each representing a different chart in Jorong Mutiara. Taxonomic tests were performed on samples from these points to ensure accurate species identification and classification. Bilih fish samples were obtained from the catch of local fishermen or Bagan owners in the sampling point area as seen in Figure 1.

Sampling

The samples used are bilih fish *(Mystacoleucus padangensis)* within a similar size range of 7-10 cm, with an average weight of 1.7 grams. Twenty bilih fish were obtained from each bagan. Based on interviews with local fishermen, bilih fish tend to swim towards bright light. Therefore, to facilitate sample collection, it was conducted at dawn around 4 AM. The bilih fish that were collected in nets of a certain size in the middle of the raft, which was intentionally lit, was lifted and brought to shore. This collection was carried out at one time, on July 23, 2023. The fish were stored in a cool box filled with ice cubes to keep the samples fresh after arriving at the laboratory. Samples were then dissected to take the gills and digestion tract. The fish was dissected by cutting from the anus dorsally to the lateral linea, then anteriorly to the back of the head and downward to the bottom of the abdomen until the contents of the fish's stomach were visible. The dissected fish was then taken for digestion and gills. Weighed and put into a container and labeled.

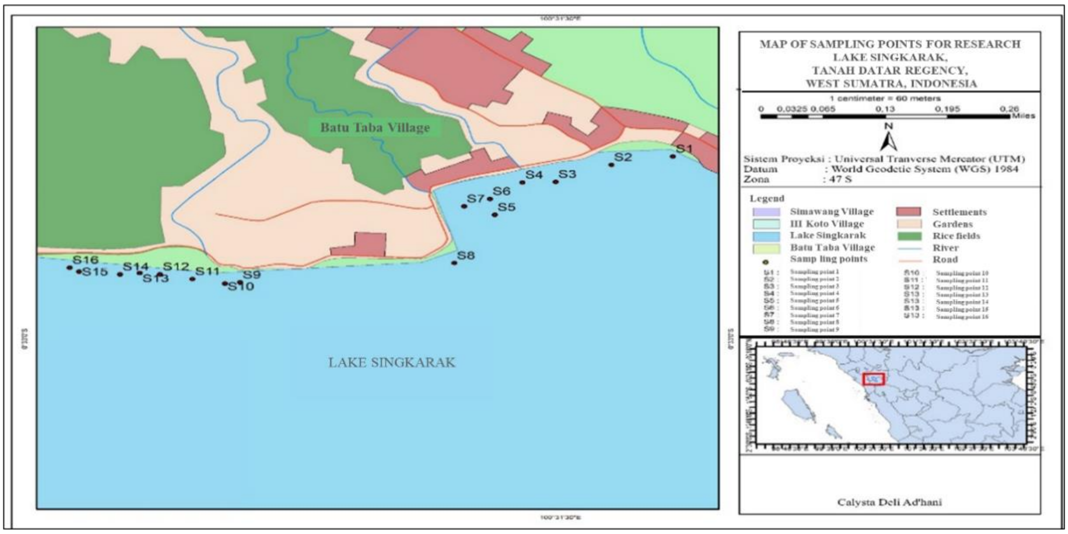

Figure 1. Sampling locations of bilih fish in Lake Singkarak, West Sumatra

Preparation and Measurement

Samples consisting of twenty Bilih fish had their gills and digestion tracts removed and were then immersed in 50 mL of NaOH solution per sample in 100 mL beakers. The samples were heated at a temperature of 55 ºC for 72 hours using a hot plate. After that, 5 mL of 30% H_2O_2 was added to each sample and left overnight (t = 24 hours). The sample solution was then filtered using Whatman filter paper 42 under vacuum conditions. Images of particles identified as microplastics based on their shape were taken with the help of meticulous software. The microplastic shapes were grouped according to the classification type provided by Hirt & Malapel, (2020); and Viršek et al., (2016). "Fiber" is characterized by being very long, straight, fibrous, thin, and sometimes short. "Fragment" is characterized by being asymmetrical, thick, with sharply curved ends, rough, and jagged. With the residual samples on the filter paper, visual identification was conducted using a microscope with a magnification of 100 times. Using Moticplus software, images were captured, and particles classified as microplastics were measured based on their morphology. The research summarized in this article is the result of the methodology chosen by Ivleva (2021); the Marine Debris Program (2015); and Mohamed et al., (2017).

