

Original Research Article

# An Analysis of Microplastics Contamination on Road Dust Around Jambi's Angso Duo Market

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| ARTICLE INFO                                                            | ABSTRACT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| <i>Keywords:</i><br>Road dust<br>Microplastics<br>FTIR<br>Contamination | Road dust is a prevalent source of microplastics found in the atmosphere. The primary contributors to the presence of microplastics in dust are vehicle traffic, road surfaces, tire erosion, and road paint. The objective of this study is to categorize the various forms of microplastic pollution present in the road dust surrounding the Angso Duo Jambi market. The research employed a random sampling technique, specifically selecting 4 sample location locations. The total aggregation of microplastics amounted to 1.67 grams. Sample B exhibited the highest prevalence of microplastics, with a distribution of 2.78 grams in the vicinity to the right of Jambi's Angso Duo Market. The analysis of microplastics was conducted using a binocular microscope, Fourier Transform Infrared Spectroscopy (FTIR). The microscopic analysis of microplastic reveals the presence of several forms, namely fibres, fragments, and films. The FTIR study results indicate that polyethylene is the prevailing polymer type. The chemical composition and types of microplastic polymers found near the Angso Duo Jambi market, as determined by the results collected, include polyethylene, polypropylene, and polystyrene. The environmental impact of microplastics is intricately linked to the characteristics of the microplastics themselves, including their kind, size, concentration, and duration of exposure. Further investigation is required to examine the enduring consequences of microplastics on the environment, particularly in relation to the contamination of road dust. |

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## 1. INTRODUCTION

Plastics have been extensively utilized worldwide since the advent of successful plastic synthesis in the early 1900s. Plastic is a synthetic polymer compound that is produced in the world at a staggering rate of 348 million tons, making it the leading producer of plastic globally. In 2017, China was the largest producer of plastic materials, manufacturing 102.3 million tonnes. The European Union followed with 64.4 million tonnes, while the United States Free Trade Agreement produced 61.6 million tonnes (Liu et al., 2019). The global output of plastic has witnessed a significant surge, rising from 500,000 tons in 1960 to a staggering 367 million tons in 2020. Notably, half of this plastic is utilized for single-use purposes.

Indonesia ranks as the second most significant contributor to global plastic garbage production. In 2008, the amount of plastic garbage in Indonesia had reached 64 million tons annually, with 3.2 million tons of this waste ending up in the ocean. Dispersed plastic garbage has the potential to contaminate the ecosystem and jeopardize the well-being of organisms. The primary source of plastic pollution in the environment is the direct release of chemicals from products like cleaning garments and toiletries, as well as the wearing down of synthetic textiles during washing (Ebere et al., 2022).

Plastic debris in the environment undergoes fragmentation as a result of both physical wear and tear and natural decomposition. The persistent accumulation of plastic garbage poses significant environmental challenges and jeopardizes the ecology. Microplastics typically exhibit significant dimensions, pigmentation, and compactness when present in water, hence enabling their ingestion by many aquatic animals, including fish and invertebrates. Additionally, microplastics can affect the reproductive system and ultimately lead to severe effects, such as death. Hence, an increased surface area of microplastics directly correlates with an elevated likelihood of microplastics infiltrating the body or microbes. According to a study conducted by Monira et al., (2022), tire wear is responsible for around 30% of the microplastics found in rivers and oceans. Tire particles and road wear are the primary contributors of microplastics in the environment (O'Brien et al., 2021). Particles resulting from tire wear are detected within a range of 10 nanometers to 100 micrometers in size. The extent of wear is contingent upon the wear mechanism, such as fluctuations in driving conditions that impact the tire's surface, temperature, and road qualities. Furthermore, tire wear particles are commonly classified as microplastics and serve as a significant contributor to pollution.

Road dust is a prevalent source of microplastics found in the atmosphere. The origins of these microplastics can be attributed to car emissions, road surfaces, tire erosion, tire treads, and road paint. The presence of microplastics in road dust is widespread and has a substantial impact on the ecosystem (O'Brien et al., 2021). Angso Duo Market is a significant source of microplastics found in road dust. Approximately 60% of the waste undergoes decomposition, with 75% of that being vegetable waste. Hence, given this context, this study aims to determine the prevalence of microplastics in road dust surrounding the Angso Duo Jambi Market and to assess the extent of microplastic pollution in road dust.

