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Levels of Microplastics in Aquatic Ecosystem Components of the Kedung Ombo Reservoir, Central Java: Analysis of Water, Tilapia (*Oreochromis mossambicus*), Sediment, Macroalgae, and Gastropods

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ABSTRACT

The widespread use of plastics in daily activities poses a significant threat to aquatic environments and human health, primarily because plastics degrade into microplastics that easily accumulate in biota and may cause harm when ingested. The aim of this study was to identify the abundance and types of microplastics in water, gastropods, tilapia fish, macroalgae, and sediments. This study was conducted from September to December 2024 in the Kedung Ombo Reservoir. The abundance, shape, and size of microplastics were analyzed using an Olympus CX23 binocular microscope with a 4×/0.10 objective lens. Polymer type analysis of the microplastics was conducted using Fourier Transform Infrared (FTIR) spectroscopy. The abundance of microplastics found at each observation station, consisting of water, gastropods, tilapia fish, macroalgae, and sediment samples, was 122, 2,088, 2,700, 1,036, and 8,847 particles/kg, respectively. Microplastics were classified based on their size into small (<0.5 mm), medium (0.5-<1 mm), and large (1-5 mm), with percentages of 72%, 13%, and 15%, respectively. The shapes of the detected microplastics included fibers (39%), fragments (19%), films (17%), pellets (15%), and foams (11%). The microplastics detected were black (33%), red (15%), purple (6%), yellow (12%), blue (8%), green (6%), and clear (20%). The microplastics identified were polyethylene terephthalate (PET), polyethylene (PE), and polystyrene (PS). The abundance of microplastics has been detected in various compartments of the Kedung Ombo Reservoir. This needs to be monitored regularly, because microplastic accumulation on organisms can be harmful to health and the environment.

HIGHLIGHTS

This study aimed to identify the abundance and types of microplastics in water, tilapia, macroalgae, sediments, and gastropods in the Kedung Ombo reservoir, Central Java, Indonesia, which is the second largest reservoir in the region. To date, no publications have addressed the abundance of microplastics in this reservoir.

1. INTRODUCTION

Plastic waste smaller than 5 mm in aquatic ecosystem worldwide is a pressing concern, as it can harm both aquatic ecosystem and humans. This is because the extremely small size of microplastics allows them to easily enter aquatic ecosystems. This process can then be transferred to humans through the food chain (Kalčíková, 2023; Jimoh et al., 2023; Berlino et al., 2021). Microplastics in organisms can cause irritation of the gastrointestinal tract, inhibit growth, disrupt reproductive systems, and even lead to death (Ariyunita et al., 2022). Microplastic pollution has been observed in almost all aquatic environments, both lotic and lentic, including rivers (Xia et al., 2023), lakes (Ephsy and Raja, 2023), estuaries (Lee et al., 2022), and even deep oceans (Tsuchiya et al., 2023). Based on these studies, it is highly likely that Indonesia is also affected by microplastics, as it is one of the largest producers of plastic waste owing to its high population density (Ismanto et al., 2023b).

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Research on the abundance of microplastics in lentic waters is still limited, with some studies, such as those by Adji et al. (2022) and Rahmayanti et al. (2022), conducted in the Rawa Jombor Reservoir in Central Java. Although these studies have been useful, similar research has not yet been conducted in the Kedung Ombo Reservoir. This reservoir is the second largest in Central Java, after the Gajah Mungkur Reservoir, and has been developed to meet the needs of surrounding communities. It is already used for irrigation, tourism, fisheries, agriculture, and hydropower (Purnomo and Chika, 2022). High human activity in the reservoir area inevitably results in plastic waste, along with other forms of waste. Microplastics can be found throughout water bodies, including the water surface, water column, and sediments (Zhao et al., 2023). Water contaminated with microplastics can easily pollute aquatic animals, either through food intake or absorption via the skin and gills (Jimoh et al., 2023).

One of the most commonly farmed aquatic species is tilapia (*Oreochromis mossambicus*), which is easy to cultivate, resilient to changing conditions, and widely consumed. Both wild and farmed tilapia feed on algae, which are primary producers in aquatic ecosystems. The dominant type of macroalgae found in the Kedung Ombo Reservoir is *Filamentous algae*, which has a higher capacity to retain microplastics than non-filamentous macroalgae (Li et al., 2024; Primawati et al., 2025). This ability increases the risk of tilapia consuming microplastics, which accumulate in their bodies (Bao et al., 2023). This is supported by Pratomo et al. (2020), who reported that tilapia is an omnivorous fish and a voracious feeder.

In addition to water and biota, microplastics can accumulate in sediments. Microplastics that initially float on the water surface gradually settle, leading to an increase in their concentration over time (Ismanto et al., 2023a). Microplastics in sediment can impact benthic macroinvertebrates (Haque et al., 2023). One group of benthic macroinvertebrates are gastropods, with *Pila ampullacea* being the species found in the Kedung Ombo Reservoir. This group feeds on the leaves, organic matter, detritus, and algae found in the sediments (Supriatna et al., 2023). Given their habitat and food sources, gastropods are likely to be contaminated with microplastics.

Therefore, the aim of this study was to identify the abundance and types of microplastics in water, tilapia, macroalgae, sediments, and gastropods. This research is expected to provide additional information regarding microplastic pollution in the reservoir's aquatic environment, serving as a baseline data source for future studies and ongoing monitoring. Furthermore, it could provide essential information for governments or Non-Governmental Organizations (NGOs) to raise public awareness and encourage better plastic waste management practices, ultimately contributing to the creation of a safe and healthy aquaculture environment.

2. METHODOLOGY

2.1 Description of the study site

The research area was the Kedung Ombo Reservoir area, which includes three regencies: Grobogan Regency, Boyolali Regency, and Sragen Regency (Figure 1). This reservoir is located at the foot of the Kendeng Mountains, with a water source originating from Mount Merbabu, covering an area of 4,800 ha, and an average depth of 12.8 m. The water source of this reservoir comes from the Jerabung, Tuntang, Serang, Lusi, and Juwana River Basins (DAS). There are two sub-DAS flows: the Serang River with a flow to the northeast and the Uter River with a flow from south to north (Larasati et al., 2024). This reservoir was built after a survey, investigation, and feasibility study in 1969, was officially inaugurated on May 18, 1991, and has been in operation until now (Buldan et al., 2021). The construction of this reservoir contributes to improving community welfare, especially in economic and social fields. The utilization of this reservoir includes tourism, fisheries, irrigation, agriculture, and hydroelectric power (Nasution and Wulandari, 2021).

2.2 Sampling method

This study was conducted from September to December 2024, with sampling conducted in September and October. The timing was chosen based on the transitional season in Indonesia, which is considered to be more stable owing to the minimal influence of wind direction and speed on surface currents (Rifai et al., 2020). The study began with the determination of sampling locations for water and sediment using a purposive sampling method, in which sampling points were selected based on specific criteria that represent the study area. Four stations were chosen to represent the entire reservoir: Floating Net Cage (FNC) (station 1), tourist area (station 2), reservoir inlet (station 3), and reservoir outlet (station 4) (Figure 1).

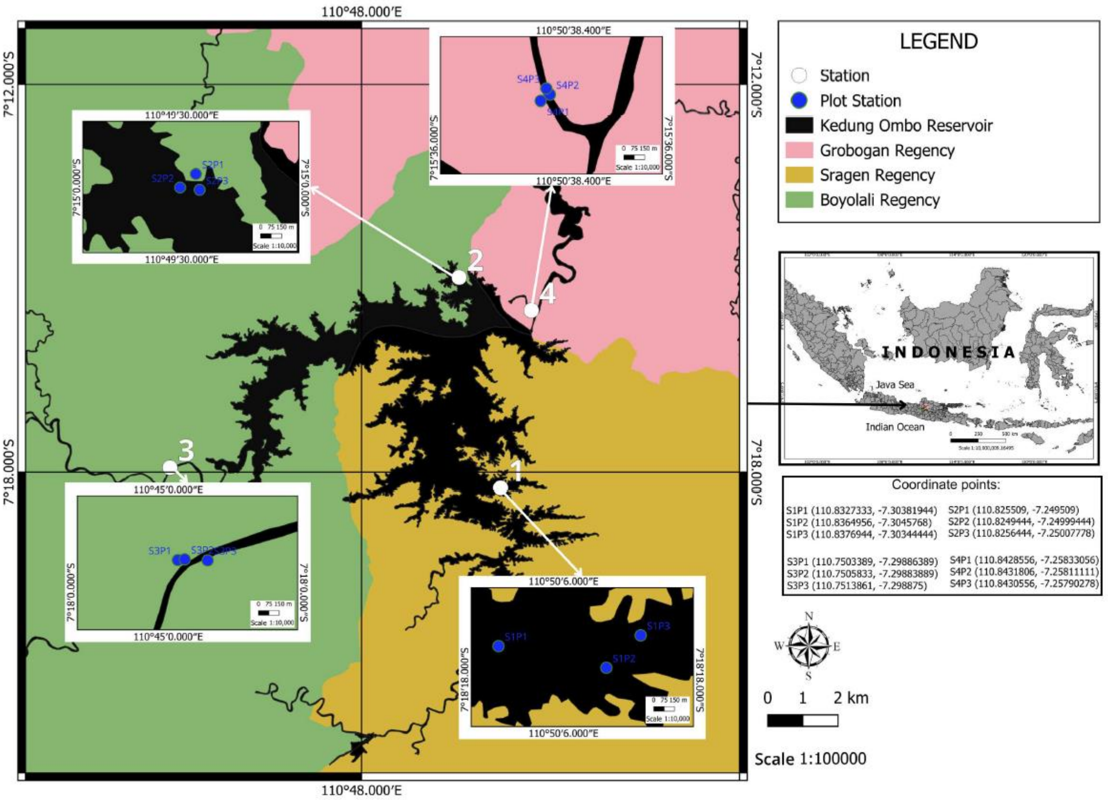


Figure 1. Location of the sampling stations in the Kedung Ombo Reservoir

The sampling method was also conducted using random sampling, which was applied to aquatic biota samples. Fish samples of consumable size were obtained from collectors and FNC (station 1), macroalgae samples were taken from FNC (station 1) and the tourist area (station 2), and gastropod samples were taken from the FNC (station 1) and the reservoir outlet (station 4).

