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Short Communication

Microplastics Contamination of Mackerel and Red Snapper as Commercial Fish from the Takalar Fish Landing, Indonesia

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Abstract

Microplastics can be ingested by marine organisms, including fish. Although it has been widely reported, further information regarding microplastic contamination in commercial fish is still needed. This study aimed to analyze the presence and concentration of microplastics in the digestive tract of the mackerel *R. kanaguarta* and red snapper *L. gibbus* and to identify the shape, size, color, and type of microplastic polymer. Digestion of the organic materials was performed using a 10% KOH solution, which was then filtered using a vacuum filtration system. The particles were observed using an Olympus microscope and clarified using FTIR. The results of the research showed that *R. kanaguarta* and *L. gibbus* landed at the Beba Fish Landing Base (PPI Beba) Takalar were contaminated with microplastics with a microplastic concentration in *R. kanaguarta* 0.21 ± 0.06 particles/g and *L. gibbus* 0.11 ± 0.04 particles/g. The microplastics found were fiber and fragment of varying colors, such as black, white, red, and yellow. The size of microplastics was dominant in the size class < 2 mm. The FTIR analysis confirmed the presence of polypropylene (PP), Ethylene/Propylene Copolymer, Nylon, Polyethylene terephthalate (PET), and polyester (PES). This study showed that both commercial fish species were contaminated with microplastics. These findings suggest that microplastics are widespread and contaminate commercial fish caught from Takalar waters. Further research is still needed on other seafood from this region, and analysis of polymer types such as FTIR is important to carry out as one of the standard methods in microplastic research.

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1. Introduction

Plastic waste pollution has spread in waters throughout the world, making it a global issue of international concern. According to Jambeck *et al*., (2015), global plastic production has increased, and it is estimated that 8.8 million tons of poorly managed plastic waste end up in the sea every year. This phenomenon has been occurring for a long time, and several studies have shown that plastics can be fragmented into smaller sizes through biodegradation, thermooxidation, or hydrolysis processes (Andrady, 2011). Small plastic measuring 0.1 μm to <5 mm were further defined as microplastics (Kroon *et al*., 2018). Boucher and Friot (2017) divided microplastic sources into primary and secondary sources. The primary sources are small particles, such as pellets, which are used in the cosmetics industry and as basic materials in the plastics industry (Wu *et al*., 2017). Secondary sources include macro-sized plastics in the environment (Bessa *et al*., 2018). Microplastics that are often found in water include films, fragments, fiber, and pellets (Zhao *et al*., 2018). Microplastics pose a major danger to marine organisms, both at low and high trophic levels, through bioaccumulation and biomagnification processes (Kumar *et al*., 2018).

Studies on microplastic contamination in various ecosystems, such as estuaries (Ambeng *et al*., 2022), coral reefs (Cordova and Hernawan, 2018; Ilham, *et al*., 2023a), neritic zone (Yona *et al*., 2023), pelagic zones (Cordova *et al*., 2019), and deep seas (Cordova and Wahyudi, 2016), have been conducted in various regions of Indonesia, including South Sulawesi. Ilham *et al*., (2023a) reported that all zones in Makassar and Pangkep waters, which are included in the Spermonde Archipelago, were contaminated with micro debris. The presence of microplastics in organisms that live in this ecosystem has also been revealed, such as corals (Syakti *et al*., 2019), cephalopods (Ilham *et al*., 2021), shells (Ilham *et al*., 2023b; Mawaddha and Tahir, 2020; Tahir *et al*., 2019), sea urchins (Tanjung *et al*., 2021) and fish (Tahir *et al*., 2020; Ningrum *et al*., 2023). More specifically, it is known that more than a third of demersal and pelagic fish populations are contaminated with microplastic particles that accumulate in their digestive tracts (Lusher *et al*., 2013).

The entry of microplastic residues into the body of fish occurs through a digestive mechanism (Hosseinpour *et al*., 2021). Because the shape of the food is the same as that of microplastic particles or because the prey has been contaminated with microplastics (Wright *et al*., 2013). Microplastic transfer can occur through the food chain; therefore, the accumulation of microplastics in fish has the potential to negatively affect human consumption (Akhbarizadeh *et al*., 2019).