## 2. METHODS

The research was conducted between March and August, with sampling sites located at Angso Duo Jambi Market on Sulthan Thaha Street, Banyan, District. The location is Jambi Market in Jambi City. Jambi. Concurrently, the Biology/Chemistry Laboratory at the Sulthan Thaha Saifuddin Jambi State Islamic University, Advanced Chemical II Characterization Laboratory, and Physics Advanced Characterization Laboratory conducted sample analysis.

## 2.1. Tools and materials

The equipment utilized includes filters, ovens, beakers, Whatman No. 42 filter paper, plastic containers for samples, stirring rods, Petri dishes, analytical balances, dropper pipettes, spatulas, stainless steel tweezers, Bucher funnels, vacuum pumps, cuvettes, centrifuges, binocular microscope *scoipeimage* 9.0, and FTIR.

The materials employed consist of road dust samples, a 30% hydrogen peroxide solution for the purification of organic compounds and elimination of organic matter,  $\text{ZnCl}_2$  for the segregation of microplastics based on their density, and demineralized water.

## 2.2. Sample Preparation

50-gram road dust samples were collected from four randomly selected locations and stored in tiny plastic containers. The dust samples underwent a process of sieving, utilizing a 4 grit stainless steel sieve, in order to isolate and remove bigger particles such as stones and other organic matter. Subsequently, every sample was placed inside a glass beaker and subjected to natural evaporation under ambient conditions for a duration of 7 days.

## 2.3. Extraction of road dust microplastics

A 30 gram specimen of road dust was combined with 70 ml of 30% hydrogen peroxide in a 500 ml beaker for a duration of 7 days in order to cleanse it of organic compounds and eliminate organic substances (Abbasi et al. 2017, Abbasi et al. 2019). Subsequently, the mixture was subjected to filtration using Whatman filter paper, followed by rinsing with demineralized water to ensure the retrieval of all particles adhered to the beaker's inner surface. Subsequently, the specimens were subjected to a 24-hour drying process in a 50°C oven to eliminate any organic compounds (Delghani et al., 2017).

## 2.4. Separation of microplastics

The sample was added with 100 ml of  $\text{ZnCl}_2$  solution to separate the microplastics in the fractionation process based on their density and stirred for 5 minutes. Then centrifuged at 350 rpm for 5 minutes, filtered through a cellulose nitrate filter and washed with demineralized water. Then the supernatant was centrifuged at 4000 rpm for 4 minutes and filtered using Whatman filter paper. Next, it was washed with demineralized water to limit the formation of  $\text{ZnCl}_2$  crystals. This separation process was repeated 3 times on the same filter paper to capture all microplastics and the filter paper was dried for several days at room temperature until dry and then placed in a Petri dish. Then the samples were analysed using a Binocular Microscope, and FTIR (Pandey et al., 2022).

## 2.5. Microplastic Abundance

The concentration of microplastics in the air exhibits significant variation. The decrease in the number of microplastic particles is directly proportional to the increase in particle size (Zhang et al., 2020). The quantification of microplastics is determined by comparing the quantity of particles detected with the number of samples taken. The abundance of microplastics can be determined by utilizing equation (1) in the following manner:

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

where: C = Abundance of microplastics ( $\text{m}^3$ )

n = Microplastic particles

m = Number of samples

### 3. RESULTS AND DISCUSSIONS

#### 3.1. Quantification of microplastic abundance in road dust

The microplastic analysis of road dust collected from four sample locations surrounding the Angso Duo Jambi market yielded a total of 1.67 grams. Microplastics were present in road dust at all sampling stations, appearing in different forms such as films, pieces, and threads. Sample B detected a higher concentration of microplastics at 2.78 grams. Nevertheless, in alternative samples, a lower quantity of microplastics was detected compared to sample B. This is due to the high traffic volume of both motorcycles and cars in the area where sample B was collected.

