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Original Research Article

Microplastic Abundance and Characteristics in The Soil Around the Jambi Talang Gulo Landfill

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ABSTRACT

Microplastics are micro-sized plastic particles formed when plastic debris degrades due to direct sunlight, weather, and environmental factors. Talang Gulo Landfill is a trash disposal facility in Jambi. The Talang Gulo landfill's high trash volume raises the danger of pollution in the surrounding area. The goal of this study is to determine the number of microplastics, the types of microplastic polymers, and the distribution of microplastics in the Talang Gulo Jambi dump. The sampling approach was utilized in the study, with three random sample locations chosen to reflect locations surrounding the landfill. The study's findings revealed that the third sample included the greatest microplastics in soil samples near the Talang Gulo Jambi dump, at 1.52 grams, followed by the first sample at 0.6 grams and the second sample at 0.13 grams. FT-IR can detect microplastics such as polystyrene (PS) and polyvinyl chloride (PVC).

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1. INTRODUCTION

Plastic is a synthetic substance that has been used in society as packaging for food and beverages. Plastic packaging material was chosen because it is lighter, cheaper, more versatile, and easily accessible, therefore plastic production grows year after year. Increased global production has a negative influence on the environment (Fallahian, 2022). Plastic garbage pollutes the environment when it is used excessively and not properly managed. Single-use plastic garbage poses major environmental risks. Plastic materials created from synthetic polymers are difficult to disintegrate, and plastic trash takes hundreds of years to degrade. According to reports, Indonesia's plastic trash generation ranks fifth behind Brazil and India (Rahmadhani, 2019). Because of the high volume of plastic waste produced, plastic waste disposal facilities are overburdened, causing many people to throw trash out.

Plastic trash contamination in rivers, seas, and fields is also caused by a lack of public understanding about waste sorting and disposal in landfills. A lot of plastic waste is found along highways or in fields, and it eventually builds into minute plastic debris, known as microplastics. Microplastics are created when plastic is exposed to sunshine, weather, rainwater, environmental activities, and human activities, causing it to become brittle and eventually produce microplastic particles (Valasia, 2021). Contaminated microplastics in the surrounding soil are very dangerous for the environment, contaminated microplastics can disrupt soil functions and cause organisms in the soil to be disturbed. Soil contaminated with microplastics is usually difficult to use as agricultural land because microplastics can absorb dangerous pollutants such as PBTs (persistent, bioaccumulative, and toxic substances) and POPs (persistent organic pollutants) and spread them to the ground (Ra(Rahmayani & Aminah, 2021).

The Talang Gulo ultimate waste disposal station in Jambi City accepts plastic garbage from Jambi City and the surrounding area. The city of Jambi produces a huge amount of plastic garbage, and the back and forth of cars delivering rubbish to the dump has resulted in signs of microplastic pollution in the area surrounding the landfill. As a result, the purpose of this study is to assess the number, distribution, and polymers of microplastics in the soil near the Talang Gulo dump in Jambi city.

2. METHODS

This study was conducted from February to May, with three samples taken closest, middle, and farthest from the waste gate, as shown in Figure 1. Each of the three samples was clearly marked to avoid confusion. In this study, the samples were placed in an oven for two days at 100°C until they were fully dry. After drying, the samples were filtered through a <5 mm mesh barrier and weighed at 100 grams per sample. Each weighted sample was added to 400 mL of 10% NaCl and mixed until smooth. The material was then allowed for one day to develop a layer. The lowest layer was removed and filtered using a 100 mesh filter cloth, followed by the addition of NaCl to the uppermost layer, which was let to sit before being filtered and repeated three times to ensure that the microplastics floated to the top. The filtered material was mixed with 20 mL of 30% H_2O_2 and 5 drops of 0.05 M $FeSO_4$, stirred, and left for one day. The sample was then warmed at 90°C for 30 minutes and filtered using a 100 mesh filter cloth. Trapped samples were washed with NaCl until no trapped samples remained and transferred to a petri dish.

