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Microplastic Accumulation in Gastrointestinal Tract of Sea Fish Landed at TPI Gaung Padang, west Sumatera

Jihan Syafitri[1], Herman Hamdani[2], Rusky Intan Pratama[2], M. Rudiansyah Ismail [3]
[1]Fisheries program study, Faculty of Fisheries and Marine Science Universitas Padjadjaran
[2]Fisheries Departement, Faculty of Fisheries and Marine Science Universitas Padjadjaran
[3]Marine Department, Faculty of Fisheries and Marine Science Universitas Padjadjaran

E-mail address: jihansyafitri1224@gmail.com

ABSTRACT

The study aim to determine microplastic accumulation found in the Gastrointestinal Tract (GIT) of fish, including stomach and intestine of fish landed at TPI Gaung Padang. The research method was used by survey method. Primary data were obtained by sampling in the form of sea fish catches at TPI Gaung Padang (in situ). Sample analysis to microplastics identification of the stomach and intestines fish in FPIK Biogeoekonomi Laboratory, Universitas Padjadjaran. Research parameters include: the types of microplastic that accumulates in the stomach and intestines of fish and types of microplastic polymers. Research results show that microplastics are more commonly found in long jawed mackerel fish (*Rastrelliger kanagurta*), with fragments found more in *Rastrelliger kanagurta* and pepetek (*Leiognathus* sp.). In the digestive tract of fish, microplastics accumulate more in the stomach of fish than in the intestines of fish. Black colour microplastic is the most commonly microplastic found, and the dominante size of microplastic was in range 100 - 500 µm. Microplastic polymers were found to be derived from the type of Polyethylene (PE) with 91.53% similarity.

***Keywords**: Mycoplastic, Rastrelliger kanagurta, Leiognathus* sp.*, TPI Gaung Padang, and FTIR analysis*

1. INTRODUCTION

Marine debris is a global challenge worldwide, in addition to causing environmental pollution, also impacting the safety of marine food. In general, marine debris consists of plastic waste that is regarded as a marine pollutant worldwide, and potentially damaging the ecosystem (Maximenko et al. 2012). The plastic waste entered in the sea will be degraded by sunlight into smaller particles called microplastics (Barnes et al. 2009)..

Microplastic is a small plastic particle with a size of less than 5mm that is widespread in the ocean, at sea level, the beach and the seabed (Lusher et al. 2013). Microplastics consist of various plastic polymer components with different density. Microplastics are also distinguished by type: pellets, foam, fragments, flakes, films, fibers and sponges (Zhou et al. 2018).

Microplastics with very small size can be consumed by marine organisms. According to Lusher et al. (2013), 36.5% microplastic is found in the digestive tract of fish from 504 demersal fish and pelagic fishes. According to Browne et al. (2013), microplatics that enter the digestive tract of fish (GIT) can clog the gastrointestinal tract of fish. Non-food foreign substances that enter the digestive tract can injure the GIT wall (Birk et al. 2016).

Indonesia contributes to the world's second-largest marine debris with 187.2 million tonnes of plastic waste after China reaches 262.9 million tonnes of plastic waste (Jambeck 2015). Based on that data, it can be demonstrated that all regions of Indonesia contain a lot of plastic waste, also do not exclude the possibility of sea water Padang with an area of about 186,500 km2 and a length of beach along 2,420,357 km in zone of microplastic pollution.

Sea fish caught by fishermen is usually carried and gathered to the fish auction site (TPI). TPI Gaung is the most active TPI in Padang City, which is located in Lubuk Begalung District. Pelagis fish commonly found in TPI Gaung is a long-kept mackerel (*Rastrelliger kanagurta*), and the demersal fish species found in TPI Gaung are *Leiognathus* sp.. *Rastrelliger kanagurta* and *Leiognathus* sp. in Padang are fish potentials in the arrest activities, and also widely consumed by the people of Padang in various processed foods, and also widely marketed because of the stable price.

The accumulation of microplastics found in marine life can interfere with the food security aspect and threaten the existence of fish stocks. Data on the existence of microplastics in marine life in Indonesian waters is still very small, especially in Padang, while the level of plastic production in Indonesia is high. Accumulation of microplastic in fish allows it to be in the gastrointestinal tract, consisting of stomach and intestinal fish. Therefore, it is necessary to do research on the accumulation of microplastic in the digestive tract of marine fish landed in TPI Gaung to determine plastic pollution.

