Identification of types and abundance of microplastics in coastal sediments of Tanjung Jumlai Beach, North Penajam Paser Regency, East Kalimantan

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ABSTRACT

The existence of microplastics is affected by the many activities in the community related to the use of plastic, as well as uncontrolled disposal of plastic waste so that plastic waste enters the waters through water flows and will degrade into smaller sizes. This research aims to identify the type, abundance, and composition, as well as determine differences in abundance between types of microplastics in Tanjung Jumlai Beach sediments. Sampling was conducted by drawing a transect line 100 meters long, then dividing it into 5 lanes each measuring 20 meters. Each lane was subdivided into sub-transect boxes measuring 5×5 meters. Then, within each 5×5 meter sub-transect, 1×1 meter sub-transect boxes were created, making 25 sub-transect boxes of 1×1 meter in each 20-meter lane. From these, 5 boxes were selected using randomizer application. Sediment samples that have been processed were then identified using a microscope. There were three types of microplastics found in Tanjung Jumlai beach, namely 65% fragments with an abundance of 10.340 particles/kg/m^2, 19% fiber with an abundance of 2.960 particles/kg/m^2, and 16% film with an abundance of 2.580 particles/kg/m^2. There is a significant difference in abundance between fragment microplastics and film and fiber microplastics. There is no significant difference in abundance between film microplastics and fiber microplastics found on the coast of Tanjung Jumlai, Penajam Paser Utara Regency, East Kalimantan.

INTRODUCTION

Plastic waste contamination is a concerning issue for the environment and global public health due to continuous plastic use (Perumal et al., 2022). Plastic waste is difficult to decompose, leading to accumulation in both terrestrial and aquatic environments (Yona et al., 2021). Over time, accumulated plastic waste breaks down into small plastic particles known as microplastics, which range in size from 0.3 mm to 5 mm. Microplastics are part of marine debris that pose a more serious threat compared to larger plastic materials. They usually originate from degraded plastic waste and can be classified based on color and shape. One of the major concerns associated with microplastic pollution is that microplastics contain hazardous substances that can harm the environment and disrupt ecosystems (Watts et al., 2016).

Coastal waste pollution is a complex issue affecting regions near coastlines (Pasaribu et al., 2021). One area in East Kalimantan with several coastal regions is Penajam Paser Utara Regency, which includes Tanjung Jumlai Beach as one of its coastal sites. Approximately 80% of plastic waste originates from land-based sources, including residential areas, commercial activities, public spaces, agriculture, and industrial

activities (Septian et al., 2018). Like many Indonesian beaches, Tanjung Jumlai Beach experiences various human activities, ranging from household activities to tourism-related activities. These intensive human activities may contribute to plastic pollution, particularly microplastic contamination, which could negatively impact the surrounding coastal environment.

Therefore, this study is necessary to analyze microplastic content in the sediments of Tanjung Jumlai Beach. The information obtained from this research can serve as a reference for sustainable fisheries and marine resource management.

METHODOLOGY

This study was conducted in August 2023 with sediment sampling carried out along the coast of Tanjung Jumlai Beach, Penajam Paser Utara Regency, East Kalimantan. Sediment sample analysis was performed at the Water Quality Laboratory, Faculty of Fisheries and Marine Science, Mulawarman University, East Kalimantan.

The research procedure involved several stages, the first of which was determining the sampling points. The selection of sampling points was based on field observations of the conditions at Tanjung Jumlai Beach and aligned with the Guidelines for Marine Debris Monitoring issued by the Ministry of Environment and Forestry (KLHK). The sampling point was located at coordinates 1°22'58.213" S, 116°42'23.004" E (Figure 1).

