

# Characterization of microplastic in trawl fish caught in Padang City (Indonesia) coastal area

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**Abstract.** Edwin T, Primasari B, Purnama RA. 2023. Characterization of microplastic in trawl fish caught in Padang City (Indonesia) coastal area. *Biodiversitas* 24: 516-522. Marine organisms can ingest microplastics that are distributed in the oceans. It can harm marine organisms because carcinogenic materials easily attach to microplastics. Trawl fish is a commercial fish with a high demand from people in Padang City, West Sumatera, Indonesia. This study aimed to analyze the abundance of microplastics in the gastrointestinal tract of fish. Also, analyze the microplastic characteristics in trawl fish caught on Pasir Jambak Coast and Purus Coast in Padang City. The species studied were Sulphur goatfish (*Upeneus sulphureus*), Indian mackerel (*Rastrelliger kanagurta*), and White sardinella (*Sardinella albella*). Microplastics were identified using microscopy and FTIR spectroscopy. Microplastic abundance in Sulphur goatfish, Indian mackerel, and White sardinella was  $3.89 \pm 1.36$  per fish,  $4.22 \pm 1.28$  particles per fish, and  $2.50 \pm 0.46$  particles per fish, respectively. The size of the most commonly found microplastics ranged from 1-5 mm and was categorized as the Large Microplastic (LMP) type. Fourier Transform Infra-Red (FTIR) spectroscopy analysis showed that the origin of the type of microplastic polymer found was Polyethylene Terephthalate (PET). Statistically, it shows that the difference in the location and time of sampling does not provide a significant difference in the concentration of microplastics in fish and seawater. The results of this study indicated that microplastics were found in the waters and all fish samples on the coast of Padang City studied. Microplastics in the trawl fish can be used to manage plastic waste in the city to prevent a worse impact due to plastic pollution in the future.

**Keywords:** Indian mackerel, microplastic abundance, microplastic characteristics, sulphur goatfish, white sardinella

## INTRODUCTION

Marine pollution is caused by plastic waste and other materials containing plastic dumped into the ocean due to poor solid waste management. Plastics that are difficult to degrade can undergo fragmentation, biologically or chemically. Plastics tend to be degraded by sunlight through photodegradation and oxidation. The fragmentation causes plastic degradation to a size <5 mm, called microplastic (James et al. 2022). A study by Lusher et al. (2013) shows that microplastics are widespread in the oceans on the seabed, beaches, and sea surfaces. That is due to its buoyancy and micro size, which allows this material to be far transported in water (Horton and Dixon 2017). Water microplastics are divided into two types: primarily manufactured industrially and secondarily derived from degradation (Eriksen et al. 2013; Rocha-Santos and Duarte 2017).

Various marine organisms can inadvertently consume microplastics. Microplastics that are uptaken by aquatic organisms will cause various persistent accumulative and toxic chemicals found in them (Yagi et al. 2022). The entry of microplastics into the bodies of marine animals can damage the function of organs. Such as the digestive tract, reduce growth rates, inhibit enzyme production, reduce steroid hormone levels, affect reproduction and cause exposure to addictive plastics with greater toxic properties (Wright et al. 2013). According to Ryan et al. (2009),

microplastics can affect intestinal swelling and lower the immune system in marine animals. The digestive tract of fish that contains microplastics can cause the fish to experience a decrease in appetite (Hirai et al. 2011). The existence of these microplastics also harms living things. Microplastics found in surface waters are known to be quickly degraded into finer particles that can be consumed by plankton. These organisms are involved in the food chain by transferring these toxic plastic particles to the trophic level, like fish which are eventually taken up by humans and can cause carcinogenic effects, skin irritation, and multiple organ dysfunctions (Onyena et al. 2022). Microplastics that are digested by marine organisms also impact humans who consume them. The persistent bioaccumulation of various microplastic chemicals causes lethal and damaging conditions in humans. Therefore, microplastics in aquatic organisms that humans consume are important to investigate.