The total samples analyzed included 24 water samples and 24 sediment samples collected from four (4) stations, with three (3) substations perstation. Additionally, eight (8) tilapia samples perstation were analyzed, with each fish sample divided into muscle and gastrointestinal tract samples. Four (4) gastropod and four (4) macroalgae samples were collected from each station.

2.3 Sample extraction method

2.3.1 Water

Upon arrival at the Laboratory of Fishery Resources and Environmental Management, FPIK, UNDIP-Semarang, 100 mL of a 30% H_2O_2 solution was added to each water sample, which was collected in 100 mL sample bottles to decompose organic matter. The bottles were then covered with aluminum foil (Haque et al., 2023; Wijayanti et al., 2023). The samples were incubated for 3 days in the dark before being filtered using Whatman No. 42 filter paper (pore size 2.5 μm) with the assistance of a vacuum pump (Anjeli et al., 2024).

2.3.2 Fish and gastropods

After weighing, the sample was extracted using a 10% KOH solution at a volume equivalent to two-thirds (2/3)of the sample's weight to dissolve organic particles surrounding the microplastics (Hassine et al., 2024). The sample was then incubated for 5 days at 40°C to ensure complete degradation, as indicated by a clear yellow solution and the presence of organic particle deposits in the beaker (Haque et al., 2023). After incubation, the samples were filtered through Whatman No. 42 filter paper using a vacuum pump.

2.3.3 Macroalgae

Upon arrival at the laboratory, sample extraction was performed using 1 mL of a 30% hydrogen peroxide (H_2O_2) solution to degrade organic matter, followed by storage at room temperature for five minutes. The sample was then maintained at 45°C until complete degradation (Taurozzi et al., 2024), after which microplastic filtration was performed using Whatman No. 42 filter paper with the assistance of a vacuum pump.

2.3.4 Sediment

Approximately 100 g of wet sediment sample was dried and sieved using a sieve shaker. All samples that passed through a 5 mm mesh sieve were weighed (3 g each) and mixed with a 30% hydrogen peroxide (H_2O_2) solution at a sample-to-solution ratio of 1:20 (1 g of sample to 20 mL of 30% H_2O_2 solution) (Haque et al., 2023; Anjeli et al., 2024). The samples were left to stand for six hours before adding an NaCl solution was added (prepared by dissolving 60 g of NaCl in 100 mL of distilled water and heating it on a hot plate/stirrer (PMC Data Plate Digital Model 739) at 25-40°C with a rotation speed of 300 rpm for 30 min). The sample was then centrifuged using a Gemmy Centrifuge (PLC-05 PLC 05) for two minutes at 1,000-4,500 rpm to obtain a supernatant containing microplastics, which was subsequently filtered using Whatman No. 42 filter paper with the aid of a vacuum pump. The remaining sediment sample underwent further density separation using a $ZnCl_2$ solution (density=1.70 g/mL), followed by centrifugation and microplastic filtration.

2.4 Observations on microplastic abundance

All microplastics filtered on Whatman filter paper were placed in Petri dishes and dried at 35°C for three hours until the filter paper was completely dry (Leitão et al., 2024). The dried samples were then examined under an Olympus CX23 binocular microscope using a 4×/0.10 objective lens to identify the shape, color, and abundance of microplastics.

2.5 Quality control

The samples obtained from the study location were transported using reusable containers that had been washed with distilled water (aquades) to minimize contamination. Upon arrival at the laboratory, the extraction procedure was performed using cotton lab coats and latex gloves (Haque et al., 2023). Furthermore, all the equipment used for sample extraction was made of non-plastic materials and also washed with aquades. To ensure the absence of microplastic contamination, a blank procedure was conducted using filter paper during the extraction process (Suparno et al., 2024). After completing the extraction and analysis procedures, the filter paper used in the blank procedure was analyzed using a microscope to ensure that no contamination occurred during the sample processing.

2.6 Calculation of microplastic abundance

The abundance of microplastics in water, aquatic biota, and sediment samples was calculated using the following formula (Anjeli et al., 2024).

$$\text{Microplastic abundance}\left(\frac{\text{particles}}{\text{Liter}}\right) = \frac{\text{a number of MPs particles}}{\text{filtered water volume}} \quad (1)$$

$$\text{Microplastic abundance}\left(\frac{\text{particles}}{\text{Kg}}\right) = \frac{\text{a number of MPs particles}}{\text{the wet weigh sample}} \quad (2)$$

$$\text{Microplastic abundance}\left(\frac{\text{particles}}{\text{Kg}}\right) = \frac{\text{a number of MPs particles}}{\text{the dry weigh sample}} \quad (3)$$

2.7 FTIR analysis

Fourier Transform Infrared (FTIR) analysis was conducted at the Research Center for Radioisotope Technology, Radiopharmaceuticals, and Biodosimetry (PRTRRB), National Research and Innovation Agency (BRIN), and Puspiptek-Serpong to identify the types of microplastics based on their polymer composition. Microplastic samples filtered on filter paper were placed in an FTIR spectrometer (Bruker Alpha II), which emits infrared light with a spectral range of 4,000-400 cm^{-1} and a spectral resolution of 2 cm^{-1}. The infrared rays emitted by FTIR are absorbed and re-emitted by the plastic polymer, generating an electromagnetic spectrum at specific wavelengths. Variations in these wavelengths correspond to differences in polymer types, facilitating the identification of microplastic compositions (Yona et al., 2021).

2.8 Data analysis

Microplastic data were analyzed for abundance using one-way analysis of variance (ANOVA) with the assistance of SPSS software (IBM SPSS Statistics 27). This analysis was used to determine whether there were significant differences in the average abundance of microplastics collected from each sampling station.

3. RESULTS AND DISCUSSION

3.1 Sample extraction method

3.1.1 Water

The microplastic abundance in the water samples taken from each observation station consecutively was 105±57 particles/L, 128±72 particles/L, 95±51 particles/L, and 158±51 particles/L (Figure 2). The average microplastic abundance across all stations was 122±28 particles/L, which is lower than that of Kaptai Lake, Bangladesh (131±67 particles/L) (Fardullah et al., 2025), but significantly higher than that of Yahekou Reservoir, China (6.68 particles/L) (Shen et al., 2025). Based on these results, no significant difference was found between the stations ($p<0.303$), with the highest value observed at the reservoir outlet area (station 4), which was 158±51 particles/L. A similar finding was reported by Rahmayanti et al. (2022), who compared the microplastic abundance between the inlet and outlet areas of the Rawa Jombor Reservoir in Central Java. The microplastic abundance in water samples from the outlet area was higher than that from the inlet, as the reservoir outlet was the final point of the water flow, after passing through the inlet and the entire reservoir area. Reservoirs used for floating restaurants, fishing areas, and Floating Net Cages (FNC) can lead to an increase in microplastic waste concentration, which is eventually carried to the outlet during the release of reservoir water.

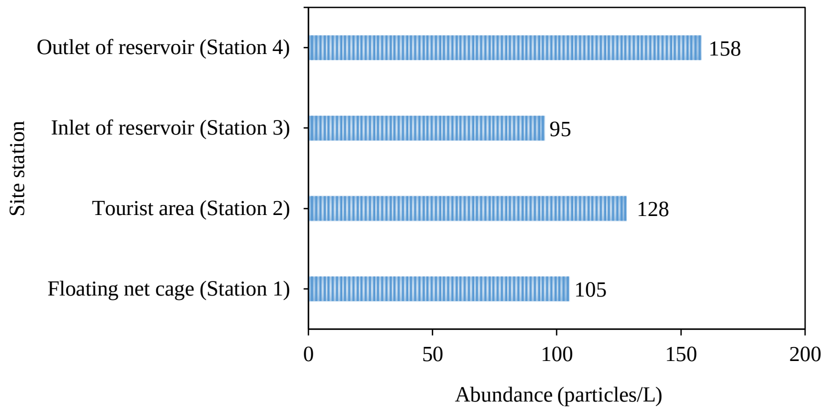


Figure 2. Average abundance of microplastics in water samples

3.1.2 Fish

The fish samples used in this study were of consumable size and suitable for human consumption. Wild fish tend to have smaller body lengths and weights than farmed fish from Floating Net Cages (FNC), as their food acquisition depends on natural foraging in aquatic environments. The average weight of the cultivated fish samples was approximately 189 g, while that of the wild fish was 105 g. The results of microplastic abundance detected in wild fish showed an average of 3,398±1,628 particles/kg, which was higher than that of cultivated fish samples, which had an average microplastic abundance of 2,003±393 particles/kg (Table 1). These results indicated a significant difference ($p<0.001$). Based on these findings, it can be concluded that the weight of fish does not correlate with the abundance of microplastics accumulated in their bodies. This aligns with the research of Haque et al. (2023), which rejects the initial assumption that larger fish require more energy, thus requiring more food and ultimately accumulating more microplastics. The weight and length of the fish did not influence their microplastic accumulation capacity. One factor that affects microplastic accumulation in fish is the method of food acquisition. Herbivores, planktivores, and omnivores are at a higher risk of microplastic exposure compared to fish with other feeding patterns (Adji et al., 2022).