The sampling site in this study was strategically chosen due to its high human activity, allowing for the identification of the sources of microplastic contamination in road dust, such as tire treads, road paint marks, tire wear particles, brake wear particles, and asphalt wear particles. The composition of road dust in Iran consists primarily of spherical particles, fibers, fragments, and films. A wide variety of particle types have been identified in road dust samples collected in Iran. Particles found in road dust tend to be smaller in regions with heavier traffic. It has been noted that driving might cause plastic to break down into smaller pieces, leading to an increased presence of microplastic particles in smaller sizes (Yukioka et al., 2020). The presence of fragmented plastics in soil or roadside dust is strongly correlated with human activities (Patchaiyappan et al., 2021). A study conducted in Busher, Iran (Abbasi et al. 2017b) revealed that the predominant type of plastic identified was fiber, accounting for 75.87% of the total.

#### 3.2. Characterization of microplastics in road dust using a binocular microscope

A binocular microscope was employed to discern and segregate microplastics on filter paper extracted from road dust samples, and images were captured using 9.0 software. Particles viewed under a microscope might be categorized as fibers, pieces, or films. The microscopic examination of road dust samples collected from the Angso Duo market in Jambi is presented in Figure 1. The figure displays the results obtained from the road dust samples collected around the Angso Duo market in Jambi. Figures a.1 and a.2 illustrate that microplastic exists in the form of a thin sheet. Conversely, photos b.1 and b.2 depict the morphology of microplastics in the form of fibers, whereas images c.1 and c.2 illustrate the morphology of microplastics as pieces.

Fiber is a slender form of microplastic. Microplastics of fiber origin are typically derived from garments and textiles. Fragmentary microplastics are diminutive fragments or small components characterized by regular contours. Conversely, film-like microplastics refer to components that possess an extremely thin and delicate layer (Girao, Caputo, and Ferro 2017). Microplastics in the form of film and fragments are generated from disposable materials like plastic bags and bulky plastic items.

Nevertheless, this investigation yielded fiber-shaped microplastics derived from tire wear particles, with the fiber form being the prevailing type of microplastic. According to prior research conducted by Narmadha et al. (2020), fiber has been identified as the predominant type of dust that drifts from both urban and rural surroundings in Nagpur. Prior studies have elucidated the presence of microplastics in urban road dust samples, manifesting as fibers, pieces, films, and balls. Notably, the fibers exhibited surfaces characterized by roughness and cracks (Pandey et al., 2022). Furthermore, the majority of microplastic samples derived from road dust consisted of fragmented pieces and fibers. Dust emissions from the ground surface can contribute to the presence of suspended microplastics in the atmosphere. Hence, the release and settling of particulate matter between the terrestrial surface, atmosphere, and aquatic ecosystem are interconnected with the movement of microplastics (Cai et al., 2017).

