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# DETECTION OF MICROPLASTICS IN THE DIGESTIVE TRACT OF COMMERCIAL FISHES FROM SWALAYAN X YOGYAKARTA CITY

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**ABSTRACT:** Plastic waste in waters can be degraded into microplastics with a size <5 mm. Microplastics in waters can enter the bodies of organisms, including commercial fishes. This study aims to analyze the abundance and characteristics of microplastics in the digestive tract of three species of commercial fishes from Supermarket X, Yogyakarta City, DIY Province. This study is an exploratory research that used three species of fishes, milkfish (*Chanos chanos*), mackerel (*Rastrelliger* sp.), and tuna (*Euthynnus affinis*). Fish samples were purchased from Supermarket X, Yogyakarta City, DIY Province, taken using quota sampling technique. The fish digestive tract was taken, soaked in 10% KOH, heated in oven at 60° then filtered. The obtained microplastics were then observed under a light microscope. The Kruskal Wallis test was performed to differentiate the abundance and characteristics of microplastics among the three species of fishes. The results showed the abundance of microplastics in the digestive tract of mackerel 465.00 ± 222.69 microplastics/individual, milkfish 471.67 ± 58.53 microplastics/individual and tuna 554.00 ± 122.19 microplastics/individual, but not significantly different. The forms of microplastic found were fiber, fragments, films, and pellets but not significantly different. The color of the microplastics obtained were not significantly different between fish species. Microplastics are dominated by the size range of 101 – 200 µm. Based on the FT-IR results, the microplastics found were Polypropylene (PP). Microplastics detected in the digestive tract of three species of commercial fishes from Supermarket X, Yogyakarta City, DIY Province have abundance and characteristics that are not significantly different.

**Keywords:** Fiber, Film, Fragment, FT-IR, Polypropylene.

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## INTRODUCTION

Plastic is versatile and inexpensive, so it has been in demand since it was first produced in the 1950s (Hale et al., 2020). Discarded plastic can be degraded to a size of 0,1 – 5,000 µm which is called microplastic (CONTAM, 2016). Microplastics are persistent, resulting in pollution on land and water (Lusher et al., 2017). In marine waters, microplastic pollution is expected to double by 2030. Microplastics in the waters can enter the body of aquatic biota, directly when ingesting water or indirectly as a result of ingesting prey that already contains microplastics (Lusher et al., 2017; Vendel et al., 2017; Yona et al., 2020). The physical impacts caused by microplastics in the body of biota include blockage of the digestive tract which causes false satiety and decreased productivity (Gall & Thompson, 2015). The physiological impact caused by microplastics in the biota's body is caused by plastic materials which trigger hormonal disturbances and lead to carcinogenic effects. Microplastic accumulation in the human body can trigger chromosomal changes that cause obesity, infertility, cancer (Sharma & Chatterjee, 2017), transfer of pathogens (Barboza et al., 2018), chronic inflammatory lesions (Prata et al., 2020). Microplastics also cause changes in the size of the primary gill lamella (Suwartiningsih et al., 2023). It is very important to detect the presence of microplastics in the bodies of aquatic biota consumed by humans. This is done to determine the potential transfer of microplastics to the human body.

Detection of microplastics in aquatic biota in various countries have been done, for example on echinoderms, crustaceans, and fish (Danopoulos et al., 2020). Therefore, fish is one of the organisms that can be used as an indicator of pollution, including pollution of microplastics in aquatic environment. Research on the detection of microplastics conducted in Indonesia includes seafood such as blood clams (*Anadara granosa*), milkfish (*Chanos chanos*) and tilapia (*Oreochromis niloticus*) from the coast of the Semarang area (Widianarko & Hantoro, 2018). Microplastics were also detected in several species of fish with economic value, such as kite fish (*Decapterus russelli*), mackerel (*Rastelliger* sp.), lemuru fish (*Sardinella lemuru*), and largehead hairtail (*Trichiurus lepturus*) originating from the Bali Strait (Sarasita et al., 2020). Microplastics were detected in frigate tuna (*Auxis thazard*), large-scale croaker fish (*Johnius heterolepis*), skipjack tuna (*Katsuwonus pelamis*), and Japanese threadfin bream (*Nemipterus japonicus*) from Baron Beach, Yogyakarta (Suwartiningsih et al., 2020). Microplastics were also detected in tuna (*Euthynnus affinis*) from five traditional fish auction markets on the south coast of Java (Andreas et al., 2021). Microplastics were detected in skipjack tuna from three fish markets in Ternate, Maluku (Lessy & Sabar, 2021).

