OCCURRENCE OF MICROPLASTICS IN WATER, SEDIMENT AND MILKFISH (Chanos chanos) IN CITARUM RIVER DOWNSTREAM (CASE STUDY: MUARA GEMBONG)

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Abstract. Microplastics in aquatic environment can possibly enter into the aquatic organism, so this study aims to identify the microplastic concentrations in water, sediment, and milkfish. The samples are taken in downstream Citarum river at Muara Gembong. Water samples were taken using a manta trawl pulled by a boat while sediment and milkfish samples were taken using the grab sampling method. Organic removal and cleaning was conducted by using the Fenton Oxidation method which use Fe and H₂O₂. The average of microplastic concentrations in river water, seawater ponds, mixed water, and seawater consecutively are 0.0574 ± 0.025 particles/m³, 3.000 ± 2.645 particles/L, 0.666 ± 0.577 particles/L and 1.333 ± 1.155 particles/L. The average of microplastic concentrations in sediment sea water pond, sediment mixed water pond and sea sediment samples consecutively are 3.666 ± 0.577 particles/20g, 2.667 ± 1.527 particles/20g, 2.333 ± 0.577 particles/20g and 0.667 ± 1.154 particle/20g. The average of microplastic concentrations in the gut and gills of milkfish in sea ponds and mixed ponds consecutively are 2.333 ± 2.266 particles/fish and 2.222 ± 3.768 particles/fish. The average of microplastic concentrations in milkfish tissues in the sea and mixed water ponds are 1.333 ± 1.000 particles/fish and 1.111 ± 1.167 particles/fish.

1. Introduction

Plastic production has increased since 1950 [1]. In 2012, global production of waste had reached 3.4 million tons and half of it is a non-degradable waste and this figure is expected to double by 2025 [2]. The improper plastic disposals eventually will be fragmented and have led to an increase in tiny plastic particles including microplastics which polluting the environment [3,4]. Microplastic is plastic which size < 5 mm. [3,4]. Microplastics have been observed and founded in marine [5], freshwater [6,7], and terrestrial [8].

Microplastic in the environment can possibly consumed by the organism, across trophic levels through zooplankton [9,10], annelids [11,12], echinoderms [13,14], bivalves [15,16], fish [17-19], turtles [20] and birds [21]. The effect of microplastics intake by fish was been also observed by several authors. Microplastic (polyethylene) has been reported to reduce significantly acetylcholinesterase (AChE) in juvenils [22]. In addition, 100% fish mortality was observed after 96 h polyethylene [22].

Citarum is the biggest river in West Java on which occupied an area 6,614 km². There are 2,822 industries and 18.64 million residents who reside along the river. Citarum River is one of the dirtiest and most polluted rivers in the world and has the losses for the people who still utilize the water of Citarum River [23]. The abundance of microplastics often associated with population density and the resident's activity [24]. This research aims to identify of microplastics in water, sediment, and milkfish.

2. Methodology

2.1 Sampling location

This study was conducted on Citarum river downstream, especially at Muara Gembong, Bekasi District. The sampling location was shown at Fig. 1.

Fig. 1 Sampling location

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2.2 Sampling methods

The determine of sampling point on the river and the milkfish pond based on purposive sampling, based on the sampling location and the water used for the pond. The water sample at the river and milkfish pond taken by manta trawl and grab sampling while sediment samples taken by Eckmann Grab [25]. Volume reduce water takes only one sample at a time. The sampling period was in March 2019, during wet season.

2.3 Microplastics separation

Separated water sample according to the mesh that used at manta trawl (125µm). The sample that held with a mesh will dry at 60°C and then the destruction are used Fenton Oxidation method using H₂O₂ and Fe to clean the organic materials with 75°C [25,26]. Particles that suspected as microplastics were picked up for analysis using FT-IR [29]. Based on characterization of microplastics, the most shape, color and size of microplastic, at water samples from Citarum River were black fragments with the size range 1000 - 5000 µm, and milkfish pond were black film with the size range 500 - 1000 µm and the sea were blue and red fragment with the size range 500 – 1000 µm. The result can be seen in Fig 3.

2.4 Microplastics visualization

Visualization with a microscope was carried out to determine the shape and size of microplastic using ImageJ software [30]. The type of plastic polymer determined visualization using FT-IR. The wavelength range used in FT-IR between (4000 - 550 cm⁻¹) where the results of the polymer spectrum will be matched with the polymer spectrum standard [29].