The microplastics found in the test samples were then identified for their specific polymer composition using the Perkin Elmer Frontier C90704 Spectrum IR Version 10.6.1 Fourier Transform InfraRed (FT-IR) Spectrometer method. Software connected to the FT-IR instrument was used to read the spectra produced by the samples. The residual samples on the filter paper, identified visually using a microscope, were categorized into five shapes: fiber, fragment, granule, and film. Subsequently, each identified shape was extracted from the filter paper using tweezers and a magnifying glass and then placed onto the holder of the FT-IR instrument. The results were recorded as a list of absorption peaks for each microplastic sample shape. These results were then matched with a list of reference absorption peaks of each polymer type, and the abundance of microplastics was recalculated by excluding all verified non-plastics. A 70% matching rate is acceptable (L. Su et al., 2019)

Data Analysis

The results of previous sample testing are presented in tables and graphs, and the shape and size of microplastics are displayed in the form of images from microscope observations (Figure 5). Meanwhile, the FT-IR test results are presented as a table of wavelength-matching results with references to determine the type of polymer (Figure 2). The abundance of verified microplastics was calculated using formula 1 and the abundance of microplastics based on their characteristics (polymer, shape, and size) was calculated using formula 2:

$$\text{Verified microplastics (\%)} = \frac{\text{Verified Items}}{\text{Visually Identified Items}} \times 100 \quad ....(1)$$

$$\text{Abundance (\%)} = \frac{\text{Total verified particles}}{\text{Total microplastics}} \times 100 \quad \text{....................(2)}$$

The size and weight of bilih fish were recorded from twenty fish at each sampling point. After verification based on the results of the FT-IR test, the size and weight of fish with and without microplastic adsorption were separated and averaged. The results were then presented in the form of boxplot graphs to show the distribution of the majority of the size and weight data of bilih fish.

Then, to see if there is a significant difference between the abundance and characteristics of microplastics on the catchment path and the entire sampling point area, statistical analysis is carried out using the help of SPSS IBM Statistic 29 software. The inputted data is first seen for its normal distribution (normality of data) to determine whether the next test method is parametric or non-parametric. This study tested the hypothesis of a significant difference in the abundance of microplastics in digestion and respiration for all sampling points using the Kruskal-Wallis Test ($P < 0.05$). Moreover, the second hypothesis of a significant difference in the abundance of microplastics in the two suction pathways (digestion and respiration) was tested using the Mann-Whitney U Test ($P < 0.05$).

Results and Discussion

Microplastic Abundance in Bilih Fish (*Mystacoleucus padangensis*) from Various Sampling Points

Overall, 7.14%-23.53% (average = 11.48%) of microplastics were identified in the digestion tract of bilih fish from sixteen different sampling points. Meanwhile, 7.69% to 17.39% (average = 11.85%) of microplastics were identified in the respiration of bilih fish (Table 1). The average abundance of microplastics in bilih digestions ranged from 0.15-0.35 particles/location and 0.15-0.3 particles/location in bilih respiration for all sampling areas (Table 2).

Table 1. Percentage of verified microplastic abundance in bilih fish digestion and respiration system

Sampling Points	Fish	Visually identified items			Verified items			Verified items (%)		
		Digestion	Respiration	Total	Digestion	Respiration	Total	Digestion	Respiration	Total
S1	20	40	45	85	3	7	10	7.50	15.56	11.76
S2	20	17	20	37	4	3	7	23.53	15.00	18.92
S3	20	38	30	68	5	3	8	13.16	10.00	11.76
S4	20	39	48	87	3	4	7	7.69	8.33	8.05
S5	20	33	38	71	3	3	6	9.09	7.89	8.45
S6	20	48	33	81	4	5	9	8.33	15.15	11.11
S7	20	38	26	64	5	3	8	13.16	11.54	12.50
S8	20	42	30	72	3	3	6	7.14	10.00	8.33
S9	20	58	37	95	6	4	10	10.34	10.81	10.53
S10	20	42	39	81	4	3	7	9.52	7.69	8.64
S11	20	52	35	87	6	4	10	11.54	11.43	11.49

