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Determination of Microplastics in Sediment of Kelantan and Pattani Bay

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Abstract. This study was conducted to determine the presence of microplastics in sediment of Kelantan and Pattani Bay. Sediment samples were collected from Sri Tujuh Beach, Tumpat and Talo Kapo Beach, Pattani Bay in between May and July 2019. Microplastics were isolated from sediment samples using wet peroxide oxidation (WPO) followed by density separation. Microplastics were sorted visually according to their shapes and colors after being examined under photographed microscope. A total of 52 pieces of microplastics were identified and the most abundant particle found in this study was threadlike shape. Fourier Transform Infrared (FTIR) spectroscopy has been used to identify functional groups in the composition of microplastics. This study shows that degraded of large plastic materials to microplastics due to some factors such as weathering can impact abundance of microplastics in both places, as these locations are well known for fishing activities, industrial areas and also as tourism area.

1. Introduction

Marine debris is a globally recognized environmental issue of increasing concern. Marine ecosystems worldwide are affected by human-made waste, most of which is plastic [1, 2]. Plastic is a major contributor to ocean pollution where a previous study estimated between 1.15 to 2.41 million tonnes of plastic enters the oceans via rivers annually, with peak months being between May and October [3]. The top 20 contributing rivers, which according to the report are mostly found in Asia, contribute around 67% of all plastics flowing into the ocean from rivers around the world [3]. The demand for plastic has increased dramatically over the last 70 years. According to Plastic Ocean, 300 million tons of plastic is produced globally every year.

The increase production of plastic from different sources could lead into increasing of plastic debris that abundance in waters and lead into continual transformation of secondary microplastics [4]. There will be high possibility where the microplastics will break-down into nanoplastics and it may cause high risks into environment. Due to the wide variety of sources and routes, it causes the secondary microplastics difficult to identify [5].

The distributions of microplastics in marine environment such as sediments, open waters and organisms is become widely concerns [6]. The occurrence of microplastics in sediments was mainly



associated to density of the microplastics. The approximate of plastic particles density was determined by the type of polymer used and the process of manufacturing that involved.

There are many studies have been reported in the occurrence and impacts of the microplastics in marine environments in other country [7-12] but less investigation has been carried out in Malaysia and Thailand. Therefore, the purpose of this study is to determine the microplastics presents in sediment in Kelantan and Pattani Bay.

2. Material and Method

2.1. Sampling site

The sampling was performed in May and July 2019. Sri Tujuh Beach, Tumpat, Kelantan and Talo Kapo Beach, Pattani Bay, Thailand were selected to collect the sediment samples. By using the Global Positioning System (GPS), the location of the sampling points was determined. Four sampling points at Talo Kapo Beach, Pattani Bay and three sampling points at Sri Tujuh Beach, Tumpat were selected as sampling sites. Each of the sampling points was coordinated and illustrated as shown in Table 1, Figure 1 and Figure 2.

Table 1. Information of each sampling points of sediments

Points	Place	Latitude	Longitude	Depth (cm)
S1	Sri Tujuh Beach, Tumpat	6°13'05.4"	102°07'47.9"	45
S2	Sri Tujuh Beach, Tumpat	6°13'00.4"	102°08'02.4"	40
S3	Sri Tujuh Beach, Tumpat	6°12'58.5"	102°07'34.7"	30
S4	Talo Kapo Beach, Pattani Bay	6°53'14.5"	101°17'52.5"	60
S5	Talo Kapo Beach, Pattani Bay	6°53'01.6"	101°17'23.0"	55
S6	Talo Kapo Beach, Pattani Bay	6°52'55.6"	101°17'08.3"	45
S7	Talo Kapo Beach, Pattani Bay	6°54'15.3"	101°14'45.9"	65



