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Identification of Microplastics in Sediment and Shoots (Polymesoda erosa) in the Flows of Lampulo Banda Aceh

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Abstract

The spread of microplastics in waters and sediments can be harmful to marine biota. These microplastics can enter the food chain and eventually reach humans so that they can pose a dangerous risk to humans. This study aimed to determine microplastic abundance, polymer, and characteristics based on shape, color, and size in sediments and crab shells in the waters of Lampulo Banda Aceh. This study began with sampling, sample preparation, and microscopic analysis. Identification using a binocular microscope with a magnification of 4×0.10 and identification of polymer types using FTIR. Some types of microplastics found were fragments, fibers, and films. The abundance of microplastics in sediment samples amounted to 1910 particles/kg, while in crab shell samples amounted to 2500 particles/kg. The results of microplastic analysis using FTIR on crab shell samples showed the presence of microplastic polymers such as Polypropylene (PP), Polystyrene (PS), Polyamide (PA), High-density polyethylene (HDPE), and Low-density polyethylene (LDPE). The sources of microplastics come from household waste and the activities of residents, so this is a factor in the presence of microplastics in the waters and causes problems for biota living in Lampulo waters.

Keywords: Microplastics, Sediment, Crab Shells, Microscopy, FTIR, Abundance, Lampulo Waters

1. Introduction

Plastic waste pollution can harm the environment and human health due to the adverse effects of plastic use. Humans and water will constantly interact because the ocean is one of humanity's primary food sources, livelihood, trade, and transportation. These interactions often potentially harm marine ecosystems (Wahyudin, 2020). Plastic that has entered marine waters will eventually break down into smaller sizes. When plastic waste is exposed to UV radiation, it will react and shrink from its original size over time. Waves can also cause plastic waste to break into small pieces and accumulate in soil and water (Octarianita, 2021).

Microplastics initially float on the river's surface because their density is lower than the density of water. Microplastics deposited in sediments can be influenced by water dynamics such as currents and waves (Seftianingrum, 2023). Microplastics found in sediments and marine waters will be very easy to eat and enter the body of the biota (Ramadhani, 2022). *Shellfish* is a marine biota that can potentially be exposed to microplastics. Mussels are a type of filter feeder biota that filters water to obtain food suspended in water and bottom sediments in waters so that microplastics will enter the mussel's body. Microplastics that have entered the clam's body will accumulate and are difficult to digest properly. In addition, microplastics can clog and damage organs, cause nutritional deficiencies, and even cause the death of organisms. The additives can decompose, interfering with the reproductive system's endocrine glands and carcinogenic effects. Microplastics become vectors of Persistent Organic Pollutants (POPs) compounds and adsorb heavy metals so that there is a double toxic effect (Pratiwi, 2023). When shellfish contain high concentrations of microplastics and are consumed by humans, trophic transfer will occur, which can endanger the health of the body (Pungut, 2021).

The amount of plastic waste on Lampulo Beach is a problem that harms marine life, natural resources, and human health. Indirectly, the waste comes from human activities, and it is feared that it will increase and accumulate. Even if left unchecked, the waste will degrade and become microplastic. This condition will hurt food safety and health and is potentially dangerous if consumed. This research is interested in evaluating microplastics in crab shells.

2. Materials and Methods

The location for sampling sediments and crab shells is in the waters of Lampulo Beach, Banda Aceh. Sediment samples and crab shells obtained were then identified at the Environmental Engineering Laboratory, Ecology, and Multifunctional Microbiology of Ar-Raniry State Islamic University.