Research related to microplastics in fish collected from fish landings has been conducted at several locations in Indonesia, including TPI Tambak Lorok (Senduk *et al*., 2021), PPI Kedonganan (Gresi *et al*., 2021), TPI Belawan (Ezraneti *et al*., 2022), PPI Beba (Daud *et al*., 2021). However, the justification for microplastic particles in this study was only based on morphological identification without clarifying the type of polymer. Therefore, the plastic particles that have been reported in these studies may not be microplastics (Kroon *et al*., 2018). In research conducted by Ilham *et al*., (2023a) at the same time, a high population on some islands. The anthropogenic influence of the mainland affects the surrounding environmental conditions, including the presence of microdebris in the coral reef ecosystem. In addition, microdebris contamination in scleractinian corals is still not widely known as an issue for this ecosystem. This study aimed to examine the presence of microdebris contamination on scleractinian corals in the Spermonde Islands. A sampling of scleractinian corals, including Fungia fungites, Galaxea fascicularis, Porites cylindrica, and the water column was carried out on four islands, representing four zones in the Spermonde Archipelago, including Kayangan (KY in Makassar waters of twenty-eight samples analyzed using an FTIR microscope, only 7% of the particles were proven to be plastic, whereas the others were identified as other materials such as wool, cotton, and paint as the dominant material, which reached 50%. Therefore, this study emphasizes that microplastics cannot be justified by simply observing their morphology. So, further examination is still needed to clarify whether the particles reported are microplastics.

Pangkalan Pendaratan Ikan Beba (PPI) Beba is a fish landing base located in North Galesong District, Takalar Regency. The activities of PPI Beba are as a landing and marketing place for fish caught by fishermen, as well as a forum for developing fishing communities Asni *et al*., (2022). In previous research, microplastics were found in fish from Beba Landing Base (PPI) (Daud *et al*., 2021). However, the type of polymer obtained from the microplastic is still unknown. In the present study, we collect the most common fish landed at PPI Beba, including mackerel *Rastrelliger kanaguarta* and red snapper *Lutjanus gibbus*. This fish is in demand by the public, and its stock is abundant on the market (Teti *et al*., 2019) Refers to the habitat and the type of prey, *R. kanaguarta* is a pelagic fish and planktivorous organism found in the neritic zone (Prahadina *et al*., 2016), while *L. gibbus* is a demersal and carnivorous fish found at the sea bed (Aguilar-Betancourt *et al*., 2017). Therefore, this research aims to calculate differences in contamination and microplastic characteristics of each species. To ensure that the particles found were plastic, polymer type analysis was added to clarify the findings.

2. Materials and Methods

2.1 Material

This research used specimens of *R. kanaguarta* and *L. gibbus* taken at the Beba Fish Landing Base (PPI Beba), Takalar Regency, which were harvested from the waters of Takalar and the waters of the surrounding small island (Figure 1). Twelve fish were analyzed for each species as replicates, and fish were selected at a medium size ranging from 21 to 24 cm because they are most commonly commercialized at PPI Beba. To prevent microplastic contamination, gloves were used during the washing process, and the fish were placed in a plastic sample in a cool box (Lusher *et al*., 2017). Other supporting materials were aluminium foil, 47 mm Whatman filter paper with a pore size of 0.45 *µm,* Aquabidest, and 10% KOH solution.

2.1.1 Ethical approval

The surgical process in this research was carried out on the basis of approval from the Zoology Laboratory, Faculty of Mathematics and Natural Sciences, Hasanuddin University (No.: 098/ZOO/BIO/2024) which has been taken into consideration and review research procedures outlined by the researcher.

