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ORIGINAL ARTICLE

Source of Microplastic Pollution Within Human Stool in the Surabaya River Basin Area

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KEYWORDS

Microplastics;
River water pollution;
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ABSTRACT: The Surabaya River is a tributary downstream of the Brantas River, which is the longest river in East Java. The source of raw water for the city of Surabaya comes from the Surabaya River. Currently, the pollutants in the Surabaya River are not only organic and heavy metals but also microplastics. This study aims to identify the microplastic content in human stool as well as possible sources of microplastic pollutants in the community living in the Surabaya river basin area. This research was conducted on ten samples of human stools in the Surabaya river basin area. The results showed that the types of microplastics found in human stool samples were divided into three types, namely the type of fibre, the type of fragment, and the type of filament. The most common types of microplastics were the types of fragments and filaments found in nine human stool samples. Meanwhile, the type of fibre was only found in seven samples of human stool. With the discovery of the three types of microplastics in human stool, the human stool in the Surabaya river basin area has been contaminated by microplastics. This can be possible because most of the respondents' drinking water consumption comes from bottled water. In general, this type of microplastic fragment can come from plastic bottles, plastic bags and pipe fragments.

INTRODUCTION

Solid waste is a problem for people around the world and threatens environmental health, especially in the aquatic environment. One type of waste that is commonly found in the aquatic environment is plastic waste Plastics were created and produced on a large scale because they have many advantages ranging from economical price, durable or not easily damaged, lightweight and easy to obtain, so that the use of plastic is increasingly in demand by the public. Therefore, world plastic production has increased every year and reached 322 million tons in 2015 [1]. It is estimated this production amount will increase 100 times by 2050 [2]. Currently, plastic accounts for 10% of the total waste produced by humans [3]. Most of the plastics dumped into the environment don't undergo a recycling

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process first and eventually accumulate in marine waters which then become a source of pollution in the sea. It is estimated that 60-80% of waste in the sea comes from plastic waste [4].

Indonesia is the largest contributor of plastic pollutants to the world's oceans after China, with a size of 0.48 - 1.29 million metric tons of plastic/year [5]. This number increases from year to year in line with the increasing demand for plastic by the community. A large amount of plastic waste in Indonesia's oceans will threaten the life of marine life in it. Data on the presence of microplastics from Indonesian waters is still very minimal, even though on the other hand, the level of plastic pollution in Indonesia is high. The four main rivers in Indonesia, including the Brantas, Bengawan Solo, Serayu, and Progo rivers, are among the top 20 rivers polluted with plastic in the world [6]. However, these four rivers are still used as the main source of drinking water in several big cities to this day [7]. This condition has the potential to have a complex impact on the environment, such as a decrease in river water quality, the threat of decreasing marine biodiversity, and even disturbing human health through indirect water and biota consumption [8-11]. In addition, plastic waste that is not properly managed in the environment can absorb organic pollutants from its surroundings. Adsorption is influenced by the surface conditions of the particles, pH, hydrophobic and electrostatic interactions [12]. Therefore, unmanaged plastic waste in the environment has been considered an emerging pollutant, mainly because of its potential ecological risk to aquatic ecosystems [13, 14].

The Brantas River (320 km) is the second-largest river in Java after the Bengawan Solo [15]. The river flows through 15 densely populated cities and is the main source of water supply and irrigation in East Java Province. The lower part of Brantas branches into two parts in Mlirip (Mojokerto City), namely the Surabaya River (42 km) and the Porong River (14 km).

All fish species in the Surabaya River contain microplastics in the guts of the fish (guts intestine). Research on plastic fragments in the fish stomach showed that of the 103 fish samples observed, 72% of the fish samples in the Surabaya River were positive for microplastics in their intestines. As many as 33% -38% of carnivorous fish samples contained microplastics in their intestines, 67% -100% of herbivorous fish samples also contained microplastics in their intestines, and 72% -83% of samples of polyphagous fish (horn beetle species) had microplastics in their intestines. The highest microplastic content was found in herbivorous fish and polyphagous fish [16].

According to research conducted in Austria by Austria's Environment Agency and the Medical University of Vienna which analyzed 8 stool samples from all over the world including Finland, the Netherlands, Poland, Austria, England, Italy, Russia, and Japan, it resulted in 8 out of 8 stool samples positive for microplastics [17]. From every 10 grams of stool, 18-172 microplastic particles are measuring 50-500 µm, 62.8% of the stool contain Polypropylene (PP) type of plastic, and 17.0% of the stool contain Polyethylene terephthalate (PET) plastic [17]. As a form of prevention of the dangers of microplastic pollutants to human health, this study aims to identify the microplastic content in human stool as well as possible sources of microplastic pollutants in the community living in Surabaya river basin area. Many similar studies have been conducted in developed countries to determine the content of microplastics in human stool, but similar studies in Indonesia have not been carried out. The results of this study will provide important input for the development of microplastics research in Indonesia.