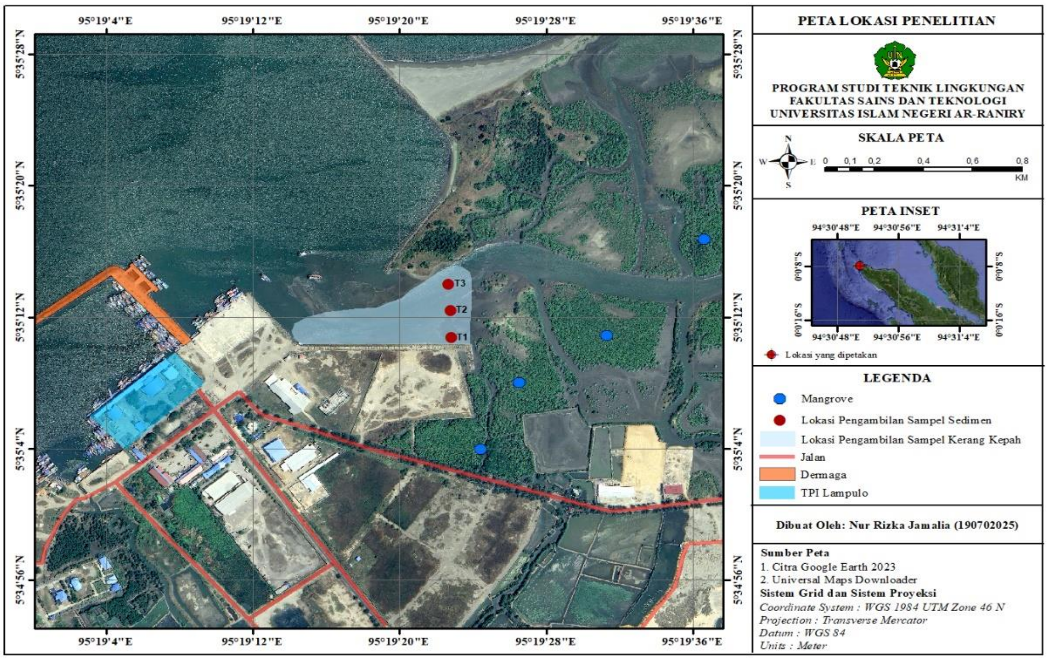


Figure 1. The research location

The sample in this study was taken as purposive sampling. Three sediment sampling points are point at location one (T1), point at location two (T2), and point at location three (T3). Binocular microscope analysis was conducted to see the shape manually, count the number of particles, and analyze the samples descriptively. The identification of microplastics found was categorized based on size, shape, color, and abundance. Furthermore, microplastic polymers were identified using FTIR. The results of the data identified from this study are then analyzed descriptively and presented as pictures and graphs.

The tools used in this study are sample bottles, sample containers, PVC pipes, analytical balance, pestle and mortar, 40 mesh sieve, measuring cup, beaker glass, aluminium foil, magnetic stirrer, scalpel, label paper, stationery, incubator, vacuum filtration, Whatmann paper No. 42, volume pipette, tweezers, petri dish, desiccator, binocular microscope, inoculum needle, and image raster. The materials used in this study were crab mussel samples (60 tails), sediment samples (100 grams/sample), distilled water, NaCl (Sodium Chloride), H_2O_2 (Hydrogen Peroxide) 30%, and KOH (Potassium hydroxide) 10%. The number of microplastic particles found in dry sediment weight is used in calculations to determine the abundance of microplastics in sediments. The equation formula can be used to calculate the microplastic abundance analysis (Laila et al., 2020) To determine the contamination from microplastic pollution present in a sample and the amount of microplastics found in shellfish.

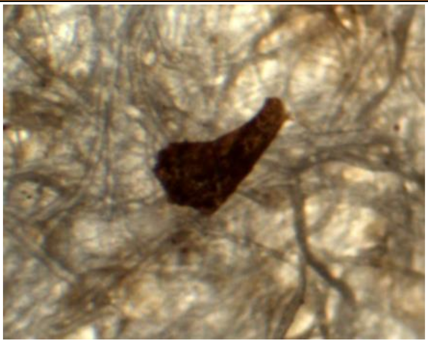
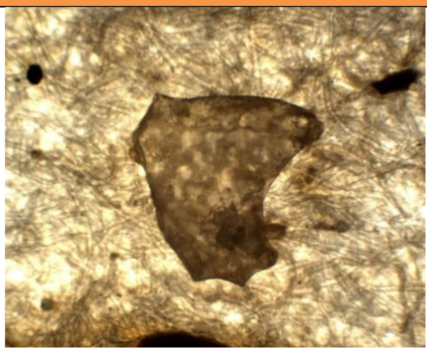
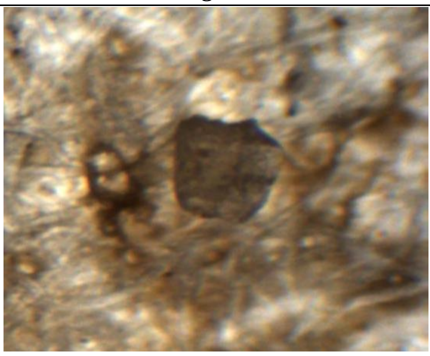
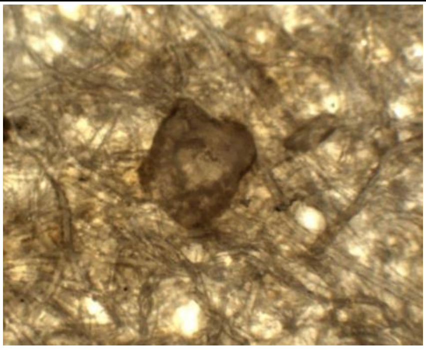
After using a microscope, FT-IR is used to determine the chemical functional groups of microplastics present in the sample to confirm various types of synthetic polymers made from various microplastic fragments.