The presence of microplastic contamination in fish is generally detected from the digestive tract (Lusher et al., 2017) as the main route for microplastic entry into the fish's body. Detection of microplastics in the digestive tract of commercial fish has been carried out in various markets, including modern markets in Sleman Regency, DIY Province (Suwartiningsih & Nafi'a, 2022). However, the detection of microplastics in the digestive tract of commercial fish from the modern market in Yogyakarta City has never been carried out. In fact, Yogyakarta City is the most populous city in DIY Province (Chintya et al., 2018) so the potential for fish consumption is greater. Therefore, this study was conducted to analyze the abundance and characteristics of microplastics in the digestive tract of three species of commercial fish from Supermarket X, Yogyakarta City, DIY Province. With data on microplastics in the digestive tract of commercial fish, various efforts to prevent and minimize the entry of

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microplastics into the human body can be carried out, as well as the framework of plastic waste management.

## METHODS

This research is an exploratory study that explores the abundance and characters (shape, color, size, and type) of microplastics in the digestive tract of three species of commercial fish from Supermarket X, Yogyakarta City, DIY Province. The total sample of fish used was 12 fish. Fish samples were taken using quota sampling technique. There are three species of fish used. There were milkfish, mackerel and tuna. Four individuals were taken as samples for each species of fish; three individuals were used to analyze the abundance, shape, color, and size of microplastics; while one individual is used for polymer type analysis. Research data collected by observation method.

All fish samples were taken and put in an ice box to be taken to the Laboratory of Ecology and Systematics, Department of Biology, Faculty of Applied Science and Technology, Ahmad Dahlan University. Fish are identified through the fishbase.org website. Their length were measured and their weight were weighed. Equipment sterilization and microplastic extraction using procedures according to Rochman et al. (2015). All equipment is sterilized using distilled water and 70% alcohol. All equipment was wrapped in aluminum foil, dried in the oven for 12 hours at 50°C. Sterilization is done to prevent contamination.

After the fish sample was dissected, the digestive tract was taken from the esophagus to the anus. The digestive tract is then measured for length and weighed, then put into a flakon bottle. Then added 10% KOH as much as ± 3 times the volume of the digestive tract, incubated for 12 hours at 60°C. The addition of 10% KOH and incubation were carried out to destroy the digestive tract. During the incubation process, one bottle of flacon containing only 10% KOH was also included as a control. After the incubation is complete, the results are then filtered with filter paper. The pellet on the filter paper was transferred to the petri dish. The microplastic in the petri dish was then transferred to the top of the object glass, then covered using a glass cover. The microplastics were then observed under a light microscope with a maximum magnification of 10 X 100. The detected microplastics were documented using a microscope camera. Microplastic length measurements using the Image Raster application. The type of microplastic polymer was determined using Fourier Transform Infrared (FT-IR) spectroscopy (Ibrahim et al., 2017). Data on microplastic abundance per fish species were compared using the Kruskal Wallis test. Correlation test was conducted to determine the relationship between fish length and weight, digestive tract length and weight and the abundance of microplastics. Microplastic character data (shape, color, size, and type) were analyzed descriptively, presented in tabular form.

## RESULTS AND DISCUSSION

The results showed that the average abundance of microplastics in the digestive tract of the three species of fish was 496,89 ± 137,22 microplastics/individual. The abundance of microplastics in this study was higher than similar microplastic studies from various regions in Indonesia (Table 1). This is caused by samples taken from urban areas. Urban areas with high population density and activity produce more plastic waste which results in a higher abundance of microplastics (Tibbetts et al., 2018).