Tilapia (*Oreochromis mossambicus*), an omnivorous fish known for its voracious appetite, tends to accumulate more microplastics in wild populations than farmed tilapia from FNC, because food in FNC systems is more controlled and limited. Microplastics that accumulate in fish bodies have the potential to enter the human food chain through consumption. Exposure to microplastics poses multidimensional health risks through various pathways, such as ingestion, inhalation, and skin contact. Although research on the long-term impacts of microplastics is ongoing, preliminary evidence suggests that the accumulation of these particles can affect the human digestive, hormonal, respiratory, and cardiovascular systems. Therefore, it is crucial to promote preventive efforts to reduce microplastic exposure to safeguard human health and environmental sustainability (Emenike et al., 2023).

A comparison of microplastic abundance in fish muscle and gastrointestinal tract (GIT) was also conducted to determine the potential intake of microplastics into the body of fish. The microplastic abundance in the GIT, measured at 2,428±1,283 particles/kg, was higher than that in the fish muscle, which was 272±123 particles/kg, showing a highly significant difference ($p<0.001$), as shown in Figure 3. A study by Adji et al. (2022) also indicated that the abundance of microplastics in the gastrointestinal tract of fish was higher than that in the gills and muscles. Microplastics can enter the body of fish through the digestive system, where they are absorbed by the blood and transported throughout the body (Aryani et al., 2021).

Table 1. Average abundance of microplastics in tilapia fish samples

Fish sample	x̄ wet weight (g)	x̄ length (cm)	x̄ width (cm)	x̄ microplastic abundance (particles/kg)
Cultivated	189±45.5	18.5±7.0	6.0±2.1	2.003±393
Wild	105±27	17.1±1.5	5.2±0.6	3.398±1.628

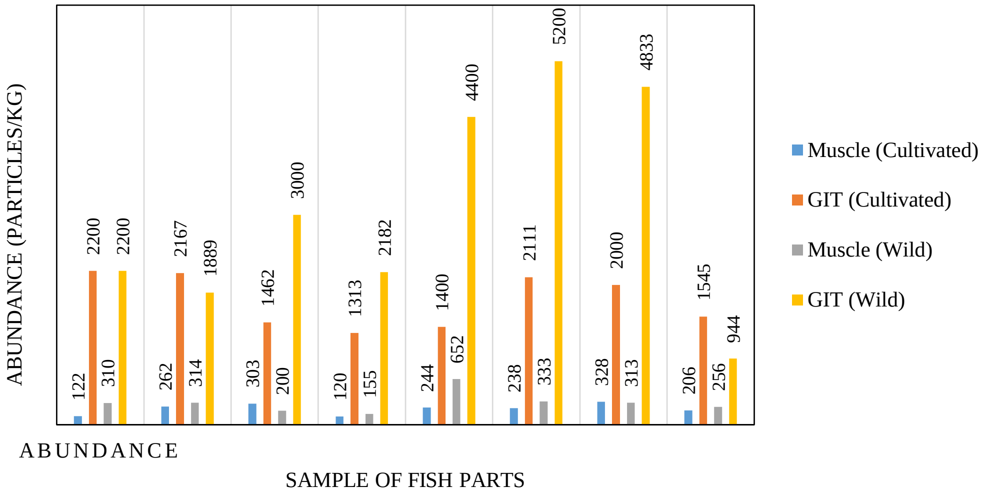


Figure 3. Average percentage of microplastic abundance in fish muscle and gastrointestinal tract samples

3.1.3 Macroalgae

The macroalgae found in the Kedung Ombo Reservoir are *Filamentous algae*. The microplastic abundance in the macroalgal samples was 964±237 particles/kg and 1,107±244 particles/kg, with the highest value observed at the tourist station (station 2), although no significant difference was found ($p<0.434$) (Figure 4). The wild-growing macroalgae in this reservoir serve as a food source for wild fish that are not farmed in cages. Most fish caught by fishermen (wild fish) feed on *Filamentous algae*, which represent the first trophic level in the food chain of this reservoir. *Filamentous algae* can capture microplastics because their branched surfaces. Microplastics not only adhere to them but can also become entangled, trapped, and caught in *Filamentous algae* (Li et al., 2024). This finding aligns with the results of this study, which indicate that fish that consume *Filamentous algae* contain higher levels of microplastics than fish that eat pellets.

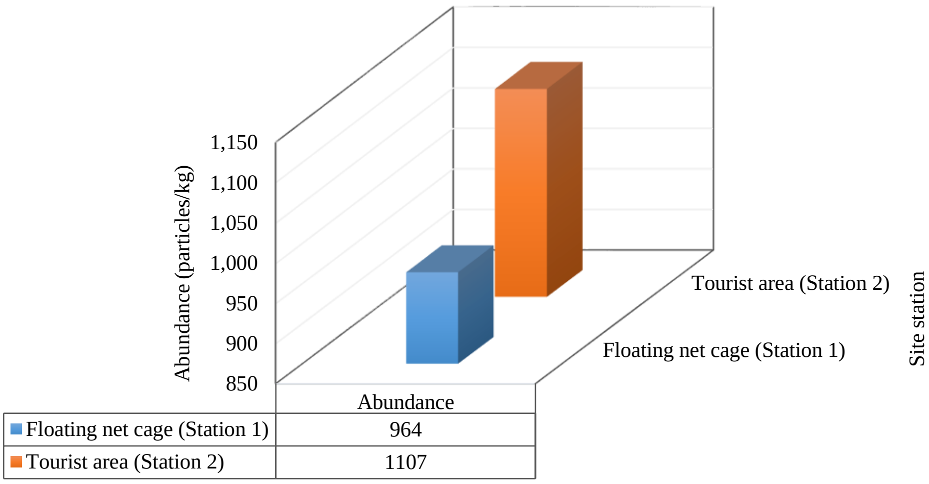


Figure 4. Average percentage of microplastic abundance in macroalgae samples

3.1.4 Sediment

The microplastic abundance in sediment samples taken from each observation station consecutively was 8,417±3,452 particles/kg, 11,111±2,711 particles/kg, 7,833±1,085 particles/kg, and 8,028±1,474 particles/kg. The average microplastic abundance across all stations was 8,847±1,529 particles/kg, which was higher than that of the Yahekou Reservoir, China (491 particles/kg) (Shen et al., 2025). These results indicate no significant difference between the stations ($p<0.140$), with the highest value recorded at the tourist station (station 2) at 11,111±2,711 particles/kg. This finding contrasts with the microplastic abundance in the water samples, where the highest value was found in samples taken from the reservoir outlet (Figure 2). One of the factors influencing microplastic abundance in sediment is current velocity (Rahmayanti et al., 2022). Stronger river-shaped currents at the reservoir outlet make it more difficult for microplastics to settle into the sediment. In contrast, the tourist area, which has calmer water, allows microplastics to settle more easily. The utilization of the tourist station (station 2) for fishing, floating restaurants, and Floating Net Cages (FNC) has led to higher microplastic abundance at this station compared to other stations. The microplastic abundance in sediment samples was much higher than that in other samples (Figures 9, 11), consistent with the findings of Ismanto et al. (2023b), which suggest that microplastics initially float on the water surface due to the current. Over time, microplastics begin to settle and accumulate in the sediment, making them a gradual repository for accumulated microplastics.

3.1.5 Gastropods

The gastropod samples obtained from the floating net cage area (station 1) and the reservoir outlet (station 4) consisted of Apple Snail (*Pila ampullacea*). The microplastic abundance in the gastropod samples was recorded as 2,456±867 particles/kg and 1,719±403 particles/kg, respectively. The highest value was observed in the sample obtained from the FNC (station 1), but no significant difference was observed ($p<0.174$) (Figure 6). Gastropods can be contaminated with microplastics both directly and indirectly, either from microplastics carried by water or from those settled in the sediment (Supriatna et al., 2023). This indicates that microplastic abundance in the sediment is directly proportional to microplastic accumulation in the bodies of gastropods. In line with this study, the microplastic abundance in the sediment at the FNC (station 1) was higher than that at the reservoir outlet (station 4) (Figure 5), which corresponds with the results of microplastic abundance in the gastropod samples living in these areas (Figure 6).