2.2 Method

2.2.1 Sample preparation and tissue dissolution

The digestive tracts of *R. kanaguarta* and *L. gibbus* were taken by dissection. Each digestive organ was weighed using a digital scale and placed in a glass jar. The sample was digested with a 10% KOH solution at a ratio of 1:3 or until the sample was submerged (Jaafar *et al*., 2021). The samples were left for up to three weeks at room temperature. Because the sample was not completely dissolved, it was incubated at 60°C for two weeks. The homogenized solution was filtered using 47 mm Whatman filter paper with a pore size of 0.45 µm with a vacuum system. The filter paper was then placed in a petri dish to avoid contamination. Other contaminants were prevented by filtering all solutions used, and the extraction process was carried out under laminar air flow (LAF) HLM120.

2.2.2 Morphological observations and FTIR test

The particles contained in the filter paper were morphologically observed using an Olympus SZ61 stereo microscope and Dino-Eye Edge AM7025X microscope camera. Morphological identification of microplastics refers to Hidalgo-Ruz *et al*., (2012), including having no visible cellular or organic structure, fiber-type microplastics must have the same thickness throughout their length, the particles must have a clear color, and if the particles are white, they must be

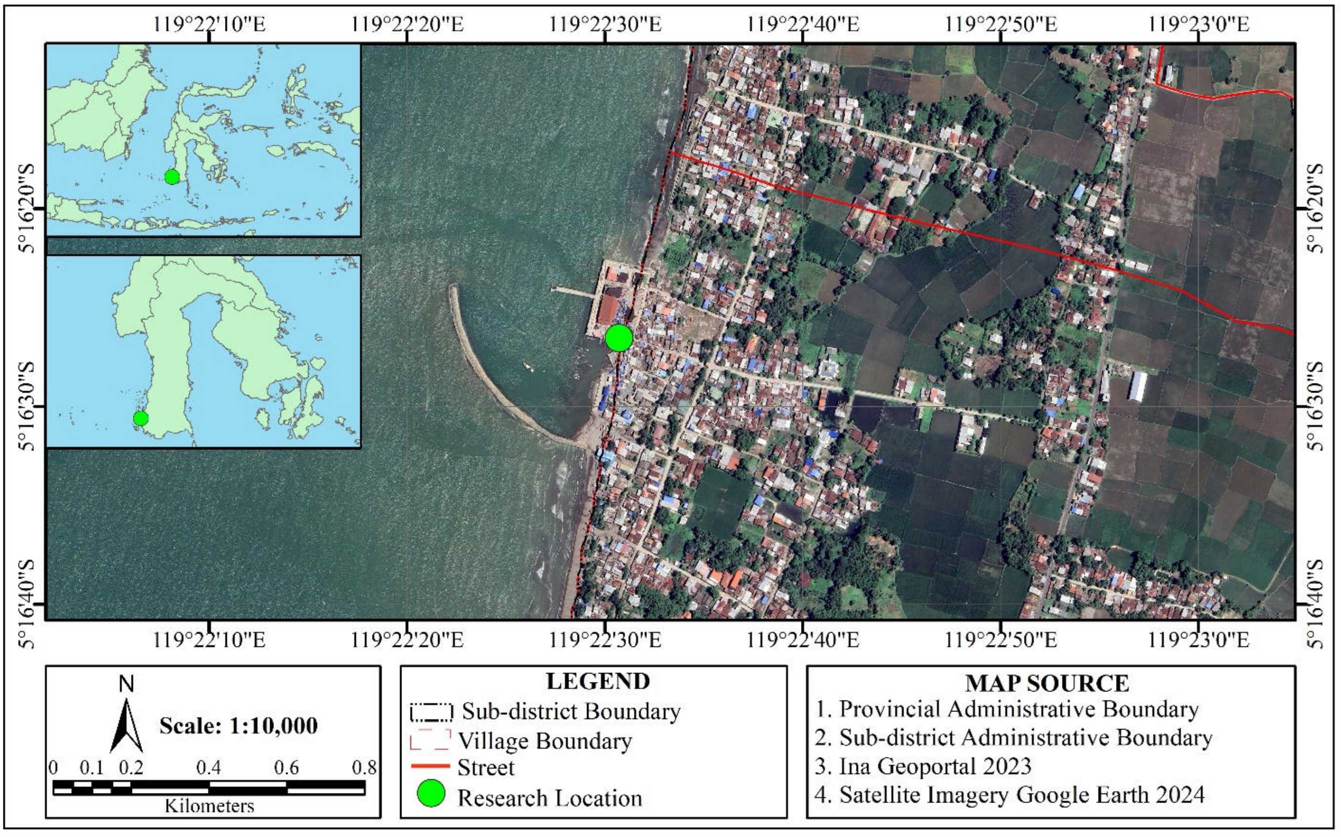

Figure 1. Sampling location of commercial fish *R. kanaguarta* and *L. gibbus* in Takalar Regency, Indonesia