MATERIALS AND METHODS

This research is an observational study because it looks at the formation of microplastics in human stool in detail and sources of microplastics through interviews. 10 samples of stool were observed from people who live in the Surabaya river basin area. Observation of samples was carried out for 5 months at the Ecoton Laboratory, Gresik. Observation of human stool samples was carried out using materials: (i) 10 grams of stool, (ii) H_2SO_4 90%, H_2O_2 90% 3:1, (iii) aquadest, dan (iv) Natrium Chloride (NaCl). As for the tools used in observing human stool, among others: (i) digital scales; filter; (iii) distilled water spray, (iv) centrifuge, (v) erlenmeyer, (vi) stirrer; (vii) funnel; dan (viii) microscope. The working procedure in microplastic observation is shown in Figure 1. In addition to observing human stool samples, this study also carried out data collection activities using a questionnaire instrument to research respondents consisting of variables: (i) frequency of eating meat and seafood, (ii) the use of toothpaste with particles, (iii) source of drinking water, and (iv) consumption of plastic bottled water [17]. The data in this study are presented in the form of Figures and Tables and analyzed descriptively quantitatively. In addition, a literature review was also carried out using a literature review of articles published in the ScienceDirect and Google Scholar databases with keywords in the form of "microplastic AND water pollution".

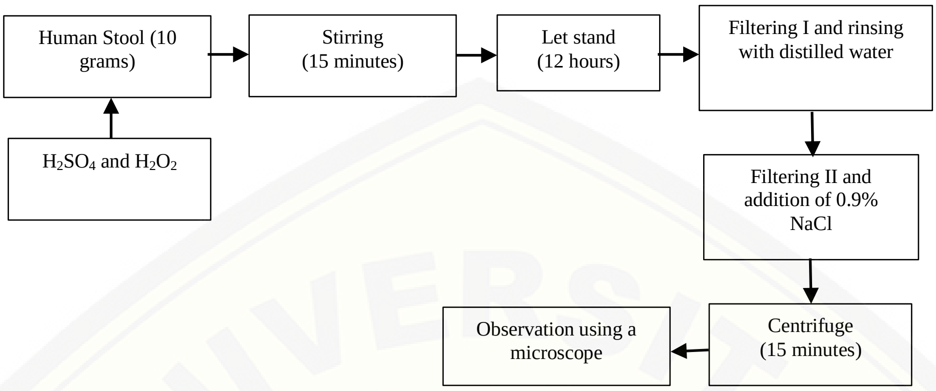


Figure 1. Observation Procedure Diagram.

RESULTS AND DISCUSSION

The results of data collection using a questionnaire to 10 respondents (Table 1) show that the majority of respondents have a frequency of eating meat and seafood in the past 1 week as much as 2-4 times a week, using particle toothpaste such as containing sea salt, the source of drinking water consumed is from bottled water, as well as the majority of respondents in the last 1 week before taking stool samples consuming water in plastic packaging.

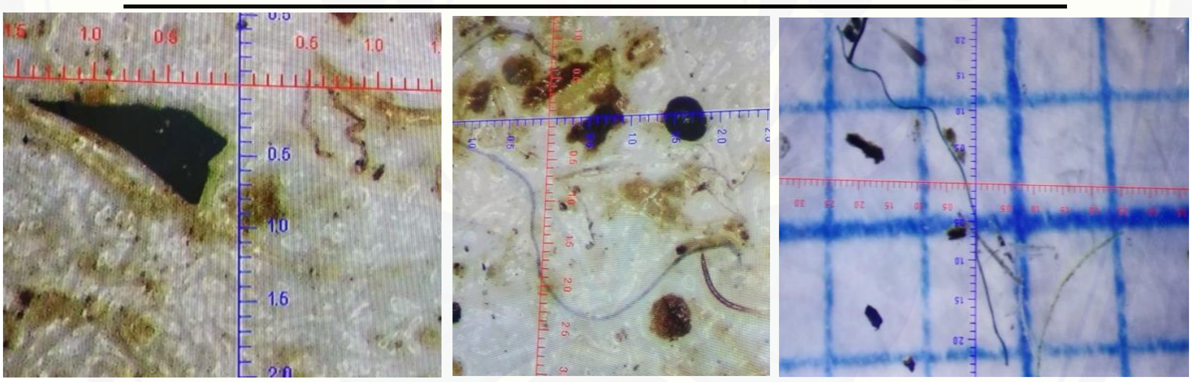
Table 1. Variable Distribution of The Frequency of Eating Meat and Seafood, Use of Toothpaste With Particles, Sources of Drinking Water, And Consumption of Plastic Bottled Water.