2. MATERIALS AND METHODS

The study was conducted from July to September 2019. The materials used in this study included 30 *Rastrelliger kanagurta*, 30 *Leiognathus* sp., alcohol, nitric acid (65%), and NaCl saturated. This study used the Survey method by taking fish samples from TPI Gaung. Measurement of data is done directly to the object examined and identified microplastic forms contained in the stomach and intestinal fish.

2. 1 Procedure

separation of the stomach and intestines of fish

Samples of the fish are surgally used by surgical scissors, starting from the anus in the direction of the dorsal side/lateral side (LL). It is then cut into the anterior direction until the back of the fish head and to the lower part of the stomach, so that the stomach content of the fish is visible. Stomach and intestinal fish are stored separately in a container vial with alcohol 30%.

Identification of Microplastic Types

Stomach and intestinal fish are destroyed using nitric acid in the ratio of 4:1. Samples were soaked in acidic space for approximately 24 hours until completely destroyed. The sample suspension is heated for about 10 minutes with a water bath. The suspension was then diluted with 0.1 N NaCl saturated as much as 4 dilution and screened using filter paper and transferred into the petri dish to observe the type of myroplastic (fiber, film, fragments, pellets) using a stereo microscope (Witte et al. 2014 with modifications).

Identification of Microplastic Polymers

Particles are analyzed using the Fourier Transform Infrared (FTIR) with the Attenuated Total Reflectance (ATR) technique. The collected microplastic samples were cleaned with distilled water and placed on the sampling plates of optical windows with a diameter crystal plate. The results of microplastic polymer tests use the software to read the wavelength spectrum generated by microplastics and then matched with the standard spectrum of the polymer database to determine the type of polymer (Ory et al. (2017).

2. 2 Observation parameter

Based on the type of microplastic consists of: pellets, foam, fragments, flakes, films, fibers, and sponges. These types of pellets are described as hard, ordinary, oval or cylindrical plastic particles. Foam type of mild foam, yellow sponge and porous. Fragment-shaped pieces of hard, jagged and irregular plastic. Debris in the form of flat plastic sheets. Transparent, smooth and thin film. Fiber is threadlike, thin and solid in color (Zhou et al. 2018).

Plastics contain various types of polymers according to their composition, density and shape. Microplastic polymers consist of several types: polyethylene (PE), polypropyliene (PP), polystyrene (PS), polyvinyl chloride (PVC), polyurethane (PEU) (Zhou *et al.* 2018).

2. 3 Data analysis

The data of microplastic content obtained are compared with previous studies. The data obtained from the microplastic identification of the *Rastrelliger kanagurta* and *Leiognathus* sp. in the form of microplastic contained in each type of fish. Data analysis using comparative descriptive analysis involves the amount of microplastic found in the intestines and the stomach of the fish. Data analysis is done using Ms. Excel software. The contents of the data that is obtained further in comparison with previous studies so that it can be concluded.

3. RESULT DISCUSSION

3.1 Microplastic Type Accumulation in Fish

Rastrelliger kanagurta used in this study ranged in size from 210 to 250 mm with a weight range of 98-169 grams. *Leiognathus* sp. is used with a range of 125-160 mm in size and weight range 32-67 grams. Microplastic is found in all samples used in this study. The type of microplastic found consists of fibers, films and fragments (Figure 1).

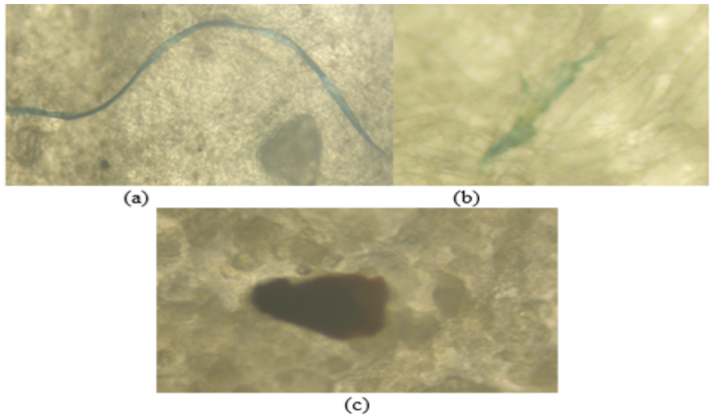


Figure 1. Types of Microplastic in Zeizz Microscopes with magnification 10.
Information: (a) fiber, (b) film, (c) fragment

Accumulation of microplastic in *Rastrelliger kanagurta* found much more than *Leiognathus* sp.. The average microplastic in *Rastrelliger kanagurta* is 15.2 particles/fish. The average microplastic on *Leiognathus* sp. is 8.9 particles/fish. The amount of microplastic in *Rastrelliger kanagurta* is 456 particles, with the most widely found microplastic fragment percentage (57%), then fiber (40%) And the type of film found in the fewest numbers (3%) (Figure 2).

