Microplastics in Gastrointestinal Track of Some Commercial Fishes from Bengkalis Waters, Riau Province Indonesia

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Abstract. Microplastic is a particle that has a size of <5 mm, where its existence might be able to contaminate the biota in the aquatic environment. This research was conducted in the coastal waters of Bengkalis Island in early 2020 with the aim to determine the types and analyze its abundance of microplastics in each area with suspected different sources of input. Thirty six individual samples of Duri fish (Arius maculatus), Lomek (Harpodon nehereus), and Biang (Setipinna breviceps) were collected from the north and south parts of Bengkalis island with the help of local fishermen in each sampling location. The average abundance of microplastics found in the gastrointestinal tract of fish was 62.96 particles/ind which consisted of fiber, film and fragment. The highest microplastics abundance was found in Duri fish (72.22 particles/ind), whilst the lowest was found in Lomek fish (55.56 particles/ind). Although the abundance of microplastic in coastal waters of north Bengkalis (Malacca Straits area) were higher that that in the south of Bengkalis (Bengkalis Straits area), statistically they were not significantly different (p>0.05). This was presumably due to differences in oceanographic influences such as current and waves between the two water masses as well as anthropogenic activities in both areas that can affect the spread and distribution of microplastics.

1. Introduction
Increased community dependence on the use of plastics in every activity without realizing it has a long-term impact. Wastes generated from all activities both directly and indirectly can be discharged into the river and then flowed into the sea. At sea, floating garbage can be degraded into small particles. Almost all types of plastic will float in a body of water, and for a long time cause the plastic to be torn and degraded by sunlight (photodegradation), oxidation, and mechanical abrasion to form plastic particles [1, 2].

Plastic waste is classified into macroplastic, mesoplactic and microplastic. Microplastic has a particle size with a range of 0.3 - 5 mm [3]. The existence of microplastic in the sea is one of the focuses in the problem of marine pollution because its existence is difficult to control due to the contamination which could be originated from community activities around the coast of the island or shipments from other areas. Bengkalis Island consists of open sea waters in the east and north, which is part of the Malacca Strait, and Bengkalis Strait waters in the west and south of the island. The coastal waters of Bengkalis Island has been one of the important fishing ground areas for local fishermen.

The presence of microplastics in the water column can disrupt marine ecosystems, aesthetics, and are dangerous because small microplastic sizes can potentially be consumed by marine animals. The impact of microplastic is more serious than large plastic because microplastic can be swallowed by...
fish and plankton so that it can disrupt the food chain in the water. Wide distribution of microplastic, high density in waters [4], size [5] and prey-like colors (white, black and yellow) result in microplastic being potential to be consumed by various marine organisms both invertebrates and fish [6]. The smaller the microplastic particles, the more likely they are to be accumulated by organisms in the waters [7].

The entry of microplastics into the bodies of marine animals such as fish, due to their small size and large surface area, can be a carrier of dangerous contaminants. Various chemical contaminants that exist in the waters can be attached to microplastic particles and then eaten by fish and finally by humans as the highest trophic level in the food chain [8]. The lack of preliminary information about microplastics in Bengkalis Island coastal waters and the importance of the area as a fishing ground, this study was conducted to determine its presence in the gastrointestinal tracts of fish commonly caught in these coastal waters.

2. Methodology
The research was conducted in the waters of Bengkalis Island in February – April 2020. Fish samples were collected from 6 locations that were considered to represent the study area, with the criteria in the southern part being Bengkalis Strait waters, namely Ketam Putih Village, Bengkalis Kota and Meskom Village, and in the North part being Malacca Strait waters are Jangkang Village, Selat Baru Village, and Pambang (Figure 1). Sample analysis was carried out at the Marine Chemistry Laboratory, Faculty of Fisheries and Marine Science, University of Riau.

![Figure 1. Map of study site and sampling location](image)

Samples of Duri Fish (*Arius maculatus*), Lomek Fish (*Harpodon nehereus*) and Biang fish (*Setipinna breviceps*) were collected from Bengkalis Island waters with the help of local fishermen, where the types of fish sampled are the dominant fish species and fish that are often consumed by the community. All samples taken were stored in plastic samples and given 4% formalin solution and stored in a cool box for further analysis in the Laboratory of Marine Chemistry at the Faculty of Fisheries and Marine Science, University of Riau.