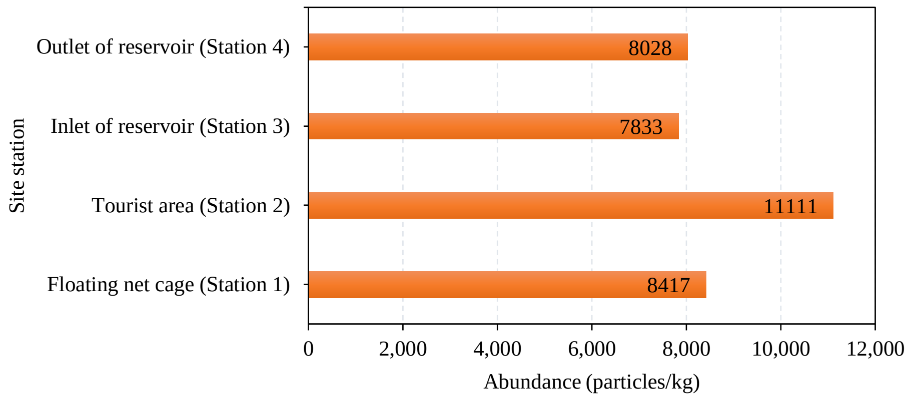


Figure 5. Average of microplastic abundance in sediment samples

3.2 Size of microplastic

The size of the microplastics in this study was divided into three categories: small (<0.5 mm), medium (0.5-<1 mm), and large (1-5 mm). The microplastic size percentages, in order, were 72%, 13%, and 15%, with small microplastics dominating (Figure 7). The percentages of microplastics in each sample, starting from the smallest size, were as follows: water (84%, 8%, and 8%), sediment (71%, 12%, and 16%), gastropods (74%, 12%, and 14%), macroalgae (79%, 16%, and 5%), and fish (77%, 9%, and 14%, respectively). These results are also in line with those of the study by Haque et al. (2023), conducted in the Buriganga River, Bangladesh. The percentage of microplastics smaller than 0.5 mm was dominant, which can be interpreted as an indication of long-term microplastic pollution in the water. This is due to the slow degradation of plastics under sunlight.

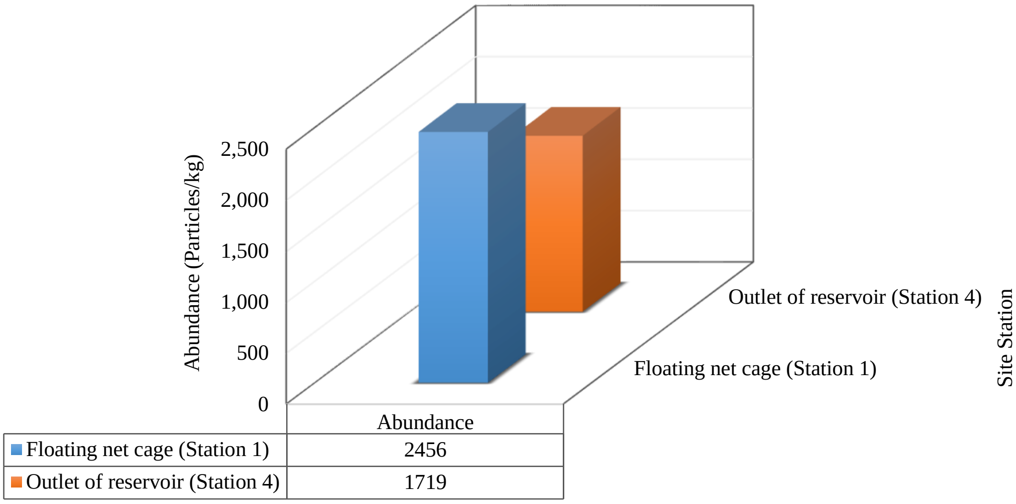


Figure 6. Average of microplastic abundance in gastropod samples

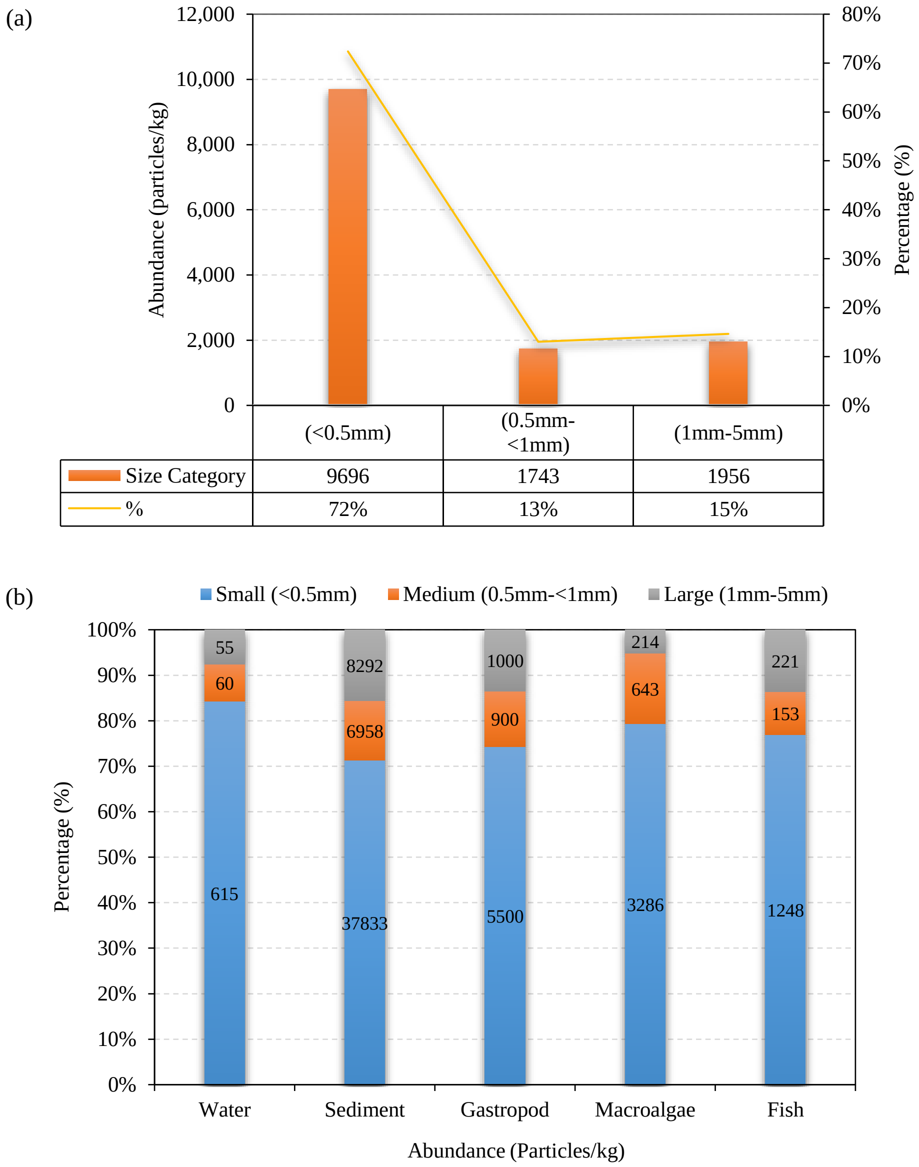


Figure 7. Microplastic abundance based on (a) size category and (b) sample category

3.3 Forms of microplastic

The forms of microplastics found in this study were divided into five categories: fiber, fragment, film, pellet, and foam (Figure 8), with the following percentage results: 39%, 19%, 17%, 15%, and 11%, respectively (Figure 9). The most common form of microplastics was fiber (39%). This is understandable, as the reservoir is also used for Floating Net Cages (FNC) and fishing activities that involve nets and other fishing gear. Plastic-based fishing gear is a source of microplastic pollution in the form of fibers (Ismanto et al., 2023b). The second-highest percentage, after fiber, was fragments (19%). Fragment microplastics originate from the degradation of larger plastics, such as beverage bottles and other single-use plastic packaging (Cordova et al., 2022; Cordova et al., 2019).