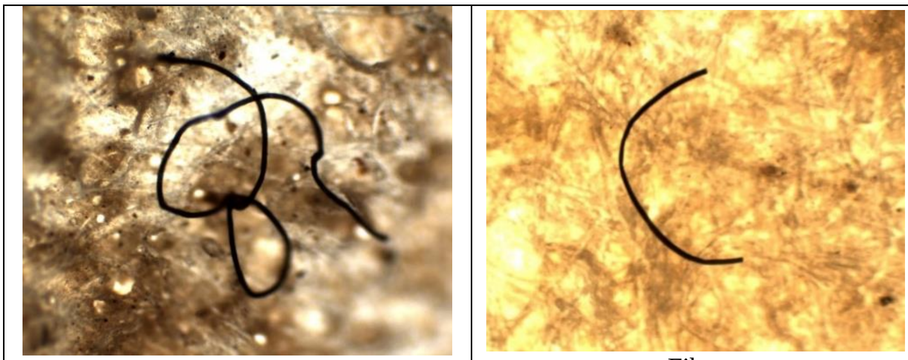
3. Results and Discussion

The results of the microplastic abundance study in Lampulo waters showed that microplastics were found more in the body of the shellfish than in the sediment. The presence of microplastics in the shellfish found in Lampulo waters is closely related to the aquatic environment and sediments, which are the shellfish's habitat. Long-term exposure to microplastics at concentrations relevant to the environment can impact marine biota. As a sedentary and filter-feeder organism, various pollutants, including microplastics, can accumulate in the shellfish body (Pratiwi, 2023). Microplastic pollution needs to be studied to measure the abundance and types of microplastics found in Lampulo waters. This research aims to help further manage plastic waste pollution. Therefore, the results of this study are beneficial for analyzing microplastics in crab shells consumed in Lampulo waters, as well as microplastic studies in sediments.

According to Rahmatillah (2023), microplastics are found in various forms, such as fragments, fibres, and films. Table 1 shows observations made with a binocular microscope on sediment samples and crab shells found in Lampulo waters to facilitate the identification and classification of microplastic.

Table 1. The shape of Microplastic

Microplastic (in sediment)	Microplastic (in crab shells)
 Fragment	 Fragment
 Film	 Film



Fibre Fibre

The following are the results of observations, presented in graphical form according to the shape of the microplastics in Figure 2.