The city of Padang-Indonesia on the west coast of the Indian Ocean is rich in tropical fish. Fish is one of the main dishes in the city of Padang, and trawl fish is one of the favorites because these fish are fresh and cheap. Fishermen usually trawl on the coastal area when the weather is good and sell the catch to the people on site. This activity is known as "Maelo pukek". The cath uses the net to be stretched on the shoreline, then pulled together with a rope that reaches 400 meters. The trawl fish usually vary depending on the season. However, certain types are usually found throughout

the year, namely Sulphur goatfish (*Upeneus sulphureus*), Indian mackerel (*Rastrelliger kanagurta*), and White sardinella (*Sardinella albella*). Maelo pukek is usually done in the coastal areas of Purus and Pasir Jambak, Padang City. A high abundance of microplastic in Indonesian rivers (Meijer et al. 2021) makes it possible to transport to the sea and be uptaken by aquatic organisms. Studies show that microplastics in humans are caused mainly by fish consumption (Abidli et al. 2021). However, there is still minimal information regarding the abundance of microplastic in trawl fish caught on the coast of Padang City.

For these reasons, this paper focuses on the microplastic abundance in the trawl fishery in the coastal area of Padang City. This study aimed to analyze the abundance and characteristics of microplastics, including shape, color, size, and polymer type. Information about the microplastic abundance in trawl fish will be useful as information on pollution to fish and is also essential for managing plastic waste in Padang City, West Sumatera, Indonesia.

## MATERIALS AND METHODS

### Sample collection

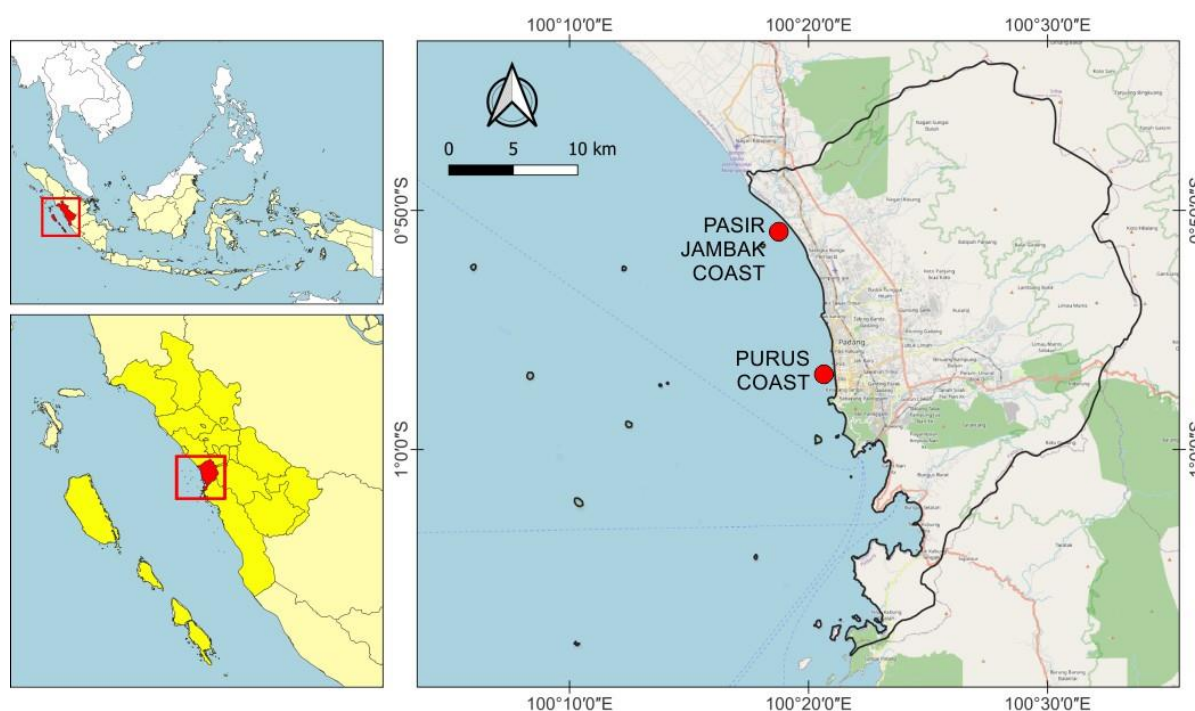
The analyzed trawl fish is the species which always be available in all seasons. They are Sulphur goatfish (*Upeneus sulphureus*), Indian mackerel (*Rastrelliger kanagurta*), and White sardinella (*Sardinella albella*). The sampling of fish and seawater on the Pasir Jambak Coast (0°50'32" S, 100°19'5" E) and Purus Coast (0°56'27" S, 100°21'6" E) of Padang City, West Sumatra Province, Indonesia, where trawl activities are located. Seawater and fish were sampled three times per fortnight, with three replications per sample. The seawater sampling method is based on the Indonesian

National Standard of 6964.8:2015 concerning the Seawater Test Sampling Method. On the other hand, fish samples of the same size and length were collected for each species.