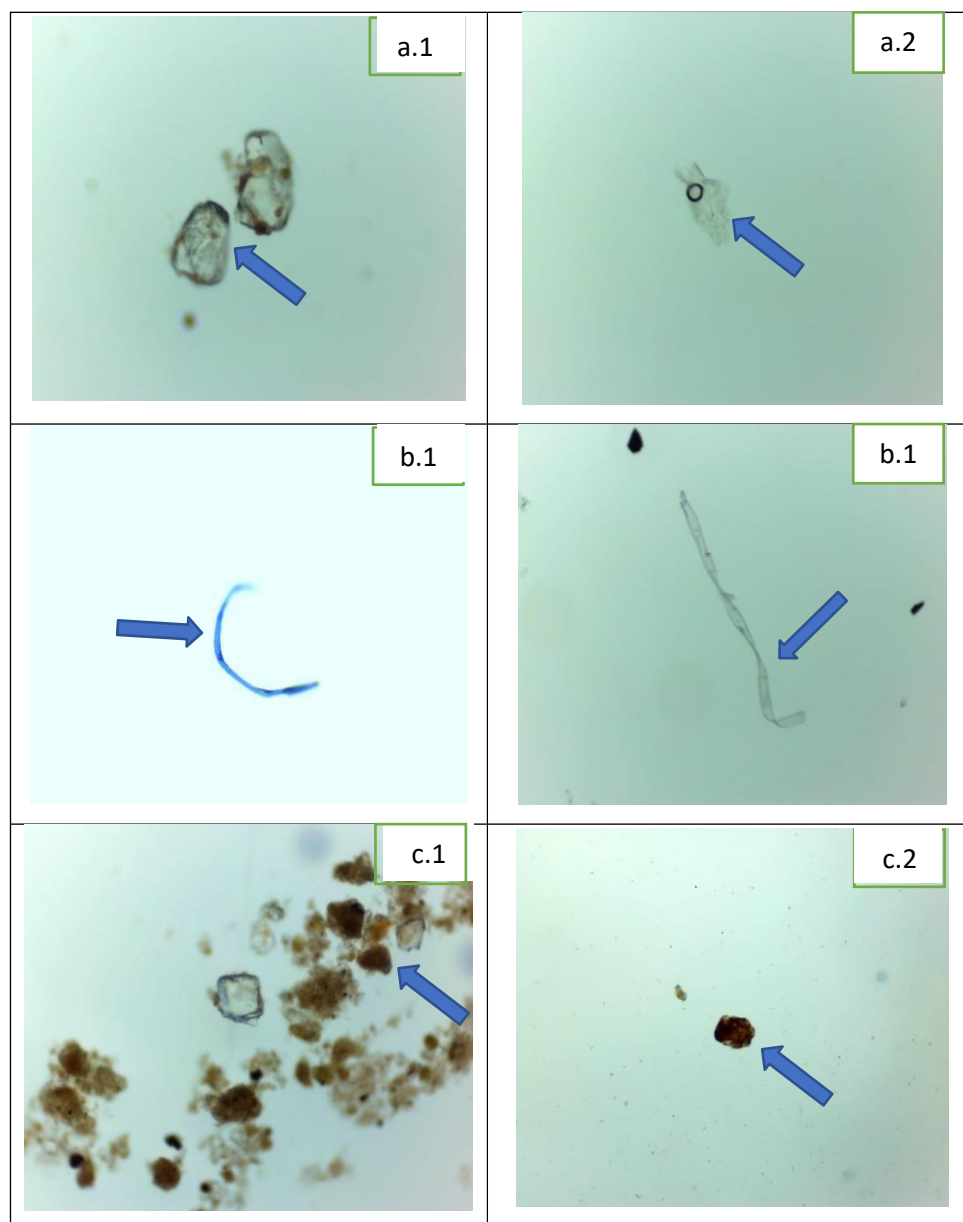


Figure 1. Presents the outcomes of an examination conducted using a binocular microscope on several forms of microplastics found in road dust samples. These types include (a.1&a.2) film, (b.1&b.2) fiber, and (c.1&c.2) fragments.

### 3.3. Characterization of microplastics in road dust using a FTIR

FTIR examination reveals the presence of several microplastic polymers, as depicted in Figure 2. The prominent peaks in the FTIR spectrum were detected at wavelengths around  $2973.99\text{ cm}^{-1}$  -  $2867.20\text{ cm}^{-1}$ ,  $1051.96\text{ cm}^{-1}$  -  $1030.83\text{ cm}^{-1}$ , and  $777.91\text{ cm}^{-1}$  -  $530.04\text{ cm}^{-1}$ . These peaks provide evidence of the presence of microplastics composed of polyethylene (PE), polypropylene (PP), and polystyrene (PS). The microplastic polymers identified through FTIR analysis of road dust often include polypropylene, polystyrene, PE, polyethylene terephthalate or polyester, and polyvinyl chloride (Singh et al., 2023). The atmospheric suspension of microplastics encompasses several types of polymers, such as PET, PE, PS, polyacrylonitrile, ethylene vinyl acetate, and alkyd (Liu et al., 2019).

