Microplastics contamination in three species of marine fish harvested by coastal land trawl in Banda Aceh City and Aceh Besar Regency waters, Indonesia

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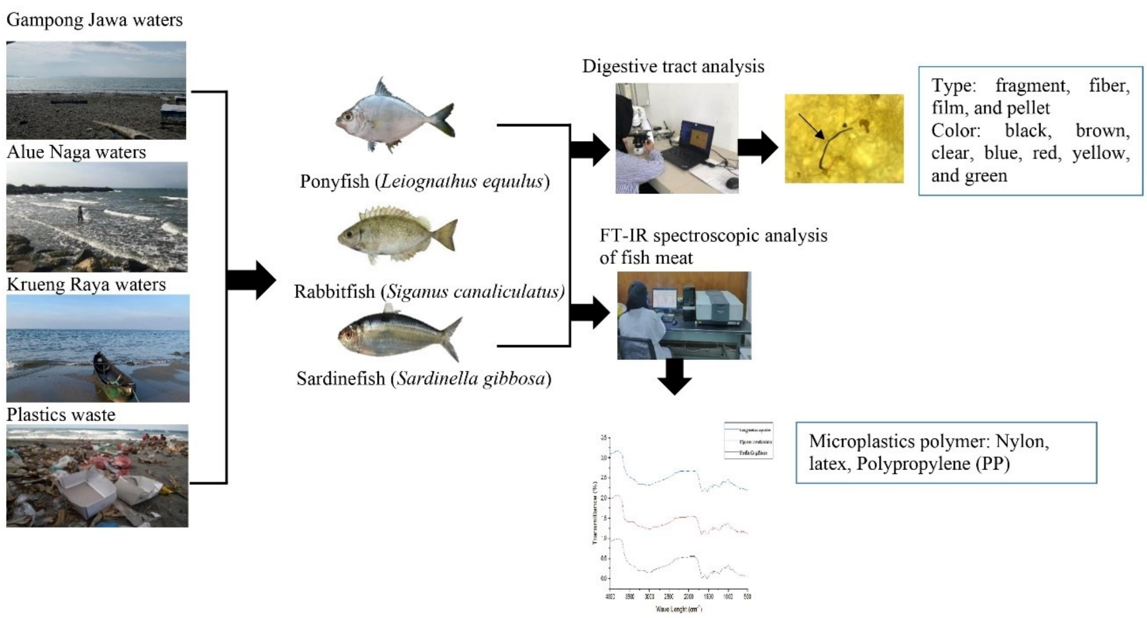
GRAPHICAL ABSTRACT



Abstract

Banda Aceh City and Aceh Besar Regency are two of the areas experiencing rapid population growth and increased waste production, including plastics. The areas are directly adjacent to the coast, and the generated plastic waste has the potential to pollute the sea and fish. Therefore, this research aimed to analyze microplastics contamination in three species of marine fish caught in the coastal areas of Banda Aceh and Aceh Besar. The sampling was carried out for 3 months from January to March 2024 at three locations, namely Gampong Jawa (Station 1), Alue Naga (Station 2), and Krueng Raya (Station 3). The fish samples were ponyfish (*Leiognathus equulus*), rabbitfish (*Siganus canaliculatus*), and sardine fish (*Sardinella gibbosa*). The results showed that there were four forms of microplastics, namely fibers, fragments, films, and pellets, with seven types of colors, including black, brown, clear, blue, red, yellow, and green. The dominant shape and color were fragment and black, respectively. In ponyfish, the highest and lowest number of microplastic particles were found in samples caught in Alue Naga waters (4.51 particles/fish) and Krueng Raya waters (2.80 particles/fish). Meanwhile, rabbitfish had the highest and lowest abundance in Alue Naga waters (3.60 particles/fish) and Gampong Jawa waters (2.83 particles/fish), respectively. The highest and lowest abundance of sardine fish was found in Gampong Jawa waters (3.77 particles/fish) and Krueng Raya waters (1.50 particles/fish), respectively. In general, ponny fish had a higher abundance of microplastics than the other two species, and microplastics were highest in fish from the Alue Naga station based on location. According to Fourier Transform Infrared Spectroscopy (FTIR) test on flesh samples of the species, three types of polymers were detected, namely latex, nylon, and polypropylene. In this context, the flesh of species analyzed were contaminated with microplastics.

Key words: Microplastic contamination, ponyfish *Leiognathus equulus,* rabbitfish *Siganus canaliculatus,* sardines *Sardinella gibbosa*, and Spektroscopi Fouries Transform Inframerah

1. Introduction

Water pollution from plastic contamination is among the most terrible global issues (Singh et al. 2024). Plastic does not decompose easily in a short period due to high molecular mass density (Rodrigues *et al.* 2019; Fachrul 2021). Generally, the waste comes from inland and enters the waters, while some are washed away, and sinks to the seabed. Approximately 250,000 tons of plastic waste are floating in the ocean (Eriksen *et al.* 2014). China is the country that contributes the most to the sea, followed by Indonesia (Purba *et al.* 2019). The pollution mostly comes from agricultural and fishery activities, as well as industrial and domestic wastes (Yuan *et al.* 2019; Gao *et al.* 2021; Sewwandi *et al.* 2022; Turner *et al.* 2021; Ozgenc et al. 2024). In waters, plastics have the potential to contaminate aquatic biota, intentionally or unintentionally, through food chains or webs. Microplastics accumulate in the bodies of aquatic biota such as shellfish, fish, and mollusks, causing damage to digestive organs, inhibiting enzyme production, altering the reproduction process, reducing steroid hormone levels, and causing the death of the biota (Masura *et al.* 2015; Schwarzer *et al.* 2022; Ahmed *et al.* 2023; Zhang *et al*. 2023). Additionally, toxic chemicals can be absorbed to increase the toxic level in waters (Wang *et al.* 2018). In this context, aquatic biota contaminated with microplastics is unsafe to consume (Dewi 2022; Aghilinasrollahabadi *et al.* 2021; Wang *et al.* 2020; Fu *et al.* 2019).

