Microplastics Ingestion by Skipjack tuna (*Katsuwonous pelamis*) in Ternate, North Maluku - Indonesia

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Abstract. Microplastic (MPs) is a contaminant of concern worldwide. Rivers are implicated as significant pathways of micro-plastic transport to marine and lake ecosystems, and microplastic ingestion by freshwater biota is a risk associated with microplastic contamination, but there is little research on microplastic ecology within freshwater ecosystems. Microplastic uptake by fish is likely affected by environmental microplastic abundance and aspects of fish ecology, but these relationships have rarely been addressed. We measure the distribution and abundance of micro-plastic in skipjack tuna from 3 markets in Ternate. In total 948 MPs pieces were obtained in 16 fish samples. The identified MPs characteristics show that the micro-plastic character is categorized from the type of fiber, film, and fragment, while the colour of microplastic is black, red, blue, green, brown, grey, and white.

Keywords: Microplastic, Skipjack tuna, Ternate-North Maluku

1. Introduction

Microplastic (MPs) the particles of plastics that have the size < 500 µm (5 mm) had become concerned by most scientists recently[1][2]. Same to the plastics, microplastic is resistant to the environment due to the chemical compounds and characteristics. It was spread widely around the world, in sediment[3], in agroecosystem[4], in urban estuary[5], in Antarctica[6], and freshwater system[7]. Furthermore, microplastics in small pieces could be ingestion by marine organisms such as fish[8],[9], filter feeder [10], [11], zooplankton [12]. In the marine food web, the MPs particles ingested by small fish can be transferred to top marine predators [13]. Globally, marine fish has the highest percentage of plastic pollution (68% of selected samples), followed by pelagic fish, demersal fish and freshwater fish [14]. In the fish body, the digestive tract (GIT) generally contains more microplastics than other body parts [15].

The distributions and migration of skipjack tuna mostly found around in tropical and subtropical areas in the world. This depends on environmental variables such as sea surface temperature, salinity, and surface chlorophyll-α concentration [16]. Ternate Island located in the tropical region, Eastern Indonesia which has the surface temperature and chlorophyll-α conditions are suitable for skipjack tuna habitats so this fish is available every year in this region [17]. This leads the skipjack tuna is a
popular fish in North Maluku and one of the main export commodities as well as local consumption [18]. These fish are widely sold in all traditional and modern markets in Ternate city.

The presence of MPs in fish should be identified particularly the fish that were consumed by people. MPs in fish or other food have negative effects especially in human health [19]. Unfortunately, the research related to MPs in food consumption in Indonesia is still limited. The study tends to evaluate the presence of MPs in the marine environment that focused on identifying the characteristics and abundance of MPs ingested by skipjack tuna that is sold in three Ternate markets. The MPs characteristics in this research can be categorized in the form and in the colour. This research as a preliminary strategic step that will support various studies both normatively and empirically with a variety of available data, as an effort to realize sustainable food security in the city of Ternate, North Maluku.

2. Materials and Methods

2.1 Sample Collection

During July 2019, a total of 16 skipjack tuna samples was collected from three local fish markets (Bastiong, Gamalama, and Dufa-Dufa) in Ternate city. The sampling location is shown in Figure 1. The representative size of skipjack tuna was sampled from the markets every weekend for three times sampling. Then, the sample was loaded to the Fisheries and Marine Science laboratory. The biometric of sample involve total weight and fork length was measured to the nearest 0.1 g and 0.1 cm, respectively[20][21].

2.2 Sample Extraction and Microplastics identification

In laboratory, the stomachs and intestines were dissected, and the tissue was placed in clean beakers. The weights and the length (to the nearest 0.1 g and 0.1 cm) of the stomachs and intestines were recorded by using an electronic weight balance and manual measurement.
The stomachs and intestines of the sample were dissected, and the tissue was placed in clean beakers. The wet weights and the length (to the nearest 0.1 g and 0.1 cm) of the stomachs and intestines were recorded by using an electronic weight balance and manual measurement, in order to separate the MPs abundance and to degrade organic matter and enable detection of MPs particles, fish GIT contents were subjected to hydrogen peroxide digestion according to [22] and [21][21]. Volumes of 20 to 30 mL of KOH 10%, depending on the amount of GIT sample, were added to each beaker glass container. The beaker covered with aluminum foil and stored at room temperature for 2 - 3 weeks until the dissolution of the organic material was observed to be complete.

Next, the filtration of the sample solution was performed with a vacuum filtration method onto whatman glass fiber filters (~1μm pore size). During the process, distilled water was added to enhance performance. Filters were stored in Petri dishes individually and dried in an oven at 40ºC for 24h. The filtered particles were observed under the stereomicroscope (40x magnification). The MPs are assessed visually and characterized by type into fibers, fragments, and films based on [22].

3. Result and Discussions

3.1 Sample Biometric

Biometric data measured for each sample were quite similar in all sampling locations. The weight and fork length of the skipjack tuna (Katsuwonus pelamis) collected from all sample ranged from 2.9 – 6.4 Kg with a mean of 4.9 Kg and 48 – 69 cm in length with an average 58.07 cm, respectively. The skipjack tuna sample used in this study had been reached the range size for fishing targets. According to [23], the size of skipjack tuna tagged in eastern Indonesia range between 28 – 83 cm fork lengths. Based on the correlation value between weight and length of the skipjack sample, they could be categorized into a mature level [17] (Figure 2). Meanwhile, the weight and length of GIT sample registered ranged from 29.8 – 53.2 g, with an average of 40.3 g and length from 14 – 19.3 cm, average 16.89 cm.