Figure 1. Three sampling points at Sri Tujuh Beach, Tumpat

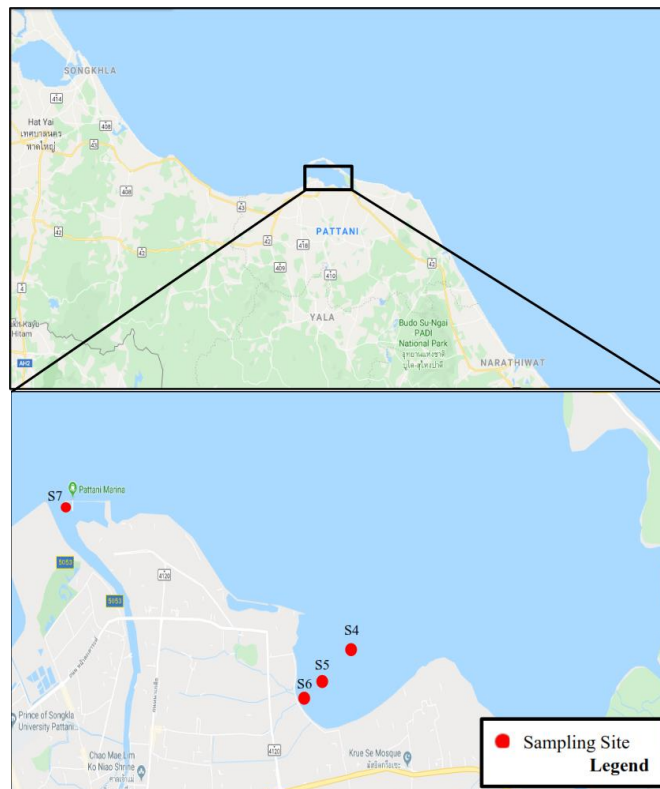


Figure 2. Four sampling points at Talo Kapo Beach, Pattani Bay

2.2. Sampling procedure

A grab sampler (Ekman) was used to collect the sediment. The samples were transferred and stored in killing jar. At each sampling interval, the Ekman grab sampler was cleaned carefully with deionized water to reduce cross-contamination. In order to avoid airborne of microplastics contamination, the jar was sealed with an aluminium foil before closing with their lids. The sediment samples were kept in an ice box and transferred to the laboratory. The sediment samples were kept in -2°C freezer before further analysis.

2.2.1. Isolation of Microplastics.

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, the samples underwent density separation process.

Density separation was carried out by increasing the density of the aqueous solution using sodium chloride (1.5 g cm^{-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 [13]. Then the mixture was 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.

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, all the sediment samples from four sampling points at Talo Kapo Beach, Pattani Bay and three sampling points from Sri Tujuh Beach, Tumpat contains microplastics. There are 52 totals of microplastic particles that have been found in both studied areas (7 sampling point). In Sri Tujuh Beach, Tumpat, the abundance of microplastics was high in sampling point S1 and S3. This result is understandable given that sampling point S3 is located downstream, which water flow to the sea from river. Compared with other sampling point, the amount of microplastics presents in the sediment of sampling point S2 is lower.

In Talo Kapo Beach, Pattani Bay, most of microplastics have been found in sampling point S7. Sampling point S7 is located at park and there is fishing activities among the local people. Compared to other three sampling points, these microplastics was common in the sampling point S7 due to high population and more visitors. The level of microplastics pollution is higher in some of the studies areas due to actively of human activity [14, 15].

The abundance of microplastics in Sri Tujuh Beach, Tumpat is higher than Talo Kapo Beach, Pattani Bay which is 34 pieces particles of microplastics particles were identified in Sri Tujuh Beach, Tumpat while in Talo Kapo Beach, Pattani Bay, 18 pieces particles of microplastics were detected. The difference between ranges of abundance is 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 compared to the sampling point at Talo Kapo Beach, Pattani Bay.

The microplastics that have been collected are classified based on shape and colour and tabulated in Table 2 and Table 3. In this research, three types of microplastics were identified which are fiber, fragment, and film by using photographed microscopy.