The sample is subsequently calculated using the formula:

$$C = \frac{n}{m} \quad (1)$$

C is the microplastic abundance (number of particles per kilogram), n is the number of microplastic particles, and m is the dry weight of sediment (kg) (Joesidawati, 2018). After estimating the abundance of microplastics, the samples were examined with a binocular microscope and FT-IR.

Figure 1. Sampling map

3. RESULTS AND DISCUSSIONS

Based on the findings from identifying soil samples from three separate locations, it was discovered that the total amount of microplastics in the samples was 2.25 grams. Figure 2 shows that there were 0.6 grams per 100 grams in sample 1, 0.13 grams per 100 grams in sample 2, and 1.52 grams per 100 grams in sample 3. The abundance calculation yielded the following sample distribution: sample 3 > sample 1 > sample 2.

The most common cause of the high abundance of microplastics in sample 3 was that the location had previously been used as a rubbish dump before the Talang Gulo TPA was relocated to its current position, leading to a buildup of microplastic particles. This is thought to be the primary cause of the high abundance observed. Sample location 3 also features a large amount of plastic waste, either on the surface or buried. Meanwhile, sample location 2 is a slightly steep sloping region, so any debris is likely to fall into location 1, resulting in very little plastic waste. Sample location 1 still receives new rubbish since it is adjacent to the main road where waste-carrying vehicles enter the landfill. As a result, there is a considerable amount of microplastic at site 1.

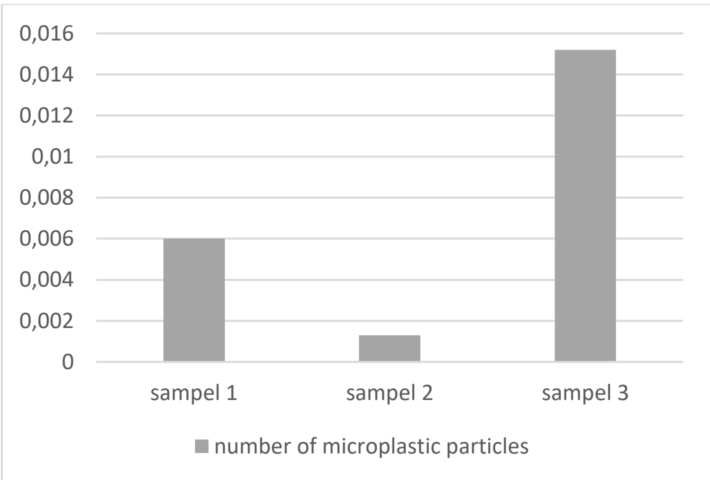

Figure 2. Number of microplastic particles.

The hue of microplastics in the landfill is identified by sorting the visible samples, segregating the colors, and weighing them. The identification results revealed that 45% of the microplastic samples were mostly transparent, with the remainder being blue, white, and black. The clear and white color is created by microplastics that have been present in the sample location for an extended period of time and have been exposed to UV light, resulting in photodegradation. Because of their low density, colored transparent microplastics are commonly found in food and beverage waste (Kim et al., 2021). Dark colored microplastics, such as blue and black, typically absorb other pollutants because microplastics can change color to black due to their propensity to absorb large amounts of contaminants. PBTs (persistent, bioaccumulative, and toxic compounds) and POPs (persistent organic pollutants) are examples of commonly absorbed pollutants. Blue microplastics are also made from synthetic dyes, which can pollute the soil and potentially harm soil organisms like worms and plants.

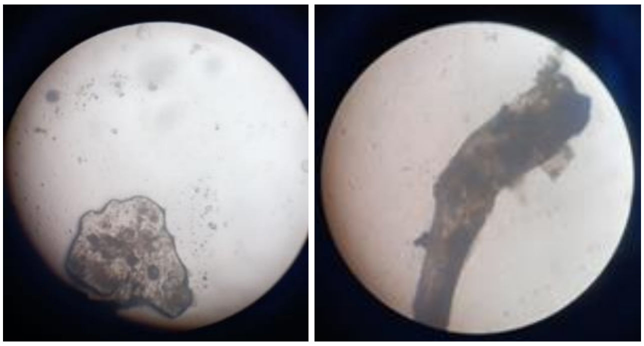

Figure 3. Form of microplastic filaments and pieces.