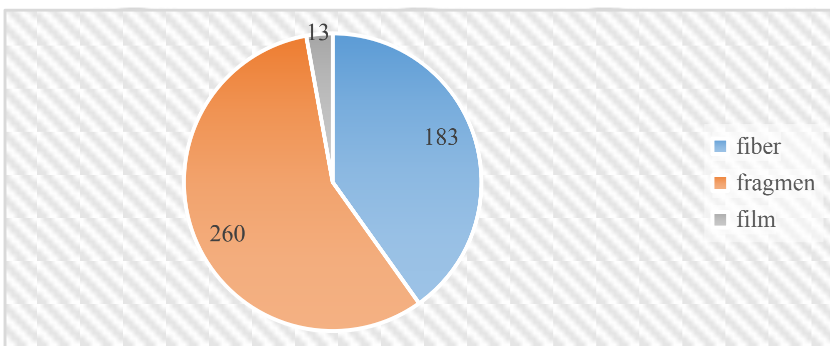


Figure 2. Microplastic Type in *Rastrelliger kanagurta*

Microplastics in *Leiognathus* sp. found 267 particles consisting of fibers and types of fragments. The form of microplastic fragments are most commonly found in *Leiognathus* sp. with a proportion of 60%, while others 40% are plastic fibers. No type of microplastic film was found accumulating in *Leiognathus* sp. (Figure 3).

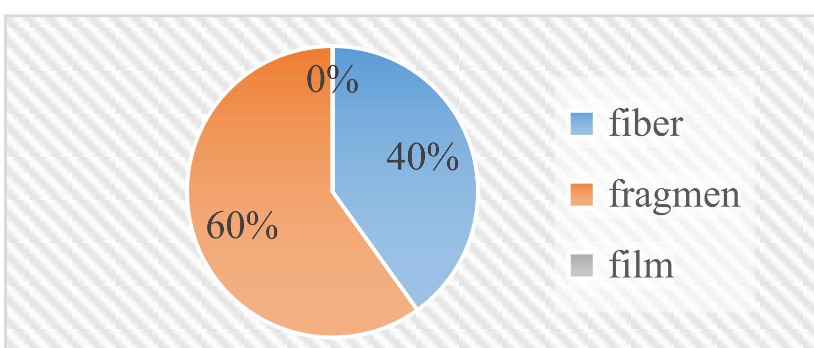


Figure 3. Microplastic Type in *Leiognathus* sp.

The most common type of microplastic found in fish species in this study is fragments. According to Thompson et al. (2009), particle fragments are more commonly found in the intestinal fish because it is easily distributed in the water column. Fragments are pieces of strong synthetic polymer plastic pieces such as drinking bottles and other plastic food packaging. Microplastic fibers are also often found in this study. Microplastic fibers usually come from a rope (a type of fibre) used by fishermen to catch fish or plastic sacks that are degraded (Nor and Obbard 2014). Based on this, indicates that the waste of plastic contained in the sea may be derived from fishing activities. Microplastic film is only found in *Rastrelliger kanagurta* and not found in *Leiognathus* sp., it is similar to the findings of Rochman (2015), a microplastic film found only in pelagic fishes. Microplastic film is from fragmentation of plastic waste with a lower density than seawater, so it has the ability to float in the marine environment.

Rastrelliger kanagurta and *Leiognathus* sp. live in different aquatic environments. Based on this, it is suspected that microplastics spread in water column. According to the Seltenrich (2015), microplastics can float or sink, even accumulating at the seabed by microplastic density.

Rastrelliger kanagurta and *Leiognathus* sp. are omnivorous that can eat phytoplankton, detritus or zooplankton. Based on this, microplastics found in fish can occur directly or indirectly by consuming the zooplankton contaminated with microplastics. According to Wright et al. (2013), high density microplastics can be digested through fish prey. The process of entry of microplastics into the fish body can occur during normal eating activities. According to Battaglia et al. (2016), the process of microplastic entry digested by fish is closely related to the difference feeding strategy.