Research onmicroplastic pollution in global marine waters have been reported in the waters of Western Pacific Ocean and South China Sea contaminated by microplastics with densities of 187–1816 particles/m^3 (Cui *et al.* 2022). Pan *et al.* (2022) reported the contamination in surface water in the central part of North Pacific Ocean, which had an average abundance of 123 particles/m^3. Microplastics are also contaminating Antarctic sea surface water with an average abundance of 0.10-0.14 particles/m^3 (Zhang *et al.* 2022). A similar research was reported from Indonesian waters by Takarina *et al.* (2022), where the coastal sea waters of Ancol, Muara Baru, and Muara Angke-Muara Karang were polluted with an abundance of 1532 particles/L. The waters of Menjangan Kecil Island, Karimunjawa Islands, have been contaminated with 17.21 particles/L of microplastics (Seprandita *et al.* 2022), while those of West Coast, Karimun Island, Riau Islands Province, were contaminated by 95.25 particles/L of microplastics (Suriyanto *et al.* 2020). These research were mostly focused on seawater pollution and lacked analysis on fish. The issue is important to ensure food security for Indonesian people and the global community. Presently, research on the microplastics contamination have been reported by Maulana *et al.* (2023) on mullet fish (*Mugil cephalus*) and bagok fish (*Hexanematichthys sagor*) in the estuary waters of Krueng River, Aceh. Besides the estuary area, migratory pelagic fish such as tuna *Eythynus affinis* in Pulai Baai Bengkulu and mackerel *Rastrelliger* sp. in Belawan, North Sumatra, have also been contaminated with microplastics having an abundance of 52.7 particles/fish and 136 particles/fish, respectively (Purnama *et al.* 2021; Arisanti *et al.* 2023). In Pangempang waters, East Kalimantan, the coral reef fish *Ephinepelus coioides* was also contaminated with microplastics, with an abundance of 15.4 particles/fish (Anjani *et al.* 2023).

Fishery is an important sectors in Aceh, Indonesia. Most Acehnese are artisanal fishermen with small boats that can only operate up to 3-5 miles from the coast. Some fishermen still use traditional fishing gear such as hauling coastal trawl. Several research reported that the dominant fish caught in the coastal waters of Banda Aceh and Aceh Besar includes ponyfish fish (*Leiognathus equulus)*, rabbitfish (*Siganus canaliculatus)*, and sardine (*Sardinella gibbosa)* (Muchlisin 2017; Adrian 2019; Fahlevi 2019). These fish have the potential to be contaminated by microplastics due to coastal waters close to sources of pollution such as settlements, agriculture, fisheries, and industries. The research on microplastics contamination of fish in this coastal areas has not been carried out. These areas are densely populated and produce a high volume of plastic waste.

In this study, the Fourier Transform Infrared Spectroscopy (FTIR) approach was employed to detect the presence of Alkane compound as a characteristic of microplastic polymers in fish muscles. This approach was scarely adopted in microplastics contamination research in fish. Therefore, this research aimed to analyze the microplastics contamination of three dominant species of marine fish commonly caught by coastal fishermen in Banda Aceh City and Aceh Besar Regency waters to ensure food security for Indonesian people.

2. Materials and Methods

2.1. Time and site

This research was conducted from January to March 2024. Microplastic analysis was performed at the Chemistry and Biotechnology Laboratory, Faculty of Marine and Fisheries, Syiah Kuala University, Banda Aceh, Indonesia, while Fourier Transform Infrared Spectroscopy (FTIR) was carried out at the Environmental Quality Assessing Laboratory in the Faculty of Engineering, University Syiah Kuala, Banda Aceh. Ponyfish, rabbitfish, and sardine were collected from three locations, namely Gampong Jawa Banda Aceh city (Station 1), Alue Naga Banda Aceh city (Station 2), and Krueng Raya Aceh Besar Regency (Station 3). These locations are found in Banda Aceh Bay, as shown in Figure 1. The sample was caught by an inland coastal trawl operated by local fishermen and a total of 30–50 individuals of each species were taken randomly at each location per month. The samples were kept in a coolbox containing ice cubes (4ºC) and transported to the Marine Chemistry and Biotechnology Laboratory, Faculty of Marine and Fisheries, Universitas Syiah Kuala University, Banda Aceh, Indonesia.

2.2. Sample preparation and analysis

Fish were weighed for total body weight and length before dissecting the stomach to remove the digestive tract. Subsequently, the digestive tract was opened, and the contents were pooled in Erlenmeyer flask, and 10% KOH was added until the sample was submerged. Erlenmeyer was covered with aluminum foil and left for 24 hours to degrade organic materials. In addition, the sample was filtered using Whatmann filter paper (Sartorius Cellulose Nitrate Membrane, 0.45 m) and the filter paper was transferred to a petri dish, covered and heated in an oven at 60ºC (Rochman, 2015; Cauwenberghe and Jansen 2014). The dried filter paper was analyzed for microplastics using a stereo microscope (Primo Star Zeiss) with 400x and 100x magnifications. The shape, color, type, and size were analyzed based on Basri (2021) and Widianarko and Hantoro (2018). The abundance of microplastics in fish digestive tract samples was calculated based on Boerger *et al.* (2010).

2.3. Spectroscopy Fourier Transform Infrared (FTIR)

FTIR test was carried out to detect types of microplastics polymers in fish flesh using ATR method (Nor and Obbard 2014). The polymer wavelength spectrum was analyzed using software (IR Solution) to read the spectrum. Subsequently, the spectrum was compared with a standard from a plastic polymer database using Euclidean distance to determine the type of polymer (Lusher *et al.* 2013).

A total of three fish samples of every species were taken randomly from different locations. The fish flesh was crushed and dried using an oven at 60ºC for 48 hours. After drying, the fish was ground into powders and transported to laboratory at the Faculty of Engineering, Universitas Syiah Kuala, Banda Aceh. FTIR followed the procedure based on Baalkhuyur *et al.* (2018) where a fine sample was taken using a spatula. In addition, potassium bromide (KBr) was added in a ratio of 1:9 (sample: KBr) and placed on a plate before conducting a spectrum reading process using FTIR (Shimadzu IR) machine. The wavelength was plotted in graphical form to analyze the peak, and the results were compared with a database based on Jung *et al.* (2018).