**Table 1. Comparison of the Average Abundance of Microplastics in the Digestive Tract of Commercial Fishes from Previous Studies.**

| Location | Species | Habitat | Number of Samples | Percentage of Microplastics (%) | Abundance of Microplastics/ Individual | Method | Reference |
|---|---|---|---|---|---|---|---|
| Semarang | Milkfish (*Chanos chanos*). | Sea | 90 | 25 | 3.36 ± 1.02 | KOH 10% | Widianarko & Hantoro (2018) |
| Selat Bali | Kite fish (*Decapterus russelli*), mackerel (*Rastelliger* sp.), lemuru fish (*Sardinella lemuru*), and largehead hairtail (*Trichiurus lepturus*). | Sea | 120 | 100 | 5.03 ± 1.42 | H2O2 30% | Sarasita et al. (2020) |
| Baron Beach, Daerah Istimewa Yogyakarta | Frigate tuna (*Auxis thazard*), large-scale croaker fish (*Johnius heterolepis*), skipjack tuna (*Katsuwonus pelamis*), and japanese threadfin bream (*Nemipterus japonicus*). | Sea | 80 | 100 | 95.65 ± 38.80 | KOH 10% | Suwartiningsih et al. (2020) |
| Bengkulu | Tuna (*Euthynnus affinis*). | Sea | 30 | 100 | 10.50 ± 7.20 | KOH 10% | Purnama et al. (2021) |

The increase in the abundance of microplastics goes hand in hand with the increasing dependence of humans on plastic (Hermawan et al., 2022). The use of plastic for various purposes triggers an increase in plastic waste which will be degraded to form microplastics (Sutanhaji et al., 2021). Various activities at fishing ports, tourism, fish farming, and improper disposal of industrial and domestic waste have contributed to an increase in the abundance of microplastics in marine waters (Curren et al., 2021).

The lowest abundance of microplastics in this study was in mackerel 465,00 ± 222,69 microplastics/individual. The abundance of microplastics in milkfish was 471,67 ± 58,53 microplastics/individual and the highest abundance in tuna was 554,00 ± 122,19 microplastics/individual (Table 2) but not significantly different (p<0,05). The mackerel in this study showed the lowest abundance of microplastics. Mackerel is an omnivorous fish that feeds on phytoplankton, zooplankton, crustaceans and copepods (Utami et al., 2014). Meanwhile, milkfish is a herbivorous fish (Azis et al., 2015) with the main food was phytoplankton such as *Nitzschia* sp. (Djumanto et al., 2017). Mackerel and milkfish may accumulate microplastics due to errors in detecting plankton-like foods (Nurhidayati et al., 2022; Ory et al., 2017).

**Table 2. The Abundance of Microplastics in the Digestive Tract of Three Species of Fish from Supermarket X, Yogyakarta City, DIY Province.**

| Local Name (Scientific Name) | Number of Samples (Individuals) | Number Sample with Microplastics (Individuals) | Body Length (cm) | Body Weigh (g) | Digestive Tract Length (cm) | Digestive Tract Weight (g) | Range of Individual Microplastics | Average Individual Microplastics (Microplastics/ Individual) |
|---|---|---|---|---|---|---|---|---|
| **Milkfish (*Chanos chanos*).** | 3 | 3 | 34.50 ± 0.85 | 368.67 ± 40.53 | 243.27 ± 14.25 | 15.39 ± 3.40 | 424 - 537 | 471.67 ± 58.53 |
| **Mackerel (*Rastrelliger* sp.).** | 3 | 3 | 25.37 ± 0.35 | 188.00 ± 1.00 | 14.27 ± 1.36 | 3.62 ± 0.65 | 316 - 721 | 465.00 ± 222.69 |
| **Tuna (*Euthynnus affinis*).** | 3 | 3 | 28.20 ± 1.44 | 304.00 ± 101.13 | 15.35 ± 3.61 | 25.13 ± 5.54 | 413 - 629 | 554.00 ± 122.19 |
| **Average and Stdev** | | | 29.36 ± 12.03 | 286.89 ± 50.43 | 90.96 ± 6.89 | 14.71 ± 2.45 | 316 - 721 | 496.89 ± 82.77 |

Tuna in this study was detected to contain the most microplastics because it is a carnivorous fish with food such as shrimp, anchovies, and squid (Risti et al., 2019). Carnivorous fish will accumulate more microplastic due to trophic transfer (Hastuti et al., 2019). Microplastics can enter the bodies of aquatic biota directly through ingested water or from food that has previously contained microplastics (Neves et al., 2015).

