Analysis of suspended atmospheric microplastics size at different elevation in Universiti Teknologi Malaysia, Kuala Lumpur

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Analysis of suspended atmospheric microplastics size at different elevation in Universiti Teknologi Malaysia, Kuala Lumpur

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Abstract. Atmospheric microplastics can be found in the atmospheres of urban, suburban, and even remote locations. To date, limited studies have been done in investigating the microplastics contamination at different elevation. In this regard, suspended atmospheric microplastics were sampled at two different elevations in Universiti Teknologi Malaysia, Kuala Lumpur. The sampling was done using SIBATA High-Volume Sampler HV-1000R pump for 24 hours sampling, twice a week for 10 weeks. The primary objective of this research is to analyze the size of the suspended atmospheric microplastics at different elevation which is ground level (H1) at1.5m and upper level (H2) at 10m. The finding shows that the range size of the microplastics at H1 is between 70 to 1855 μm and H2 is 102 to 5429 μm indicate that the microplastics size at higher elevation is larger compared to the lower ground. The range abundance of microplastic is also discussed where it is between 97 to 775 particle/m^2/day, with the particulate concentration ranging from 16.39 to 96.81 µg/m^3/day for both locations. The EDI indicate that children are much more exposed to polymer-based MPs by dust consumption than teenagers and adults, with 4.6 particle/kg.day at H1 and 3.4 particle/kg.day at H2.

Keyword: Suspended atmospheric microplastics, size, elevation, abundances

1. Introduction

Microplastics are being defined as plastic particles which ranging between 1 μm to 5 mm [1]–[3]. Primary and secondary plastics are both types of microplastics. Primary microplastics are purpose-made microplastic particles for example, microbeads while secondary microplastics are formed by the fragmentation and degradation of microplastics, such as fibres from synthetic fabrics [4], [5]. This differentiation may be significant for the study of atmospheric transport since its form may alter its aerodynamics and hence atmospheric transport [6]. There is compelling evidence that microplastics

infiltrate the environment at every stage of a plastic product's life cycle - from manufacturers through trash disposal - posing the risk of trophic transfer and human health exposure [7]–[9].

Many studies on microplastic contamination in the aquatic environment have been done in recent years [10]. However, limited studies have been done on the suspended of atmospheric microplastics (SAMPs) at different elevation [11]. To date, the atmospheric microplastic suspended contamination in Malaysia is still unknown. In this regard, the goal of this study is to investigate the size of suspended atmospheric microplastics in Universiti Teknologi Malaysia, Kuala Lumpur Campus. In addition, the study also investigates the correlation of particulate concentration with microplastics abundance. This research is also to analyze the estimate of daily abundance of microplastic intake (EDI) of the SAMPs. The atmospheric microplastic sample were collected in Universiti Teknologi Malysia, Kuala Lumpur at a different elevation. The sampling location were selected due to the high traffic activities and high number of populations in the area.

This paper presents the current level of knowledge on atmospheric microplastics as well as sample collection, analysis, and detection techniques. As the research on atmospheric microplastics is still green globally, result from this study can fill the knowledge gap on understanding the level of emission of the atmospheric microplastics. Moreover, this study is a stepping stone for future development of atmospheric microplastics detection, monitoring and prevention in Malaysia. In supporting the SDG 11 indicator, this study facilitates a better environment for humankind as it will helps to detect the risk exposure from the atmospheric microplastics pollution.

2. Methodology

The overall framework of the study is illustrated in Figure 1, which showed that there are three main objectives of the study.

2.1. Sampling Location

Figure 2 shows the location of sampling site for H1 and H2. The height for H1 was done at 1.5 meter from the ground, which is the typical height at which humans are exposed to inhale contaminants [12]. The height for H2 was done at 10 meters from the ground.

2.2. SAMPs Sampling

A high-volume sampler (SIBATA High-Volume Sampler HV-1000R) were used for all 16 samples (n=16) for 10 weeks sampling time in between December 2021 until March 2022. Each of the samples requires a total of 24 hours of sampling time with flowrate of 1000L/min. Glass-fibre filters (ADVANTEC GB-100R) were used for all the samples and one (1) filter is being used for the blank filter. The meteorological data were also collected in order to conduct a future correlation study between weather and the suspension rate. Following each collection, the samples are carefully transferred and preserved in their respective beakers. The funnel and beaker are thoroughly cleaned with ethanol and ultra-pure water to ensure that all particles are recovered. All samples were wrapped in aluminium foil to prevent contamination and are kept safe until the next processing step is performed on them. In order to prevent contamination of the sample, preventive measures were done throughout the experiment, which include wearing cotton lab coat, using nitrile gloves and using cleaning of the workbench using cotton rug.

