Determination of Microplastics in Surface Water and Sediment of Kelantan Bay

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Determination of Microplastics in Surface Water and Sediment of Kelantan Bay

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Abstract. This study was conducted to determine the presence of microplastics in surface water and sediment ofKelantan Bay. The samples were collected between May and July 2019. Microplastics were isolated from the surface water and sediment samples by using wet peroxide oxidation (WPO) followed by density separation. Microplastics were sorted visually according to their shapes and colours after being examined under photographed microscope. The most abundant particle found in this study was threadlike and fragment shapes. Fourier transform infrared (FTIR) spectroscopy was used to identify functional groups in the composition of microplastics to determine the types of microplastic found in the samples. Polypropylene (PP) was the most abundance type of microplastic found in the surface water and sediments of Kelantan Bay. This study provides an insight of the types of microplastics found in Kelantan Bay and therefore, further actions need to be taken to curb the distribution of microplastics in marine ecosystem from threatening the marine food chain of Kelantan Bay.

1. Introduction

Plastics have become a valuable commodity and an important part of everyday life, more so that global plastic production has increased from 1.5 million tons in the 1950's to 322 million tons in 2015 [1]. Most plastics are materials that are persistent for many years possibly as much as hundreds when released to the marine environment. Plastics are polymers which are a chain of molecules that are derived from small molecules of monomers that are extracted from oil and gas [2]. With time plastics in the environment can fragment into smaller pieces of microscopic plastic particles that, when smaller than 5 mm in size, are called microplastics [3]. Other small man-made microplastic particles that can be found in the marine environment are categorised as primary microplastics due to the fact that they are produced and used in such as industrial abrasives, cosmetics or as pellets used for production of plastic materials [4,5].

Microplastics in surface water and sediments for amounts, distribution, trends and composition in marine environments have been proposed as one of ten emerging issues in Malaysia while in global context, Malaysia is among the top ten worst polluters [6]. Due to the diverse nature of microplastics, which comprise a wide variety of chemical compositions, densities, shapes and sizes, the particles can be expected to have different distributional patterns[7]. Through analysis of microplastic abundance in several environmental matrices such as sediment and surface water, the microplastics present in bodies were differed [8,9]. In fact, plastic has been shown to be ingested by a large variety of marine species which be taken up via other pathways such as the gills in crabs [10]. This can end up in human food

chain which be harmful towards human body too [11]. Some types of microplastics, with a higher density than seawater, may readily sink and accumulate in sediment. Lighter particles could also reach the sea floor as marine snow following degradation, aggregation and biofouling. Sediments provide a habitat for several key species in aquatic environments and microplastics have shown to affect benthic biota [12]. The overall aim of this project was to better understand what microplastics present in the marine environment which potential to accumulate in the food chain. Therefore, in this study, the microplastics present in surface water and sediment at Kelantan bay were determine and characterise.

2. Material and Method

2.1 Sampling site

The sampling was performed in between May and July 2019. The Sri Tujuh Beach, Tumpat, Kelantan was selected as a sampling site. Three sampling points at Sri Tujuh Beach, Tumpat were selected. Each of the sampling points was coordinated and illustrated as shown in Table 1, Table 2, and Figure 1, respectively. The samples were collected with three replicates at each point.

Table 1. Information of each sampling points of surface water

Points	Place	Latitude	Longitude
W1	Sri Tujuh Beach	6°13'05.4"	102°07'47.9"
W2	Sri Tujuh Beach	6°13'00.4"	102°08'02.4"
W3	Sri Tujuh Beach	6°12'58.5"	102°07'34.7"

Table 2. Information of each sampling points of sediments

Points	Place	Latitude	Longitude
S1	Sri Tujuh Beach	6°13'05.4"	102°07'47.9"
S2	Sri Tujuh Beach	6°13'00.4"	102°08'02.4"
S3	Sri Tujuh Beach	6°12'58.5"	102°07'34.7"