The results of the correlation test (Table 3) showed no correlation between fish length and weight, digestive tract length and weight, and microplastic abundance. This is different from the results of a previous study conducted at Supermarket X, Sleman Regency, DIY Province which showed that the longer the digestive tract, the lower the abundance of microplastics (Suwartiningsih & Nafi'a, 2022). Milkfish which is herbivorous has a longer digestive tract than omnivorous and carnivorous fish but accumulates the least microplastic compared to mackerel as omnivorous fish and tuna as carnivorous fish (Table 2). Herbivorous fish have a digestive tract length of about 2 – 21 times the body

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length, omnivorous fish are 0,8 – 5 times the body length while carnivorous fish 0,5 – 2,4 times the body length (Meliawati et al., 2014).

**Tabel 3. Correlation of Fish Length, Fish Weight, Digestive Tract Length, Digestive Tract Weight, and Abundance of Microplastics in the Digestive Tract of Three Species of Fish from Supermarket X, Yogyakarta City, DIY Province.**

| | | Fish Length | Fish Weight | Digestive Tract Lenght | Digestive Tract Weight | Abundance of Microplastics |
|---|---|---|---|---|---|---|
| Fish Lenght | Correlation Coefficient | 1.000 | .883** | .767* | .550 | .083 |
| | Sig. (2-tailed) | . | .002 | .016 | .125 | .831 |
| | N | 9 | 9 | 9 | 9 | 9 |
| Fish Weight | Correlation Coefficient | .883** | 1.000 | .633 | .667* | .367 |
| | Sig. (2-tailed) | .002 | . | .067 | .050 | .332 |
| | N | 9 | 9 | 9 | 9 | 9 |
| Digestive Tract Lenght | Correlation Coefficient | .767* | .633 | 1.000 | .167 | -.100 |
| | Sig. (2-tailed) | .016 | .067 | . | .668 | .798 |
| | N | 9 | 9 | 9 | 9 | 9 |
| Digestive Tract Weight | Correlation Coefficient | .550 | .667* | .167 | 1.000 | .350 |
| | Sig. (2-tailed) | .125 | .050 | .668 | . | .356 |
| | N | 9 | 9 | 9 | 9 | 9 |
| Abundance of Microplastics | Correlation Coefficient | .083 | .367 | -.100 | .350 | 1.000 |
| | Sig. (2-tailed) | .831 | .332 | .798 | .356 | . |
| | N | 9 | 9 | 9 | 9 | 9 |

The forms of microplastics found in the three species of fish were pellets (27,00 ± 71,91 microplastics/individual), films (84,11 ± 105,20 microplastics/ individual), fragments (176,33 ± 115,06 microplastics/individual), and fiber (209,44 ± 67,39) (Figure 1) with the highest abundance of fiber and the fewest pellets (Table 4) but not significantly different between fish species ($p <0,05$). Previous research on several consumption fish at Baron Beach, Gunung Kidul Regency, also found that the most abundant form of microplastic was fiber (Suwartiningsih et al., 2020). The high level of microplastic in the form of fiber in the three species of fish because these three fish are pelagic fish. Pelagic fish are a group of fish that live on the surface of the waters to the middle layers of the waters (Amri, 2017). The forms of microplastic found in the digestive tract of fish is influenced by food habits (Hastuti et al., 2019). Fiber is commonly found in the digestive tract of pelagic fish because of its thin shape, which makes it easy to float and is mostly found on the surface of the water (Hiwari et al., 2019) or because the shape of fiber is similar to fish food. Fiber is an elongated plastic fiber, derived from broken nets, ropes and synthetic fabrics (Dewi et al., 2015). Fiber can come from fishing (Dewi et al., 2015) or washing activities (Hiwari et al., 2019; Rochman et al., 2015).