### Microplastic analysis and characterization

Sample analysis was carried out at the Laboratory of the Department of Environmental Engineering of Andalas University. The method used for the analysis of microplastics in seawater is based on the method of Masura et al. (2015). First, the seawater was sampled at a location with a depth of 1 m. From that sampling point, seawater samples were composited from three different depth points, namely 0.2, 0.5, and 0.8 m depth, according to procedures of seawater sampling in the Indonesian National Standard. Next, the samples were perturbed and not allowed to settle for about 200 mL; the seawater sample was filtered using a 0.3 and 5mm sieve. Following the destruction process of organic matter by adding 30% H<sub>2</sub>O<sub>2</sub> and Fe<sub>2</sub>SO<sub>4</sub>, and the heating process using a hot plate for 30 minutes at 75°C. The deposit and supernatant were separated by adding a saturated NaCl solution and stirring using a magnetic stirrer at 180 rpm for 20 minutes. Finally, the filtration process was carried out using filter paper with a size of 0.3 mm with the help of a vacuum pump.

The method of microplastic analysis in fish uses the method carried out by Foekema et al. (2013). First, fish samples were dissected, and their digestive tracts were taken from the intestines and stomach. After that, the destruction process was carried out by adding 10% KOH solution with a volume of approximately three times the tissue volume. The next stage is incubated at room temperature for 24 hours until the organic matter is destroyed. Then the filtration process is carried out using a vacuum pump. The abundance of microplastics in fish and seawater uses equations (1) and (2):



**Figure 1.** Sampling locations on the coast of Pasir Jambak Coast and Purus Coast, Padang City, West Sumatra, Indonesia

$$\text{Microplastic abundance in water} = \frac{\text{Number of microplastic particles}}{\text{Water volume}} \quad (1)$$

$$\text{Microplastic abundance in fish} = \frac{\text{Number of microplastic particles}}{\text{fish}} \quad (2)$$

The type and characteristics of microplastic in fish and seawater samples were identified using a microscope with a magnification of four or ten times to analyze their size, shape, and color. The photograph of the microplastic shape was cropped using the PicsArt application. The type of microplastic polymer was identified using the Perkin-Elmer brand Fourier Transform Infra-Red (FTIR) Spectroscopy method with a wavelength of 600-4000 cm<sup>-1</sup>. FTIR was carried out at the Chemical Laboratory, Padang State University.

Descriptive statistical analysis was carried out using Microsoft Excel. Data normality analysis was conducted using the Shapiro-Wilk method first because each sample was in a smaller number than 50 (N<50). After the normality test shows that the data is normally distributed, followed by the one-way-ANOVA test, the ANOVA test was analyzed to observe the significance of microplastic abundance in fish based on sampling time and sampling location. The ANOVA interpretation results in a significant difference if P<0.05 and no significant difference if P>0.05. Furthermore, correlation analysis between the concentration of microplastics in the seawater and each fish species in this study used Pearson correlation because the data were normally distributed. The statistical analysis in this study was performed using IBM SPSS 22.0.

## RESULTS AND DISCUSSION

### Abundance of microplastic

Figure 2.A and Table 1 present the microplastic concentration in fish samples. While Table 2 shows the abundance of microplastic in seawater. Three individual fish were taken for each species at each sampling location to obtain representative results, with a sampling frequency of three times for two weeks each. The average abundance of microplastics in each species is as follows; the Indian mackerel was 4.22±1.28 particles/fish, Sulphur goatfish was 3.89±1.36 particles/fish, and White sardinella had less than 2.50±0.46 particles/fish. The average microplastic abundance in the water of the Purus coast is 26.67 particles/L, while in the Pasir Jambak coast is 35 particles/L, which explains the higher contamination of the Purus coast compared with the Pasir Jambak coast. Purus coast is located in the city center and is visited by the public because it is one of the tourist areas in Padang city. As a tourist area along the Purus coast road, there are many street vendors and the potential for plastic waste generated by tourist activities. Moreover, seawater is a final disposal site for plastic disposal in the environment that comes from rivers, marine waste, and trawl activities using plastic nets that are not appropriately managed. These microplastics will be eaten by living organisms and causing microplastic pollution to aquatic organisms (Horton and Dixon 2017).