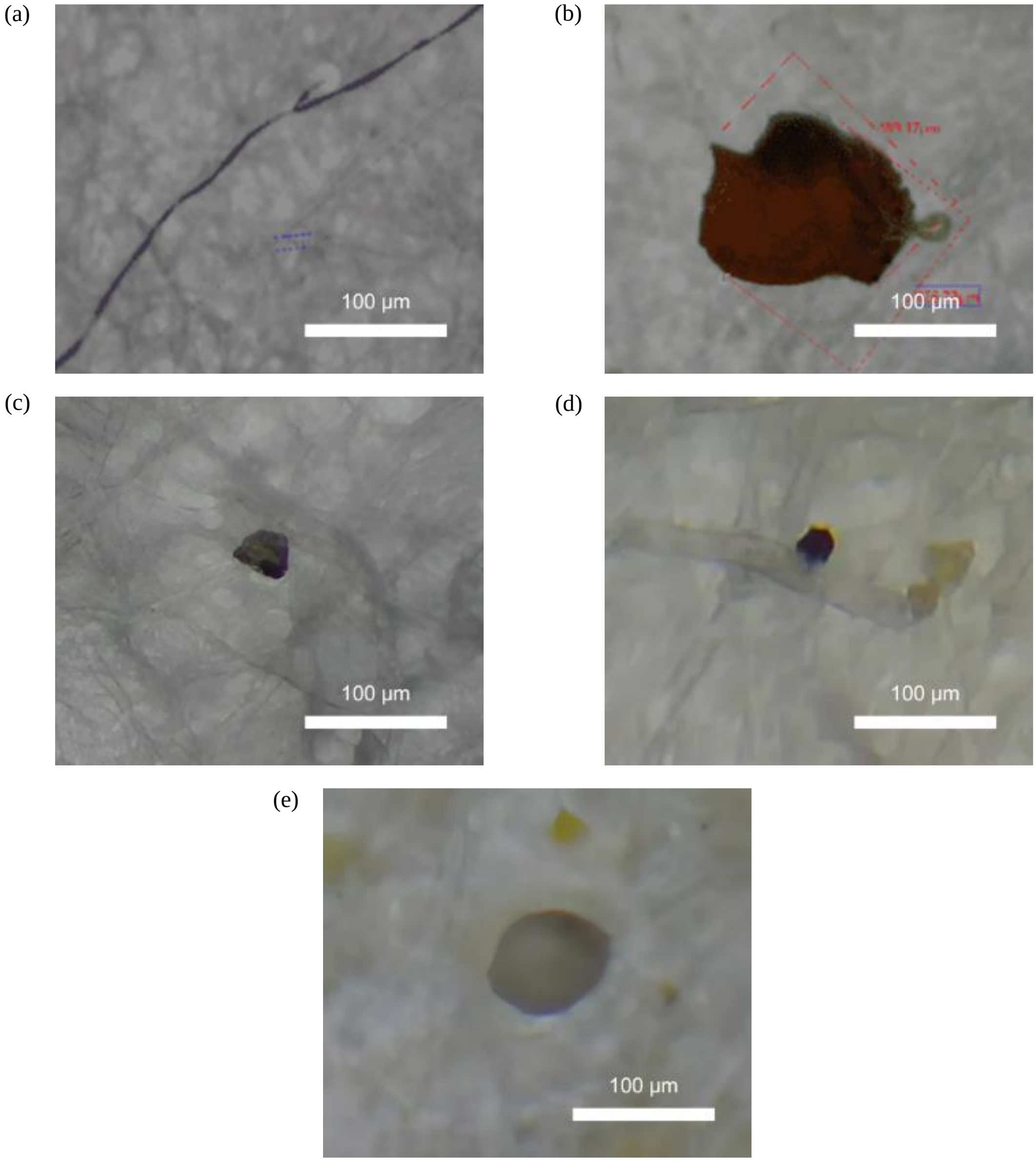


Figure 8. The form of microplastic (a) Fiber, (b) Fragment, (c) Film, (d) Pellet, and (e) Foam

3.4 Colors of microplastic

In addition to observing the size and shape of microplastics, a binocular microscope can be used to examine the color of microplastics. In this study, several colors of microplastics were found, including black, red, purple, yellow, blue, green, and clear (Figure 10), with percentages of 33%, 15%, 6%, 12%, 8%, 6%, and 20%, respectively (Figure 11). The majority of microplastics found were black. Black microplastics may indicate the amount of pollutants absorbed by them (Laksono et al., 2021). Dark colored microplastics, such as red, purple, yellow, blue, and green, suggest that these microplastics have not undergone significant change or have retained the original color of their plastic source, while transparent microplastics indicate photochemical degradation due to ultraviolet (UV) light exposure (Anjeli et al., 2024). The presence of color in microplastics is believed to have little impact on their characteristics, as microplastics have subjective traits and cannot be used as a reference for visual identification. However, identifying color can be useful in the study of aquatic organisms, as some species consume microplastics present in aquatic environments (Frias and Nash, 2019).

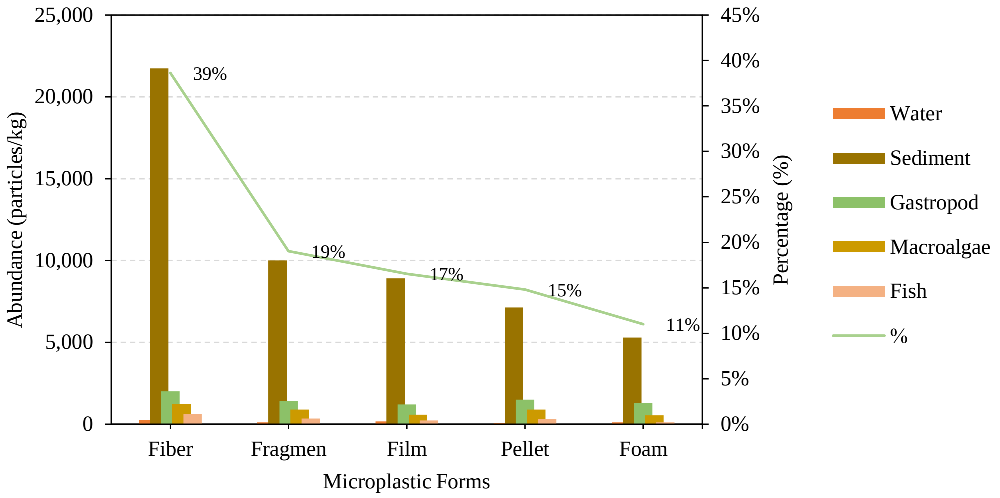


Figure 9. Percentage of microplastic quantity based on form

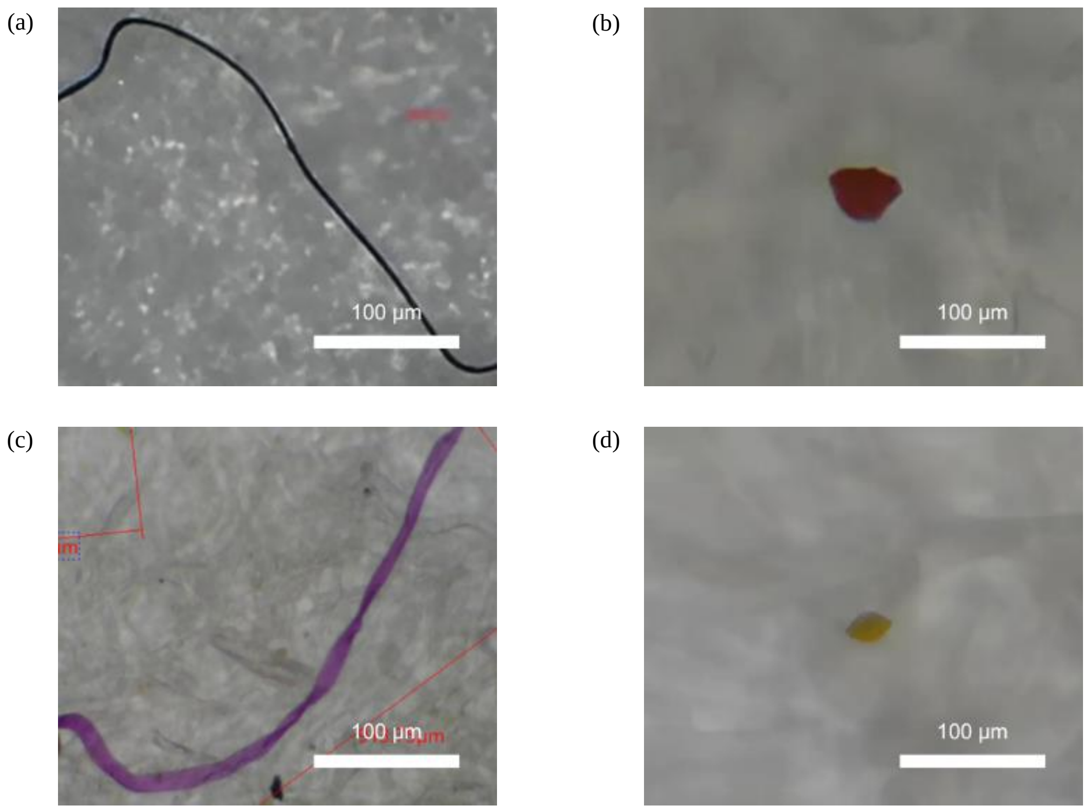
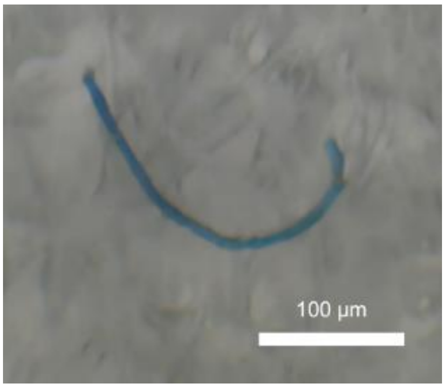


Figure 10. The color of microplastics (a) Black, (b) Red, (c) Purple, (d) Yellow, (e) Blue, (f) Green, and (g) Clear

(e)



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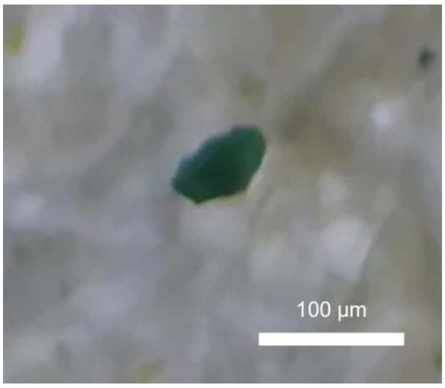

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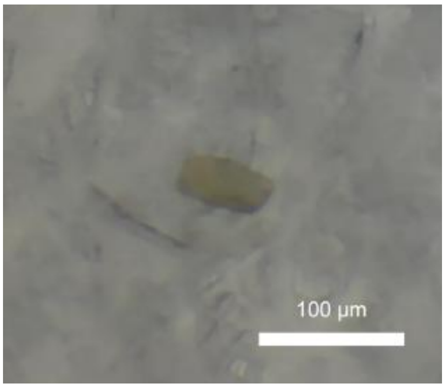


Figure 10. The color of microplastics (a) Black, (b) Red, (c) Purple, (d) Yellow, (e) Blue, (f) Green, and (g) Clear (cont.)