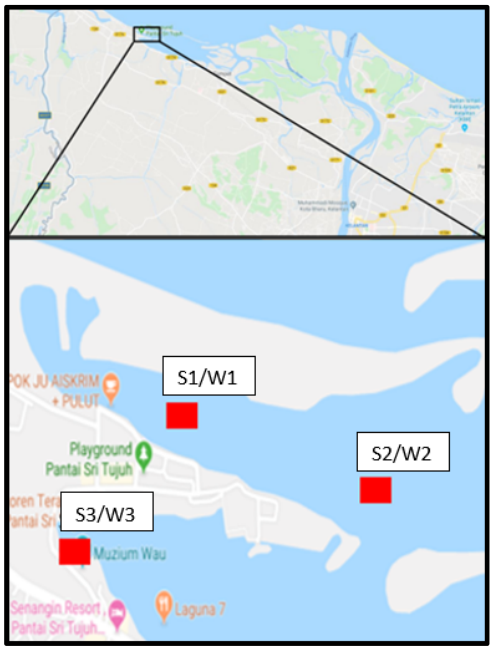


Figure 1. Sampling points of surface water and sediment at Sri Tujuh Beach, Tumpat

2.2 Sampling procedure

A Water Grab Sampler was used to collect surface water samples. About 250 mL of surface water (0 – 30 cm in depth) were collected and transferred into glass bottles. For sediment sampling, a grab sampler (Ekman) was used to collect the sediment (0 – 45 cm in depth). The samples was transferred and stored in killing jar. At each sampling interval, the Water Grab Sampler and Ekman grab sampler were cleaned carefully with deionized water to reduce cross-contamination. In order to avoid airborne of microplastics contamination, the jar were sealed with an aluminium foil before closing with their lids. The surface water and sediment samples were kept in an ice box and transferred to the laboratory. The water samples were then kept in 4°C chiller and the sediment samples were kept in -2 °C freezer before further analysis.

2.2.1 Isolation of Microplastics

Surface water samples were pre-treated using wet peroxide oxidation (WPO) method in order to eliminate the interference of organisms in the samples. About 20 mL of surface water samples were poured into a beaker. Then, about 40 mL of aqueous 0.05 M Fe (II) solution was added and followed by 40 mL of 30% hydrogen peroxide and mixed it for 5 minutes at room temperature. A stir bar was added to the beaker and heated on a hotplate at 75°C with watch glass covered on it. The beaker was removed from the hotplate as soon as gas bubbles were observed and placed it in the fume hood until the boiling subsides. About 20 mL of 30% hydrogen peroxide wase added whenever the natural organic materials was in visibility.

For sediment samples, the samples were first treated by drying method for one night or until completely dried at temperature of 60°C. Then, about 20 g of dried sediment was weighed by using analytical balance and transferred into a beaker. After the pre-treatment process, both samples (surface water and sediment)underwent density separation process.

Density separation was carried out by increasing the density of the aqueous solution using sodium chloride (1.5 gcm^{-3}) in order to determine the abundance of microplastics in the surface water and sediment samples. An amount of 6 g of sodium chloride was added into the samples and the mixture was stirred for 15 minutes on a hotplate. Then the mixture were removed from the hotplate and kept cover loosely with an aluminium foil for three days. After three days, the mixture was filtered by using Whatman no. 4 filter paper with the vacuum pump. The filter paper was dried for further analysis.

2.2.2 Sorting and identification of microplastics

All of the filter papers were inspected and photographed under microscope (DS-Fi2) with 4x – 10x magnification. The measurement was conducted by using a resolution of 1280 x 960 pixels. Particles that possess organic structure were carefully identified and discarded from the analysis. Inspected microplastic particles were assessed based on shape, colour and size. Category of shape of particles (fiber/line, fragment, film, foam, bead/pellet) were evaluated in accordance to the definition described in previous study [13].

The sample was gently transferred to a sample carrier for FTIR analysis. Fourier transform infrared (FTIR) spectroscopy (Nicolet iS10 FTIR spectrometer) was used to identify the functional groups associated with polymer chemical properties. The samples were analysed using attenuated total reflection (ATR) in the mid-IR range of 4000-650 cm^{-1} and 18 scans per analysis.

3. Result and Discussion

In this research, microplastics were found in the surface water and sediment samples at the three sampling points from Sri Tujuh Beach, Tumpat. The abundance of microplastics was high in point W3 and point S3 than when compared to W1, S1, W2 and S2 sampling points. This is understandable that point W3 and point S3 were located in downstream, which water flow to the sea from river. Compared with other sampling point, the amount of microplastics presents in the surface water and sediment is lower.