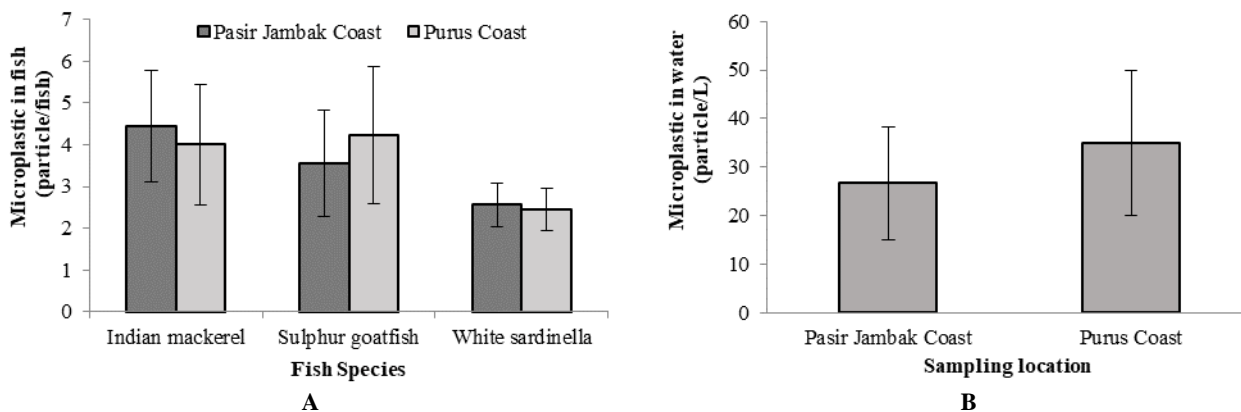


Figure 2. Microplastic in fish (A) microplastic in water (B)

Table 1. The fish characteristic and the abundance of microplastic

Species	Common name	Type of fish	N	Body weight (g)	Body length (cm)	Abundance of microplastic in fish (particle/fish)
Pasir Jambak Coast						
<i>Rastrelliger kanagurta</i>	Indian mackerel	Pelagic fish	9	25.04 ± 5.55	13.20 ± 0.53	4.44 ± 1.74
<i>Upeneus sulphureus</i>	Sulphur goatfish	Demersal fish	9	35.96 ± 2.90	13.17 ± 0.56	3.56 ± 1.51
<i>Sardinella albella</i>	White sardinella	Pelagic fish	9	29.00 ± 3.88	15.06 ± 0.39	2.56 ± 1.81
Purus Coast						
<i>Rastrelliger kanagurta</i>	Indian mackerel	Pelagic fish	9	28.22 ± 5.87	12.67 ± 1.12	4.00 ± 1.50
<i>Upeneus sulphureus</i>	Sulphur goatfish	Demersal fish	9	26.00 ± 6.52	12.14 ± 1.12	4.22 ± 2.64
<i>Sardinella albella</i>	White sardinella	Pelagic fish	9	30.84 ± 3.89	14.76 ± 0.67	2.67 ± 1.73

Compared to other studies, this study result is almost the same as research conducted by Neves et al. (2015) which found that the microplastic content in semi-pelagic fish *Boops boops* in the Balearic Islands was between 2.47 to 4.89 particles/fish. The microplastic abundance in this study was higher than fish in the deep waters of coastal and offshore southwestern Japan, ranging from 0.00-3.13 particles/fish (Yagi et al. 2022). Compared to the study by Syafitri et al. (2021), the concentration of microplastics in Pufferfish in Gaung- Padang City was higher at 15.2 particles/fish. The abundance of microplastic that enters the digestive tract depends on each species's habitat and eating habits (Yagi et al. 2022).

Zhu et al. (2019) study on microplastics originating from the Maowei Sea in China revealed ranges from 1.2 to 10.1 particles/L. Other research conducted by Nasution (2021) found that the concentration of microplastics in Padang Beach was 1.67 to 6.67 particles/L. Those two studies showed a lower abundance of microplastics than this one, which found 26.67 to 35 particles/L microplastics in the seawater. However, the study by Nel (2015) on the microplastic abundance along the southeastern coast of South Africa showed a much higher abundance of 257.9±53.36 particles/L. The difference in the abundance of microplastics in coastal areas due to plastic contamination that ends up in the water on the coast is due to its lightweight nature, which makes it easy to migrate to other areas. Therefore, it can exist in the marine environment through primary or secondary sources.