3. Result

A total of 132 samples of ponyfish, 117 rabbitfish, and 126 sardine were successfully collected from Gampong Jawa location. For Alue Naga, 83 ponyfish, 113 rabbitfish, and 99 sardines were collected. Meanwhile, 165 ponyfish, 124 rabbitfish, and 163 sardines were collected from Krueng Raya location (Table 1). The analysis of the digestive tract of ponyfish showed that the highest and lowest abundance of microplastics was found in Alue

Naga (4.51 particles/fish) and Krueng Raya waters (2.80 particles/fish), respectively. In rabbitfish, the highest and lowest number was found in Alue Naga (3.60 particles/fish) and Gampong Jawa waters (2.83 particles/fish). In sardine, the highest and lowest number was found in Gampong Jawa (3.77 particles/fish) and Krueng Raya waters (1.50 particles/fish), respectively. There are four shapes of microplastics in the digestive tract of the sample fish, namely fibers, fragments, films, and pellets (Table 1 and Figure 2). The fragments are the most dominant shape or form in the three species of fish from the sampling locations.

Based on sampling time and location, the high abundance of microplastics in ponyfish during January, February, and March 2024 was found at Alue Naga, Gampong Jawa, and Alue Naga station, respectively. For rabbitfish, the highest abundance of microplastics was found in fish from Krueng Raya, Alue Naga station, and Gampong Jawa station during January, February, and March 2024, respectively. Meanwhile, for sardines, the highest abundance was found at Gampong Jawa station, Alue Naga station, and Kreung Raya station during January, February, and March 2024, respectively.

There were seven colors of microplastics found in the digestive organs of the three species of fish namely black, brown, clear, red, blue, yellow, and green (Table 2). The dominant and the least common colors in these fish were black and green, respectively (Figure 5). In ponyfish, the black color is most often found at stations 3, 2, and 1 for ponyfish, rabbitfish, and sardine. Based on fish species, ponyfish has the highest abundance of microplastics (Figure 4a), followed by rabbitfish and sardines. Meanwhile, fish samples from Alue Naga have a higher abundance of microplastics compared to other locations (Figure 4b).

FTIR test on ponyfish flesh showed the peak wavelengths in the range of 3269.34 cm-1 (N-H stretch), 2931.80 cm^{-1} (Aromatic CH out of plane, =CH band), 1666.50 cm^{-1} (C=C stretch), 1527.62 cm^{-1} (NH band, C-N stretch), and 1398.39 cm^{-1} (CH2 band). In rabbitfish, the peak was in the range of 3265.49 cm^{-1} (N-H stretch), 2931.80 cm^{-1} (Aromatic CH out of plane, =CH band), 1681.93 cm^{-1} (C=C stretch), 1539.20 cm^{-1} (NH bend, C-N stretch), and 1398.39 cm^{-1} (CH2 band). In sardine, the peak was in the range of 3269.34 cm^{-1} (N-H stretch), 2931.80 cm^{-1} (Aromatic CH out of plane, =CH band), 1666.50 cm^{-1} (C=C stretch), 1535.34 cm^{-1} (NH band, C-N stretch), and 1398.39 cm^{-1} (CH2 band) (Figure 6). Based on the wavelength values, there were three types of polymers detected, namely latex, nylon, and polypropylene. The indication was characterized by the presence of wavelength peaks in the range 2800–3000 cm^{-1} (CH stretch), 1769–1535 cm^{-1} (NH band), and 1375–1450 cm^{-1} (CH3 band). CH stretch or band bonds are commonly used to predict the structure and identity of latex polymers since the presence and type of C-H bonds are an integral part of the basic structure. Even though the amide and methylene group (CH2) are the most significant bonds to determine the type of nylon polymer, CH bonds were used as a reference for predicting polypropylene polymers.

4. Discussion

The sample fish from the three locations have been contaminated by microplastics. In ponyfish, rabbitfish, and sardine, the microplastic abundance ranged from 2.80–4.51, 2.83–3.60 and 1.50–3.77 particles per fish, respectively. The average particle was higher in ponyfish than the two other species. However, the abundance in pobyfish was lower than the waters of Segara Anakan Cilacap, Central Jawa, which reached 2.32–28.56 particles per fish (Hotijah 2022). The number of microplastics in rabbitfish and sardines was also lower compared to other waters. For example, rabbitfish in the waters of Sorong, West Papua, and sardines in Kendari Bay had average of 55 (Iriani *et al.* 2023) and 209.6 particles per fish, respectively (Hatia *et al.* 2021).

The results of the analysis show that there were four shapes of microplastics found in fish and seawater in Banda Aceh and Aceh Besar, namely fragments, fibers, films, and pellets. This research was in agreement with Panjaitan *et al.* (2021), which analyzed microplastics in red snapper (*Lutjanus* sp.) in Kedonganan waters, Bali, Indonesia. The results showed that fragments were mostly found in the digestive organs of the fish. Film is the second shape of microplastics found in three fish species at all research locations. On the Red Sea coast of Saudi Arabia, film and fibers were also reported to pollute the digestive tract of grouper (*Epinephelus* sp.).

Fragments and films have a lower density, and easily float on the surface of the water. This condition causes microplastics to be easily carried by currents from the beach to the open sea. The floating characteristic also causes many fragments and films to be filtered during the sampling of water (Febriani *et al.* 2020). This was confirmed by the results, where the materials were dominant in the water and digestive tract of the three species. Purba *et al.* (2019) stated that the weight of microplastics determines distribution, where microplastics weighing less were distributed widely by currents and tides.