3.2 Microplastic in Specific Organs

Accumulation of microplastic is found more in the stomach than in the intestinal fish. The proportion of microplastic in *Rastrelliger kanagurta* fish is 58% in stomach and 42% in the intestines. The proportion of microplastic found in the abdomen of *Leiognathus* sp. is 60% and the proportion in the intestine is 40%. According to Jabeen et al. (2017) stating that in the stomach and intestines of fish shows the same microplastic distribution, in the stomach and intestines of different species of fish, with more microplastic quantities in the stomach than in the intestine Species Larimichthys crocea. The amount of microplastic accumulated in the intestine and stomach in the fish can be seen in Figure 4.

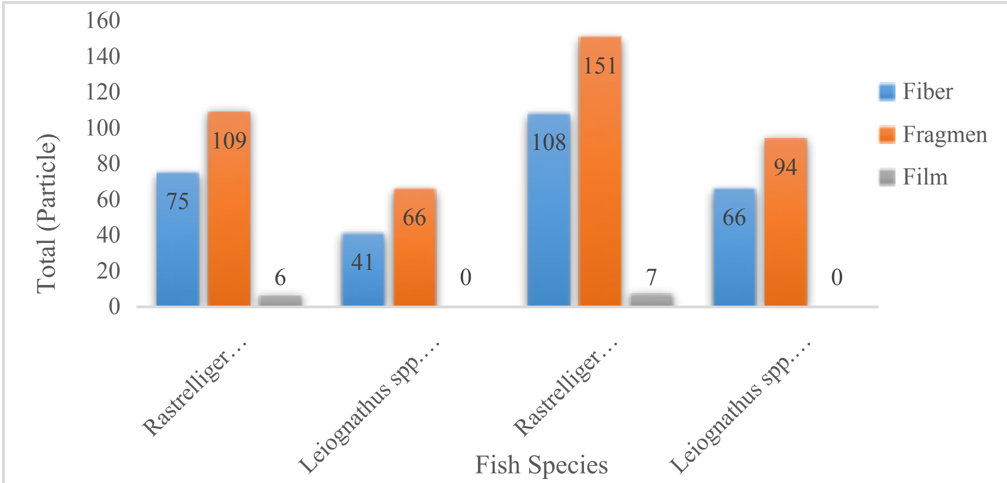


Figure 4. Microplastics Accumulation in Gastrointestinal Fish

In the digestive tract fish there are different morphological variations according to fish feeding habits. The amount of microplastic found in the stomach is suspected because of the large surface area of the stomach, so that microplastic accumulates on the wall of the stomach. In accordance with the statement of Jabeen et al. (2017), a higher percentage of mesoplastic is found in the complex stomach, in addition to the hole from the stomach toward the narrow colon holding more plastic accumulates in the stomach. Microplastic with irregular shape can cause snagging on the wall of the stomach.

3.3 Microplastic Identification Based on Colour

Microplastic is found in several colors. The microplastic colors found in this study consist of blue, brown, green, black, red, orange and white (Figure 5).

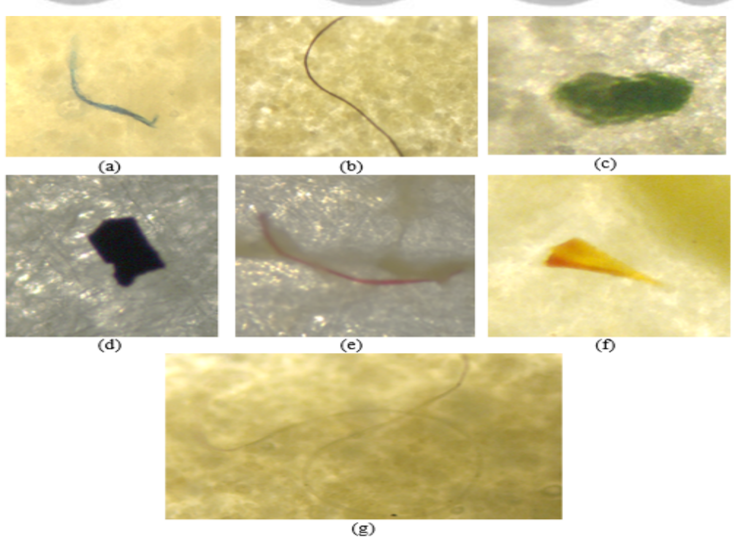


Figure 5. Microplastics Clour in Zeizz Microscopes with magnification 10 (a) blue, (b) brown, (c) green, (d) black, (e) red, (f) orange, (g) white.