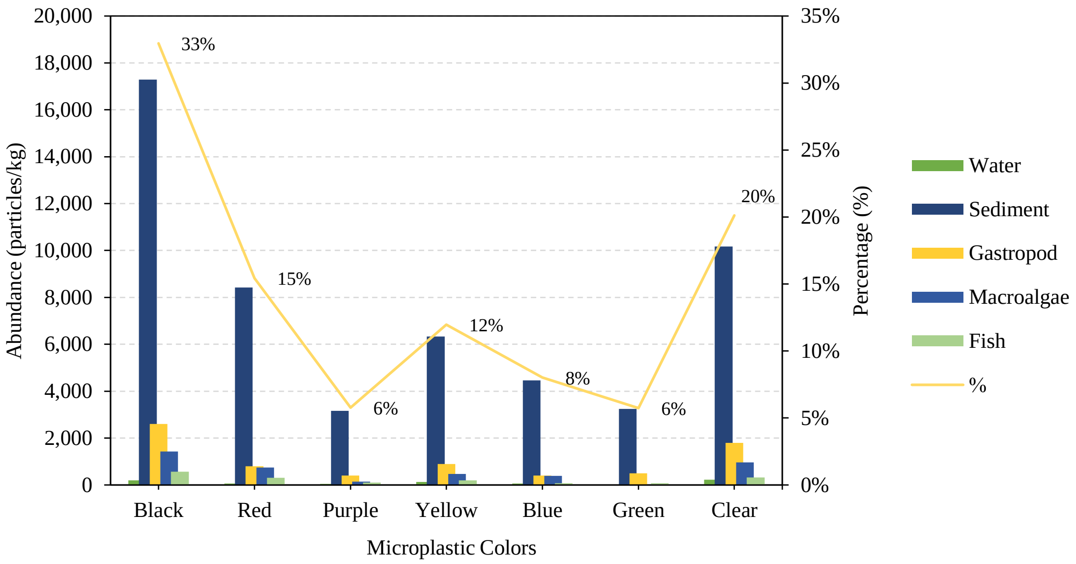


Figure 11. Percentage of microplastic quantity based on color

3.5 Types of microplastic

The microplastic types were determined using FTIR analysis, conducted at the Radioisotope Application Laboratory for Environmental Studies, Center for Radioisotope, Radiopharmaceutical, and Biodosimetry Technology Research, National Research and Innovation Agency (BRIN), Puspiptek-Serpong. The FTIR (Fourier Transform Infrared) analysis results (Figure 12) showed the presence of similar functional groups, namely hydroxyl/hydroxide groups, OH (3,331 cm^{-1}, 3,337 cm^{-1}, 3,338 cm^{-1}, and 3,283 cm^{-1}), C=C groups (1,625 cm^{-1}, 1,631 cm^{-1}, and 1,573 cm^{-1}), and C-O groups (1,029 cm^{-1}, 1,097 cm^{-1}, 1,029 cm^{-1}, and 1,054 cm^{-1}) (Figure 13). Based on these findings, the plastics identified are likely to be polyethylene terephthalate (PET/PETE), polyethylene (PE), and polystyrene (PS)

(Käppler et al., 2016; Veerasingam et al., 2021; Yona et al., 2021).

Research on the FTIR analysis of microplastics has been conducted in several aquatic environments in Indonesia, such as the study by Supriatna et al. (2023), which identified nine types of microplastic polymers in rivers in Surabaya, East Java Province. The polymers found in sediment were PVC, PET, Nylon, CA, PP, PE, PS, PA, and PMMA (Polymeric Methyl Methacrylate). The most common polymers found in the waters of Surabaya are PS, PP, and PE. A similar study was also conducted in one of the reservoirs located in Central Java Province, namely the Rawa Jombor Reservoir, by Adji et al. (2022) and Rahmayanti et al. (2022). In a study by Adji et al. (2022), the polymers identified in the water and sediment samples from the reservoir included Nitrile, Latex, HDPE, EVA, Nylon, LDPE, and PP. The polymers found in aquatic biota samples from the reservoir were PS, EVA, Nitrile, Latex, PET, PE, and PP. The aquatic biota species studied by Rahmayanti et al. (2022) included zooplankton, benthos, and fish.

