International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

https://ijpsat.org/
Vol. 47 No. 2 November 2024, pp. 369-376

Isolation and Identification of Microplastics in Seaweed in the Nipah River Waters, Pesisir Selatan Regency

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Abstract—Microplastics are known to have a significant impact on seaweed through the process of absorbing water and nutrients from the surrounding environment. Microplastics can cause physical damage and potentially cause toxic effects. The purpose of this study was to identify the types of seaweed and analyze microplastics in the waters of the Nipah River, Pesisir Selatan Regency based on the number, type and color. This study was conducted in February - April 2024. Microplastic observations were carried out at the LLDIKTI X Laboratory using an Olympus CX21 microscope. The results showed that the seaweed found included Padina sp., Turbinaria sp., and Sargassum sp. The types of microplastics identified were fibers, fragments and films. The most dominant microplastic color was red, while the highest number of microplastics was found at station 2 with a total of 7 particles/gr.

Keywords—Microplastics, seaweed, identification, types, abundances.

I. INTRODUCTION

Pesisir Selatan Regency, located in West Sumatra Province, has very beautiful natural beauty. This potential has been utilized by the Regency Government to make the area a rapidly developing tourist destination. The waters of the Nipah River face a significant risk of contamination from microplastics, due to the rapid expansion of industry, tourism, and population growth. Anthropogenic activities are one of the main contributors to environmental pollution. According to research conducted by [1] plastic waste contributes more than 50% of solid waste found in marine areas, and 80% of this plastic waste comes from coastal areas, posing a significant threat to marine pollution. The presence of plastic waste in the sea can be associated with various processes, including exposure to ultraviolet (UV) rays, climate change, physical abrasion caused by ocean phenomena such as tidal waves, currents, and winds, which result in the fragmentation of plastic waste into smaller particles. The sustainability of water and ocean quality, which is the basis for ecosystems, economies, and communities as a whole, is threatened by the threats posed by plastic pollution. The marine environment includes various ecosystems, including seaweed, seagrass, coral reefs, mangrove forests, and deep-sea ecosystems.

The issue of plastic pollution in the aquatic environment has emerged as a global concern due to its detrimental impacts on marine and coastal ecosystems. Furthermore, the degradation of plastic waste into smaller particles, namely micrometers (microplastics) and nanometers (nanoplastics), facilitates their entry into the food chain, ultimately affecting humans as the top predator in the food chain. Plastics, which are not digestible, tend to accumulate in the bodies of biota. Despite their small size, the consumption of microplastics can transfer pollutants to biota tissues, causing disruption of ecophysiological functions related to health and biodiversity.

The significant amount of waste present in water bodies is associated with a variety of factors, including domestic and industrial waste, as well as human activities such as fishing, which involves the use of nets made of plastic fibers. Microplastics, defined as plastic fragments smaller than 5 millimeters in size, play a significant role in marine pollution. The presence of microplastics in the ocean is of great concern because they can act as vectors, transferring chemicals from seawater to organisms through ingestion [2]. The presence of microplastics in sediments is also influenced by the distance from the depositional area and the intensity of tidal activity in the area [3]. Benthic plants and animals are often used as indicators of water quality because of their susceptibility to changes in their environment, especially water contamination. Microplastics that attach to marine plants and animals will form biofilms, so that the density of these microplastics will increase which will gradually sink and become suspended on the seabed. The transfer of microplastics in digestion occurs continuously in the food chain due to incomplete degradation in one biota and then moving to another biota [4]. To date, more than 690 marine species, including fish, crustaceans, mammals, bivalves, and seabirds, have been identified as contaminated by microplastics. However, there is still a scarcity of field studies investigating microplastic pollution in aquatic plants such as seaweed. Seaweed plays an important role in marine ecosystems by functioning as primary producers and providing food and habitat for consumers and other related organisms [4].

Research conducted by [5] found microplastics in red seaweed *Gracillaria* sp, green seaweed *Halimeda* sp. and *Caulerpa* sp, and brown seaweed *Sargassum* sp. (500 g each) found at Jerat Lanjheng and Selayar Beaches, on the southwest side of Bawean Island at a depth of 1-6 meters. The Nipah River waters community cultivates seaweed along the Nipah River coast which is used for feed, therefore it is necessary to conduct research on microplastics in the seaweed. This research is very important in assessing the abundance and composition of microplastics in seaweed in the Nipah River Waters of Pesisir Selatan Regency which aims to identify the types of seaweed and analyze microplastics found in the Nipah River waters based on the number, type and color.