The presence of microplastics in each sampling point might be due to the location of the sampling points in Sri Tujuh Beach, Tumpat is located at beach that has been developed with resorts, restaurant,

jetty and tourism attraction place. These studies areas generally do not have the serious level of microplastics contamination compare to the previous case study in Skudai River that reported as among of polluted river in Peninsular Malaysia [14]. Based on the previous study, 11 tons of rubbish was collected from Skudai River for every month [15]. However, the abundance of microplastics in this studies areas was quite high than pristine areas. This shows that microplastic contamination in this studies area still needs to be concern.

Classification of the microplastics found in the surface water and sediment samples are shown in Table 3 and Table 4. The microplastics that have been collected were classified according to their shapes and colours. In this research, three types of microplastics were identified namely fiber, fragment and film. Fragment was the most common type of microplastics that found within the vicinity compared to the other type of microplastics. Highest number of microplastic fragments in the studied areas was probably due to the existing tourism activities. Some of the plastics also were degraded from plastics used by fishermen to capturefish or selling things.

Table 3. Types of microplastics found in surface water of Kelantan Bay

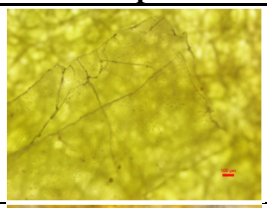
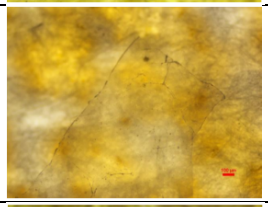
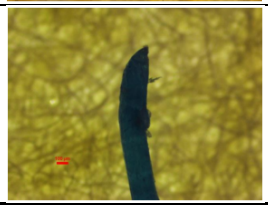
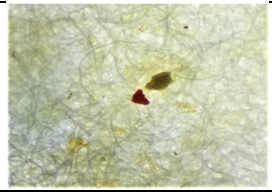
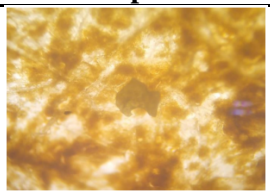
Sampling Point	Microscope Result	Physical Characteristics
W1		Shape: Fragment Colour: Transparent
W2		Shape: Fragment Colour: Transparent
W3		Shape: Fiber/ Threadlike Colour: Blue

Table 4. Types of microplastics found in Sediment at Kelantan Bay

Sampling Point	Microscope Results	Physical Characteristics
S1		Shape: Fiber/ Threadlike Colour: Blue
S2		Shape: Fragment Colour: Red

Sampling Point	Microscope Results	Physical Characteristics
S3		Shape: Fragment Colour: Blue

Fiber also has high abundancy in the vicinity. Blue color of microplastics was the most common colour that found in the samples, then followed by transparent. The red colour of microplastics also been detected in the collected samples. The results showed that, most of the microplastics present in the samples were between 100 – 5000 μm of sizes. Microplastics size ranging from 500 to 5000 µm may lead to high chances of ingestion incidence by aquatic animals [16]. All microplastics obtained were derived from the fragmented and weathered of larger plastic items where this type of plastic particles is usually categorised as secondary sources of microplastics. According to Eerkes-Medrano et al. [17], secondary sources of microplastics are typically associated with high population density areas, of which based on the level of local human activities [11].

There were 45 totals of microplastics that have been found using Fourier transform infrared spectroscopy (FTIR) analysis. There identified polymers were Polyethylene (PE), Polyethylene Terephthalate (PETE or PET), High-Density Polyethylene (HDPE), Low-Density Polyethylene (LDPE), and Polyamide (PA).

Based on the Figure 2, the FTIR spectra shows 96.42%, matched with polypropylene wave numbers according to library setup in the Thermo-scientific FTIR. Polypropylene (PP) is a tough, rigid and crystalline thermoplastic produced from propene (or propylene) monomer. It is a linear hydrocarbon resin. From the analysis conducted, most of the samples collected in Kelantan bay contained PP microplastics which became the most abundance pollutant in the marine environment and brings harmful effect towards aquatic organisms [18, 19].