Sampling Points	Fish	Visually identified items			Verified items			Verified items (%)		
		Digestion	Respiration	Total	Digestion	Respiration	Total	Digestion	Respiration	Total
S12	20	41	23	64	5	3	8	12.20	13.04	12.50
S13	20	47	23	70	6	4	10	12.77	17.39	14.29
S14	20	35	20	55	4	3	7	11.43	15.00	12.73
S15	20	46	36	82	6	3	9	13.04	8.33	10.98
S16	20	38	24	62	5	3	8	13.16	12.50	12.90
Total		654	507	1161	72	58	130	11.48	11.85	11.56

Table 2. Verified microplastic abundance in bilih fish digestion and respiration system

Sampling Points	Average ± SD		Mann-Whitney U Test
	Respiration (particle/location)	Digestion (particle/location)	
S1	0.35 ± 0.73	0.15 ± 0.49	0.021
S2	0.15 ± 0.48	0.2 ± 0.52	
S3	0.15 ± 0.48	0.25 ± 0.63	
S4	0.2 ± 0.52	0.15 ± 0.48	
S5	0.15 ± 0.48	0.15 ± 0.48	
S6	0.25 ± 0.63	0.2 ± 0.61	
S7	0.15 ± 0.48	0.25 ± 0.71	
S8	0.15 ± 0.48	0.15 ± 0.48	
S9	0.2 ± 0.52	0.3 ± 0.73	
S10	0.15 ± 0.48	0.2 ± 0.52	
S11	0.2 ± 0.52	0.3 ± 0.57	
S12	0.15 ± 0.48	0.25 ± 0.71	
S13	0.2 ± 0.52	0.3 ± 0.57	
S14	0.15 ± 0.48	0.2 ± 0.52	
S15	0.15 ± 0.48	0.3 ± 0.65	
S16	0.15 ± 0.48	0.25 ± 0.55	
Kruskal-Wallis Test	0.922	0.982	

The abundance of microplastics in the digestion and respiration of bilih fish showed no significant difference between the abundance of microplastics for the two pathways (digestion and respiration) against the sampling point ($P>0.05$) even though microplastics were found in all areas of the sampling point. This could be because all fish sampled were at the same growth stage, so differences in fish size between individuals were not significant (Zhang & Wang, 2020). This analysis shows that microplastic consumption is proportional to fish size and weight. Physical characteristics of fish, such as mouth size and stomach volume, limit the ability of organisms to swallow them when these microplastics are mistaken for food (L. Su et al., 2019).

Identification of Polymers in Bilih Fish Digestif and Respiration *(Mystacoleucus padangensis)*

Of the 1161 particles identified from the digestion and respiration of bilih, 130 particles were confirmed to be plastic. The spectrum obtained can be seen in Figure 2 and the graphs can be seen in Figure 4. The three types of polymers identified included polyethylene terephthalate (PET) with a percentage of 51.67%; polyvinyl chloride (PVC) with a percentage of 29.58%; and polyethylene (PE) with a percentage of 18.75% for digestion. Polyethylene terephthalate (PET) with a percentage of 51.58%; polyvinyl chloride (PVC) with a percentage of 33.32%; and polyethylene (PE) with a percentage of 15.10% for respiration.