The blue microplastic is found 73 particles, brown color 149 particles, green color 17 particles, black color 412 particles, color red 50 particles, orange color 21 particles, and white color 1 particle. The amount of microplastic found in fish by color can be seen in Table 1.

Table 1. Microplastic Color in samples

Colour of Microplastics	**Total (Particle)**				
	***Rastrelliger kanagurta* Intestines**	***Rastrelliger kanagurta* Stomach**	***Leiognathus* sp. Intestines**	***Leiognathus* sp. Stomach**	**Total**
Blue	22	25	10	16	73
Brown	33	54	23	39	149
Green	5	11	1	0	17
Black	108	144	67	93	412
Red	14	23	4	9	50
Orange	8	8	2	3	21
White	0	1	0	0	1
Total	**190**	**266**	**107**	**160**	**723**

The most widely found microplastics in this study are black. Black microplastics are more widely found than other colors, as many use black plastic bags. The dominant color found in this study allowed to resemble the form of feed consumed by fish. According to Jatelah et al. (2017), there are many variations of plastic color in marine fish, but there is no reference that certain plastic colors are found on certain types of fish.

3.4 Microplastic Identification Based on Size

The size of microplastic found in this study was 4,475 to 1,261,027 µm. Microplastic measurements found at *Rastrelliger kanagurta* and *Leiognathus* sp. are grouped in 7 sizes (Table 2), according to Nor and Obbbard's findings (2014).

Table 2. Microplastic Size in Sample

Size (µm)	**RI***	**RS****	**ΣR*****	**LI***	**LS****	**ΣL*****
0-20 µm	39	51	90	14	26	40
20-40 µm	48	74	122	31	38	69
40-60 µm	19	24	43	6	12	18
60-80 µm	15	9	24	4	14	18
80-100 µm	7	6	13	9	3	12
100-500 µm	53	75	128	35	50	85
500-1000 µm	9	27	36	7	17	24
1000-5000 µm	0	0	0	1	0	1

* RI: *Rastrelliger kanagurta* Intestines LI: *Leiognathus* sp. Intestines
** RS : *Rastrelliger kanagurta* Stomach LS : *Leiognathus* sp. Stomach
*** ΣR Total in *Rastrelliger kanagurta* ΣL : Total in *Leiognathus* sp.

Microplastic observations found in all samples have varying sizes. According to Cole et al. (2013) A microplastic with a size of 0.4-30, 6 µm can be consumed by zooplankton. The size of microplastic is found dominant in the *Rastrelliger kanagurta* with a size of 20-40 µm and a size of 100-500 µm so it can be indicated that the microplastic found in the *Rastrelliger kanagurta* can be derived from the zooplankton consumed by fish and microplastics are consumed directly from the water column because they resemble prey. Microplastics in *Leiognathus* sp. is more dominant at a size of 100-500 µm, the microplatic contained in the *Leiognathus* sp. is likely to be consumed directly by fish from the water column.

The size difference of microplastic accumulates in the stomach and intestines can be seen in Figure 6.