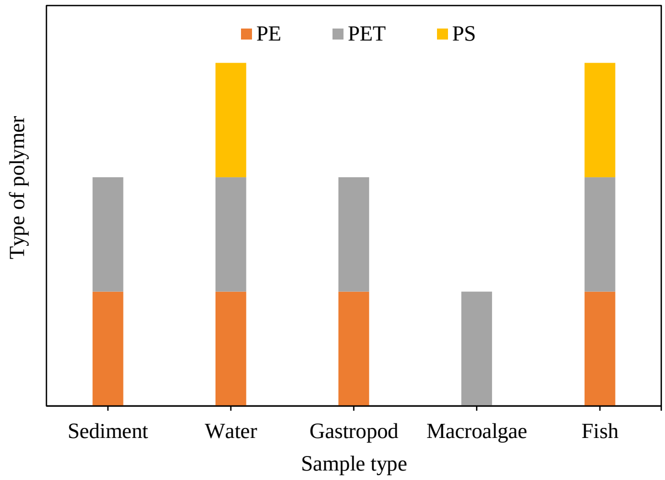


Figure 12. Types of plastic polymers detected from FTIR results

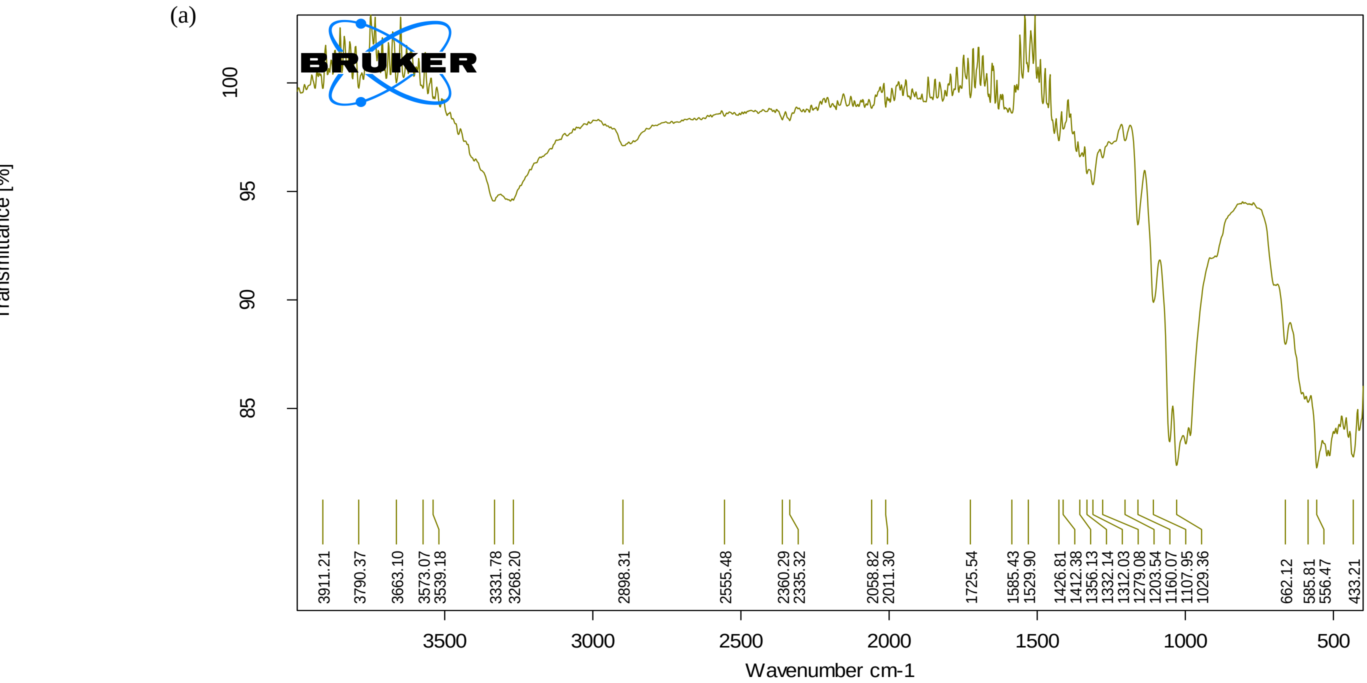
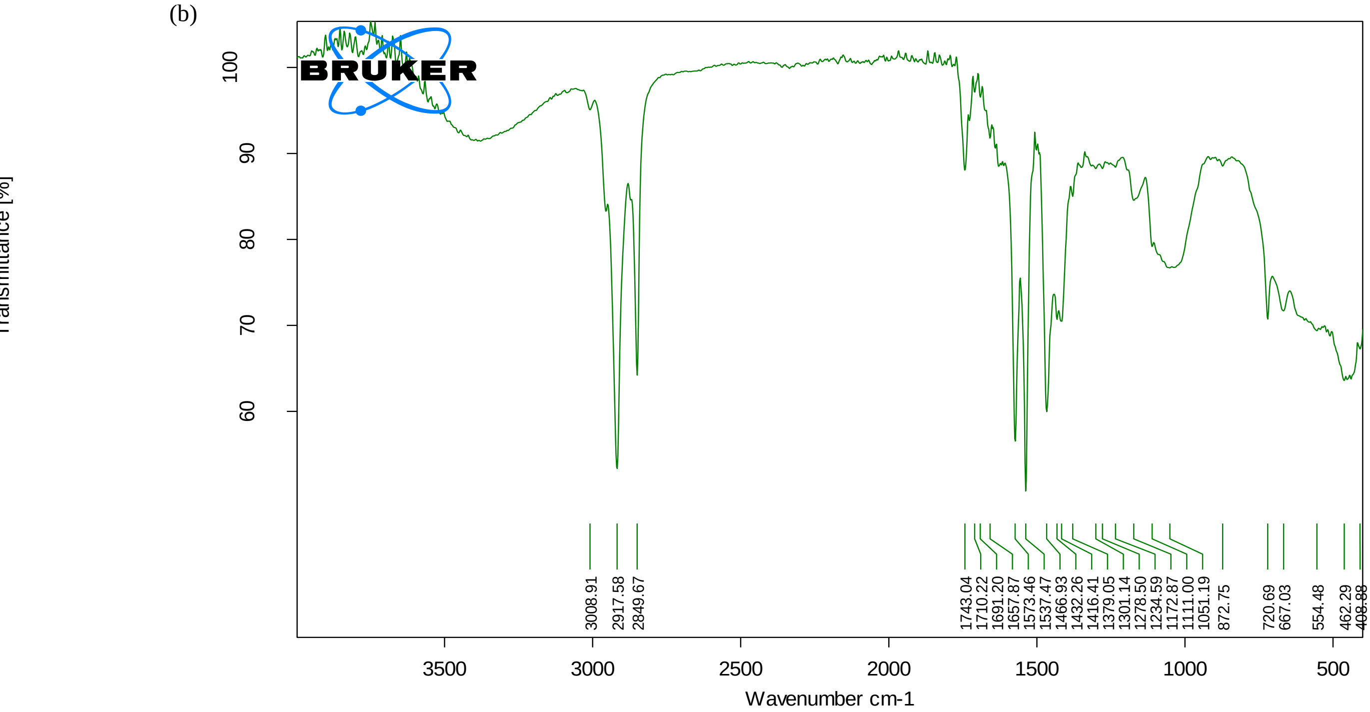


Figure 13. FTIR analysis results of microplastics in (a) water sample, (b) tilapia GIT sample, (c) tilapia muscle sample, (d) macroalgae sample, (e) sediment sample, and (f) gastropod sample

(b)



(c)

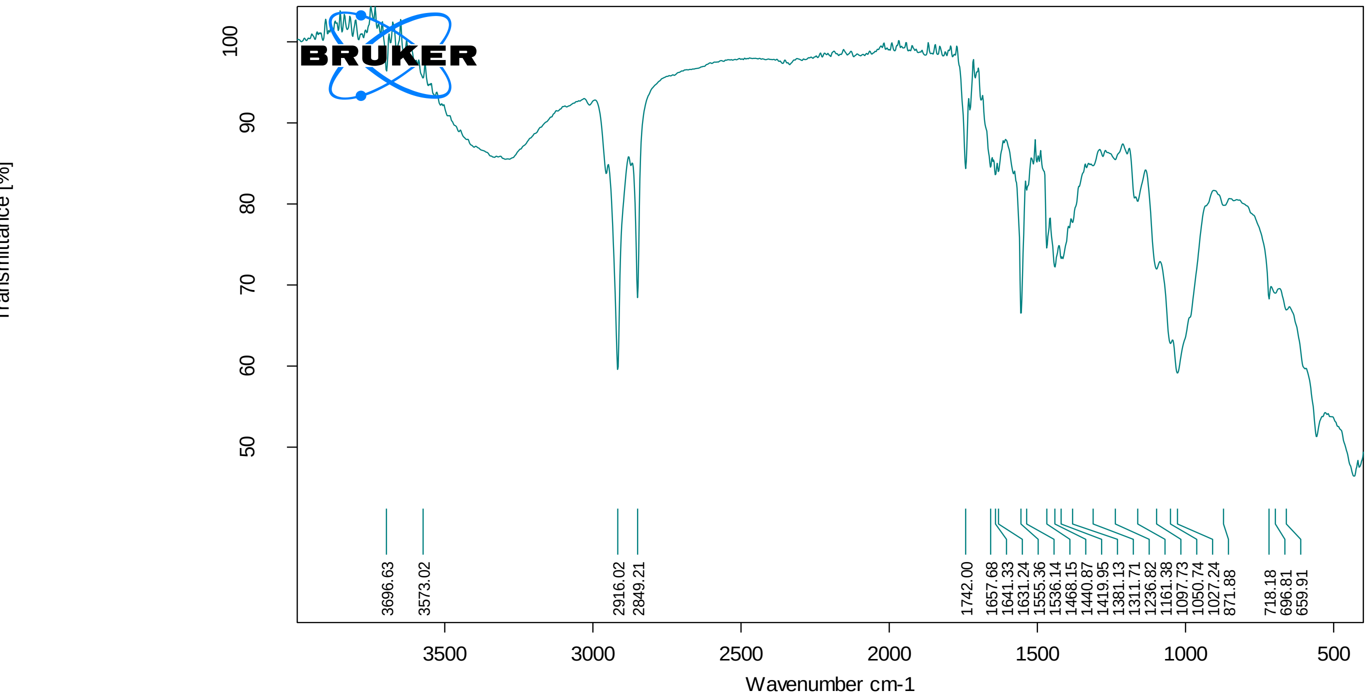
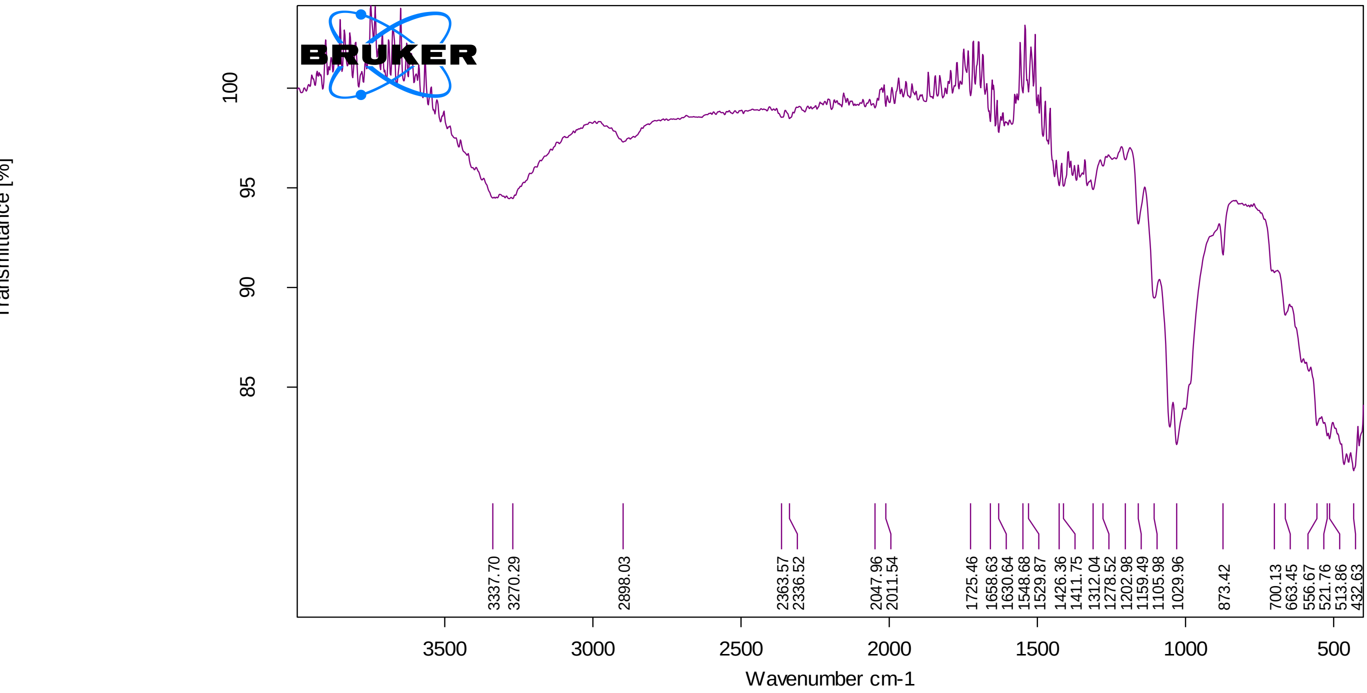


Figure 13. FTIR analysis results of microplastics in (a) water sample, (b) tilapia GIT sample, (c) tilapia muscle sample, (d) macroalgae sample, (e) sediment sample, and (f) gastropod sample (cont.)