Stool Samples	Frequency of Eating Meat (Last 1 Week)	Frequency of Eating Seafood (Last 1 Week)	Use of Particle Toothpaste	Source of Drinking Water	Consumption of Plastic Bottled Water (Last 1 Week)
A1	1-2 times	Rarely	Yes	Water Utilities (PDAM)	Never
A2	Never	Rarely	No	Bottled water	Yes
A3	Never	Rarely	No	Bottled water	Yes
A4	1-2 times	Rarely	No	Bottled water	Yes
A5	2-4 times	2-4 times	No	Bottled water	Yes
A6	2-4 times	2-4 times	Yes	Bottled water	Yes
A7	2-4 times	2-4 times	Yes	Bottled water	Yes
A8	2-4 times	2-4 times	Yes	Bottled water	Yes
A9	2-4 times	2-4 times	Yes	Bottled water	Yes
A10	2-4 times	2-4 times	Yes	Bottled water	Yes

The results of the observation of the ten human stool samples under the microscope showed that all samples contained microplastics consisting of types of fibres, fragments, and filaments (Table 2). The majority of microplastics found in human stool samples were fragmented with a percentage of 52.6%. The most microplastic findings were in stool A1 samples which had the characteristic of rarely consuming seafood in the last one week before sampling but the frequency of eating meat 1-2 times in the last 1 week. In addition, respondents use toothpaste with particles such as containing sea salt, the source of drinking water used daily comes from water utilities (PDAM) without consuming bottled water in the last 1 week. The number of microplastics found in the stool sample of respondent A1 in this observation can be caused by the use of particle toothpaste such as containing sea salt and the use of drinking water sources from water utilities (PDAM) which has the potential for microplastic contamination in the water distribution process. The types of microplastics in respondent A1 consisted of 2 types, namely fragments and filaments. An overview of the types of microplastics in human stool is presented in Figure 2.

Table 2. Observation Results of Microplastic Types in Stool Samples

Stool Samples	Number of microplastics by type			Total
	Fiber	Fragmen	Filamen	
A1	-	14	2	16
A2	-	2	2	4
A3	1	1	2	4
A4	1	1	1	3
A5	-	2	2	4
A6	2	-	4	6
A7	2	8	-	10
A8	2	5	3	10
A9	4	2	6	12
A10	2	6	1	9
Total	14 (17.9%)	41 (52.6%)	23 (29.5%)	78 (100.0%)



(a) (b) (c)

Figure 2. Microplastic Findings in Three Stool Respondents Samples: (a) microplastic fraction; (b) fibre microplastic; (c) fibre and fragment microplastics

Microplastic is a type of plastic waste that is smaller than 5 mm in size and is grouped into 2 types, namely primary and secondary microplastics. Primary microplastics are the product of plastic made in micro-form, such as microbeads in skincare products that enter waterways. Secondary microplastics are in the form of fragments, parts, or fragmentation of larger plastics [18].

There are still many microplastics in the waters with several types including fibres, fragments, films, pellets, sheets, and foams. Fibre-type microplastics are derived from the monofilament fragmentation of fishing nets, ropes and synthetic fabrics. Meanwhile, fragments are a type of microplastic in the form of larger plastic shards. Fragments generally come from bottles, plastic bags and pipe fragments. Likewise, film-type microplastics also come from very thin plastic shards. Pellets come from the remaining raw materials for industrial activities, toiletries, soap and facial cleansers. Meanwhile, foam comes from packaging and plastic bags [19].

One of the factors causing the abundance of microplastics in the waters is inseparable from human behaviour. Sources of microplastics that pollute the lake come from domestic activities, such as washing machines and other anthropogenic activities in the form of agricultural activities [20]. Wastewater that comes from agricultural sources hasn't treatment and becomes a source of pollutants in lake water. Likewise in seawater waters in the same study said that the microplastics that pollute seawater are sourced from commercial ports, wastewater treatment plants and domestic activities. Another study said that the microplastic types of fibre found in the sediments on the coast of Mangunharjo Village, Semarang City were sourced from boat ropes that were no longer used by fishermen or which experienced friction and then decomposed into plastic particles of very small sizes which were then carried by the inflow into the water [21]. Another condition occurred in Muara Badak, Kutai Kartanegara Regency, the source of microplastic fragments came from drink bottles, the remains of wasted jars, mica folders, gallon pieces and small pieces of scattered paralon pipes. film-type microplastics come from plastic bags, scattered food packaging. Meanwhile, microplastic fibre types are sourced from fishing nets and fishing rods [22].

Microplastics can also be harmful to human health. The presence of microplastics ingested by large numbers of fish can cause health impacts for humans who accidentally consume microplastics in the fish's body. The chemicals contained in microplastics can cause major damage to the human system [23]. Swallowed plastics can cause internal damage, disrupt the digestive enzyme system or hormonal balance, and have an impact on reproduction [24]. Therefore, the pathway of entry for microplastics in the human body is more dominant when humans consume seafood. The entry of microplastics in the human body can affect several organ functions such as eye irritation and respiratory organs, changes in cell structure, impair liver and brain function, insulin resistance, the onset of diseases such as chronic bronchitis and skin diseases, and are carcinogenic [25].

CONCLUSIONS

In this study it can be concluded that the feces of ten respondents were contaminated by microplastic types of fiber, fragments and filaments but mostly dominated by microplastic fragments. The indications of microplastic pollution in human stool mostly come from the consumption of bottled drinking water consumed by respondents. In general, this type of microplastic fragment can come from plastic bottles, plastic bags and pipe fragments. As a suggestion from the results of this study, respondents are advised not to use drinking water bottles that are used repeatedly or to buy bottled water products that are guaranteed to be packaged and distributed to consumers.

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Conflict of interests

The authors declare no conflict of interest.

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