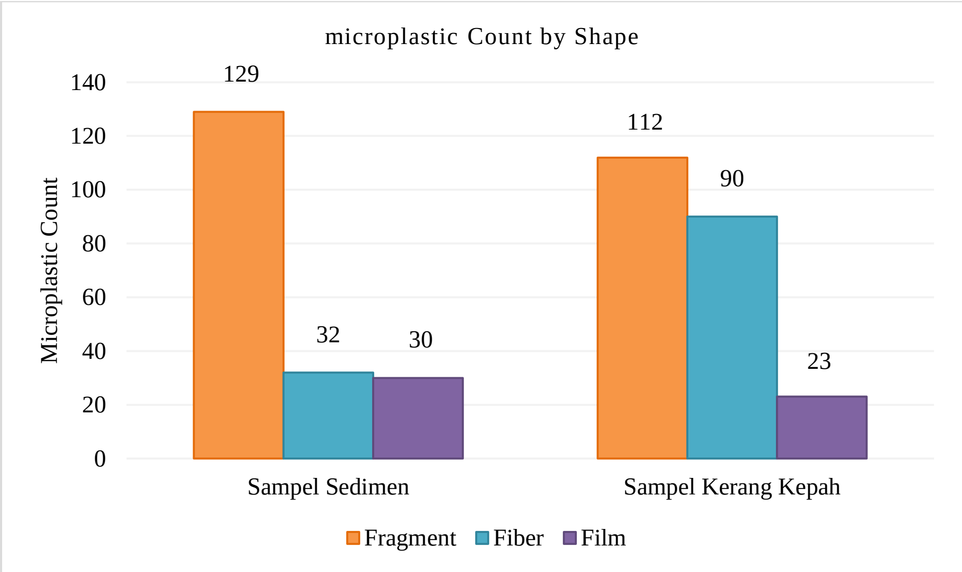


Figure. 2. Number of microplastics by shape

Figure. 2 gives the most common form of microplastics found in the fragment type and continues with fibre and film-type microplastics. The number of microplastics in sediment and shellfish samples is almost the same, with fragment-type microplastics having the most significant number. Fragments are waste from agricultural tools, plastic bags, plastic bottles, used gallons, paragon pipes, bottle caps, and buckets.

Fiber-type microplastics obtained at the research site indicate that there are many activities of fishermen who use fishing nets or threads to catch fish and household waste from rope degradation and textile fibres from clothing fabrics (Seftianingrum, 2023). Film-type microplastics were found in small amounts in Lampulo waters. The presence of film-type microplastics can be caused by community activities in the sea, tourism, and indirect waste disposal that is carried into the sea. Film-type microplastics have a transparent or translucent colour and have a thin, fragile, and irregular texture. These microplastics degrade faster than other microplastics (Naoqih, 2022).

Understanding the colour of microplastics is very important and related to indicating the type of polymer present in the microplastics. The colour of microplastics can help identify the type of plastic used in their production. In addition, the colour of microplastics can also increase knowledge in detecting microplastic types (Seftianingrum, 2023). This research performs several colour groups of microplastic particles, such as black, transparent, brown, blue, red, and green. The abundance of microplastics in sediment samples based on colour can be seen in Table 2.

Table 2. Average Abundance of Microplastics by Color in Sediment Samples

Shape of Microplastic	Sediment Sample														
	T1					T2					T3				
	Transparent	Black	Brown	Blue	Green	Transparent	Black	Brown	Blue	Green	Transparent	Black	Brown	Blue	Green
Fragment	7	14	1	-	-	37	55	10	-	-	2	1	-	-	2
Fibre	-	3	-	-	-	7	16	-	1	-	2	3	-	-	-
Film	6	-	-	-	-	16	4	-	-	-	4	-	-	-	-
Total	13	17	1	-	-	60	75	10	1	-	8	4	-	-	2

Table 2. explains that in sediment samples of the three location points, it can be seen that the most dominating colours are black and transparent colours, while brown, green, and blue colours are the least found. The dominant colour of microplastics found in sediment samples is black, with 96 particles, followed by transparent colour, with 81 particles; brown, with 11 particles; green, with two particles; and blue, with only one particle. The most common type of black microplastics found in sediment samples is fragments. Black fragments can come from black plastic fragments.

Table 3. Average Abundance of Microplastics by Colour in Crab Shell Samples

Shape Mikroplastik	Crab Shell Samples				
	Transparent	Black	Brown	Blue	Red
Fragment	79	8	25	-	-
Fiber	12	64	4	8	2
Film	16	2	4	1	-
Total	107	74	33	9	2

Table 3 shows the colour in crab mussel samples; the dominant colours of microplastics found are transparent, black, and brown. Meanwhile, blue and red are the least common colours. The samples contained 107 transparent microplastic particles, 74 black particles, 33 brown particles, nine blue particles, and two red particles. The blue and red microplastics came from broken fishing lines or nets used by fishermen at sea and clothing fibres from laundry waste. The black and brown colours come from dark and dense colours that can absorb pollutants and heavy metals in the waters. This pollution poses a risk to biota, which becomes the food chain for humans who consume them. The transparent colour indicates that the microplastics have been polluting the environment for a long time, causing the original colour to fade. The colour of microplastics will change if they enter the water for a long time. To estimate how long microplastics are in the water by colour photodegradation index approximation.