Microplastic fragments and films come from plastic bags, jar packaging, bottles, and paralon pipes (Dewi *et al.* 2015; Claessens *et al.* 2011). Research observed a lot of plastic waste, such as plastic bags, plastic packaging, and mineral water bottles, in the sampling location area. This is one of the causes of the high number of particles in the fish sampled at the research location. Even though the amount was not as large as fragments and films, fiber-type microplastics were also found in each fish. Calderon *et al.* (2019) reported that fibers were reported in several species in the waters of Ciénaga Grande de Santa Marta, North Colombia, with an abundance of up to 17 particles per fish. Therefore, the abundance in the three species was lower compared to the location. Anthropogenic activities such as fishing activities, fishing ports, and settlements determine the abundance of microplastics in the waters (Zhao *et al.* 2018; Lolodo and Nugraha 2019) and pellets were the least common shape. A similar result was reported by Pamungkas *et al.* (2022), which reported the least amount of pellets in the digestive tract of marine fish in Wulan River Estuary, Demak, Central Java. The microplastics are the main materials for making plastics for human needs and rarely directly used (Zhao *et al.* 2018; Sulistyo *et al.* 2020).

The abundance of microplastics is influenced by human activities in the water. In addition, tides and waves influence the abundance of the materials. For example, high waves and currents cause stirring and this process lifts waste at the bottom of the waters to the surface (Barnes *et al.* 2009). Ponyfish, rabbistfish, and sardines live in shallow waters in coastal areas. The three species sampled are hervivorous-omnivorous fish such as plankton and detritus. Microplastics are similar in size and shape to natural food, such as plankton and other small organisms. Therefore, the fish accidentally ate microplastics since the particles were misplaced for food or preys (Prihatiningsih *et al.* 2014; Wang *et al.* 2022; Walkinshaw *et al.* 2020; Yuan *et al.* 2022).

This research showed that black was the dominant color found in the three fish samples at all locations. The same results have also been reported by Johan *et al.* (2021) on the digestive tract of gulama fish (*Johnius trachycephalus*) in the waters of Segara Bay, Bengkulu City, as well as in grouper *(Epinephelus areolatus*), yellowfin grouper (*Nemipterus japonicas*), flyingfish (*Alepes vari*), and tuna (*Atropus atropus*) in the waters of Tuban, East Java (Hidayati *et al.* 2023). The color changes are caused by degradation (Khuyen *et al.* 2022), and the longer the process, the more the color will fade (Azizah *et al.* 2020). Degradation is influenced by waves, currents, and exposure to sunlight (Kye *et al.* 2023; Sutkar *et al.* 2023; Zhao *et al.* 2022). According to Febriani *et al.* (2020), bright color such as red, green, and yellow shows that the microplastics have not been subjected to significant discoloration. Black contains many contaminants and other organic particles since the color has a high ability to absorb pollutants (Hiwari *et al.* 2019; Huang and Xu 2022; Jitkaew *et al.* 2024).

FTIR analysis of the flesh fish produced wavelengths of 416.62-3269.34 cm^{-1}, 418.55-3562.52 cm^{-1}, and 420.48-3269.34 cm^{-1} in ponyfish, rabbitfish, and sardine fish, respectively. Therefore, the flesh of the three fish samples detected three polymers, namely nylon, latex, and polypropylene. The nylon polymer was also found in mackerel (*Rastrelliger* sp.) and squids (*Loligo* sp.) in the waters of Semarang City (Suprijanto *et al.* 2020), as well as lemuru fish (*Sardinella lemuru*) in Bangka (Pratiwi *et al.* 2023). Nylon has a small pore size and is resistant to high pH and temperature (Huang *et al.* 2013; Narang *et al.* 2011). Meanwhile, latex has a low density and mostly floats on the surface of the water (Jung *et al.* 2018; Lambert *et al.* 2013, Gilmour dan Lavers 2021). This material also has elastic properties, does not oxidize easily, and is resistant to water. Latex is used as material for making gloves, baby drinking bottles, balloons, and mattresses (Lutfinor 2017; Boonying *et al.* 2022; Prihatin *et al.* 2018; Ahmed 2020).

Polypropylene is commonly used in the textile industry to produce cloth, and carpets (Park *et al.* 2004). The material is also used in plastic containers for storing food, drink bottles, straws, and drinking bottles. The polymer has a low density, strong, durable, resistant to high temperatures (Salsabila *et al.* 2022; Rossatto *et al.* 2023; Muhib *et al.* 2023; Giacinto *et al.* 2023), and can be used for fish nets and ropes (Alsabri *et al.* 2022). In addition, polypropylene was found in tuna (*Auxiz rochel*) from Damas Prigi Beach, Trenggalek Regency, East Java (Trivantira *et al.* 2023), and two species of fish (*M. cephalus* and *H. sagor*) in the estuary of Krueng Aceh river (Maulana *et al*. 2023).

Fish or aquatic biota contaminated with microplastics when consumed threatens human health and the impacts include inflammation of the digestive tract and constipation (Zhao *et al.* 2023; Qiao *et al.* 2019). This causes dysbiosis disorders that reduce the body's immune system, potentially causing chronic disease (Fackelmann *et al.* 2019; Deng *et al.* 2020), hormonal balance disorders, and reproductive dysfunction (Gallo *et al.* 2018; Kontrick *et al.* 2018). Therefore, the management of plastic waste in the sea must pay serious attention, and anticipatory steps need to be taken through strict policies regarding the use of plastic materials and increasing awareness of recycling in the community. Further research is crucially needed to analyze the microplastics concentration in fish muscles to determine whether it passed the safety limits or is still safe for humans.

5. Conclusions

In conclusion, Banda Aceh and Aceh Besar waters were under threat from plastic waste. This research confirmed that ponyfish, rabbitfish, and sardines had been contaminated with microplastics. In ponyfish, the highest and lowest number of particles was found in fish samples caught in Alue Naga waters (4.51 particles per fish) and Krueng Raya waters (2.80 particles per fish), respectively. In rabbitfish, the highest and lowest was in Alue Naga (3.60 particles per fish) and Gampong Jawa waters (2.83 particles per fish), respectively. Meanwhile, the highest and lowest abundance of sardines was found in the waters of Gampong Jawa (3.77 particles per fish) and Krueng Raya (1.50 particles per fish), respectively. FTIR test on the flesh of the three species showed that there were three types of polymers, namely latex, nylon, and polypropylene.