II. RESEARCH METHODOLOGY

2.1 Time and place of research

The study was conducted from February - April 2024. The sampling process was carried out in the waters of the Nipah River, Pesisir Selatan Regency. Identification of seaweed types was carried out at the Expertise Laboratory of the Faculty of Fisheries and Marine Sciences, Bung Hatta University, while identification of the number, type and color of microplastics was carried out at the LLDIKTI X Padang Laboratory.

2.2. Tools and materials

The tools used in this study were knives, 0.1 gr digital scales, erlenmeyer flasks, incubators, whatman filter paper, microscopes and petri disks. The materials used in this study were seaweed, distilled water, 90% alcohol, 10% KOH saturated NaCl, and 30% H_2O_2.

2.3. Research methods

The method used in this study is a descriptive method. Sampling was carried out by purposive sampling. Seaweed samples were taken based on the dominant distribution in each transect line by taking 5 strands by cutting the base of each seaweed and then placing the sample in a plastic bag.

2.3.1. Sampling

Sampling was carried out based on a modified method developed by [6], namely sampling was carried out using 3 transect lines that were stretched perpendicularly from the coastline to the sea as far as 50 m. Each transect line was given a distance of 25 m parallel to the coastline. The samples taken were the dominant seaweed on each transect line. Sampling was carried out at distances of 0 m, 25 m, and 50 m on each transect line. For sample preparation, the leaves on the seaweed were weighed as much as 50 grams and each sample was cut using a cutter to make it thin [5].

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2.3.2 Seaweed microplastic extraction

The procedure for extracting microplastics from seaweed is a modified method from research conducted by [7]. Seaweed leaves are taken as much as 50 grams, cut crosswise, put into an Erlenmeyer flask, and 10% KOH is added until the sample is submerged (approximately 3 times the sample volume) or 150 ml, cover the Erlenmeyer flask with aluminum foil and then incubate at 60ºC for 5 days. If there is still residue or organic material in the sample that has not been destroyed during the first incubation period, then add 5 ml of 30% H_2O_2 solution. Then let it stand again at room temperature for 24 hours. After the sample has dissolved, filter it using whatmann filter paper size 40, then wash the sample using distilled water. Next, wrap the sample contained in the filter paper with aluminum foil and dry it in the oven to make the identification process easier [7].

2.3.3 Identification of microplastics from seaweed

The identification process uses a trinocular microscope with 40x and 100x magnification. The dried sample is transferred into a petri dish to facilitate identification. Place the sample on a glass slide on the object table and set the macrometer and micrometer focus on the object. To make it easier, use software to record microplastic particles that can be connected to the microscope lab optics. Furthermore, the number, type and color of microplastics are observed under a microscope, Olympus CX23 and then documentation photos are taken [8].

2.4 Data analysis

Data on microplastic content from seaweed samples were analyzed descriptively quantitatively, data is presented in the form of tables and graphs.

III. Result and Discussion

3.1. Identification of seaweed

Based on the research on each transect (I, II and III) three different types of seaweed were found. At a distance of 0 meters, the most common type of seaweed found was *Padina* sp. At a distance of 25 meters, *Turbinaria* sp. seaweed was found, while at a distance of 50 meters, *Sargassum* sp.

3.2 Microplastic identification based on quantity

The results of microplastic identification on seaweed leaves are one of the parameters that can indicate significant microplastic contamination in the waters of the Nipah River, Pesisir Selatan Regency. Plastic waste that is intentionally or unintentionally disposed of will enter the aquatic ecosystem and undergo degradation, resulting in the formation of microplastics, which are smaller in size. As a result, these microplastics have the potential to pollute the surrounding environment and organisms that inhabit the waters, especially seaweed.

TABLE 1. Number of microplastics found in seaweed

Types of Seaweed	Test	Types of Microplastics			Abundance (particles/gr)
		Fiber	Fragment	Film	
***Padina* sp.**	1	2	1	0	3
	2	1	0	1	2
	3	0	0	0	0
		Amount			5
***Turbinaria* sp.**	1	0	3	2	5
	2	0	1	0	1
	3	0	1	0	1

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		Amount			7
***Sargassum* sp.**	1	0	1	1	2
	2	0	0	1	1
	3	1	1	0	2
		Amount			5
		Total Microplastics			17

The highest abundance of microplastics was found in seaweed of the *Turbinaria* sp. type, which amounted to 7 particles/gr. Meanwhile, when viewed based on the type of microplastic, fragments were the most commonly found type, which amounted to 5 particles/gr and films with an amount of 2 particles/gr. The abundance of microplastics in *Padina* sp. and *Sargassum* sp. grass each had the same value, which was 5 particles/gr. In *Padina* sp. seaweed, 2 particles/gr of fiber type microplastics, 1 particle/gr of fragment and 1 particle/gr of film were found. While in *Sargassum* sp. seaweed, 1 particle/gr of fiber type microplastics, 2 particles/gr of fragment and 2 particles/gr of film were found. Overall, the microplastics found in the 3 seaweed samples amounted to 17 particles/gr. The graph of the average abundance percentage of microplastics based on the types found in seaweed can be seen in Figure 1.