Moreover, microplastics in the ocean can come from lands such as domestic/municipal waste along coastlines, untreated waste disposal, agricultural practices, beach tourism, and recreation. In addition, to insufficient or non-working waste disposal sites, solid waste such as plastic, glass, metal, paper, rubber, textiles, processed wood, cigarettes, caps/caps, drinking bottles, and straws are dumped into the sea continuously by the human population.

Plastic waste in the sea can also come from natural phenomena such as tsunamis, hurricanes, extreme floods, and rain (Onyena et al. 2022).

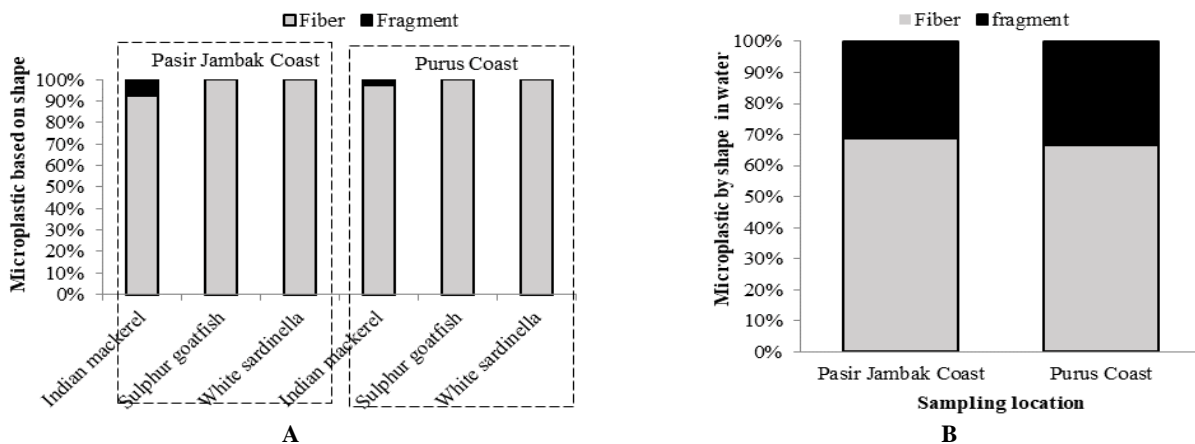
**Microplastic characteristics**

The characteristics of microplastics identified in this study include shape, color, size, and type of polymer. The shape of microplastics in fish and water samples is shown in Figure 3. The microplastics found in fish and water samples, namely fiber and fragments, are shown in Figure 4. The type of fiber was the most dominant form of microplastic found on the Padang coast. Fiber-shaped microplastics in Indian mackerel with a percentage of 94.74%, while 100% fiber shape was found in Sulphur goatfish and White sardinella. In the seawater, microplastics in the fiber shape were found in 68%, and the rest in a fragment shape.

On the other hand, Ningrum et al. (2022) also found fiber-shaped microplastics as the dominant shape in the anchovy samples collected in several harbors in Indonesia. This type of fiber-microplastic was a microplastic that comes from the coastal community's activities, where most people work as fishermen. Generally, this type of microplastic was produced from the fragmentation of monofilament clothing, ropes, fishing gear, fishing rods, and nets (Nor and Obbard 2014). A study by Nasution (2021) found fiber microplastic in Padang Beach with a percentage of 95%. Fiber microplastic was also found in the study by Phaksopa et al. (2021) on microplastic in fish around the east coast of Thailand, with a percentage of 83.33% in pelagic fish and 88.89% in demersal fish.

**Table 2.** The abundance of microplastic in seawater

Sampling location	N	Microplastic abundance (particle/L)
Pasir Jambak Coast	3	26.67 ± 11.55
Purus Coast	3	35.00 ± 15.00



**Figure 3.** A. Percentage of microplastics based on shape in marine fish samples; B. Percentage of microplastics by shape in seawater samples

The color of microplastics found in fish and water samples is shown in Figure 5, that the colors of microplastics found in fish samples and water samples, namely black, blue, red, yellow, and white. The dominant microplastic colors were black in Indian mackerel fish, Sulphur goatfish, and seawater, respectively 52.86%, 56.58%, and 56.76%, while the dominant in White Sardinella fish is blue with a percentage of 42.22%. The same results as the study conducted by Phaksopa et al. (2001) showed that the microplastic found in fish was dominantly black for pelagic fish by 50%, while for demersal fish was 66.70%. Color analysis of microplastics due to their potential to contribute to the likelihood of ingestion. These microplastics may be considered food by some of their prey organisms (Rocha-Santos and Duarte 2017).