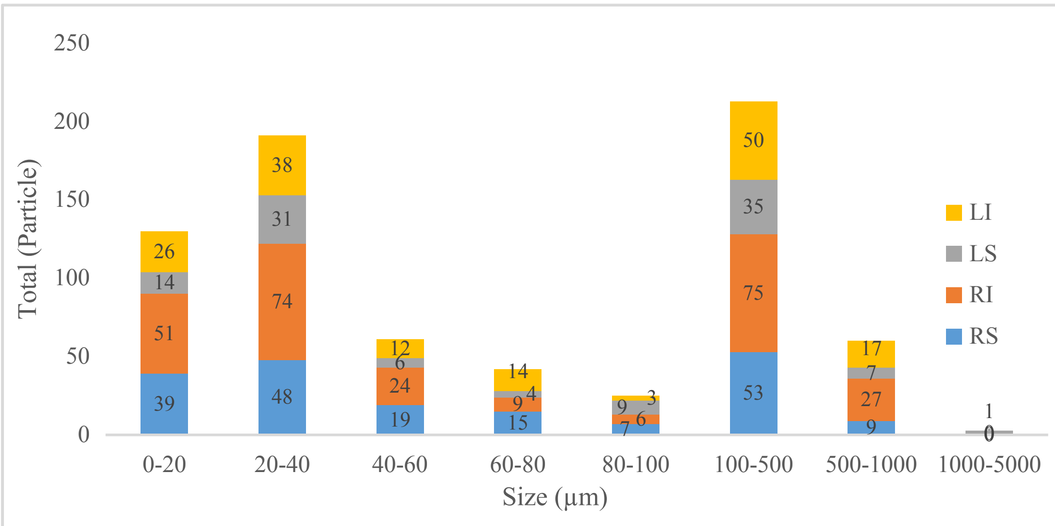


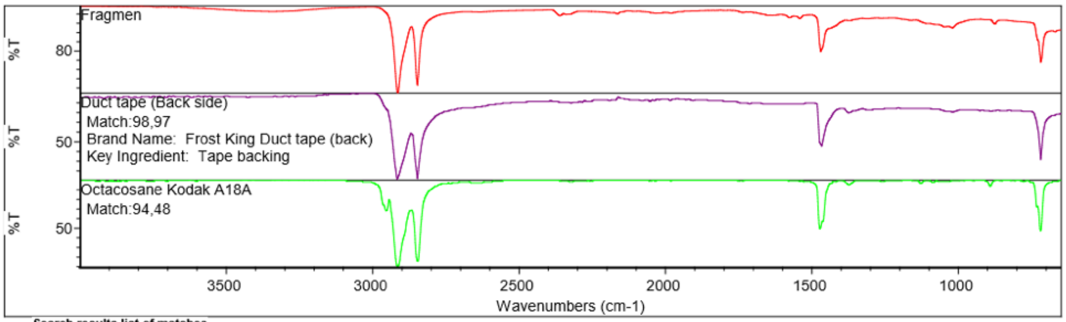
Figure 6. Microplastic size in the stomach and intestines of fish

The microplastic size found in this study is generally greater in the stomach of fish than in the intestinal fish. Small microplastics are also found in the stomach of the fish, this is considered due to the activity of enzymes that can break down microplastic into smaller sizes.

3.5 Identification of Microplastic Polymers in Fish

Observation to determine microplastic polymer using FT-IR (Fourier Transform Infrared). The observation of microplastic polymers using 1 sample is the most widely found, black fragment type. The purpose of observation is to use FT-IR to determine the chemical composition of microplastic samples. The results of microplastic polymer use FTIR on fragments, consisting of Polyethilene (PE) with a similarity level of 91.53%, can be seen in the Figure 7.

Search results for: Fragmen
Date: Tue Dec 03 15:28:16 2019 (GMT+07:00)
Search algorithm: Correlation
Regions searched: 3495,26-649,97



Search results list of matches

	Index	Match	Compound Name	Library Name
1	46	98,97	Duct tape (Back side)	Common Materials
2	4068	94,48	Octacosane Kodak A18A	HR Comprehensive Forensic FT-IR Collection
3	2233	91,92	Olefin Fiber, High mw polyethylene, high crystallinity, MT12	HR Comprehensive Forensic FT-IR Collection
4	2796	91,53	PolyEthylene, SPP	HR Comprehensive Forensic FT-IR Collection
5	1567	91,37	Igniter Cord, Plastic tube (outer layer of 3, yellow)	HR Comprehensive Forensic FT-IR Collection
6	1118	90,97	Duct Tape, Backing, Scotch Home and Shop Duct Tape	HR Comprehensive Forensic FT-IR Collection
7	2778	90,74	Polyethylene from Allied-Signal Spectra fiber	HR Comprehensive Forensic FT-IR Collection
8	2789	90,69	Polyethylene, high density, Nalgene HDPE	HR Comprehensive Forensic FT-IR Collection
9	2614	90,65	Poly(Ethylene - Acrylic Acid), 92:8, Polysci.	HR Comprehensive Forensic FT-IR Collection
10	1489	90,60	HDPE (Tyvek)	HR Comprehensive Forensic FT-IR Collection

Figure 7. FTIR Analysis of Microplastic Fragments

Polyethylene (PE) is a type of polymer that is widely found, because it is widely produced (Ory et al. 2017). Based on the results of microplastic polymer found in this study allows microplastic derived from various plastic materials that have undergone a long process of degradation.

4. CONCLUSION

The average accumulation of microplastics found in the *Rastrelliger kanagurta* is 15.2 particles/fish, many more than *Leiognathus* sp. 8.9 particles/fish. Microplastic proportions in *Rastrelliger kanagurta* 58% in stomach and 42% in the intestines. The proportion of microplastic in *Leiognathus* sp. is 60% in stomach and 40% in the intestines. Microplastic Polymers found in the study consist of Polyethilene (PE) plastics with a similarity rate of 91.53%.

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