(d)



(e)

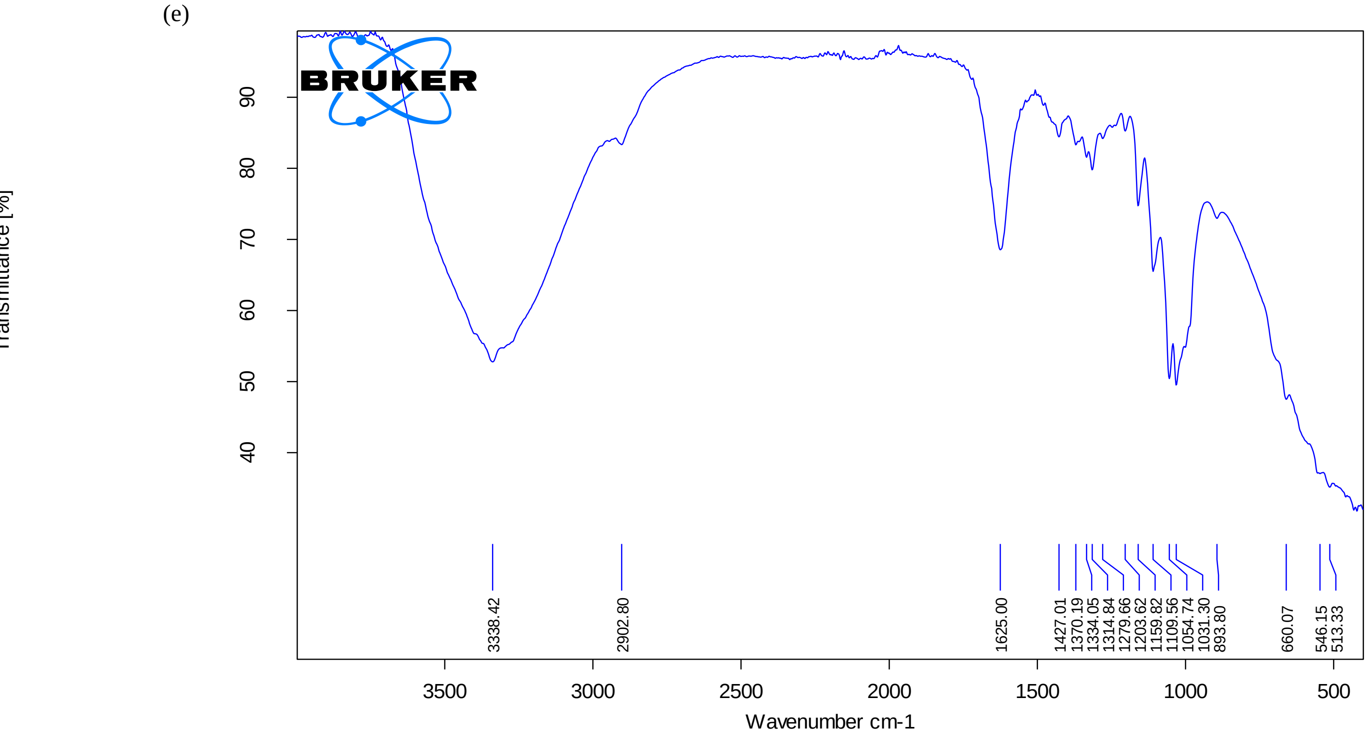


Figure 13. FTIR analysis results of microplastics in (a) water sample, (b) tilapia GIT sample, (c) tilapia muscle sample, (d) macroalgae sample, (e) sediment sample, and (f) gastropod sample (cont.)

(f)

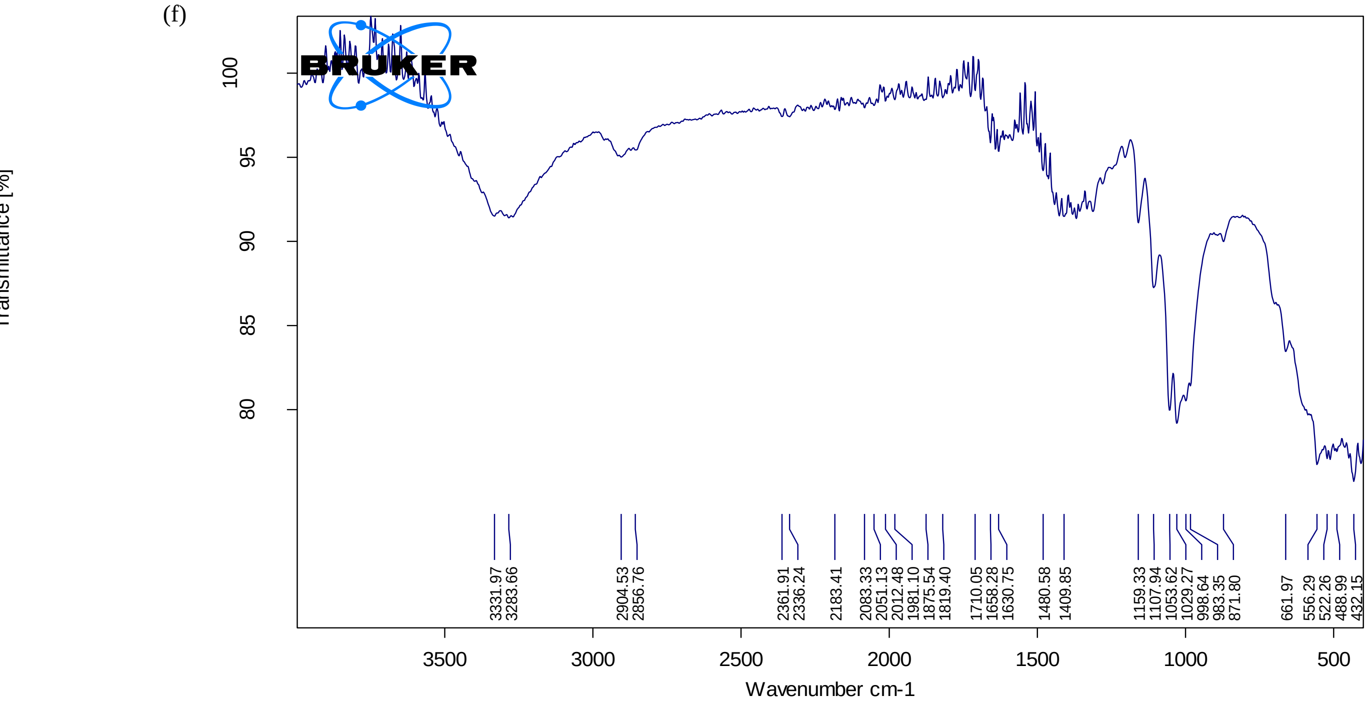


Figure 13. FTIR analysis results of microplastics in (a) water sample, (b) tilapia GIT sample, (c) tilapia muscle sample, (d) macroalgae sample, (e) sediment sample, and (f) gastropod sample (cont.)

4. CONCLUSION

It can be concluded that the microplastic abundance in water, gastropods, tilapia, macroalgae, and sediment samples was 122 particles/L, 2,088 particles/kg, 2,700 particles/kg, 1,036 particles/kg, and 8,847 particles/kg, respectively. The collected microplastics were classified into several sizes: small (<0.5 mm), medium (0.5-<1 mm), and large (1-5 mm), with percentages of 72%, 13%, and 15%, respectively. The forms of microplastics obtained included fibers (39%), fragments (19%), films (17%), pellets (15%), and foam (11%). The colors of microplastics found were black (33%), red (15%), purple (6%), yellow (12%), blue (8%), green (6%), and clear (20%). The detection of microplastics in various compartments of the ecosystem highlights the need for collective efforts to raise public awareness of plastic waste management, both through environmental education and policies to reduce plastic waste in the area. Further research is also required across various trophic levels of organisms and on an annual research timeline, as the Kedung Ombo Reservoir experiences different natural phenomena each season, such as upwelling.

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AUTHOR CONTRIBUTIONS

Experimental Run and Data Collection, Noor Maulidah; Methodology, Validation, Supervision and Writing Original Draft Preparation, Noor Maulidah, Muslim Muslim; Formal Analysis; Data Curation, Visualization, Writing-Review and Editing, Noor Maulidah, Muslim Muslim, Heny Suseno.

DECLARATION OF CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

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