Based on the size of the microplastic can be categorized into small microplastic (SMP) and large microplastic (LMP). The size of microplastics in fish and water samples is shown in Figure 6, and the most dominant size of microplastics found in fish and water samples was in the range of 1-5 mm and was categorized as large LMP. The distribution of large microplastic in Indian mackerel,

Sulphur goatfish, White sardinella, and seawater was 61.84%, 72.86%, 75.56%, and 59.46%, respectively. The study by Zhu et al. (2019) in fish samples in the Maowei Sea found LMP-sized microplastics with a percentage of 73%. In another study conducted by Syafitri et al. (2021), the size of the microplastic found in puffer fish, namely LMP Microplastic, which was more significant, was thought to have just undergone a degradation process.



Figure 4. Photograph of microplastics found in trawl fish in the form of fragments (left) and fibers (right)

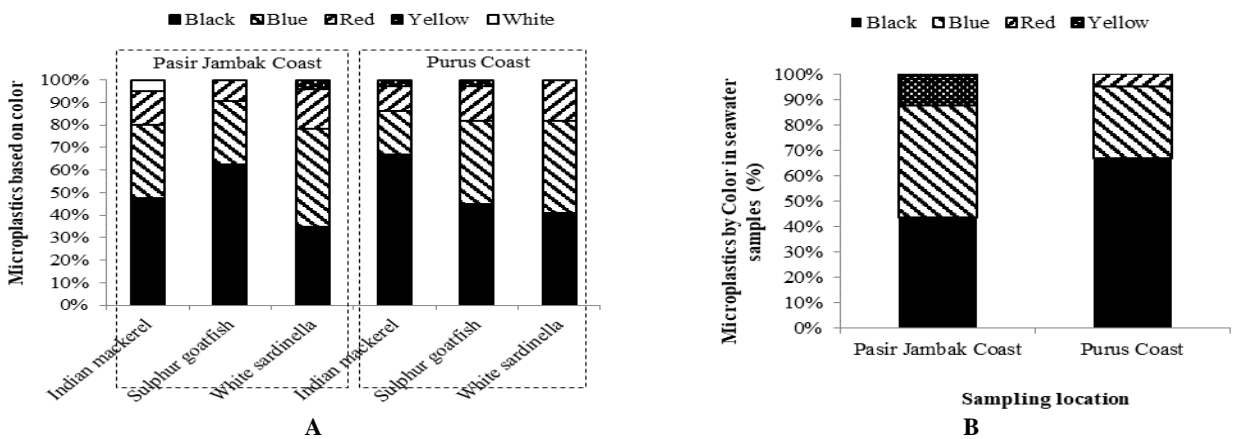


Figure 5. A. Percentage of microplastics based on color in marine fish samples; B. Percentage of microplastics by color in seawater samples