Table 2. Types of microplastics found in Sediment of Sri Tujuh Beach, Tumpat, Kelantan and Talo Kapo Beach, Pattani Bay, Thailand

Physical Characteristics (Shape)	Points							Total of Microplastics	
	S1	S2	S3	S4	S5	S6	S7	Sri Tujuh Beach	Talo Kapo Beach
Fragment	4	1	7	0	0	0	2	12	2
Film	0	0	0	1	3	2	6	0	12
Fiber	6	3	13	0	1	1	1	22	4
TOTAL	10	4	20	1	4	3	10	34	18

Table 2 showed that fiber and fragment types of microplastics were found in the sediment samples of Sri Tujuh Beach, Tumpat. The abundance of the microplastics fiber and fragment are high in S3 compare to S1 and S2. Film was not detected in the sediment samples of Sri Tujuh Beach, Tumpat. While at Talo Kapo Beach, Pattani Bay, fragment, film and fiber were detected in the sediment samples. Film is the predominant types of microplastics in the sediment sample of Talo Kapo Beach followed by fiber and fragment. From the Table 2, S7 has the most polluted by microplastics compare to S4, S5, and S6. Fibers are the most abundance microplastics found in both study area. According to previous study, fiber is originated from ropes, lines of protection, personal care products and fishing materials [16, 17].

Table 3. Color of microplastics found in Sediment of Sri Tujuh Beach, Tumpat, Kelantan and Talo Kapo Beach, Pattani Bay, Thailand

Physical Characteristics (Color)	Points							Total of Microplastics	
	S1	S2	S3	S4	S5	S6	S7	Sri Tujuh Beach	Talo Kapo Beach
Black	1	0	1	0	0	0	1	2	1
Blue	8	3	12	1	2	1	1	23	5
Red	1	0	4	0	0	0	0	5	0
Transparent	0	1	3	0	2	2	8	4	12
TOTAL	10	4	20	1	4	3	10	34	18

There are four colours of microplastics that have been identified in the sediment samples as shown in Table 3. Blue is the dominant colour that has been detected in the sediment samples of Sri Tujuh Beach, Tumpat followed by red, transparent and black. While transparent colour of microplastics is the most common found in the sediment samples of Talo Kapo Beach, Pattani Bay. Red colour was not detected in the samples of Talo Kapo Beach.

The dominant size detected in both studied areas was 1000 to 5000 μm . Refer to case study in the literature review, microplastics size ranging from 100 to 5000 μm may lead to high chances of ingestion incidence by aquatic animals. All microplastics obtained are derived from the fragmented and weathered of larger plastic items where this type of plastic particles is usually categorised as secondary sources of microplastics which are typically associated with high population density areas, of which based on the level of local human activities [18].

There are diverse types of microplastics polymers that have been identified by Fourier transform infrared spectroscopy (FTIR) including Polyethylene (PE), Polyethylene Terephthalate (PETE or PET), High-Density Polyethylene (HDPE), Low-Density Polyethylene (LDPE), and Polyamide (PA). The results from both sites are shown in Table 4.

Table 4. Polymer types of microplastics found in Sediment of Sri Tujuh Beach, Tumpat, Kelantan and Talo Kapo Beach, Pattani Bay, Thailand

Types of Microplastic	Total of Microplastics	
	Sri Tujuh Beach	Talo Kapo Beach
Polyethylene Terephthalate (PETE or PET)	0	5
High-Density Polyethylene (HDPE)	0	3
Low-Density Polyethylene (LDPE)	4	2
Polyethylene	6	1
Polyamide	2	4

PE is the largest number of microplastic type found of Sri Tujuh Beach. PE is the thermoplastic materials and an extremely large range of applications. PE is used in applications ranging for films, tubes, plastic parts, laminates, packaging and many more. PE is also one of the important raw material for fishing nets and sources of fiber. While PETE or PET largest number of microplastic type found of Talo Kapo Beach. The sources of this PETE can be from the rubbish that has been discarded by the

tourist who visited the Pattani Marina Park. The main activity in this area is fishing, and they are also one of the sources of PETE.

4. Conclusion

The abundance of microplastics in sediment is higher which is linked with the sources and distribution of the microplastics from both of the places. Fiber and film are the dominant types of microplastics that have been found of Sri Tujuh Beach, Tumpat and Talo Kapo Beach, Pattani Bay, respectively. Blue and transparent is the most common colour of microplastics that were detected in the sediment samples for the research areas. PE and PETE or PET is the main polymers compositions found in the sediment that have been observed. This polymer forms shows different environmental behaviours based on their distinct physicochemical characteristics and on the rate of weathering, additive chemicals and interactions in between chemicals and biota.

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