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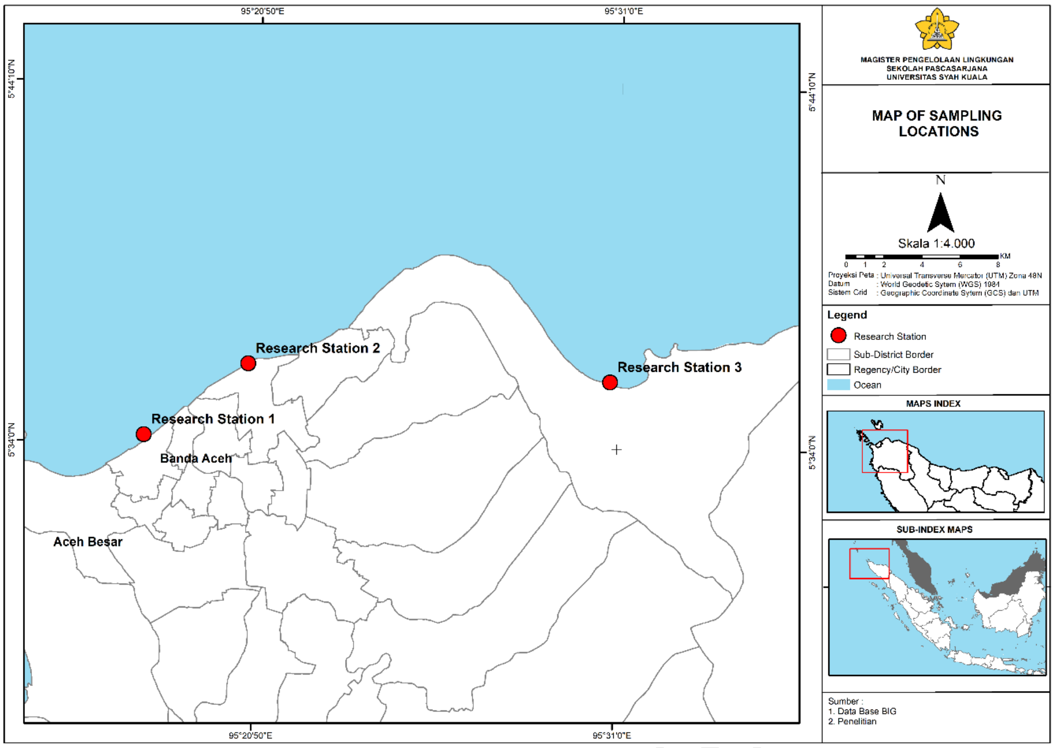

Figure 1. The map of Banda Aceh city and parts of Aceh Besar regency showing the sampling locations. Station 1 is kampung Pande, Station 2 is Alue Naga, and Station 3 is Krueng Raya

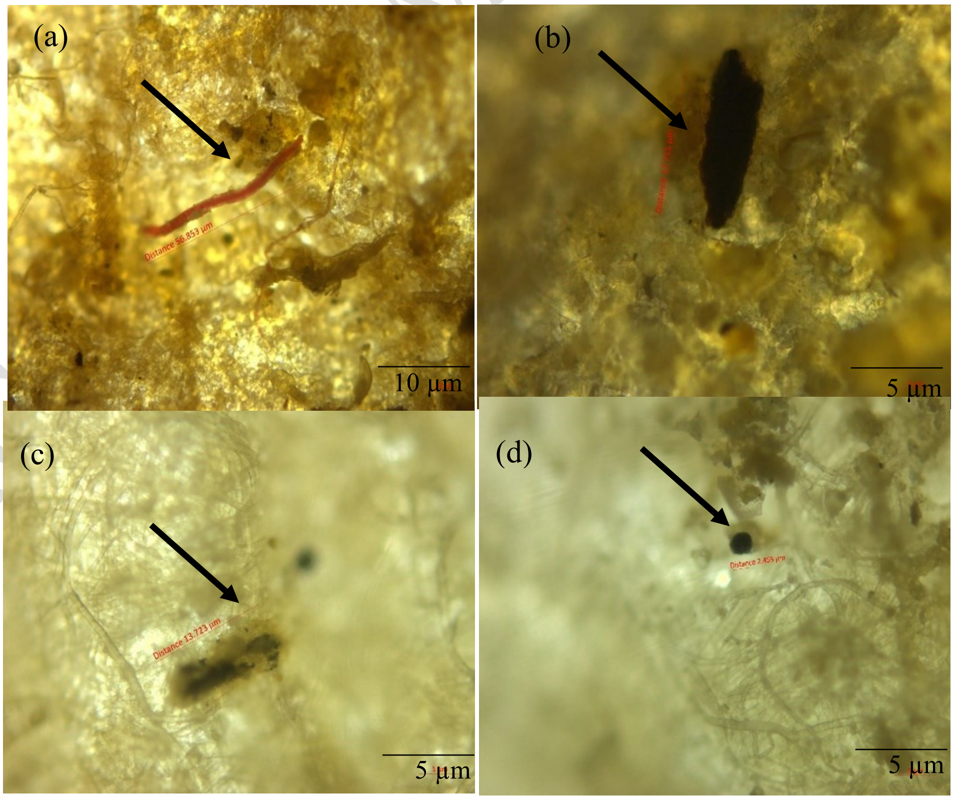

Figure 2. The shape of microplastic found in the digestive tract of fish sample. (a) Fiber, (b) Fragment, (c) Film, (d) Pellet