The size of microplastics is related to an organism's effect on its environment. This study found that the fragment-type microplastic sediment samples had sizes of 4577.67 μm^2 to 38504.29 μm^2. Fibre-type microplastics have sizes of 131.38 μm to 2844.84 μm. Film-type microplastics have sizes of 2502.84 μm^2 to 35627.75 μm^2. In crab shell samples, the fragment-type microplastics have sizes of 13787.41 μm^2 to 373520.47μm^2. Microplastic fibre type has a size of 192.45 µm to 3302.77 µm. Film-type microplastics have sizes of 24233.54 μm^2 to 1038680.12 μm^2. The size of microplastics found in this study indicates significant differences in size. They were starting from an area of 1 mm^2 to 0.1 mm^2 and a length of 13 mm to 330 mm. This degradation is impacted by environmental factors directly on the size of microplastics in Lampulo waters. Indicate microplastics decrease from their original size to a smaller due to time. The size of microplastics will decrease over time so microplastics will be fragmented in the water. Exposure to UV light and strong ocean waves can change the fragmentation of microplastics and can also affect the size of microplastics. In addition, the oxidative characteristics of plastics and the hydrolytic characteristics of seawater can also affect microplastics (Wahdani et al., 2020).

The sediment samples give microplastic fragments an abundance of 1,290 particles/kg, the microplastic fibre type has an abundance of 320 particles/kg, and the microplastic film type has an abundance of 30 particles/kg. Crab shell samples contain microplastics of 1,120 particles/kg fragment type, film of 230 particles/kg, and fibre of 900 particles/kg. the average abundance of microplastic particles in the 60 mussel samples was around 2,500 particles/kg. A comparison of the abundance of microplastics found in sediment samples and crab shells can be seen in Table 4.

Table 4. Microplastic Abundance

1	Sediment	T1	310	**1.910**
		T2	1.460	
		T3	140	
2	crab shells		2.500	**2.500**

The number of microplastics in sediment samples at three points (T1, T2, and T3) showed different contamination levels at each location. Location T1 has an abundance of 310 particles/kg, location T2 has an abundance of 1,460 particles/kg, and location T3 has an abundance of 140 particles/kg. Microplastics in sediment samples T1 and T3 have a small abundance compared to T2, which is at the centre of the water. This is because the T1 and T3 samples were taken at the water's side, where the water tends to flow, so the abundance of microplastics obtained is less than T2, where there is no water current. Flowing rivers have continuous water currents that can carry microplastics accumulating in the sediment. These microplastics can be carried far from their source, making microplastic concentrations at the edge of flowing waters lower. Where smaller plastic particles can be carried away from the initial deposition site, they are likely to be distributed to more distant locations over time.

FTIR analysis will provide information about the spectrum of infrared light reflected or absorbed by the sample. Each type of plastic has a unique infrared light spectrum pattern. based on the spectrum, the type of plastic present in the sample can be identified. The results of the FTIR analysis will provide information about the type of plastic contained in the sample. To read the wavelength results is to compare the similarity of the spectrum with the library or table of FTIR analysis instruments. Microplastic polymers that have been found will be the initial identification of the presence of plastic composition found in sediments and mussels in the waters of Lampulo Banda Aceh. Figure. 3. Presents the FTIR wave numbers of microplastic found in the crab shell samples.