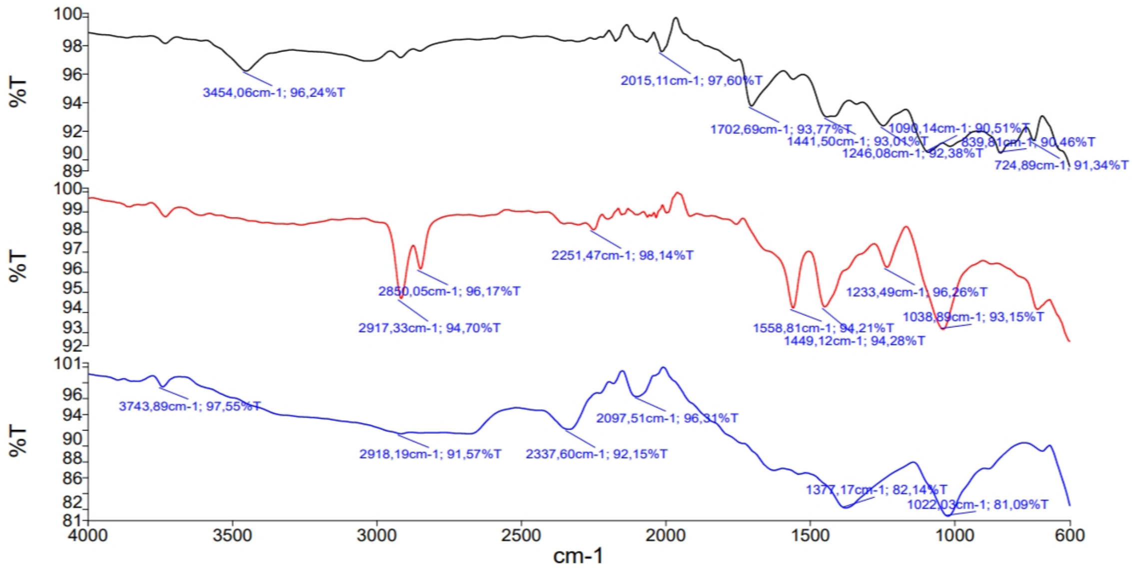

Figure 2. Perkin Elmer FT-IR test results for a. PET, b. PVC, and c. PE

Seventy-two microplastic particles, consisting of three different polymer types, were identified in the digestive tract of bilih fish, while 58 microplastic particles were found in the respiratory tract. PET was the most abundant polymer type identified in the digestion tract of bilih fish in all sampling point areas. The percentage of polymer abundance and the level of abundance in all sampling point areas can be seen in Figure 3 and Figure 4 which is closely related to Tables 3 and 4 in the supplementary material.

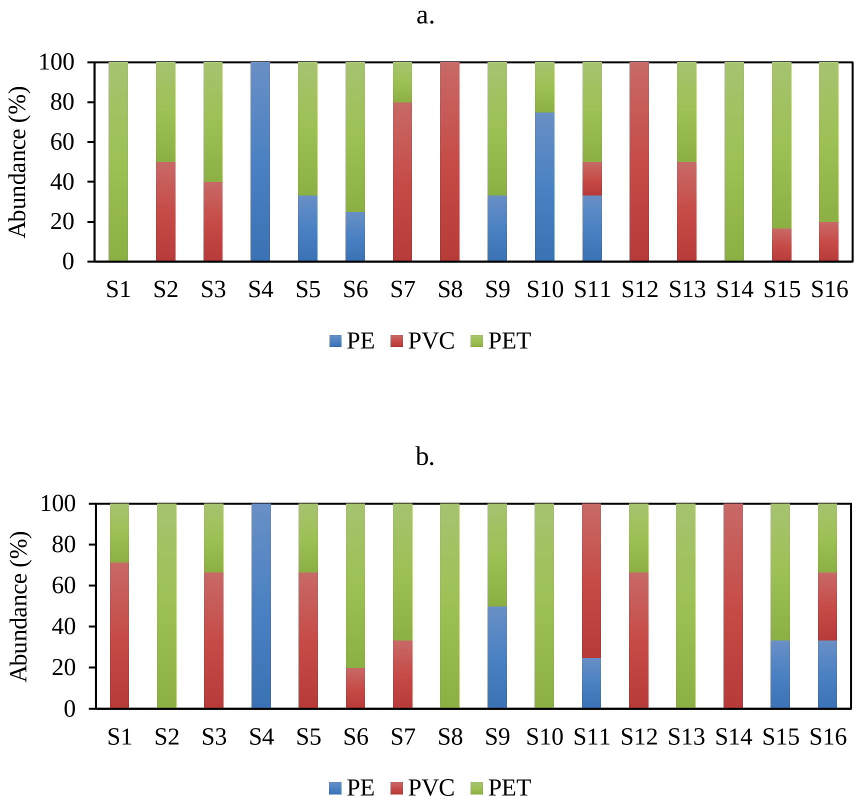

Figure 3. Percentage of polymers identified in the whole sampling point area (a. digestion, and b. respiration)