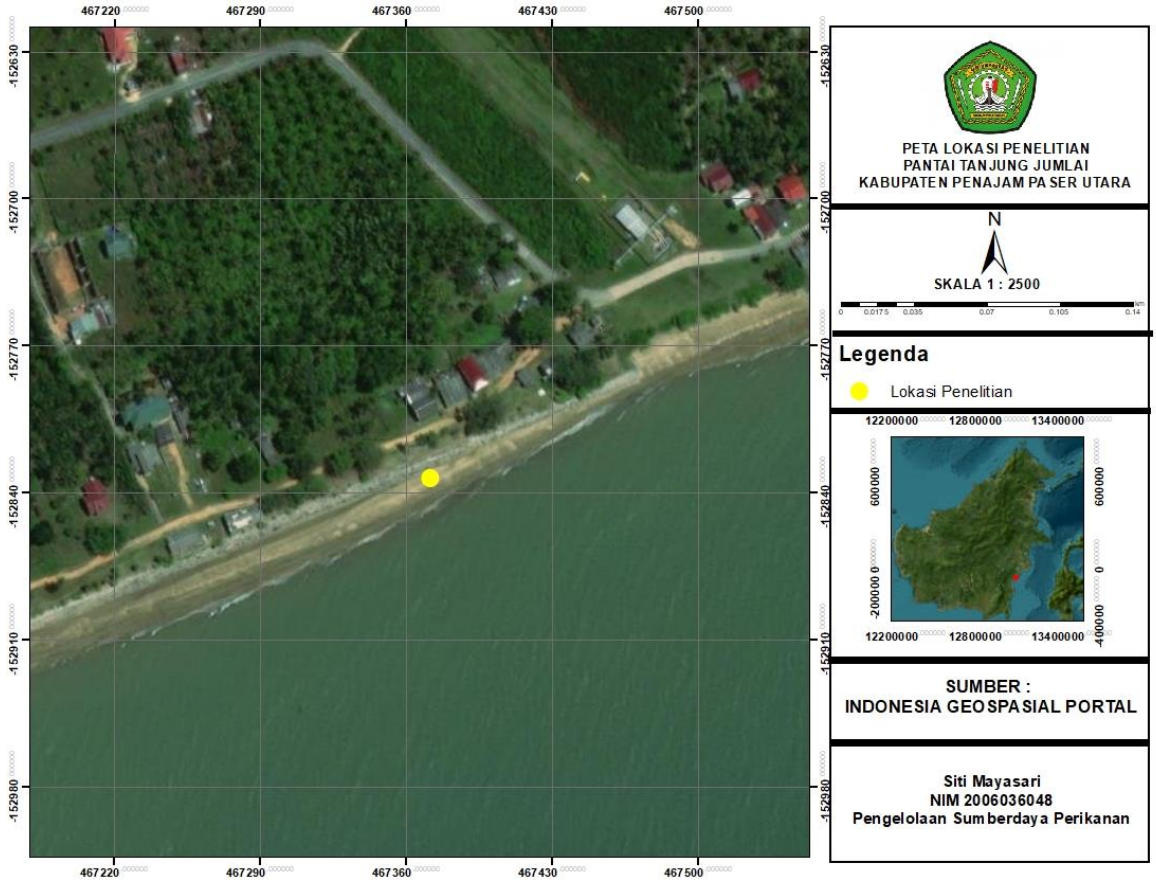

Figure 1. Study location map

The second stage was the sampling method. Sediment sampling was conducted by drawing a 100-meter transect line, which was divided into five 20-meter sections. Within each 20-meter section, sub-transect boxes were determined using a purposive sampling method. A 1×1 m sub-transect box was placed within a 5×5 m transect, resulting in 25 sub-transect boxes within each 5×5 m area.

Microplastic samples were then collected using random sampling, meaning the sediment samples were taken randomly. Around 1 kg of sediment was collected using a shovel and placed into labeled ziplock plastic bags. The next stage was the sample processing method, which included sample preparation, separation or flotation based on density, destruction of organic material, microplastic filtration and drying, microplastic identification using a microscope

The percentage of microplastics was calculated using the following formula:

$$Microplastic\ Composition = \frac{Number\ of\ microplastic\ per\ type\ (partikel)}{Total\ Number\ of\ Particles} \times 100$$

Microplastic abundance was analyzed using the following formula:

$$Microplastic\ Abundance = \frac{Number\ of\ Microplastic\ Particles\ in\ Sediment\ (particles)}{Dry\ Sediment\ Weight\ (kg)}$$

To determine the differences in microplastic abundance among types, a parametric statistical analysis (One-Way ANOVA) was conducted, followed by a Post Hoc Test for further analysis.

H_0: There is no significant difference in microplastic abundance among types in the coastal sediment of Tanjung Jumlai Beach.

H_1: There is a significant difference in microplastic abundance among types in the coastal sediment of Tanjung Jumlai Beach.

RESULT AND DISCUSSION

Composition and abundance of microplastics

The microplastics found in the sediment of the coastal transect area of Tanjung Jumlai Beach totaled 794 particles, consisting of 517 fragment particles, 129 film particles, and 149 fiber particles. The presence of these three types of microplastics in the sediment of Tanjung Jumlai Beach aligns with the findings of Rijal et al. (2021), who stated that the most commonly found microplastic contaminants are fragments, fibers, and films.

Pellet-type microplastics were not found in this study, likely because they originate directly from plastic processing industry waste (Dalimunthe et al., 2021). Since no plastic processing factories were found in the study area, the absence of pellet microplastics is reasonable.

The composition of microplastics identified in the coastal area of Tanjung Jumlai Beach is presented in percentage form as follows.