![Figure 2 – The Correlations Graph between Weight and Length of Skipjack tuna Sample](image)

3.2 Microplastics in Digestive Tract of Skipjack Tuna

Microplastics were found in all digestive tracts of fishes sample even though the abundance in each fish was different from the sampling markets. In total 948 MPs items were obtained in 16 fish samples during three times sampling period. Skipjack tuna sampled from Bastiong market has the highest number of total MPs among other sampling locations (360 items). This figure was followed...
by sampled from Dufa-Dufa market (319 items) and sampled from Gamalama market (269 items). The abundance of MPs on fishes sample from all markets during three times sampling is shown in figure 3.
Figure 3. Total MPs during Sampling Period on All Markets

The presence of MPs in the digestive tracts of skipjack tuna sample appends the list number of marine organisms that have consumed MPs in its digestive system, particularly in Indonesia. Several studies related to MPS expose in fish had been reported in Indonesia. Those studies found that the abundance of MPs in digestive tracts was varied depends on fish species and fishing location (Table 1).

| No | Spesies                   | Type of Microplastics/debris | Location of Fishing        | Reference |
|----|---------------------------|------------------------------|----------------------------|-----------|
| 1  | Johnius sp.               | Fragment, Fiber, Film        | Pangandaran Bay            | [25]      |
| 2  | Trichiurus sp.            | Fragment, Fiber, Film        |                            |           |
| 3  | Rastrelliger kanagurta    | Fragment, Film, Monofilament|                            |           |
| 4  | Decapterus macrosoma      | Styrofoam, Fragment          | Makassar Strait            | [26]      |
| 5  | Siganus argenteus         | Fragment                      |                            |           |
| 6  | Siganus canaliculatus     | Monofilament                 |                            |           |
| 7  | Oreochromis mossambicus   | Fragment, Fiber, Film        | Pantai Indah Kapuk Coast   | [27]      |
| 8  | Scatophagus argus         | Fragment, Fiber, Film        |                            |           |
| 9  | Crenimugil seheli         | Fragment, Fiber, Film        |                            |           |
| 10 | Mugil cephalus            | Fragment, Fiber, Film        |                            |           |
| 11 | Katsuwonus pelamis        | Fragment, Fiber, Film        | North Maluku Ocean         | This Study|

3.3 Characteristics of Microlastics in Skipjack Tuna

The skipjack tuna, especially in this study, are identified intake the marine microplastics with different shapes, sizes, and colours. The identification results of MPs shapes in GIT samples found that the shapes were categorized as fiber, fragment, and film (Figure 4). The shape was dominated as much as 75% fragment 23%, and film reach 2% (Figure 5A). The size of MPs ranges between 0.1 to 1.5 mm. All types of microplastics found in the sample. Based on the colour of MPs, this study found
that there are seven colours of MPs namely; black, red, blue, green, brown, grey, and white. Black was more dominant (76%) while grey was the least only 1% (Figure 5B).

![Figure 4. MPs types (a); Fiber / Fiber; (b) Fragments, and (c) Thin film](image)

There are a number of exposure pathways by which marine organisms may ingest microplastic debris. Because of the microplastics have been widely spread throughout the seawater column [28], the exposure pathway could be direct or indirect intake. Direct consumption predominant in suspension feeders and deposit feeders’ organisms [29]. While based on feeding habits, the skipjack tuna consumed the microplastics could be trough directly consumption by filter the seawater or indirectly ingest plastic while consuming prey (i.e. trophic transfer).

![Figure 5. The Proportion of MPs in Fish Sample based on Types (A) and Colors (B)](image)

The results of research conducted using skipjack samples sold at three market locations in Ternate City showed the presence of particles suspected as micro-plastic. The particles which are suspected as micro-plastic have different types and colours. In the tuna fish hull, the results obtained are PSM with the type of fiber, film, and fragment. The results of this study when compared with the results of
research conducted by many researchers prove that in the body of fish found several types of MPs. This shows that MPs has contaminated tuna, especially present in the GIT of the fish.

MPs found in skipjack tuna is thought to generally be derived from waste either sourced from households or other sources that intentionally or unintentionally wasted and emptied into the sea. Fragments can originate from wastes produced due to human activities. Fragment MPs types can generally come from diverse sources that have different shapes, sizes, and weatherizes.

Fibre is a type of micro-plastic that can originate from monofilament fragmentation in fishing nets, ropes and synthetic fabrics that contribute debris to the sea. Fiber is shaped like a thread and is the most abundant type of micro-plastic in sediments. Film is a secondary plastic polymer derived from fragmentation of plastic bags or plastic packaging and has a low density. Films and fragments have a three-dimensional shape, but fragments are smaller than film. Fragments are the result of pieces of plastic products with very strong synthetic polymers. Pellets are primary micro-plastics that are directly produced by factories as raw materials for making plastics [30].

4. Conclusion

Based on the results of the study showed that the microplastic has been identified in the hulls of tuna that are traded on the Ternate City market. From all sampled fish, microplastic was found in the stomach contents of the fish. Microplastic presence consists of three forms namely; fiber / fiber; fragments / pieces, and films / fine sheets. And comes in various colours including black; blue red; green, and white

5. References

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