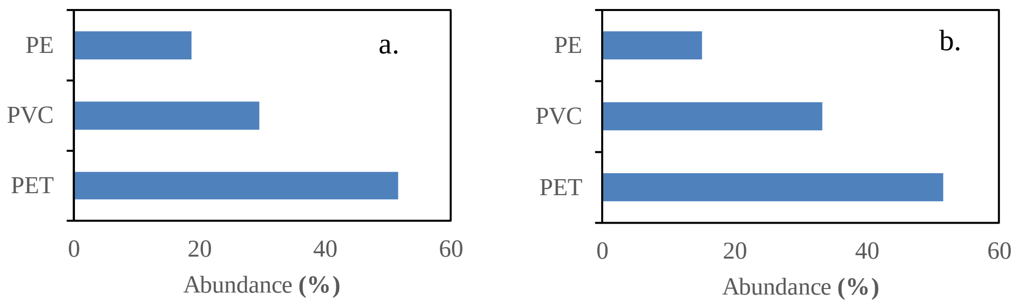

Figure 4. Abundance levels of polymers identified in the whole sampling point area (a. digestion, b. respiration)

Characterization of Microplastics in Digestions and Respiration of Bilih Fish *(Mystacoleucus padangensis)*

The results in all areas of positive sampling points contained microplastics in the form of fibers and fragments with fluctuating abundance. Fiber is the most abundant form of microplastics identified in both the digestion and respiration of bilih fish with an average abundance of 70.42% in digestion and 66.82% in respiration. The percentage of fiber in the digestion of bilih fish is higher than the percentage of fiber in the respiration of bilih fish. The lowest percentage identified was fragmented, with an average abundance of 29.58% in digestion and 33.32% in respiration. Fiber is the dominant form of microplastics in Lake Singkarak bilih fish samples with an average abundance of 67.38% from all locations. This result is by previous studies for microplastic composition observed in many freshwaters around the world (R. Su & Sun, 2021) (Xiong et al., 2022) (Yuan et al., 2019), with the proportion of fiber ranging from 55.2%-98.5%. The following forms of microplastics identified in bilih fish can be seen in Figure 5 below.

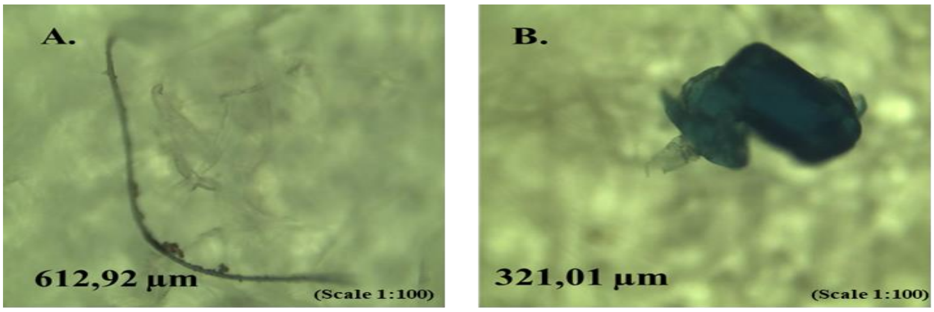

Figure 5. Forms of microplastics identified in bilih fish (A: fiber, B: fragment)

The size of microplastics in this study was calculated based on images identified through a microscope with the help of the Moticplus application. The results were then classified into three size categories, namely >0.5 mm, 0.5-1 mm, and 1-2 mm, and compared the two pathways of microplastic uptake, namely digestion and respiration, in all sampling areas. Based on the three size categories, the highest percentage of microplastic abundance was in the <0.5 mm size with a percentage of 57.19% in digestion and 55.73% in respiration, followed by the 0.5-1 mm size with a percentage of 40.73% in digestion, and 33.85% in respiration, the lowest was 2.08% in digestion and 10.42% in respiration for the 1-2 mm category. These results are from previous research conducted by (Ghorbaninejad Fard Shirazi et al., 2023), where the size of microplastics ranged from 50-500 µm or 0.05-0.5 mm for various microplastics. This is different from other studies that generally found microplastics in larger sizes (1-5 mm). One factor that influences the size of microplastics is the source of microplastics and their transportation. The farther the initial location of waste disposal or things that can be a source of microplastics to water bodies, the farther the transportation of microplastics will be to reach Lake Singkarak and the more chemical and physical degradation processes will be experienced. Initially, microplastics that emerge into water bodies can be larger particles and then break down into smaller particles over time and environmental exposure (Syamsu et al., 2024).