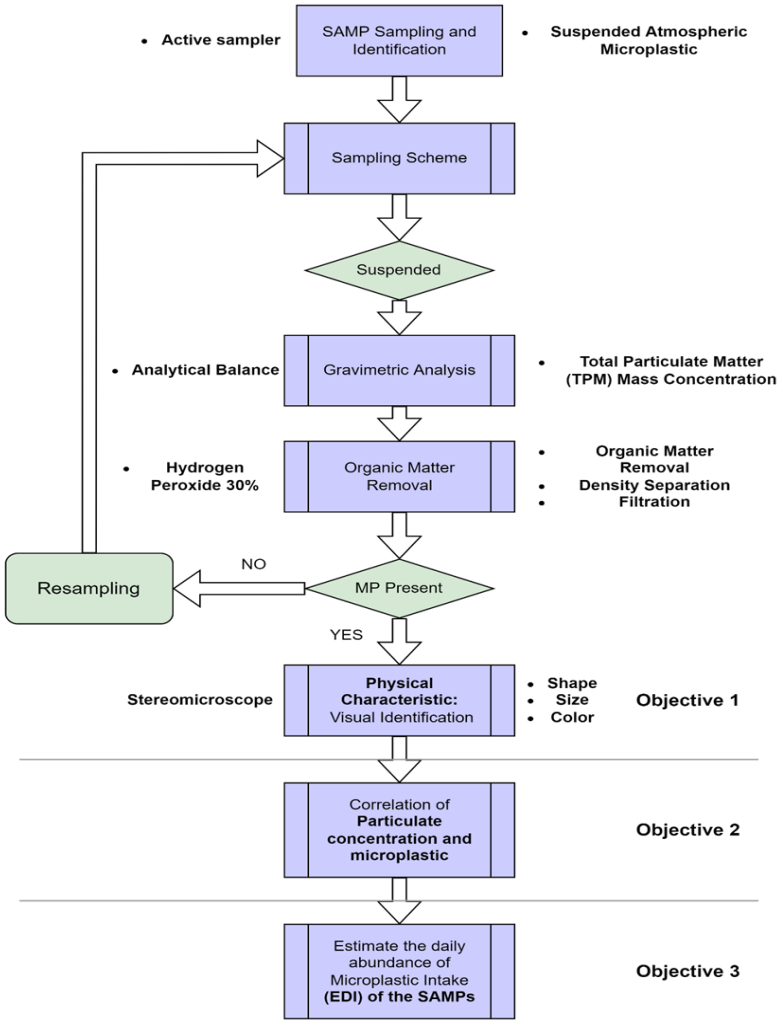

Figure 1. Study framework for the investigation of microplastics at different elevation

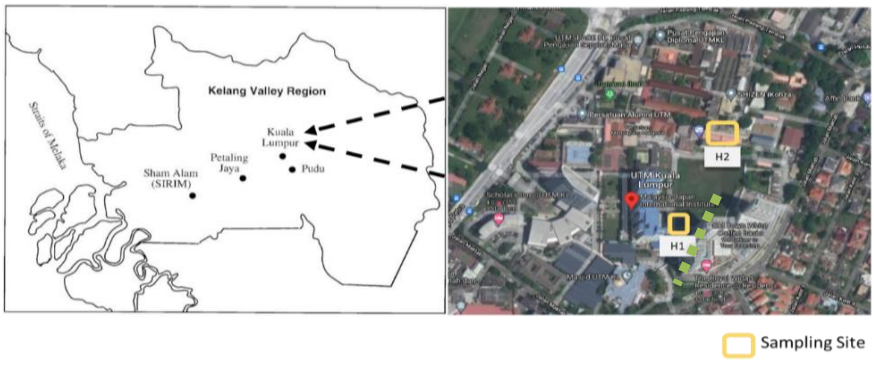

Figure 2. Sampling location in Universiti Teknologi Malaysia, Kuala Lumpur

2.3. Organic Matter Removal

Organic materials were removed with each sample were treated with 150 ml 30% hydrogen peroxide, H_2O_2 solution (R&M Brand, 1477-80) and allowed to stand for 8 days in a fume hood until there is no foamy reaction occurred [13], [14]. Next, the sample were vacuum filtered onto 47mm diameter microfiber glass filters and placed in a petri dish before dried for roughly 24 hours which equals to 1440 minutes in an oven at 60 °C.

2.4. SAMPs Detection and Identification

Visual detection and identification of the suspended microplastics that has settled on the filter, were done using a digital stereomicroscope (Olympus Zeiss SZ51, Japan). The physical characteristics of the microplastics were determine based on the count, colours and physical shape of microplastic in the collected sample.