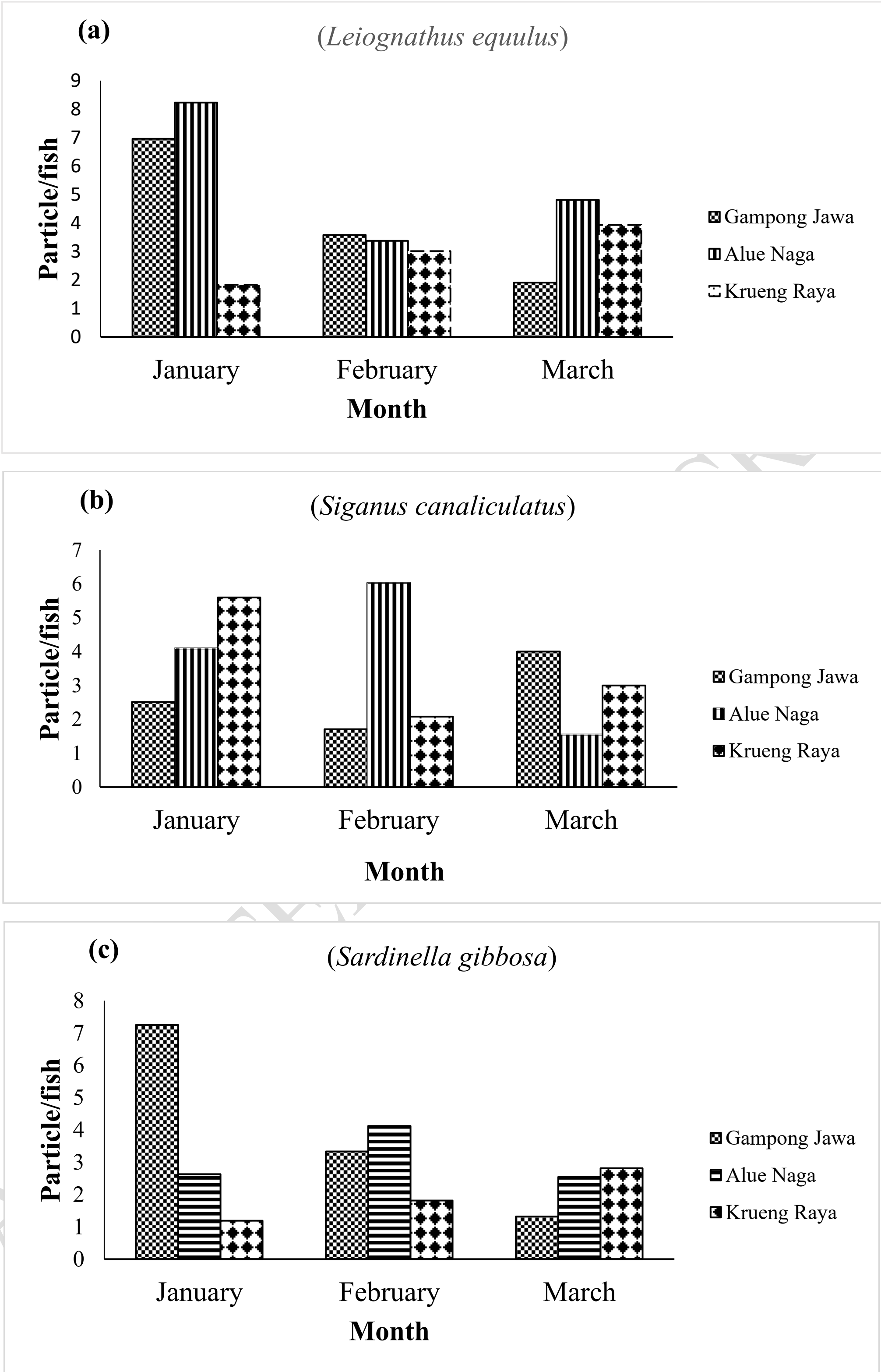

Figure 3. The abundance of microplastics in the fish sample during January to March 2024. (a) Ponyfish *Leiognathus equulus*, (b) Rabbitfish *Siganus canaliculatus*, (c) Sardijes *Sardinella gibbosa*