Microplastic Uptake by Size and Weight of Bilih Fish *(Mystacoleucus padangensis)*

Based on Figures 6 and 8, the microplastic abundance is calculated as the number of particles per fish at each sampling point. The average microplastic abundance is determined by comparing the number of verified microplastic particles in the digestive and respiratory systems of bilih fish with the number of fish studied at each sampling point. These were identified in bilih fish ranging from 8 to 10 cm in size, with an average weight of 1.7 g for each sampling point. The size and weight of bilih fish with microplastics found in the digestion and respiration were significantly greater than those without microplastics (P<0.05) (Figures 7 and 9).

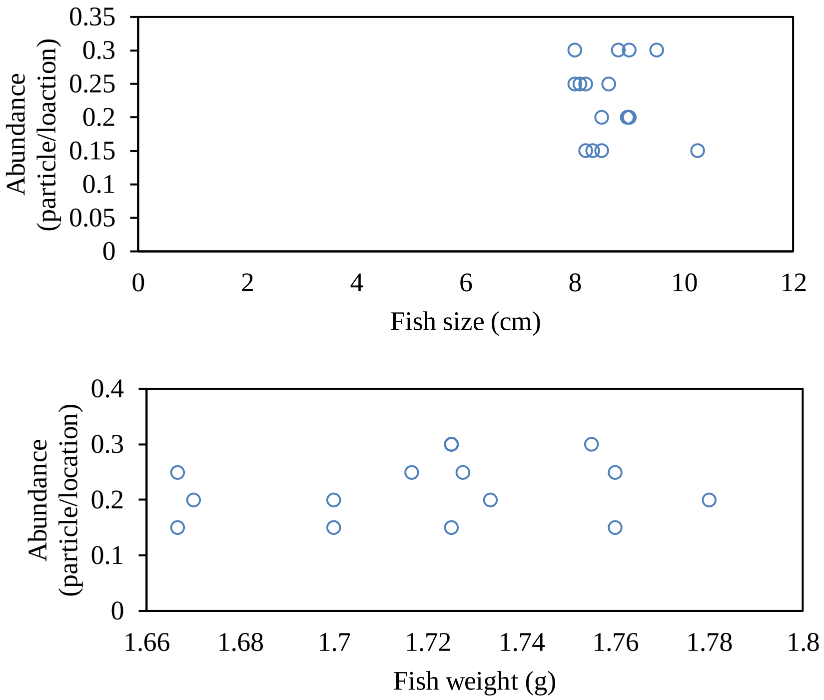

Figure 6. The microplastic abundance of size and weight of bilih fish for the digestion track

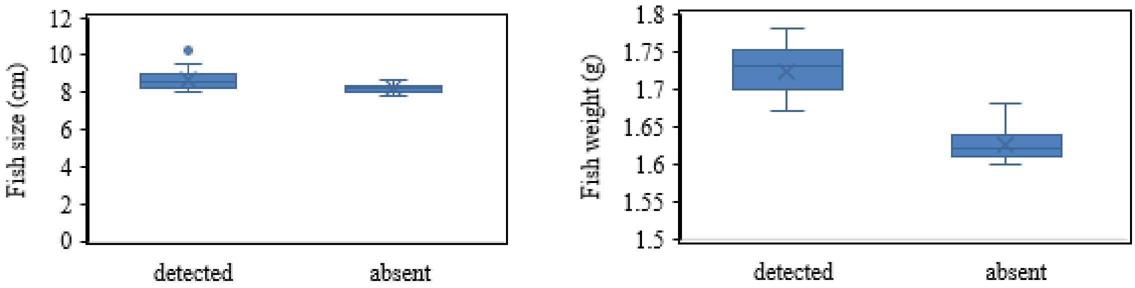

Figure 7. Size and weight distribution of digestion parts of bilih fish with and without microplastics (P<0.05)