examined at high magnification. A number of particles were selected as representations based on shape and colour for further analysis using an FTIR A224160 instrument.

2.3 Analysis Data

A parametric statistical t-test was used to determine the differences in the digestive tract wet weight and MPs concentration between species. The Pearson's correlation test was performed to determine the relationship between the wet weight of the digestive tract and the concentration of microplastics in *R. kanaguarta* and *L. gibbus*. Statistical analysis was performed using SPSS software (IBM SPSS Statistics V.22).

3. Results and Discussion

3.1 Concentration and Abundance of Microplastic

This research shows that the samples were taken from PPI Beba as a representation of pelagic and demersal fish from Takalar waters that have been contaminated with microplastics. The concentration and abundance of microplastics found in *R. kanaguarta* was higher, namely 0.21 ± 0.06 particles/g and 1.25 ± 0.35 particles/individual compared to *L.gibbus* 0.11 ± 0.04 particles/g and 1.08 ± 0.50 particles/individual (Figure 2). Differences in the diets of these species are thought to be the main factors influencing microplastic contamination. In this study, the concentration of microplastics found in the digestive tract of *R. kanaguarta* as a pelagic fish was higher than that of *L. gibbus* as a demersal fish, although the T-test did not show a significant difference. This finding is in accordance with research in the Mediterranean Sea, where pelagic fish ingested more microplastics than demersal fish (Güven *et al*., 2017).

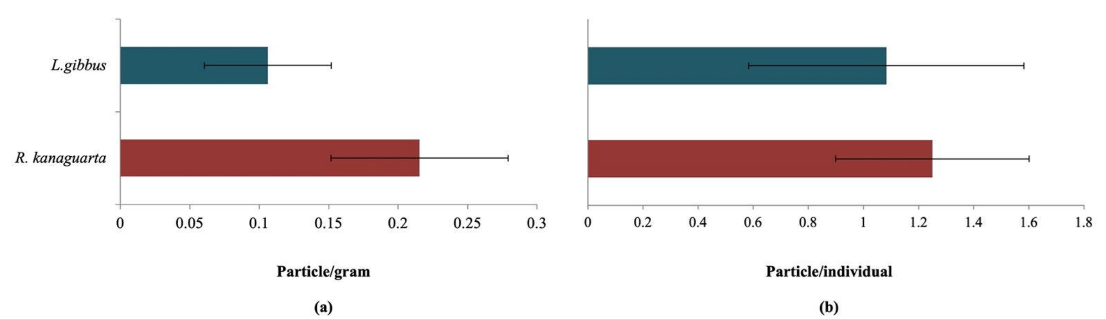

Figure 2. The consentration (a) and abundance (b) of microplastic in commercial fish *R. kanaguarta* and *L. gibbus*