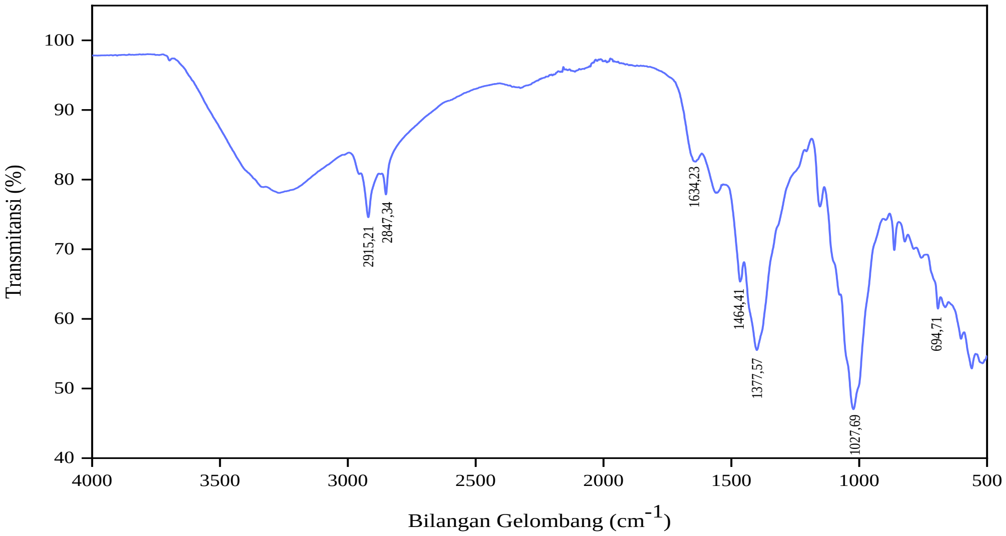


Figure. 3. The FTIR wave numbers of microplastic found in the crab shell samples.

The peak point of the number of microplastic polymers such as Polypropylene (PP), Polystyrene (PS), Polyamide (PA), High-density polyethene (HDPE), and Low-density polyethene (LDPE) are explained in Figure 3. Polypropylene (PP) polymer is characterized by absorption peaks at 2915.21 cm-1 and 1377.57 cm-1, which are C-H stretching and CH3 bending bonds. The form of microplastic film is thought to be included in the Polypropylene (PP) polymer type. Film microplastics come from plastic bags and food packaging, which tend to have a transparent color. Transparent-colour microplastics can initially identify the type of Polypropylene (PP) Polymer (Seprandita, 2022). Transparent colour microplastics have been in the water for a long time and undergo extensive UV photodegradation, which is why microplastics appear transparent. The presence of Polystyrene (PS) polymer is reinforced by the presence of absorption at the peak points 2847.34 cm-1, 1027.69 cm-1 and 694.71 cm-1 has C-H stretching, Aromatic CH bending, and Aromatic CH out-of-plane bending (Veerasingam et al., 2021). The suspected microplastic film form belongs to the Polystyrene (PS) polymer type (Seprandita, 2022). Plastic made from Polystyrene (PS) should be avoided because, in addition to being harmful to brain health, it can also interfere with women's estrogen levels, which can cause problems with development, reproduction, and the nervous system. This material must undergo a very long procedure to be recycled.

4. Conclusion

Microplastics in sediment samples and crab shells in the waters of Lampulo Banda Aceh were found to be fragments, fibres, and films, with a more dominant transparent colour, such as black, brown, blue, red, and green. The size of microplastics found in sediment samples ranged from 2502.84 μm^2 to 38504.29 μm^2. And, the size of microplastics found in crab shell samples ranged from 13787.41 μm^2 to 1038680.12 μm^2. The abundance of microplastics found in the waters of Lampulo Banda Aceh in the lowest sediment sample was found in T3 with an abundance of 140 particles/kg, T1 with a microplastic abundance of 310 particles/kg, and the highest was found in T2 obtained at 1460 particles/kg. The average abundance in sediment samples amounted to 1910 particles/kg. the abundance of microplastics found in crab shell samples amounted to 2500 particles/kg. The results of microplastic analysis using FTIR on crab shell samples showed the presence of microplastic polymers such as Polypropylene (PP), Polystyrene (PS), Polyamide (PA), High-density polyethene (HDPE), and Low-density polyethene (LDPE).

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References

Al Rahmadhani, S., Agustina, S., & Nurfadillah, N. (2022). Identifikasi Kandungan Mikroplastik Dalam Tiram (Crassostrea sp.) Di Perairan Kota Banda Aceh Dan Kabupaten Aceh Besar. Jurnal Kelautan dan

Perikanan Indonesia, 1(3), 145-150.)
Ayu, S. P., & Ningsih, A. S. (2020). Pemanfaatan Sisa Bahan Pangan Dalam Pembuatan Bioplastik. Kinetika, 11(1), 61-64.

Azizah, P., Ridlo, A., & Suryono, C. A. (2020). Mikroplastik pada Sedimen di Pantai Kartini Kabupaten Jepara Jawa Tengah. Journal of marine Research, 9(3), 326-332.

