Analysis of microplastic content in sediments of two garden ponds located in the Mulawarman University Campus

Hamdhani Hamdhani* | Jelpratiwi Mangoting | Ghitarina Ghitarina

Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, Mulawarman University
Jl. Gunung Tabur No. 1. Kampus Gn. Kelua Samarinda 76123
**E-mail: hamdhani@fpik.unmul.ac.id*

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ABSTRACT

Plastic waste is the type of waste that is most commonly found in our environment. Plastic waste that decomposes and degrades into smaller particles is called microplastic. Small-sized microplastics (<5 mm) can accumulate in water sediments and are difficult to decompose, making this material remain in the environment for a long time. This research aims to determine the microplastic content in the sediment of the main gate garden pond and FEB garden pond at Mulawarman University. This research was carried out for 3 months starting from determining the research location until microplastic analysis. The research location was determined by purposive sampling in 2 garden ponds with 5 stations in each pond. Analysis of microplastic content in sediment was carried out using a separation method based on specific gravity using NaCl solution. Microplastic identification was carried out using a stereo microscope (8-16x magnification). The results of this research show that the types of microplastics found were fiber, fragments and films with the dominant type of microplastic being fiber. The highest abundance of microplastics was found in the FEB garden pond at 4,350 particles/kg, while in the main gate garden pond, it was 3,800 particles/kg.

INTRODUCTION

Plastic waste is the most commonly found type of waste in our environment (Lestari, 2022). According to data from the National Waste Management Information System (SIPSN), the total national waste generation in 2023 reached 18.88 million tons per year, with plastic waste ranking as the second-largest contributor, accounting for 18.54% of the total waste. Over time, plastic waste in the environment undergoes weathering due to physical, chemical, and biological processes (Achmad, 2022). This process ultimately degrades plastic particles into smaller particles (micro-sized).

Microplastic pollution is a major global challenge and a threat to aquatic organisms. Environmental imbalances occurring on land and in water bodies are partly caused by the continuous and excessive use of plastic without proper waste management, leading to plastic waste disposal from human activities, which can contribute to environmental degradation (Lestari, 2023). Microplastic particles that enter the bodies of aquatic organisms have the potential to inhibit enzyme production, damage the digestive tract, reduce steroid hormone levels, disrupt reproduction, slow growth rates, and increase exposure to toxic addictive substances (Pitria, 2021).

Due to the many negative impacts of microplastic pollution on the environment, numerous studies and research on microplastics have been conducted. However, most of these studies have focused on marine and coastal areas, while research on freshwater bodies such as lakes and ponds remains relatively limited. Furthermore, the distribution of microplastics in freshwater environments, especially in artificial urban ponds, is still not well understood.

Sediments are an abiotic component of aquatic ecosystems that are highly susceptible to pollutant deposition, including microplastic particles (Hasibuan et al., 2021). This is the main reason why research is needed to determine microplastic contamination in sediments from two garden ponds located within the Universitas Mulawarman campus in Samarinda. Therefore, this study will be conducted in the Main Gate Garden Pond and the Faculty of Economics and Business Garden Pond. These locations were chosen because the Main Gate Garden Pond is situated near a main road, and the Faculty of Economics and Business Garden Pond was previously used as a waste disposal site, making both ponds highly likely to contain microplastics.

METHODOLOGY

Sediment sampling

Sediment sampling was conducted at two different garden pond locations, with each pond consisting of five sampling points.