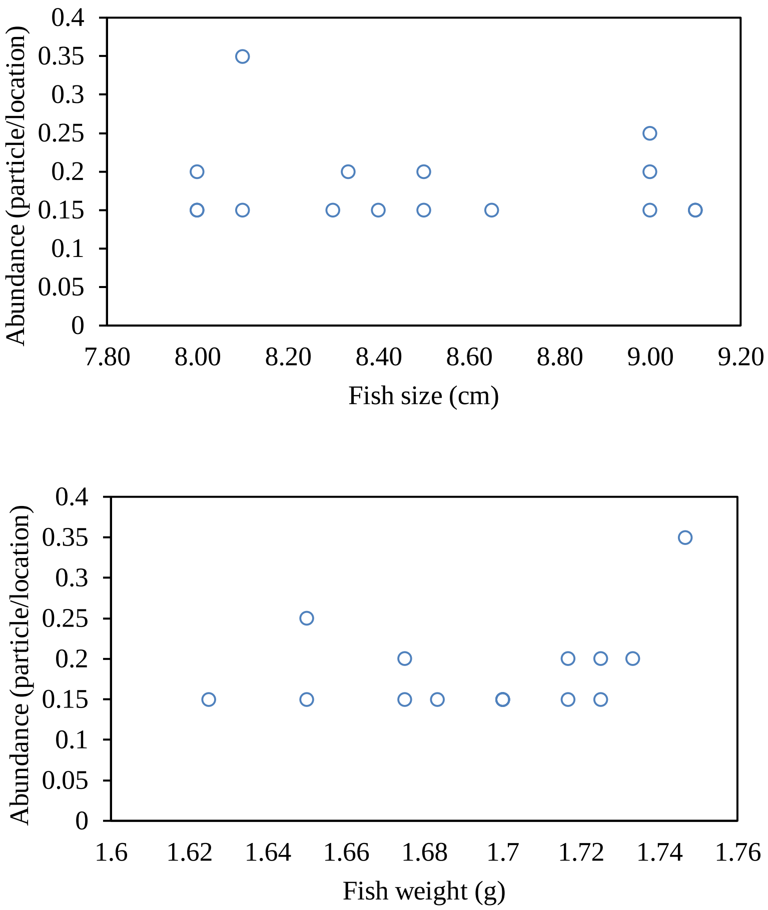

Figure 8. The microplastic abundance of size and weight of bilih fish for the respiration track

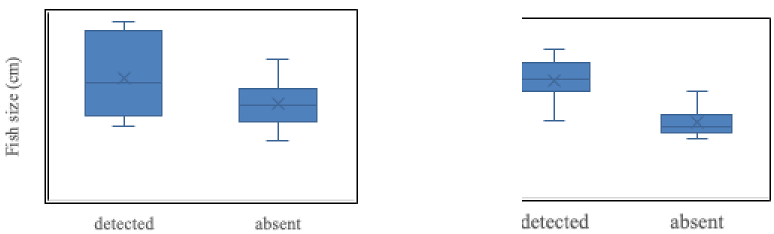

Figure 9. Size and weight distribution of respiration parts of bilih fish with and without microplastics (P<0.05)

Significant differences in results between the size and weight of bilih fish were found in this study. This proves that the abundance of microplastics in bilih fish is influenced by the size and weight of the fish, so the larger and heavier eastern mosquito fish have also documented the same thing. When microplastics are mistaken for food, the fish's physical characteristics, such as mouth size and stomach volume, will limit the ability of the fish to swallow them (Jones et al., 2020).

Conclusion

From the analysis of microplastic abundance in the digestion and respiration of bilih fish (Mystacoleucus padangensis) in Lake Singkarak, it can be concluded as follows. The polymers identified in this study are PE, PVC, and PET. Overall, 7.14%-23.53% (average = 11.48%) of microplastics were identified in the digestion tract of bilih fish from sixteen different sampling points. While 7.69%-17.39% (average = 11.85%) of microplastics were identified in the respiration of bilih fish. The highest percentage of the abundance of microplastic forms in the digestions identified was fiber at 70.42% and 66.82% in the digestions. At the same time, the lowest percentage identified was fragmented, with an average abundance of 29.58% in digestion and 33.32% in respiration.

Significant differences in results were identified between the size and weight of bilih fish and the abundance of microplastics found in the digestion and respiration of bilih fish ($P<0.05$). The size and weight of bilih fish with microplastics found in the digestion and respiration were significantly greater than fish without microplastics ($P<0.05$).

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