Based on Figure 1, it can be seen that the seaweed with the highest microplastic abundance value is *Turbinaria* sp. as much as 40%, followed by *Padina* sp. with a percentage of 30% and *Sargassum* sp. with a percentage of 30%. According to research conducted [9] microplastics can come from the disintegration of plastic that enters the environment through various means, such as rivers, runoff, ocean tides, wind transportation, or from the sea itself, such as fishing gear and aquaculture equipment. Based on several studies on microplastics that have been conducted, the results obtained state that the presence of microplastics in the environment can be a problem if it causes microplastic contamination in waters in the future, so it is feared that it can become a global threat with various implications for social and environmental conditions.

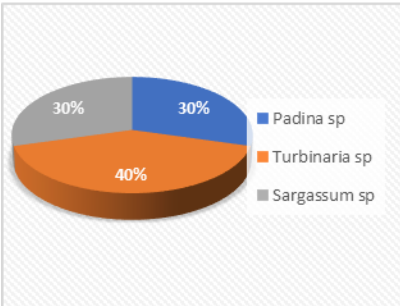

FIGURE 1. Percentage of the number of microplastics found in seaweed

Each type of seaweed found with microplastics has a different abundance. The spread of marine debris from year to year continues to increase due to the increasing human population so that pollutants are also more widely distributed in the waters. Another source of microplastics is ship travel, which significantly contributes to microplastic pollution in the area. In general, secondary microplastics, which are categorized as fiber and fragment microplastics, come from plastic fragmentation [10]. The distribution of microplastics affects their prevalence in seaweed, where the distribution of fiber microplastics can be influenced by fishing activities, such as fishing lines and nets that undergo degradation, or waste from human activities that enter sea waters. Human waste can include leftover threads from clothing, resulting from washing fabrics, and degraded plastic ropes [11].

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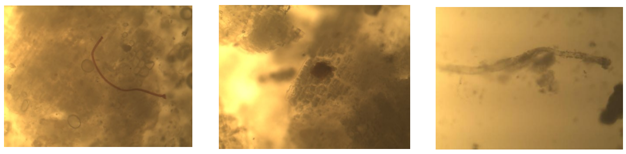
3.3 Identification of microplastics based on type

According to [12] microplastics can enter seaweed leaves through several processes, namely contaminated water and soil, root systems, air deposition, food and marine organisms and metabolic processes. After microplastics enter seaweed leaves, these particles can remain in the leaves for quite a long time depending on the environmental conditions around them. This can have an impact on the marine ecosystem as a whole because microplastics can potentially interfere with the physiological functions of seaweed and other marine organisms associated with the seaweed. Microplastics exist in various forms and exhibit diverse characteristics. This incident can be associated with the gradual fragmentation of plastic materials over a long period, resulting in a reduction in the size of the resulting plastic particles [13]. The types of microplastic variations are in the form of fibers, fragments and films [14]. The types of microplastics found in seaweed leaves from three seaweed leaf samples are shown in Figure 2.



(a) (b) (c)

FIGURE 2. Types of microplastics found: (a) fiber, (b) fragment and (c) film in seaweed.

There are three different categories of microplastics that can be identified in seaweed, namely fibers, fragments, and films. Fiber microplastics have a slender and complex structure, resembling a net, and have the ability to survive for a long time in water due to their low density (Wicaksono et al., 2020) [15]. Fragments are the type of microplastic that shows the second highest density value and are commonly found in sandy and muddy sand sediments. It takes about 20 years for fragment-type waste, such as plastic bottles, to degrade. Film microplastics, on the other hand, have a relatively lower density which facilitates their transportation, because they come from very thin plastic materials (Ayuningtyas, 2019) [9]. The results of the average abundance of microplastics by type can be seen in table 2.