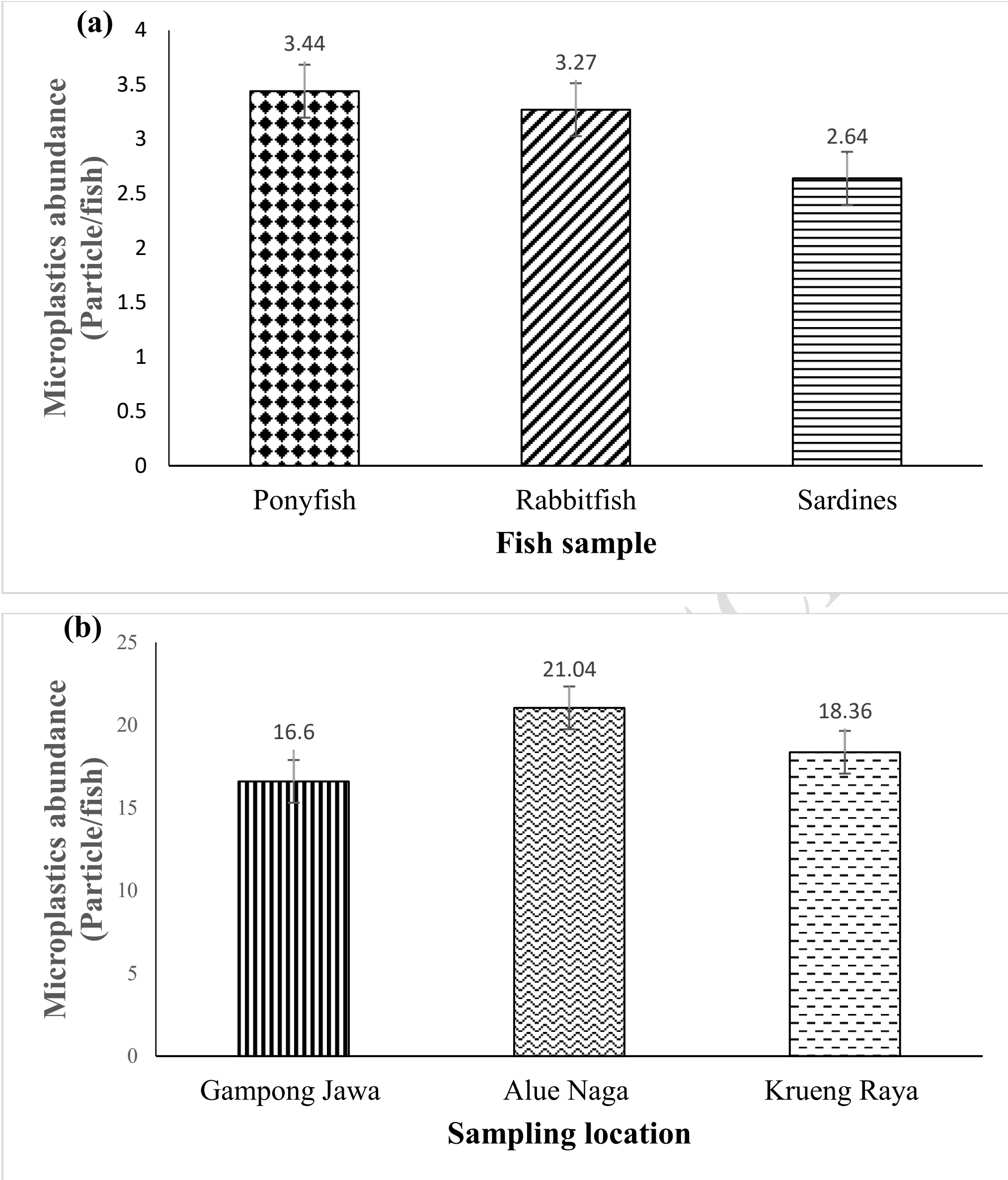

Figure 4. The abundance of microplastics based on (a) fish species, and (b) sampling location

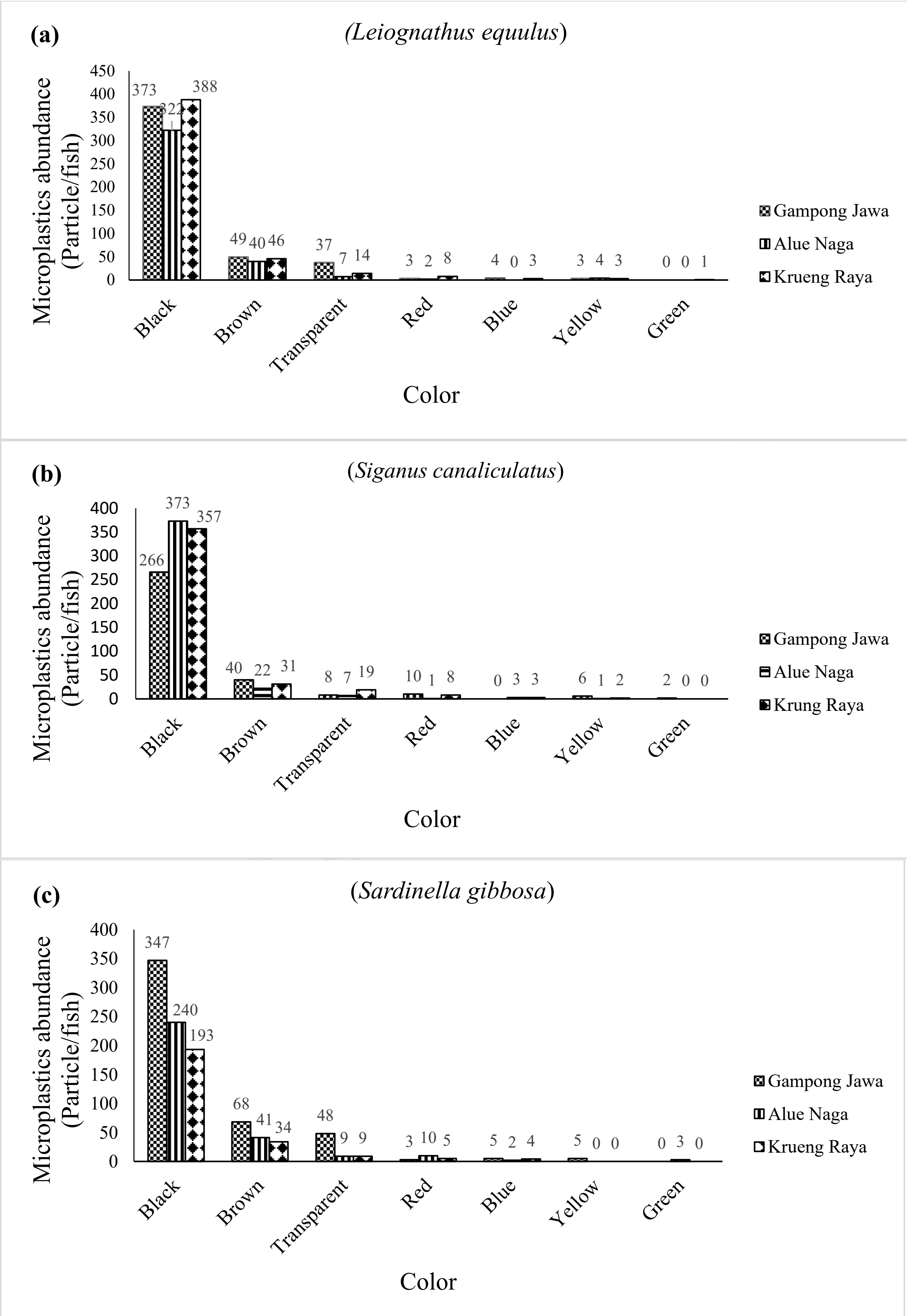

Figure 5. The abundance of microplastics based the coloring during January to March 2024 (a) ponyfish *Leiognathus equulus*, (b) rabbitfish *Siganus canaliculatus*, (c) sardines *Sardinella gibbosa.*