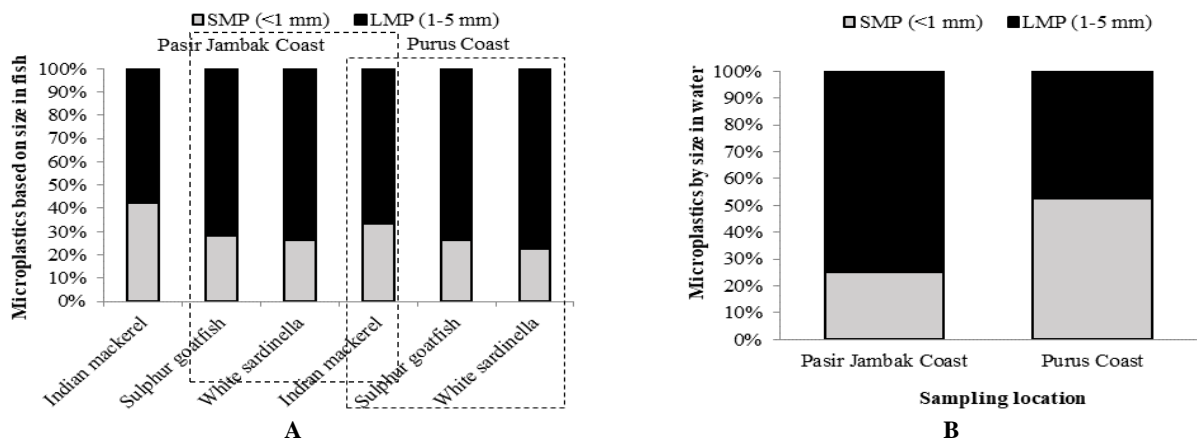
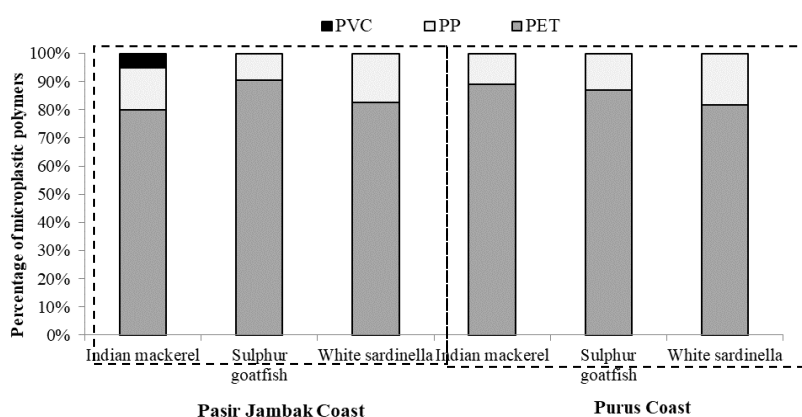


Figure 6. A. Percentage of microplastics based on size in marine fish samples; B. Percentage of microplastics by size in seawater samples



**Figure 7.** Percentage of microplastics based on polymers

The microplastic polymer type in fish and water samples is shown in Figure 7. The microplastic polymer types found in fish and water samples are polyethylene terephthalate (PET), polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC). The dominant type of microplastic polymer found in fish and water samples was PET, with the proportions of Indian mackerel, sulphur goatfish, white sardinella, and seawater 84.21%, 88.57%, 82.22%, and 80.36% respectively. The results of this study align with Phaksopa et al. (2021), that the most commonly found microplastic polymers in pelagic and demersal fish were PET, with a percentage of 83.33% and 66.67%, respectively. PET is the primary material for making ropes, beverage containers, synthetic fibers, and food containers.

### Statistical analysis

One-way ANOVA and independent samples test for temporal and spatial analysis showed no significant difference ( $P > 0.05$ ) between the abundance of microplastics in the different sampling times and locations for the three fish species. The abundance of microplastics in water generally correlates with the abundance of fish. There was a strong correlation between microplastics in the water and fish content in the three species on the Pasir Jambak coast of Indian mackerel ( $r: 0.785$ ), Sulphur goatfish ( $r: 0.991$ ) and White sardinella ( $r: 0.753$ ). However, on the Purus coast, the abundance of microplastics in the water only had a strong correlation to White sardinella ( $r: 0.981$ ) and a low correlation to Indian mackerel ( $r: 0.113$ ) and Sulphur goatfish ( $r: 0.100$ ). That shows the higher abundance of microplastic in the water, the higher probability of fish intake. Moreover, microplastic abundance in aquatic organisms can be influenced by the habitat types in which fish live (Baalkhuyur et al. 2018) and feeding habits (Talley et al. 2020).

This study concluded that the average abundance of microplastics in Sulphur goatfish, Indian mackerel, and white sardinella was 3.89 particles/fish, 4.22 particles/fish, and 2.50 particles/fish, while in the seawater, it was around 26.67 to 35 particles/L. The dominant form of microplastic was the fiber type, and the dominant microplastic color was black. At the same time, the most commonly found

microplastic size was the Large Microplastic (LMP). Furthermore, FTIR spectroscopic analysis showed that the most common type of microplastic polymer found was Polyethylene Terephthalate (PET). The ANOVA result showed that the difference in the location and time of sampling did not significantly affect the concentration of microplastics in fish and water. Consequently, the abundance of microplastics in the water will allow fish intake at any time. This study showed that microplastic pollution already impacts commercial trawl fish in the coastal area of Padang City. Therefore, plastic waste management needs to be taken more seriously so that further pollution can be prevented and the habitat for trawl fish can be conserved.

### ACKNOWLEDGEMENTS

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