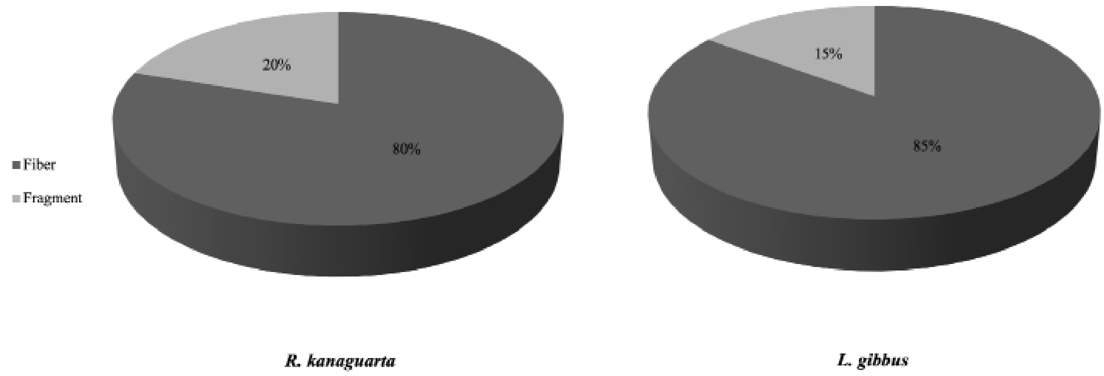

Figure 3. The form of microplastic in commercial fish *R. kanaguarta* and *L. gibbus*

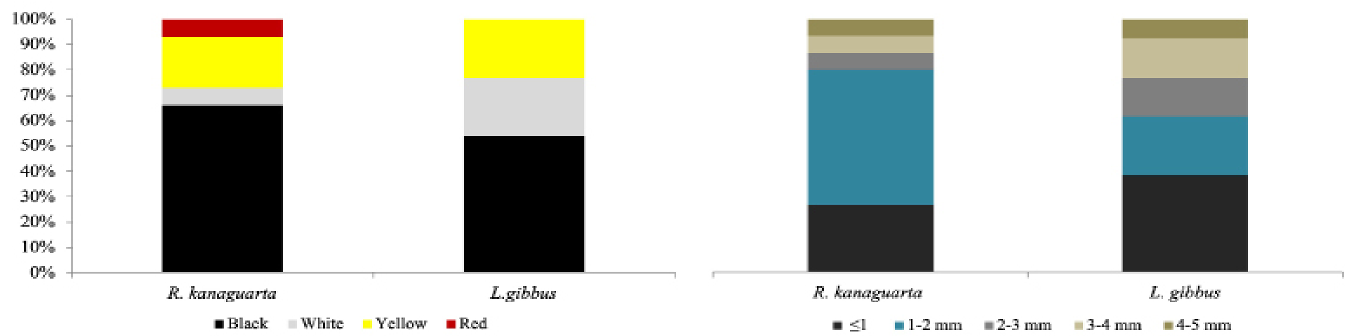

Figure 4. The Color (a) and the size (b) of microplastic in commercial fish *R. kanaguarta* and *L. gibbus*