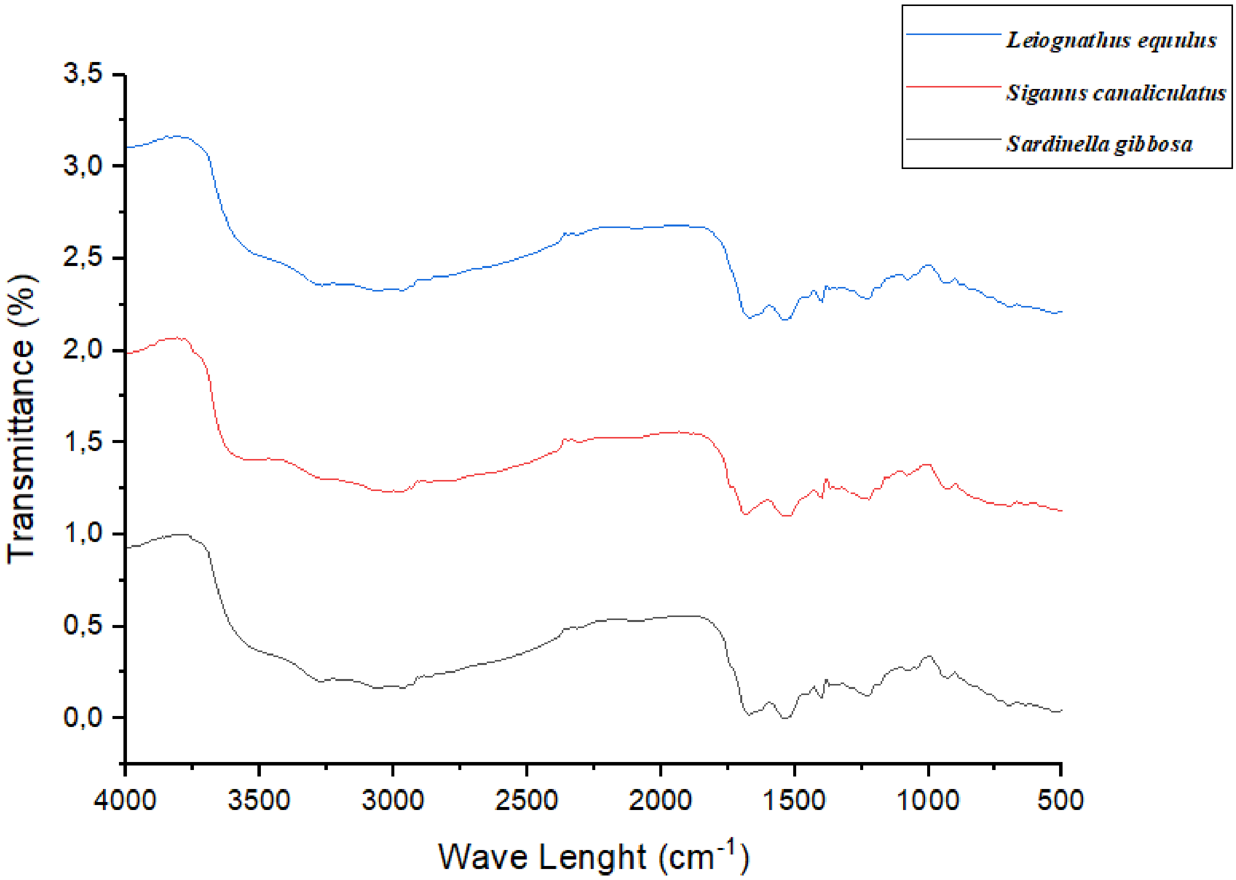

Figure 6. FTIR graphic of microplastic polymer. Blue is for *L.equulus,* red for S. *canaliculatus,* and black for *S. gibbosa*

Table 1. The average value of microplastic in the digestive tract of ponfish (*Leiognathus equulus*), rabbitfish (*Siganus canaliculatus*), and sardines (*Sardinella gibbosa*) collected during January to March 2024.

Fish species	Station	Total fish sample (ind.)	Average weight of fish (gram)	Microplastics shapes				Total	Particle/ fish	Particle/ g of fish
				Fiber	Fragment	Film	Pellet			
Ponyfish (*Leiognathus equulus*)	Gampong Jawa	132	22	17	404	40	8	469	3.55	0.16
	Alue Naga	83	37	16	316	27	16	375	4.51	0.12
	Krueng Raya	165	19	22	381	43	17	463	2.80	0.14
Rabbitfish (*Siganus canaliculatus*)	Gampong Jawa	117	26	23	275	25	9	332	2.83	0.10
	Alue Naga	113	29	19	334	32	22	407	3.60	0.12
	Krueng Raya	124	24	17	326	62	15	420	3.38	0.14
Sardines (*Sardinella gibbosa*)	Gampong Jawa	126	25	21	385	60	10	476	3.77	0.15
	Alue Naga	99	31	39	226	27	13	305	3.08	0.09
	Krueng Raya	163	19	23	175	42	5	245	1.50	0.07
Average	**-**	**124.66**	**25.77**	**21.88**	**313.55**	**39.77**	**12.77**	**388**	**3.22**	**0.12**

Table 2. The abundance of microplastics based on coloring during January to March 2024

Fish species	**Station**	**Total sample (ind.)**	**Average weigh of fish (gram)**	**Color**							**Total**	**Particle/fish**	**Particle/gram of fish**
				Black	**Brown**	**Transparent**	**Red**	**Blue**	**Yelllow**	**Green**			
Ponyfish (*Leiognathus equulus)*	Gampong Jawa	132	22	373	49	37	3	4	3	0	469	3.55	0.16
	Alue Naga	83	37	322	40	7	2	0	4	0	375	4.51	0.12
	Krueng Raya	165	19	388	46	14	8	3	3	1	463	2.80	0.14
Rabbitfish (*Siganus canaliculatus)*	Gampong Jawa	117	26	266	40	8	10	0	6	2	332	2.83	0.10
	Alue Naga	113	29	373	22	7	1	3	1	0	407	3.60	0.12
	Krueng Raya	124	24	357	31	19	8	3	2	0	420	3.38	0.14
Sardines (*Sardinella gibbosa)*	Gampong Jawa	126	25	347	68	48	3	5	5	0	476	3.77	0.15
	Alue Naga	99	31	240	41	9	10	2	0	3	305	3.08	0.09
	Krueng Raya	163	19	193	34	5	4	0	0	0	236	1.44	0.07
Average	-	-	**25.77**	**317.6**	**41.22**	**17.11**	**5.44**	**2.22**	**2.66**	**0.66**	**387**	**3.12**	**0.12**