2.5. Estimation of the Daily Abundance of Microplastic Intake (EDI)

The health risk associated with exposure to microplastics were evaluated by utilising the Eq. 1. The anticipated of daily abundance of microplastic intake (EDI) for different age groups of people in both normal and acute exposure circumstances has been determined accordingly. The average body weight was based on previous studies [15], [16].

$$EDI\ (particles/kg.\ day) = c.m/BW \quad \text{(Eq 1)}$$

Where:

c = concentration of target microplastic (particles/g)
m = ingestion rate (g/day)
BW = average body weight of various age group (kg)

3. Result & Discussion

3.1 SAMPS sizes at different elevation height

In this study, stereomicroscopy was used to quantify and analyze the physical characteristics of microplastic particles. Figure 3 shows the SAMPs sizes at H1 and H2 sampling area, which depict that the size of the microplastics range is from 70 to 5000 μm. In average, the size of the microplastics range between 70 to 1855 µm for H1 and between 102 to 5429 µm for H2. This indicate that the microplastics size are larger at higher elevation. As there is no study have been made on investigating the microplastics size at different elevation, this result can be used as a baseline data. The different size range between the two locations probably due to meteorological effect such as wind speed, wind direction, precipitation and others.

In prior investigations done in Shanghai, the typical length of plastic granules was less than 23 μm (3%) and there was a bigger number of fibres (fibres sizes 5000 μm, 67% of microplastic particles) among the samples [17]. The microplastics in the study were sampled using the majority of microplastic size in Surabaya, Indonesia, is between 1000-1500 μm (30%), followed by 500 μm (5%), and fibres were largely between 300 and 5000 μm in length [18]. Studies done in Iran discovered that the size range of microplastics is between 100 and 1000 μm [19].

It can be concluded that, the atmospheric microplastics samples from this study is within the same range with the previous study done in Shanghai, China, Iran and Surabaya, Indonesia [17]–[19]. However, the size of microplastics detected at H1 is slightly fine compared to the others. Present research on air microplastics is in its infancy and consequently suffers from a lack of comparable abundance and characterisation data. The relation between atmospheric microplastics as well as other substances, ecosystems, and human exposure must also be investigated.

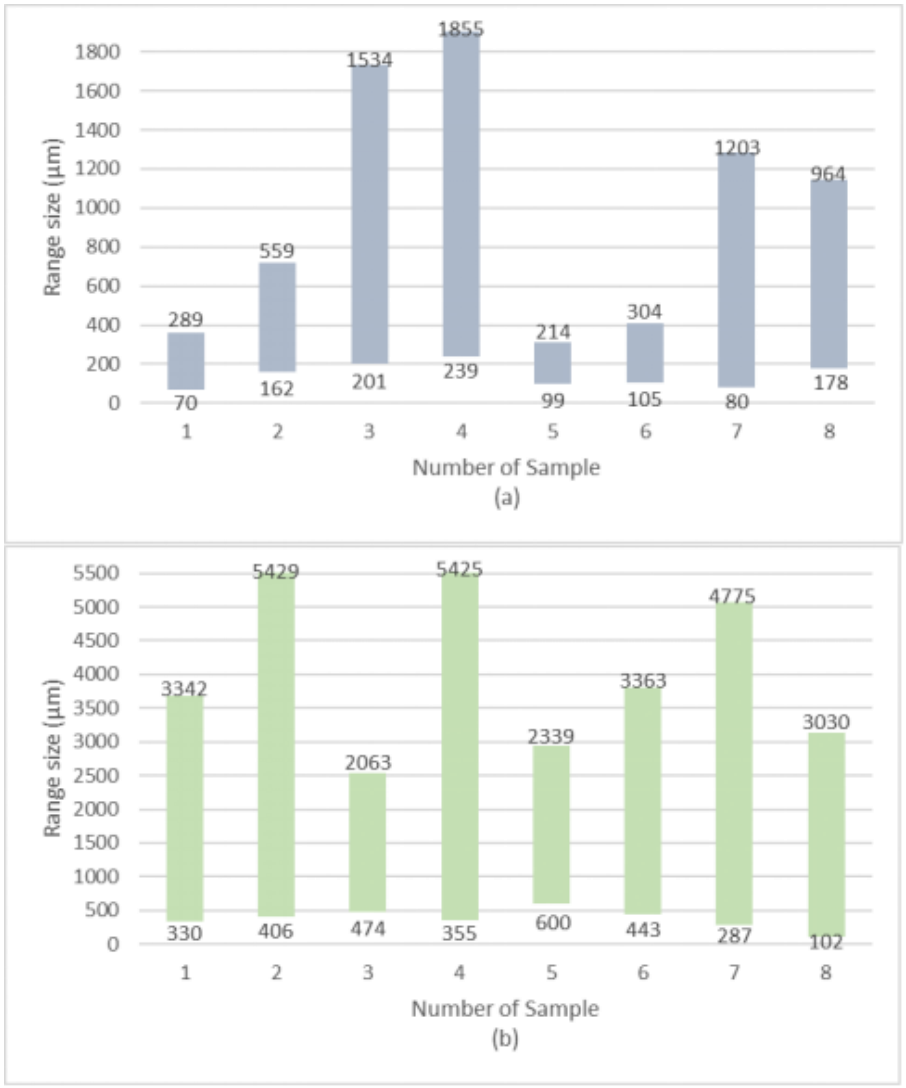

Figure 3. Range Size of Microplastics at different elevation with (a) at H1 (b) at H2