The present of PP microplastics may be originated from the activities from a nearby fishing port in the proximity. The sources of PP could be from residue of rope production and utilisation of fishing gears and strapping that acquiescent to a postulation by Dowarah and Devipriya, 2019 [20].

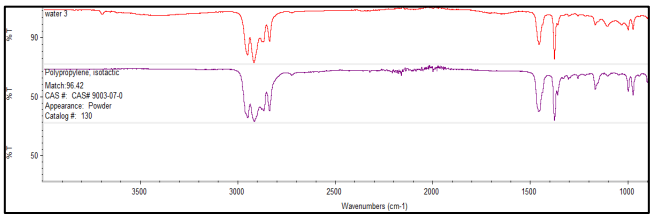


Figure 2. FTIR spectra of sample (red line-upper) and reference polypropylene (purple line-lower)

4. Conclusion

Result of this study shows the presence of microplastics in variety of shape and colour from both surface water and sediment of Kelantan bay. The content of microplastics particles mostly in ranged size of 500 μm due to the depth of sampling by using the Water and Ekman Grab Sampler. The deeper the sampling it was, the smaller the microplastics can be collected. Fragments or plastic films were dominating type of identified microplastics in in the sampling site. The characteristics of microplastics showed that different types of plastics found were very harmful to the living organism especially aquatic life as they can eat the plastics which they might think food, and eventually die. Hence, this study will give the knowledge about the microplastics which need to be focused and prevent it before posing a severe threatt to the extinction of marine entity and disrupt the food chain that may lead to hazardous bioaccumulation.

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References

[1] PlasticsEurope 2015 *Plastics - the facts **2015*** 1
[2] Shah A, Hasan F, Hameed A, and Ahmed S 2008 *Biotechnol. Adv.* **26(3)** 246
[3] Jambeck J, Geyer R, Wilcox C, Siegler T, Perryman M, and Andrary A 2015 *Sci. of Marine Life* **347(6223)** 768
[4] Auta H, Emenike C, and Fauziah S 2017 *Environ. Int.* **102** 165
[5] Sharma S and Chatterjee S 2017 *Environ. Sci. Pollut. Res.* **24(27)** 21530
[6] Kaur, C.R and Jaabi A 2017 *Sea Views* **2017(5)**
[7] Vianello A, Boldrin A, Guerriero P, Moschino V, Rella R, Sturaro A, and Da Ros L 2013 *Estuar. Coast. Shelf Sci.* **130** 54
[8] Luo W, Su L, Craig N J, Du F, Wu C, and Shi H 2019 *Environ. Pollut.* **246** 174
[9] Cho Y, Shim W J, Jang M, Han G M, and Hong S H 2019 *Environ. Pollut* **245** 1107
[10] Zhang W, Zhang S, Wang J, Wang Y, Mu J, Wang P, Lin X, and Ma D 2017 *Environ. Pollut.* **231** 541
[11] Rezania S, Park J, Md Din M. F, Mat Taib S, Talaiekhozani A, Kumar Yadav K, and Kamyab H 2018 *Marine Pollut. Bulletin* **133** 191
[12] de Sá L C, Oliveira M, Ribeiro F, Rocha T L, and Futter M N 2018 *Sci. of The Total Environ.* **645** 1029
[13] Peng G, Zhu B, Yang D, Su L, Shi H, and Li D 2017 *Environ. Pollut.* **225** 283
[14] Sarijan S, Azman S, Said M, Ismid M, and Lee M H 2019 *Environ. Asia* **12(3)** 75
[15] Hangzo P and Cook A D 2014 *NTS Insight, no. IN1401*
[16] Yang D, Shi H, Li L, Li J, Jabeen K, and Kolandhasamy P 2015 *Environ. Sci. & Tech.* **49(22)** 13622
[17] Eerkes-Medrano D, Thompson, R C, and Aldridge D C 2015 *Water. Res.* **75** 63
[18] Franzellitti S L, Canesi M, Auguste R, Wathsala H and Fabbri E 2019 *Environ. Toxicol. and Pharma.***68** 37
[19] Thompson R C, Moore C J, vom Saal F S, and Swan S H 2009 *Philosophical transactions of the Royal Society of London. Series B, Biological sciences* **364(1526)** 2153
[20] Dowarah K and Devipriya S P 2019 *Marine Pollut. Bulletin* **148** 123