Digka, N., Tsangaris, C., Torre, M., Anastasopoulou, A., & Zeri, C. (2018). Microplastics in mussels and fish from the Northern Ionian Sea. Marine Pollution Bulletin, 135, 30-40.

Iman, M. (2005). Sifat dan karakteristik material plastik dan bahan aditif. Jurnal Traksi, Vol.3, No. 2, pp. 11-17.

Laila, Q. N., Pujiono W. P., Oktavianto E. J. (2020). Kelimpahan mikroplastik pada sedimen di Desa Mangunharjo, Kecamatan Tugu, Kota Semarang. Jurnal Pasir Laut, 4(1), 28–35.
Melani, A., Herawati, N., & Kurniawan, A. F. (2022). Bioplastik Pati Umbi Talas Melalui Proses Melt Intercalation. Jurnal Distilasi, 2(2), 53-67.

Naoqih, A. W. (2022). Identifikasi Keberadaan Mikroplastik Pada Sedimen Di Sungai Gajahwong Yogyakarta.

Octarianita, E. (2021). Analisis Mikroplastik Pada Air Dan Sedimen Di Pantai Teluk Lampung Dengan Metode Ft-Ir (Fourier Transform Infrared) (Doctoral dissertation, UNIVERSITAS LAMPUNG).

Prabowo, N. P. (2020). Identifikasi Keberadaan dan Bentuk Mikroplastik Pada Sedimen dan Ikan di Sungai Code, d. Iyogyakarta. Skripsi Yogyakarta, Universitas Islam Indonesia.

Pratiwi, F. D., Notonegoro, H., Zulkia, D. R., & Arsyad, S. (2023). Potensi Kontaminasi Mikroplastik pada Kerang Konsumsi di Pulau Bangka. Jurnal Ilmu Lingkungan, 21(1), 86-93.

Pungut, P., Widyastuti, S., & Wiyarno, Y. (2021). Identifikasi Mikroplastik Pada Cangkang Kerang Darah (Anadara granosa Liin) Dengan Menggunakan Fourier Transform Infrared (FTIR) dan Scanning Electron Microscopy (SEM). SNHRP, 109-120.-

Rachmayanti, R. (2020). Konsentrasi Mikroplastik pada Sedimen di Perairan Burau Kabupaten Luwu Timur, Sulawesi Selatan (Doctoral dissertation, Universitas Hasanuddin).

Rahmatillah, A. (2023). Analisis dan Monitoring Mikroplastik di Muara Sungai Kota Banda Aceh dan Aceh Besar (Doctoral dissertation, UIN Ar-Raniry).

Seftianingrum, B., Hidayati, I., & Zummah, A. (2023). Identifikasi Mikroplastik pada Air, Sedimen, dan Ikan Nila (Oreochromis niloticus) di Sungai Porong, Kabupaten Sidoarjo, Jawa Timur. Jurnal Jeumpa, 10(1), 68-82.

Seprandita, C. W., Suprijanto, J., & Ridlo, A. (2022). Kelimpahan mikroplastik di perairan zona pemukiman, zona pariwisata dan zona perlindungan Kepulauan Karimunjawa, Jepara. Buletin Oseanografi Marina, 11(1), 111-122.

Veerasingam, S., Ranjani, M., Venkatachalapathy, R., Bagaev, A., Mukhanov, V., Litvinyuk, D., ... & Vethamony, P. (2021). Contributions of Fourier transform infrared spectroscopy in microplastic pollution research: A review. Critical Reviews in Environmental Science and Technology, 51(22), 2681-2743.

Wahdani, A., Yaqin, K., Rukminasari, N., Inaku, DF, & Fachruddin, L. (2020). konsentrasi Mikroplastik di Kerang Manila Venerupis Philippinarum di Perairan Maccini Baji, Kecamatan Labakkang, Kabupaten Pangkajen Kepulauan, Sulawesi Selatan. Jurnal Maspari: Riset Ilmu Kelautan, 12 (2), 1-14.)

Wahyudin, G. D., & Afriansyah, A. (2020). Penanggulangan Pencemaran Sampah Plastik Di Laut Berdasarkan Hukum Internasional. Jurnal IUS Kajian Hukum dan Keadilan, 8(3), 529-550.