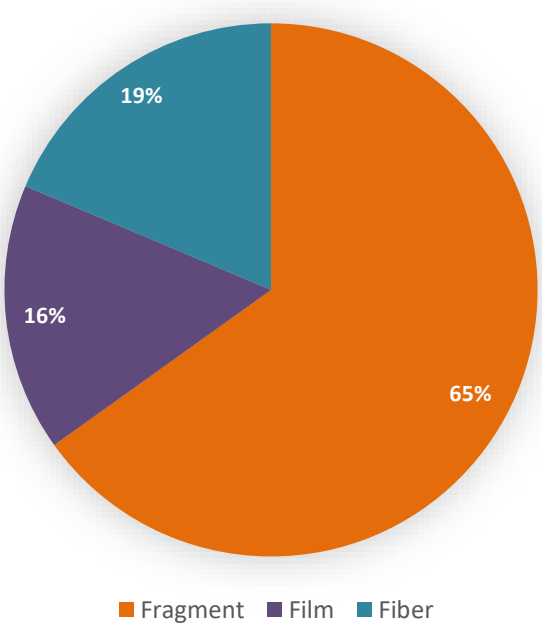

Figure 2. Composition of Microplastics in Tanjung Jumlai Beach Sediments

Based on Figure 2 above, fragment-type microplastics have the highest quantity and percentage, accounting for 65%. The second most abundant type is fiber, with a percentage of 19%, while the least common type is film, making up 16%.

Table 1. Abundance of Microplastics in Tanjung Jumlai Beach Sediments

Microplastic Type	Microplastic Abundance (particles/kg/m²)	Average Microplastic Abundance (particles/kg/m²)
Fragment	10,340 ± 5,815	413.6
Film	2,580 ± 2,838	103.2
Fiber	2,960 ± 5,183	118.4
Total	15,880 ± 13,836	635.2

Table 1 shows that fragment-type microplastics have the highest abundance compared to film and fiber microplastics. The abundance of fragment microplastics is 10,340 ± 5,815 particles/kg/m² of dry sediment, with an average abundance of 413.6 particles/kg/m².

The second-highest abundance is observed in fiber microplastics, with 2,960 ± 5,183 particles/kg/m² and an average of 118.4 particles/kg/m². The lowest abundance is found in film-type microplastics, with 2,580 ± 2,838 particles/kg/m² and an average of 103.2 particles/kg/m².

The high abundance of fragment microplastics is likely due to their dominance in the study area. This could be attributed to the presence of plastic products such as plastic beverage bottles, toiletries, and other macro- and meso-sized plastic waste, which are either discarded on the sediment surface or buried within it. The main source of microplastics in coastal and marine environments is secondary microplastics, which originate from the degradation of larger plastic materials. This type of microplastic is often linked to areas with high population density (Browne et al., 2011). The presence of plastic waste may be influenced by local community activities, tourism, and commercial activities near the beach.

One-Way ANOVA Test (Parametric statistics)

The ANOVA test results, conducted using IBM SPSS Statistics 26, for fragment, film, and fiber microplastics showed a significance value (sig) of 0.000. Since p(0.000) < α(0.05), the alternative

hypothesis (H1) is accepted, and the null hypothesis (H0) is rejected. This indicates a significant difference in the abundance of fragment, film, and fiber microplastics in the coastal sediments of Tanjung Jumlai Beach, Penajam Paser Utara, East Kalimantan.

Since H0 was rejected, a post hoc test was conducted to determine which microplastic abundances were significantly different. The results are as follows:

- Fragment vs. Film: p (0.001) < α(0.05) → Significant difference
- Fragment vs. Fiber: p (0.000) < α(0.05) → Significant difference
- Fiber vs. Film: p (0.853) > α(0.05) → No significant difference

These results indicate that the abundance of fragment microplastics is significantly different from both film and fiber microplastics, while there is no significant difference between fiber and film microplastic abundance.

CONCLUSION

1. Three types of microplastics were identified in the coastal sediments of Tanjung Jumlai Beach: fragments, films, and fibers.
2. The abundance of microplastics in the sediments of Tanjung Jumlai Beach, Penajam Paser Utara, East Kalimantan, is as follows: Fragments: Average abundance of 413.6 particles/kg/m², making up 65% of the total composition, Films: Average abundance of 103.2 particles/kg/m², comprising 16% of the total, Fibers: Average abundance of 118.4 particles/kg/m², accounting for 19% of the total composition.
3. Post Hoc Test (ANOVA) results indicate that the abundance of fragment microplastics differs significantly from both film and fiber microplastics. However, no significant difference was found between the abundance of film and fiber microplastics.

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