3. Result and discussion

3.1 Microplastic concentration at a water sample

Based on the result, it found that the highest microplastic concentration in river at water sample was in segment 1, around 0.08613 ± 0.004 particles/m³. The highest microplastic concentration in milkfish pond was in seawater pond water with 3.000 ± 2.645 particles/liter. The result could be seen in Table 1.

| Location          | Microplastic concentration |
|-------------------|----------------------------|
| The river         | 0.08613 ± 0.004 particles/m³ |
| Segment 1         | 0.04805 ± 0.000 particles/m³ |
| Segment 2         | 0.03810 ± 0.0031 particles/m³ |
| Milkfish pond     | Sea water                  |
|                   | 3.000 ± 2.645 particles/litre |
| Mixing water      | 0.666 ± 0.577 particles/litre |
| The sea           | 1.333 ± 1.155 particles/litre |

Fig 3. The amount of microplastic concentration based on shape, color and the size at water samples

3.2 Microplastic concentration at the sediment

The amount of microplastic concentrations in sediment samples presented in Table 2. It appears that the highest microplastic concentration in sediment samples downstream of Citarum River taken as many as 20 grams most found in Segment 1 (avoid to the sea) with 4.00 ± 0.316 particles/20gram. The highest microplastic concentration in sediment samples at milkfish ponds was in the pond that used seawater with 2.667 ± 1.527 particles/20 gram and the highest microplastic concentration in sediment at the sea was 0.667 ± 1.154 partikel/20gr.
Based on the characterization of microplastic, the most shape, color and size from both of gut, gill and tissue from milkfish samples in seawater ponds were blue fragments with size range 1000 - 5000 µm and black fragments with sizes range 500 - 1000 µm. The most of shape, color and size from both of gut, gill and tissue samples of milkfish were black fragments with size range 500 - 1000 µm and black fragments with size range 1000 - 5000 µm. The data are shown in Fig 5.

**Table 2. Microplastic concentration in sediment samples**

| Location          | Microplastics concentration |
|-------------------|----------------------------|
| The river         | 4 ± 0.707 particles/20gr    |
| Segment 1         | 3.4 ± 0.894 particles/20gr  |
| Segment 2         | 2.6 ± 0.548 particles/20gr  |
| Milkfish pond     | 2.667 ± 1.527 particles/20gr |
| Seawater          | 2.333 ± 0.577 particles/20gr |
| Mixing water      | 0.667 ± 1.154 particles/20gr |
| The sea           | -                           |

Based on characterization of microplastic, The most shape, color and size in sediment samples were black fibers with the size range 1000 - 5000 µm, whereas in milkfish pond were blue fragments with the size range 1000 - 5000 µm and the sea were blue fragment with the size range 500 – 1000 µm. The result can be seen in Fig 4.

**3.3 Microplastic concentration at milkfish**

The average of microplastic concentrations in milkfish samples is presented in Table 3. Based on Table 3, the highest microplastic concentrations in the fish both from seawater and mixed water ponds were gut and gills. The highest microplastic concentration in fish’s tissue was in seawater pond.

Based on water, sediment, and milkfish samples observations, the fragment was found more often 90% in water, and milkfish samples and fibers were found 48% in sediment samples. The result of microplastic’s shape shown in Fig 6.

**Table 3. Microplastic concentration at milkfish samples**

| Location          | Microplastic concentration |
|-------------------|----------------------------|
| Seawater pond     | Gut and gill 2.333 ± 2.266 particles/fish | Gut and tissue 1.333 ± 1.000 particles/fish |
| Mixing water pond | Gut and gill 2.22 ± 3.768 particles/fish | Gut and tissue 1.111 ± 1.167 particles/fish |

**Fig 4. The amount of microplastic concentration based on shape, color and the size at sediment samples**

**3.4 Microplastic visualization by microscope**

Based on water, sediment, and milkfish samples, observations, the fragment was found more often 90% in water, and milkfish samples and fibers were found 48% in sediment samples. The result of microplastic’s shape shown in Fig 6.

**Fig 6. The microplastic shape on the microscope; (a) and (b) Fade Black fragment**

**4. Conclusion**

The average of microplastic concentrations in Citarum River downstream for water and sediment samples were 0.0574 ± 0.025 particles/m³ and 3.666 ± 0.577 particles/20gr. The average of microplastic concentration in water both of milkfish pond were 3.000 ± 2.645 particles/L for seawater ponds and 0.666 ± 0.577 particles/L for mixed water ponds, while the average of microplastic concentration in sediment at both of milkfish were 2.667 ± 1,527 particles/20gr for seawater.
pond and 2.333 ± 0.577 particles/20gr for mixed water pond. The average of microplastic concentration in gut and gill samples in milkfish from both of the ponds were 2.333 ± 2.266 particles/fish for seawater pond and 2.22 ± 3.768 particles/fish for mixed water pond, while for microplastic concentrations in milkfish’s tissue were 1,333 ± 1,000 particles/fish for milkfish from seawater pond and 1,111 ± 1,167 particles/fish for milkfish from mixed water pond.

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