The sample handling is carried out with several stages, starting from the preparation, separation, and identification of the sample by referring to the procedure of [9]. The fish were dissected by cutting from the anus toward the dorsal to the lateral linea, then anteriorly to the back of the head and then down to the bottom of the stomach until the fish's bowels are visible. The contents of the stomach in the form of the stomach and intestine are taken from each sample. Each sample of the fish's digestive organs obtained was put into a sample bottle and then given a 10% KOH solution and allowed to stand for 2 weeks. This KOH solution serves to remove and destroy organic matter in the sample so that the sample is more easily observed.
Samples that were dissolved with a 10% KOH solution were observed visually under a microscope. The identified microplastic particles are grouped into three types, namely fiber, film, and fragment. Observation of microplastic particles was carried out 3 times by inserting every 1 ml sample of fish digestive organs that had been dissolved with a 10% KOH solution in the Sedgewick rafter counting cell. Each repetition of observations, the number of microplastic particles found was recorded. The identified microplastic particles are calculated in abundance with particle/ind units. Analysis of differences in microplastic abundance in fish between locations observed by t test. The whole set of statistical analyzes was performed with the help of Microsoft Excel Software and SPSS version 17.0.

3. Results and Discussion

3.1 Microplastics in fish by type

Microplastic distribution of various sizes in the water and sedimentary columns which are the living habitat of various organisms, and colors that can resemble prey (white, black and blue) can increase the potential for microplastic ingestion by various organisms including fish. Of the 25 fish obtained, only 18 fish contain digestive tract. Microplastic abundance in each fish species can be seen in Figure 2.

![Figure 2](image-url)

**Figure 2.** Microplastic abundance in three different fish (particle/ind.)

The results obtained in this study found three types of microplastic namely fiber, film and fragment (Figure 3). The average abundance of microplastics found in the digestive tract of fish is 62.96 particles/ind. The highest abundance was found in Duri fish (*A. maculatus*) while the lowest abundance was in Lomek fish (*H. nehereus*). Both of these species belong to the type of demersal fish. Demersal fish group is a type of fish whose habitat is at the bottom of the waters.

Although these species both live at the bottom of the water, the types of food of the two species are different. Duri fish (*A. maculatus*) is an omnivorous fish with food such as fish, worms, insects, shrimp and macrophytes. While Lomek fish (*H. nehereus*) is a carnivorous fish with food such as fish, shrimp, crabs, sea eels [10]. *A. maculatus* is a basic eater that does not pick and choose its food, based on this habit the potential for non-prey particles to be found in the bottom of the water is one of them such as microplastic. Biang fish (*S. breviceps*) are the fish with the second highest abundance. Biang fish is one of the fish in the pelagic fish group which is classified as omnivorous fish. The types of food include shrimp, fish, insects, detritus and worms. The presence of microplastics in the water column causes microplastic accumulation by fish. This is in accordance with the statement of [11] that habitat is more influential in the possibility of microplastic ingestion.

In all three types of fish, film-type microplastics are the highest in abundance. The large number of film types found is thought to be due to its nature which has a lower density than other types of microplastics which allows film type microplastics to float in the water column. So that when fish eat, microplastics are also accidentally included into the oral cavity. It was stated that film-type microplastics are easier to be spread out by the current [12]. Furthermore, the type of film is a secondary plastic polymer derived from fragmentation of plastic bags or plastic packaging and has a
low density [2]. In Lomek fish (*H. nehereus*), the highest microplastic abundance is found in fiber types. Fiber-type microplastics originated from fishing gear such as fishing nets and fishing lines and from synthetic materials on clothing [13]. Fiber also has a thin shape and size that causes the fiber is often found floating in the waters [14].

Microplastic abundance in the northern coastal waters is higher than in the southern part of Bengkalis Island (Figure 3). However, the t test results showed no significant difference (*p* > 0.05) for microplastic types of fiber and filaments. While the fragment types showed significantly different abundance (*p* < 0.05) for the three fish species. This is thought to be due to differences in oceanographic influences such as different currents speed and wave between northern and southern waters that can affect the spread of microplastics.

![Figure 3](image)

**Figure 3.** Microplastic abundance based on its type and sampling location (particle/ind.)

Table 1 shows a comparison of microplastic abundance in fish in several study sites. Microplastic abundance in the waters of Bengkalis Island is still lower than Banten Bay waters, but higher than other waters. The difference in the value of microplastic abundance is likely due to different water conditions and differences in the number and types of fish used as research samples. Analyzing the diversity of species by the small number of fish samples in one species is not enough to describe differences between groups or between species of fish [15].