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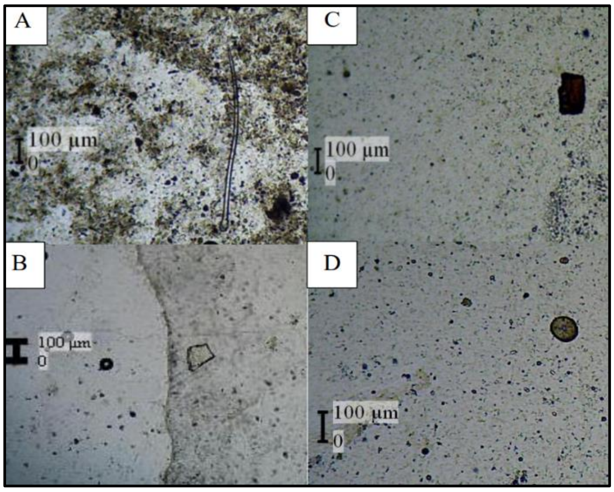
**Table 4. Forms of Microplastics in the Digestive Tract of Three Species of Fish from Supermarket X, Yogyakarta City, DIY Province.**

| Local Name (Scientific Name) | Fiber | Fragment | Film | Pellet |
|---|---|---|---|---|
| Milkfish (*Chanos chanos*) | 248.33 ± 49.50 | 171.67 ± 77.69 | 45.00 ± 19.08 | 6.67 ± 11.55 |
| Mackerel (*Rastrelliger* sp.) | 224.00 ± 45.53 | 97.67 ± 3.78 | 142.00 ± 182.04 | 1.33 ± 0.58 |
| Tuna (*Euthynnus affinis*) | 156.00 ± 82.31 | 259.67 ± 164.85 | 65.33 ± 54.01 | 73.00 ± 125.57 |
| Average and Stdev | 209.44 ± 67.39 | 176.33 ± 115.06 | 84.11 ± 105.20 | 27.00 ± 71.91 |




**Picture 1. Forms of Microplastics in the Digestive Tract of Three Species of Fish from Supermarket X Yogyakarta City, DIY Province. A) Fiber; B) Film; C) Fragment; and D) Pellet.**

The colors of the microplastics found in the digestive tract of the three species of fish include black (295,56 ± 131,56 microplastics/individual), transparent (135,00 ± 133,83 microplastics/individual), brown (48,33 ± 31,49 microplastics/individual), blue (9,22 ± 7,50 microplastics/individual), yellow (4,33 ± 4,61 microplastics/individual), purple (3,00 ± 5,38 microplastics/ individual), red (1,11 ± 1,27 microplastics/individual), and green (0,33 ± 0,71 microplastics/individual). The color most commonly found in the digestive tract of the three species of fish is black and the least is green (Table 5). The color of the microplastics found was not significantly different between fish species ($p<0,05$). Previous studies have also detected the dominance of black microplastics (Güven et al., 2017; Vendel et al., 2017; Hastuti et al., 2019; Suwartiningsih et al., 2020). The black color of microplastics is caused by its ability to absorb pollutants (Hiwari et al., 2019). Pelagic fish are detected to be dominated by black, indicating that microplastics have absorbed a lot of pollutants (Hiwari et al., 2019) at sea surface.

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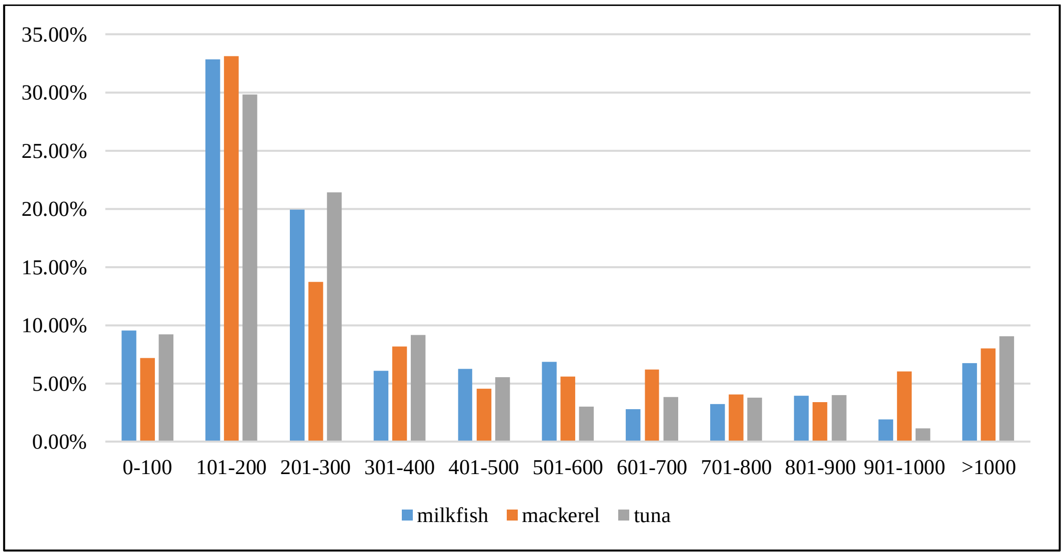
**Table 5. Color of Microplastics in the Digestive Tract of Three Species of Fish from Supermarket X, Yogyakarta City, DIY Province.**