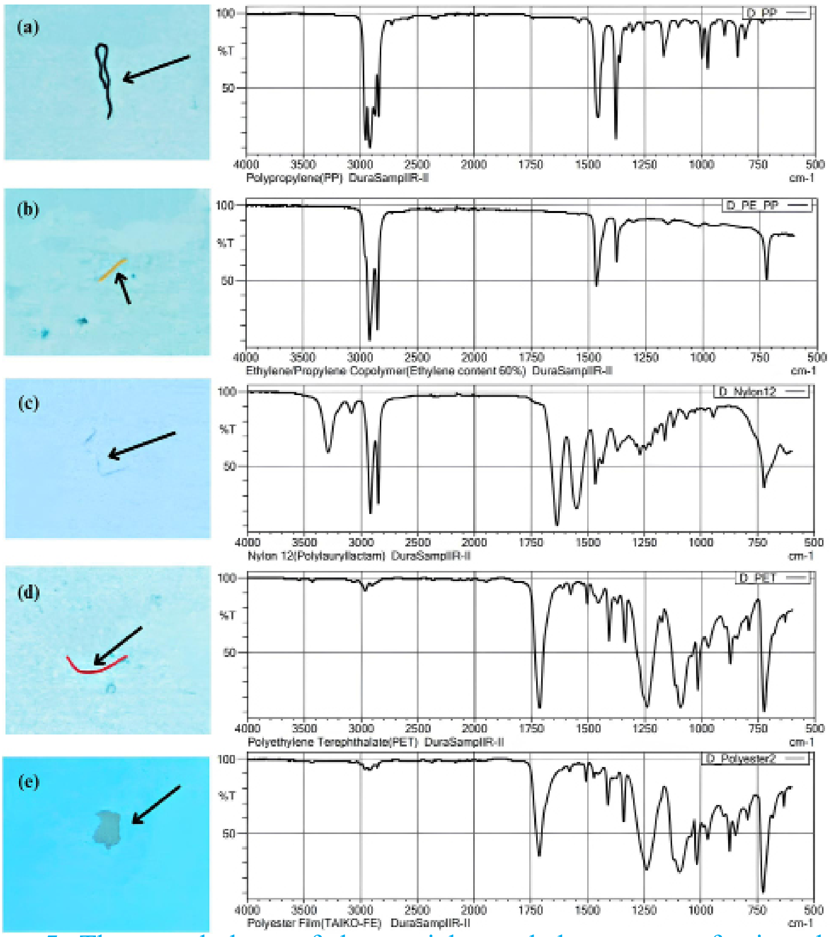

Figure 5. The morphology of the particles and the spectra of microplastic particles found in commercial fish R. kanaguarta and L. gibbus: (a) Fiber Polypropylene PP, (b) Fiber Ethylene/Propylene Copolymer, (c)Fiber Nylon, (d) Fiber Polyethylene terephthalate (PET), (e) Fragment Polyester (PES)

Table 1. Comparative study of microplastics in fish in terms of identification methods, treatment method and level of contamination in this study with previous research

Specimen and Country	Identification method	Treatment method	Level of contamination	Tipes of MPs	References
Pelagic and demersal fish, Persian Gulf, Iran	Mikroscope	30% H_20_2	2.85±1.57 part/indv and 2.46±1.46 part/indv	Fiber and Frag-ment	(Hosseinpour *et al.*, 2021)
Pelagic, India	FTIR	10% KOH	4.60%	Microfiber	(Kumar *et al.*, 2018)
Pelagic and de-mersal fish, India	μ-Raman		0.003%	Fragment	(James *et al.*, 2020)
Pelagic and demersal fish, Indonesia	Mikroscope	10% KOH	0.70 part/indv and 0.11% part/indv	Fiber	(Daud *et al.*, 2021)
Demersal fish, Indonesia	Mikroscope	10% KOH, 30% H202	7.86 part/indv and 4.46 part/indv	Fiber, Fragment and Film	(Gresi *et al.*, 2021)
Pelagic, Indo-nesia	Mikroscope	10% KOH	1.0±0.60 part/gram and 0.43±0.23part/gram	Fragment, Fiber, Pelet and Film	(Senduk *et al.*, 2021)
Pelagic, Indo-nesia	Microscope	10% KOH	16.25 part/indv	Fiber	(Ezraneti *et al.*, 2022)
Pelagic and demersal fish, Indonesia	Stereo Microscop and verified with FTIR	10% KOH	1.25±0.35 to 1.08 ± 0.50 part/indv	Fiber and Frag-ment	This study

Rastrelliger kanaguarta is a neritic pelagic fish that lives around the coast or neritic population and acts as a filter feeder where phytoplankton, zooplankton, and s mall crustaceans are the main food sources. Therefore, eating methods that do not directly select food have a high potential for direct contamination from microplastics in the water column (James *et al*., 2020). Individual size also influences the concentration of microplastic contamination in *R. kanaguarta*. The greater the weight of the individual, the greater the volume of filtered water. This was confirmed by the Pearson correlation test p-value 0.005 (<0.05), which showed that the concentration of microplastics and the wet weight of the digestive tract of *R. kanaguarta* had a significant relationship.

Meanwhile, *L. gibbus* is a demersal fish whose habitat is on the seabed and is selective in finding food where its prey consists of small fish, crustaceans, and invertebrate groups (Aguilar-Betancourt *et al*., 2017), causing *L. gibbus* to avoid the potential of ingesting microplastics directly from the water column. Therefore, it can be confirmed that microplastic contamination in the digestive tract of *L. gibbus* occurs indirectly. This condition occurs because the prey is contaminated with microplastics. Moreover, the Paerson correlation test showed that the concentration of microplastics and fresh weight of the digestive tract of *L. gibbus* did not have a significant relationship p value of 0.39 (>0.05). In other words, the concentration of microplastic contamination in the digestive tract of *L. gibbus* is not influenced by its size but rather depends on the microplastic contamination that occurs in its prey. Fachrudin (2022) also stated that there was no relationship between wet weight and microplastic concentration in snapper fish. Furthermore, according to Dalimunthe *et al*. (2021), the size of demersal fish does not affect the amount of microplastics ingested, but the ingestion of microplastics is influenced by selective eating habits.