3.2. Particulate concentration and SAMPs abundance correlation

The range abundance of microplastic particle in this study are shown in Figure 4, which indicate that the range is between 97 to 775 particle/m^2/day, with the particulate concentration ranging from 16.39 to 96.81 µg/m^3/day. Overall, there is no clear correlation that can be seen in Figure 4. Sample number 4 and 8 shows that the microplastics abundances are higher compared to the particulate concentration. This is probably due to the lower number of samplings made in this study. Previously, a study done in Iran proves that there is a significant relationship between particulate matter with diameter less than 2.5µm and atmospheric microplastics [20].

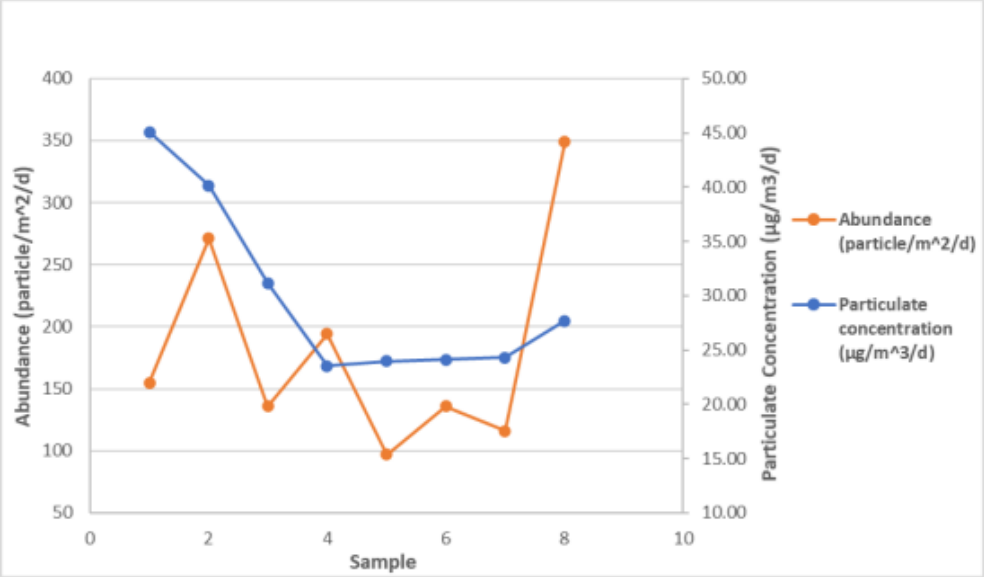

Figure 4. Correlation of the microplastics abundance with particulate concentration

3.3. Daily Abundance of Microplastic Intake (EDI)

Table 1. EDI comparison for different stage of age for two different sampling location

Height	Estimated daily intake of SAMPs (particle/kg.day)		
	Children	Teenager	Adult
H1	4.6	1.8	1.05
H2	3.4	2.4	2.3

Ingestion of dust is a significant route of exposure for MPs in humans. Table 1 shows the EDI between the two-elevation level which indicate that children are much more exposed to polymer-based MPs by dust consumption than teenagers and adults, with 4.6 particle/kg.day at H1 and 3.4 particle/kg.day at H2. The toxicological significance of MPs has been reported in recent years. In this study, it can be concluded that both location H1 and H2 shown the similar distribution, adults are significantly lowest for EDI average at 1.05 and 2.3 particle/kg.day. The result found in this study is similar to previous investigation in China and Nigeria which concluded that the microplastics intake among children were estimated higher than adult [21], [22]. This study provides information on the mass concentrations of common MPs and analyses their intake through ingestion rate, which forms the basis for estimating the hazards of MPs to human health.

4. Conclusions

Overall, the analysis on the suspended atmospheric microplastics at different elevation at Universiti Teknologi Malaysia, Kuala Lumpur has successfully been done. The size of the microplastics range from 70 to 1855 µm was at H1 and 102 to 5429 µm was at H2. The atmospheric microplastics samples from this study is within the same range with the previous study done in Shanghai, China, Iraq and Surabaya, Indonesia. However, the size of microplastics detected at H1 is slightly fine compared to the others. The is probably due to the different time of the sampling and different meteorological parameters. In addition, there is no correlation that can be found between the microplastics abundances and particulate matter concentration. The estimation of daily ingestion rate of the microplastics suggested that children have higher ingestion rate compared to the other age group.

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