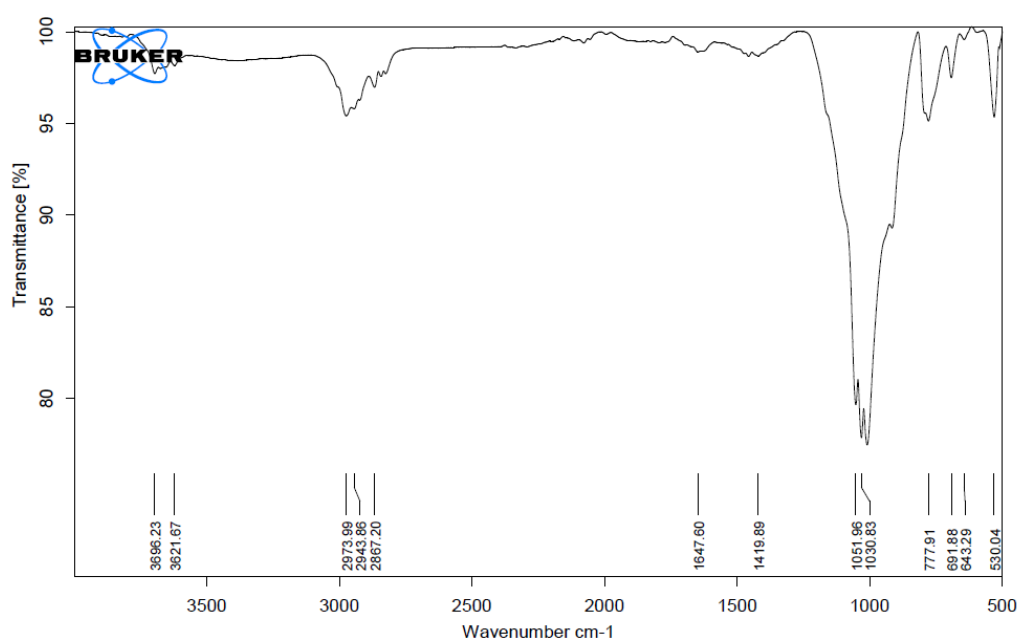


Figure 2. Results of FTIR spectrum analysis of microplastics in road dust

The spectrum depicted in Figure 2. indicates that the majority of the identified polymers were polyethylene (PE), exhibiting peak characteristics comparable to polypropylene (PP). The presence of C-H bond stretching is evidenced by a wave number of 2867 cm<sup>-1</sup>. Road dust frequently contains polyethylene (PE) polymer. This is attributed to the extensive utilization of diverse polyethylene products, including toys, milk bottles, shampoo containers, pipes, shopping bags, and plastic bags, among others. Prior studies have elucidated that the distinction between polyethylene (PE) and polypropylene (PP) is accomplished through a two-phase process due to their comparable wave number properties, which poses challenges in differentiation. The reference spectrum of polypropylene (PP) aids in the identification of both polymer forms. Moreover, polyethylene (PE) and polypropylene (PP) possess distinct attributes that set them apart from other polymers.

Polypropylene (PP) polymer exhibits C-H stretching bonds at a wave number of 2943 cm<sup>-1</sup>, C-H<sub>2</sub> stretching bonds at a wave number of 1419 cm<sup>-1</sup>, and C-H bending bonds at a wave number of 1030 cm<sup>-1</sup>. Polypropylene (PP) polymer is commonly present in synthetic rubber compounds, including tire tread, tire wear particles, and brake wear particles. This is corroborated by prior research, which discovered that approximately 8% of microplastics in Norway can be attributed to brake wear in the form of synthetic rubber materials (Monira, Bhuiyan, et al., 2022). Polystyrene (PS) is another polymer identified based on the FTIR results shown in Figure 4.4. Consistent with prior research, it has been determined that the polystyrene (PS) polymer exhibits a wave number of 691 cm<sup>-1</sup>. Polystyrene (PS) polymer is present in the dust on roads due to the erosion of road marking paint, asphalt, and tarmac. The reason for this is because when automobile tires come into contact with asphalt pavement or when the pavement is worn away by weather conditions, it will result in the detachment of the pavement and the formation of microscopic particles that accumulate as road dust.

#### 4. CONCLUSION

Microparticles of three distinct plastics (polypropylene, polystyrene, and polyethylene) were identified and analyzed in road dust near Jambi's Angso Duo traditional market using FTIR. The total amount of microplastics collected from the samples was 1.67 grams, with sample B containing the

highest concentration of microplastics at 2.78 grams. The microscopic analysis of microplastic reveals the presence of several forms, namely fibers, fragments, and films. According to our findings, road dust is an important factor to consider when measuring the state of pollution in numerous elements of our environment. The direct impact of microplastics contained in street dust on human health, as well as the relationship between secondary contaminants such as PAHs and microplastics from street dust through adsorption and their adverse effects, can be estimated for future research.

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