Thus, the possibility of microplastic contamination in *R. kanaguarta* was higher than that in *L. gibbus*. This condition is also in accordance with the research conducted by (Rummel *et al*., 2016) on pelagic and demersal fish from the North and Baltic Seas, where the potential for microplastic ingestion in pelagic fish is higher than that in demersal fish. Therefore, microplastic concentrations in fish are described as being more influenced by feeding habits, food availability, and habitat conditions (Morgana *et al*., 2018).

3.2 Morphological Identification and Microplastic Clarification Using FTIR

Fiber and fragment were the identified forms of microplastics, with fiber being the dominant form of microplastic found in both species, including *R. kanaguarta* 80% and *L. gibbus* 85%, while the percentage of fragments in *R. kanaguarta* is 20% and 15% in *L. gibbus* (Figure 3). Color observations showed that black microplastics were more abundant than those of other colors. In *R. kanaguarta*, four types of color were found, with percentages of 66% black, 7% white, 20% yellow, and 7% red, while in *L. gibbus,* three were found. color with percentages of 54% black, 23% yellow, and 23% white (Figure 4a). Both species showed that the dominant size of microplastic contamination was the size class 1-2 mm and < 1 mm (Figure 4b). The analysis of FTIR confirmed that the polymers were polypropylene (PP), Ethylene/Propylene Copolymer, Nylon, Polyethylene terephthalate (PET), and polyester (PES) (Figure 5).

Fiber was the most dominant form found in both species. This condition was in line with the composition of microplastic forms found in the waters of Takalar, Makasar, and Pangkajene Islands (Daud *et al*., 2021; Ilham *et al*., 2023a). These fibers were thought to come from domestic and local activities such as emissions from washing textiles (Senduk *et al*., 2021) and fishing using nets and ropes (Bessa *et al*., 2018). In line with the types of polymers found in this study, Polypropylene (PP) and Nylon generally come from fishing equipment (Wang *et al*., 2020).

Nevertheless, this research has not been able to show the type of polymer of all the particles found in the digestive tract of the fish. Therefore, future research is needed for thorough identification in order to provide a more concrete assessment of the source of contamination. Comparative studies have shown that similar particles have spread widely, not only in local areas but also on a global scale (Table 1). Literature regarding the study of microplastics in fish has also been collected in Indonesia, especially studies on fish from fish landings. However, none of these studies clarified the particles found, and the concern is the possibility that there are non-plastic items that are reported as microplastics (Kroon *et al*., 2018). Accordingly, research that will report microplastics in the future is expected to have used standard methods to confirm the type of polymer of the particles found.

4. Conclusion

This research can conclude that both types of commercial fish are contaminated with microplastics with microplastic concentrations in the digestive tract of fish *R. kanaguarta* as a pelagic fish being higher than *L. gibbus* as a demersal fish. The characteristics of the microplastics found were similar in terms of shape, size and color. The particles found were also confirmed to be microplastics based on further analysis using FTIR. The presence of microplastics in fish proves that the impact of plastic waste cannot be ignored. Therefore, the immediate mitigation of the release of plastic waste into the environment must be carried out. Management and recycling of plastic waste must be improved and the reduction in the use of single-use plastics supported by government programs must continue.

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Author's Contributions

All authors have contributed to the final manuscript. The contributions of each author are as follows; Sita collected the data, and designed the figures. Sita and Ilham drafted the manuscript; Sita, Ilham, Ambeng and Yakin devised the main conceptual ideas; Ambeng and Yakin critically revised the article. All authors discussed the results and contributed to the final manuscript.

Conflict of Interest

The authors declare that they have no competing interests.

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