Microplastic sample sizes can be identified as one of two types: primary microplastics or secondary microplastics. UV light, precipitation, temperature change, and other factors can all have an impact on microplastic size variations. The size of the microplastic collected is usually determined by the microplastic filter's diameter. Primary microscopy results show a tiny size of less than 1 mm. Small microplastics are extremely harmful because if they are absorbed continuously, they might build in the organism's body, endangering the food chain.

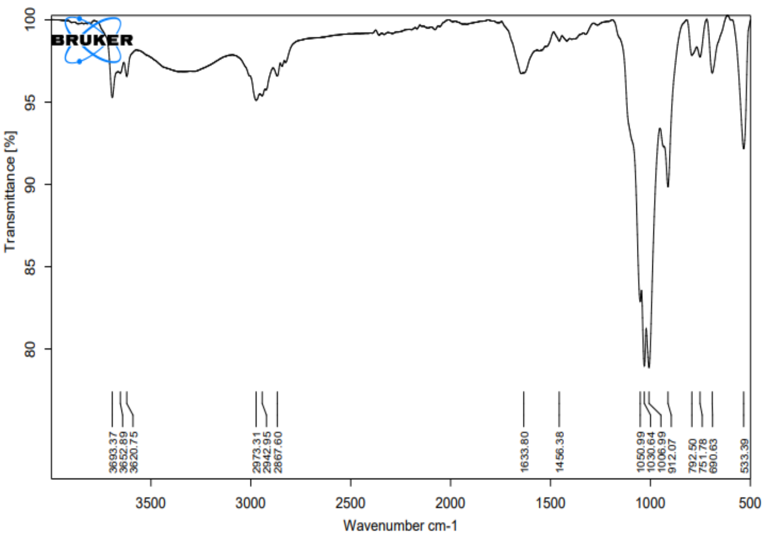

Figure 4. shows FT-IR data from microplastic samples

Characterizing the structure of microplastics in the samples revealed that four types of microplastics dominated, namely filaments, pieces, granules, and fibers, as shown in Figure 3. The test results revealed that the majority of the samples were pieces of plastics derived from food packaging, mica plastics, and so on (Nauval Putra Prabowo, 2020).

The most prevalent type of microplastic fragments is similar to the findings of Nauval Putra Prabowo (2020), who investigated riverbed sediments in the Yogyakarta area. The fragment shape achieved was caused by plastic bottle waste landing owing to river currents, resulting in plastic garbage heaped up on the riverbanks. The results of the FT-IR test show that there are 16 vibration band peaks, indicating that the microplastics detected near the Talang Gulo waste are extremely diverse. FT-IR study reveals that polystyrene (PS) and polyvinyl chloride (PVC) are the most common forms of microplastic polymers.

The presence of aliphatic C-H bonds at a wavelength of 2867.601 cm^{-1} and phenyl C-H bonds at a wavelength of 3693.368 cm^{-1} confirmed the suspected polystyrene polymer results in the FT-IR test (Jung et al., 2018). This form of polystyrene polymer is commonly used for heat-resistant, slightly hard plastic derived from electronic and home trash (Valasia, 2021). The occurrence of absorption band peaks at wavelengths of 690,632 cm^{-1}, 912,069 cm^{-1}, and 1006,994 cm^{-1} confirms the presence of PVC microplastics. Figure 4 shows a comparison of the various types of PVC microplastics to the results of FT-IR research. The peak results of the FT-IR vibration band show numerous forms of microplastics, however polystyrene (PS) and polyvinyl chloride (PVC) are the most dominating.

4. CONCLUSION

According to the research findings, the highest concentration of microplastics was discovered in samples from three land regions surrounding the Talang Gulo dump. The distribution of microplastics was 0.6 grams in sample 1, 0.13 grams in sample 2, and 1.52 grams in sample three. The microplastic polymers detected in the samples were polystyrene (PS) and polyvinyl chloride (PVC). It is intended that the findings of this study will lead to the development of research sites for microplastics in the soil, which will serve as a starting point for preventing the buildup of microplastics into the future.

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