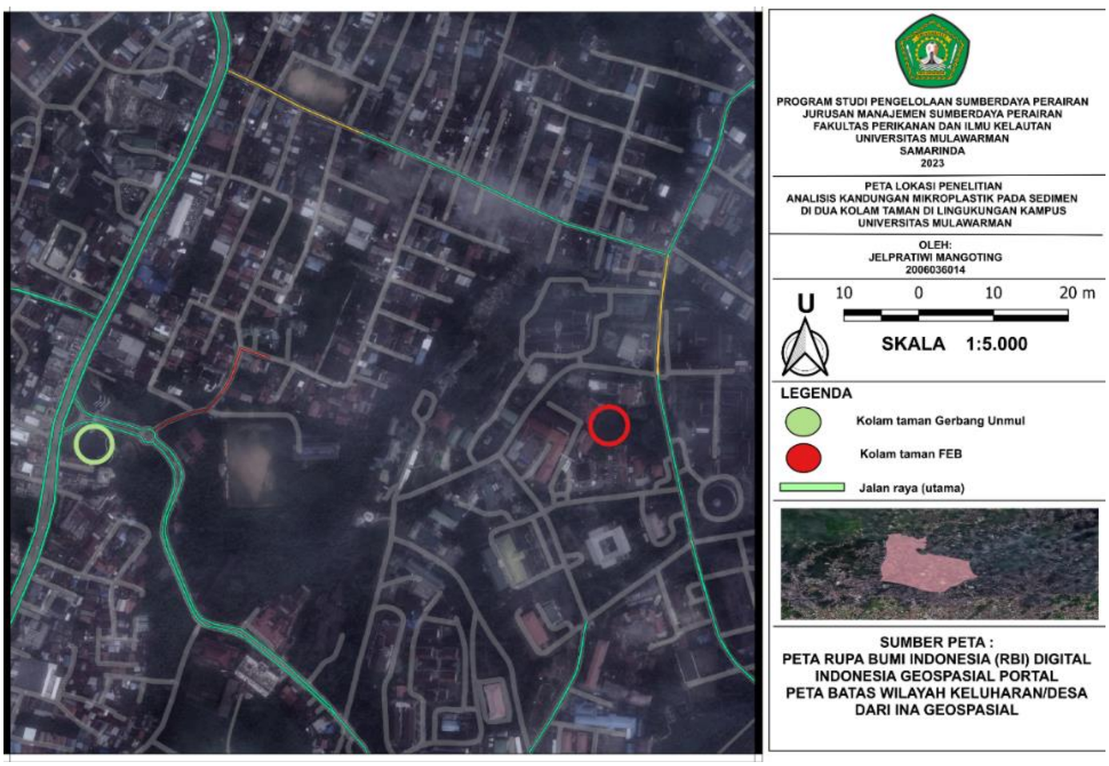

Figure 1. Study location map

The study was carried out over a period of three months, from sample collection to data analysis, at the Universitas Mulawarman Main Gate Pond and the Faculty of Economics and Business (FEB) Pond, both located within the Universitas Mulawarman campus in Samarinda, East Kalimantan.

Sediment samples were collected using a sediment grab or shovel and then transferred into ziplock plastic bags, with approximately ±500 grams of sediment taken from each pond. The samples were then analyzed in the laboratory.

1. **Microplastic abundance**
   The abundance of microplastics in sediment was calculated using Equation (1) (Boerger et al., 2010):

$$C = \frac{n}{b}$$

   Where:
   C = Microplastic abundance (particles/kg)
   n = Number of particles
   b = Sediment sample weight (kg)

2. **Significant differences in average microplastic abundance**
   The significant difference in the average microplastic abundance between the two research ponds was tested using the Independent Sample t-test. This statistical analysis was performed using software such as SPSS (Statistical Product and Service Solutions).

   The decision-making criteria are as follows:
   a. If the Sig (2-tailed) value > 0.05, then H_0 is accepted, meaning there is no significant difference in microplastic abundance between the two garden ponds.
   b. If the Sig (2-tailed) value < 0.05, then H_0 is rejected, meaning there is a significant difference in microplastic abundance between the two garden ponds.

RESULT AND DISCUSSION

Identification of microplastic types, shapes, and colors

Microplastics found in sediment from two garden ponds within the Universitas Mulawarman campus consisted of fibers, fragments, and films. The identification results of microplastic types, shapes, and quantities are presented in Table 1.

Table 1. Microplastic identification results in two garden ponds at UNMUL (particles/kg)

Station	Gerbang Unmul Pond	FEB Pond
Fiber	3.100	2.350
Fragment	200	975
Film	500	1.025
Total	3.800	4.350

Fibers are a type of microplastic formed from synthetic fibers. Fragments are microplastics that originate from broken or chipped thick and rigid plastic. Meanwhile, films are microplastics derived from plastic bags, which are generally transparent in color (Azizah et al., 2020).

The color identification of microplastic samples found a total of 64 particles, with the following distribution: 60 blue, 25 red, 20 orange, 22 black, and 29 white particles. Additionally, 8 particles were transparent. The detailed results are shown in Table 2.

Table 2. Microplastic color identification results in two garden ponds at UNMUL

Microplastic Color	Fiber	Fragment	Film	Total
Blue	35	10	15	60
Red	14	5	6	25
Orange	10	8	2	20
Black	20	1	1	22
White	25	0	4	29
Transparent	5	0	3	8

As shown in Table 1, fiber was the most abundant type of microplastic found, with blue being the dominant color (Table 2). However, blue was not only found in fiber but also in fragments and films (Table 2). Therefore, blue was the most dominant color among the detected microplastics. The photodegradation index of microplastic colors can be used to estimate how long microplastics have been present in the aquatic environment. The longer plastic remains in the water, the more its color will degrade over time (Hidalgo et al., 2012).

Microplastic abundance by type

The identified microplastic types were then processed to determine the abundance of microplastics in each garden pond. The results of microplastic abundance by type are presented in the graph below.