| Local Name (Scientific Name) | Black | Transparent | Blue | Red | Yellow | Brown | Purple | Green |
|---|---|---|---|---|---|---|---|---|
| Milkfish (*Chanos chanos*) | 320.33 ± 102.48 | 101.00 ± 49.03 | 7.33 ± 1.53 | 1.33 ± 1.53 | 7.67 ± 5.69 | 33.00 ± 14.73 | 0.67 ± 1.15 | 0.33 ± 0.58 |
| Mackerel (*Rastrelliger* sp.) | 187.00 ± 23.07 | 209.33 ± 231.81 | 14.67 ± 12.22 | 2.00 ± 1.00 | 4.67 ± 3.79 | 39.00 ± 10.82 | 7.67 ± 8.02 | 0.67 ± 1.15 |
| Tuna (*Euthynnus affinis*) | 379.33 ± 170.52 | 94.67 ± 55.16 | 5.67 ± 2.08 | 0.00 ± 0.00 | 0.67 ± 1.15 | 73.00 ± 47.29 | 0.67 ± 1.15 | 0.00 ± 0.00 |
| Average and Stdev | 295.56 ± 131.56 | 135.00 ± 133.83 | 9.22 ± 7.50 | 1.11 ± 1.27 | 4.33 ± 4.61 | 48.33 ± 31.49 | 3.00 ± 5.38 | 0.33 ± 0.71 |

The results showed that the most commonly found microplastics size from the digestive tract of the three species of fish was in the range of 101-200 µm (Figure 2). This detected size is smaller than that found in economical fish in the Bali Strait, which ranges from 300 – 1000 µm (Yona et al., 2020). Microplastics with a smaller size indicate that plastic has long been degraded in waters (Hiwari et al., 2019) due to photo-oxidation processes and due to erosion (Karbalaei et al., 2019).




**Picture 2. Percentage of Microplastic Measurements in the Digestive Tract of Three Species of Fish from Supermarket X, Yogyakarta City, DIY Province.**

The results of the FTIR test indicated that the microplastics in the three species of fish were indicated to originate from the polypropylene (PP) polymer. Polypropylene microplastics are most commonly found in water areas (Permatasari & Radityaningrum, 2020). This causes PP microplastics found in many bodies of aquatic biota (Sandra & Radityaningrum, 2021). Sources of PP microplastics include food and beverage packaging (Mar'atusholihah et al., 2020), as well as from plastic bags (Nor & Obbard, 2014). Polypropylene plastic has a low density so it is easily degraded (Maddah, 2016). The PP plastic detected in this study came from the waters of the Semarang area, which is the original habitat of the sample fish sold at Supermarket X. Previous research found that PP microplastics had become a pollutant in the Kendal river which empties into the Semarang coast (Hanif et al., 2021).

## CONCLUSION

From the results of the study, it can be concluded that the abundance of microplastics in the digestive tract of mackerel was 465,00 ± 222,69 microplastics/individual, milkfish 471,67 ± 58,53 microplastics/individual and tuna 554,00 ± 122,19 microplastics/individual, but not significantly different. The forms of microplastic found were fiber, fragments, films, and pellets but were not significantly different between species of fish. The color of the microplastics obtained was not significantly different between fish species. Microplastics are dominated by the size range of 101 – 200 µm. Based on the FT-IR results, the microplastics found were of the polypropylene (PP) type.

## RECOMMENDATION

Future research can detect microplastics in fish meat because it is the most commonly consumed part by humans.

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