### Table 1. Comparison microplastic abundance with other studies

| Location                  | Microplastic abundance (particle/ind.) | Dominant type | Reference |
|---------------------------|---------------------------------------|---------------|-----------|
| Pulau Bengkalis           | 62.96                                 | Film          | This study |
| PIK, Jakarta              | 12.21±9.76                            | Fiber         | [2]       |
| Gili Labak, Jawa Timur    | 22.3                                  | Fiber         | [16]      |
| Selat Bali                | 15                                    | Fiber         | [17]      |
| Teluk Jakarta             | 16 – 77                               | Fragment      | [15]      |
| Tambak Lorok, Semarang    | 3,36                                  | Fiber         | [18]      |

#### 3.2 Microplastic based on colour

Based on the results obtained, the dominant color of microplastic type of fiber and film for all type of fish is white. Abundance of fiber types in each fish 50.00 ± 52.223 particles/ind. (Biang fish), 75.00 ± 105.529 particles/ind. (Duri fish), and 91.67 ± 90.034 particles/ind. (Lomek fish). The abundance of film types in each fish was 83.33 ± 83.485 particles/ind. (Biang fish), 75.00 ± 96.531 particles/ind. (Duri fish), and 33.33 ± 49.237 particles/ind. (Lomek fish). While for the fragment type microplastic,
the highest abundance was found in black with an abundance of $25.00 \pm 62.15$ particles/ind. (Biang fish), $33.33 \pm 49.237$ particles/ind. (Duri fish), and $16.67 \pm 38.925$ particles/ind. (Lomek fish). Microplastic abundance based on color can be seen in Figure 4.

**Figure 4.** Microplastic abundance based on colour (particles/ind.)

Previous study showed that the colour that is often found in the type of fiber in the digestive tract of fish is black [18, 19], while other found the dominant colour obtained is blue [15]. The dominant colour fragment type obtained is white [20]. The difference in results in each of these studies can be caused by differences in the dominant microplastic colours in the water and sedimentary columns. Fragment-type microplastics are found in fish intestines because they are easily distributed in the water column [1]. These types of fragments can come from hard plastic bottles.

Color in microplastics can be used as an indication of the length of time the particle is exposed to sunlight and is degraded due to the process of color change (yellowing) indicates the length of time of exposure to sea water, and can increase the likelihood of oxidized polymers [21]. The color of the microplastic can also affect the possibility of being eaten by various organisms because the microplastic is similar to its natural prey. Microplastics can be digested by marine organisms when one particle of microplastics resembles food [8]. Some carnivorous fish prey on zooplankton and may also eat microplastics that resemble their prey with varying colors. Meanwhile, microplastic transfers can occur at the level of plankton ranging from mesozooplankton to macrozooplankton [6].

Plastic particles that accumulate in large numbers in the body of the fish can clog the digestive tract [22], interfere with the digestive process or hinder the process of absorption [23]. Microplastics can absorb toxins produced from chemicals around the sea and the environment and can indirectly be transferred into the food chain [24]).

### 3.3 Microplastics in fish based on size

The size of small microplastic particles can enter the sea through various activities both on land and in the sea itself. It was stated earlier that microplastic pollution in the sea is caused by the disposal of plastic particles with a larger size that has broken down and become smaller fragments and then carried to the sea [25]. Microplastic size of each type of fish in this study can be seen in Figure 5.
Figure 5. Microplastic abundance based on size (particles/ind.)

Microplastic size of Biang fish ranges from 60-500 µm, Duri fish ranges from 40-1000 µm and Lomek fish ranges from 60-500 µm. The size range of microplastic that is quite large in the Duri fish compared to the Biang fish and Lomek fish is influenced by the feeding habits of each fish. These feeding habits provide the potential for microplastic presence of various sizes. According to Sieburth et al. in [15], the size range of phytoplankton and zooplankton is 2-200 µm, while zooplankton are in the range of 0.2 mm - 20 dm. With food size that is almost the same as the size of the microplastic, it is very possible for fish to be contaminated by the accumulated microplastics because fish cannot distinguish between prey and other particles, including microplastics.

Acknowledgements
The author would like to thank the Marine Chemistry Laboratory Staff at the Faculty of Fisheries and Marine Science of the University of Riau who helped during the research process, from the field sampling preparation to the sample analysis in the laboratory.

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