TABLE 2. Average abundance of microplastics found in seaweed by species

Types of Seaweed	**Test**	**Types of Microplastics**			**Abundance**
		Fiber	**Fragment**	**Film**	**(particles/gr)**
***Padina* sp.**	1	2	1	0	3
	2	1	0	1	2
	3	0	0	0	0
***Turbinaria* sp.**	1	0	3	2	5
	2	0	1	0	1
	3	0	1	0	1
***Sargassum* sp.**	1	0	1	1	2
	2	0	0	1	1
	3	1	1	0	2
Amount		4	8	5	17

Based on the research results, it is known that the dominant microplastics are fragments with a total of 8 particles/gr and films with a total of 5 particles/gr. This is in line with research conducted by [16], which also found an abundance of microplastics in fish bodies from fragments and fibers. The dominance of both types of microplastics can be influenced by various environmental factors such as the high level of fishing activity in the waters around them. Certain activities that contribute to plastic waste itself, including loading and unloading ships at ports, fishing activities, mining, agriculture, plantations, household activities, industry and the entry of plastic waste from urban areas into the aquatic environment [17]. Furthermore, [18] emphasized that the types of microplastics commonly found in water are fragments, fibers, and films. The graph of the average abundance percentage of microplastics based on the types found in seaweed leaves can be seen in Figure 3.

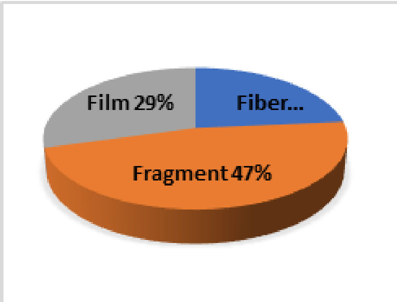


FIGURE 3. Percentage of microplastic types found in seaweed

Based on Figure 3, it can be seen that the percentage of microplastic types obtained from the seaweed samples *Padina* sp., *Turbinaria* sp. and *Sargassum* sp. The highest is in the fragment type, which is 47%, followed by the film type with 29% and the smallest percentage is microplastics from the fiber type as much as 24%. According to [19], the high abundance of fragment microplastics can be influenced by waste in rivers originating from urban areas, which is the main factor in the entry of microplastics into the marine environment. The high abundance of fragment microplastics is caused by the prevalence of waste, such as plastic bottles or other household plastic waste, on the banks of the river. The fragmentation process and the size of macro-sized polypropylene plastic waste occur while the waste flows in the river and becomes fragment microplastic waste [18]. According to research conducted by [20] and [21], it is believed that the form of microplastic fragments consists of High-density polyethylene (HDPE), Low-density polyethylene (LDPE), and Polyvinyl chloride (PVC) types.

3.4 Microplastic identification based on color

The color variations of microplastics present in seaweed leaves are quite diverse. The color displayed by microplastics is a characteristic that reflects the type of polymer used in their production. Each type of plastic has a unique color which then affects the color of the resulting microplastics. In addition, the color differences observed in microplastics can also serve as an indicator of how long they have been present in the environment [22] . Table 3 provides a visual representation of the color variations found in microplastics in three seaweed leaf samples.

TABLE 3. Colors of Microplastics Found in Seaweed Samples

Types of Seaweed	Test	Microplastic Colors	
		Black	Red
Padina sp	1	0	2
	2	0	2
	3	0	0
Turbinaria sp	1	1	2
	2	0	1

	3	2	1
Sargassum sp	1	0	1
	2	0	1
	3	1	0
Amount		4	10

The dominant color of microplastics is red, with a total of 10 particles or around 71% of the total sample. The red color indicates a certain plastic variant that has not experienced color damage. The presence of red microplastics can be associated with household laundry waste, plastic bottles, and other forms of plastic waste [24]. This is because the location of the seaweed sampling location is close to residential areas, floating net cages. In Table 3, the color that ranks second among the microplastics found is black, with a total of 4 particles or around 29%. The prevalence of black microplastics serves as an indicator of the high level of pollution in the aquatic environment. In addition, black microplastics have a high capacity to absorb pollutants and can affect the overall texture of microplastics [22] .

The color displayed by microplastics can serve as an indication of the presence of other organic particles absorbed in the microplastics or the original color of the plastic material from which they originate [22]. The color changes observed in microplastics are influenced by the duration of exposure to sunlight [23]. When the color remains bright, it indicates that the microplastics have not undergone significant changes [24]. Furthermore, according to [12], the color of microplastics in seaweed can be caused by various factors, namely the original color of the plastic, plastic degradation, dye adsorption, interaction with chemicals, accumulation of algae or other organisms and the formation of biological films formation.

IV. Conclusion

Three types of seaweed were found in the Nipah River waters, namely: *Padina* sp, *Turbinaria* sp and *Sargassum* sp. There are 3 categories of microplastics identified from seaweed, namely: fiber, fragments, and films. The highest abundance of microplastics is the fragment type (47%) with an average abundance of 17 particles/gr. The color of the microplastics found was red with 10 particles and black with 4 particles.

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