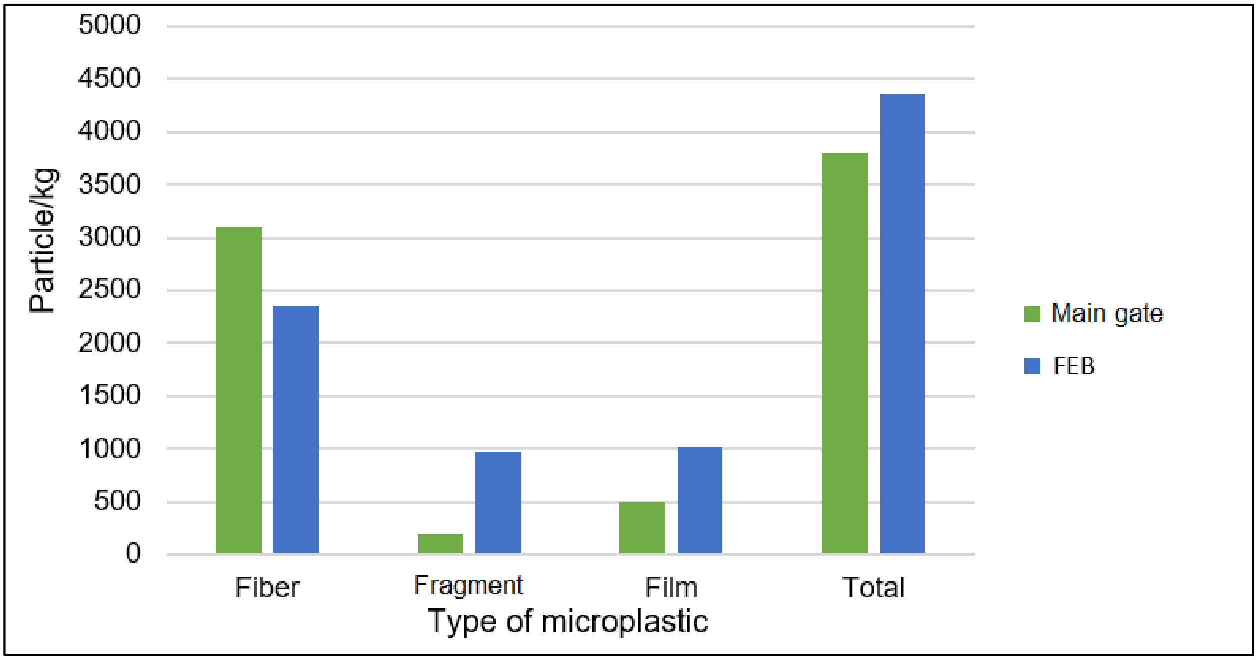

Figure 2. Graph of microplastic abundance by type in two garden ponds at UNMUL

In Figure 2, which presents the graph of microplastic abundance by type in sediment from both garden ponds, it is observed that the abundance of microplastics in Gerbang Unmul Pond includes fiber (3,100 particles/kg), fragment (200 particles/kg), and film (500 particles/kg). Meanwhile, in FEB Pond, the abundance of microplastics includes fiber (2,350 particles/kg), fragment (975 particles/kg), and film (1,025 particles/kg).

The difference in microplastic abundance in sediment from Gerbang Unmul Pond and FEB Pond is due to the uneven distribution of plastic waste. Several factors influencing the spread of microplastics include human activities around the pond, runoff from roads, pond bed topography, and natural conditions such as strong winds**.**

The total microplastic abundance in Gerbang Unmul Pond sediment was 3,800 particles/kg, while in FEB Pond, it was 4,350 particles/kg. Compared to a study by Parvin et al. (2022), where the most abundant microplastic type was fragments (59,456 particles/kg) with a total microplastic abundance of 80,347 particles/kg, the findings from Gerbang Unmul Pond and FEB Pond at Universitas Mulawarman indicate that the most dominant microplastic type was fiber. This difference is influenced by varying environmental pollution conditions at different study locations.

The results of the microplastic abundance analysis in sediment from the two garden ponds at Universitas Mulawarman indicate that the highest microplastic abundance was found in FEB Pond. This is likely influenced by anthropogenic activities around the pond and the fact that the pond was previously used as a waste disposal site, leading to the degradation and accumulation of plastic waste in the soil or sediment at the bottom of FEB Pond. Additionally, the sediment characteristics of FEB Pond are silty or muddy, which allows plastic waste to become trapped more easily in the sediment. In contrast, Gerbang Unmul Pond has sandy-mud sediment, which results in lower microplastic accumulation compared to FEB Pond.

Based on the statistical comparison between the two garden ponds using the Independent Sample T-Test, the Sig (2-tailed) value was 0.611, which is greater than 0.05, the standard significance threshold for comparing the two ponds. Since the Sig (2-tailed) > 0.05, H_0 is accepted, meaning there is no significant difference in microplastic abundance between Gerbang Unmul Pond and FEB Pond. The lack of a significant difference in microplastic abundance between the two ponds is likely due to their similar environmental conditions, as both ponds are located within the same university campus environment.

CONCLUSION

1. The types of microplastics found in both garden ponds were fiber, fragment, and film. The dominant type of microplastic in both ponds was fiber. Based on the identification results, microplastics were found in various colors, including blue, red, orange, black, white, and transparent. Blue was the most dominant color.
2. The highest microplastic abundance was found in FEB Pond, with 4,350 particles/kg, while in Gerbang Unmul Pond, the abundance was 3,800 particles/kg.
3. The T-test for microplastic abundance comparison showed no significant difference in microplastic abundance between Gerbang Unmul Pond and FEB Pond.

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