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Analysis of Microplastic Content in Ambient Air in the Campus Area (Case Study: Mendalo Campus, Jambi University)

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Abstract

Background: Microplastic pollution has become a global environmental concern, including contamination in ambient air, where air quality is an important indicator of environmental health. **Objective:** This study aimed to analyze the abundance and characteristics of microplastics in ambient air at the Mendalo Campus, Universitas Jambi. **Methods:** Ambient air was sampled using a High Volume Air Sampler with a gravimetric approach at three locations representing different campus activities: the campus backwoods area, the main campus gate, and the campus waste disposal site. Microplastics were identified based on shape, color, size, and polymer-related characteristics using microscopic observation. **Results:** All sampling points were positive for airborne microplastic contamination. Microplastic abundance varied among locations, with the highest value observed at the waste disposal site, reaching 228.709 particles/g, while other values included 91.304 particles/g, 85.432 particles/g, 33.307 particles/g, 21.498 particles/g, and 20.009 particles/g. Fiber was the dominant form, followed by film and fragment. **Conclusion:** The Mendalo Campus environment is exposed to airborne microplastic deposition; therefore, improved plastic waste management and campus-based emission mitigation are required.

Keywords: microplastics; ambient air; abundance; campus environment; environmental pollution; TSP; HVAS

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INTRODUCTION

The increase in global plastic production, which has reached more than 400 million tons annually, has led to a significant rise in plastic waste entering the environment [1]. One of the most concerning forms of plastic pollution is microplastics, which are plastic particles measuring less than 5 mm [2]. Microplastics are commonly found in various environmental media, including soil, water, and air. Although research on microplastics in water and soil has developed considerably, studies on microplastics in air remain limited, particularly within campus environments.

Campuses are areas with high levels of human activity, including mobility, food consumption, waste generation, and the use of plastic-based materials. Transportation activity is also relevant because data show that more than 68.25% of students use motorcycles as their primary mode of transportation [3]. These activities, when combined with suboptimal waste management, have the potential to increase microplastic contamination in ambient air. This study therefore focuses on determining microplastic abundance and identifying the characteristics of microplastics at three campus locations representing different pollution-source potentials.

Research in China reported that recreational areas or green spaces on campus are not always free from microplastic pollution. Instead, soil in these areas can act as a sink for long-term atmospheric deposition, although the abundance may be lower than in activity centers such as dormitory or cafeteria areas with direct waste input [4]. Other studies in indoor environments also reported the predominance of microfibers derived from student clothing, textile furnishings, and other synthetic materials [5]. These findings indicate that microplastic contamination can occur not only in highly polluted urban sites but also in educational and semi-green environments.

The discovery of airborne microplastics has raised concerns regarding human exposure and health impacts, especially for fine particle fractions that can be inhaled [6-10]. Suspended fibers in occupational environments have been associated with adverse respiratory concerns, and plastic or cellulosic fibers have been identified in human lung tissue [8,11]. Therefore, the results of this study are expected to provide preliminary information regarding the risk of airborne microplastic exposure to the campus academic community and to support sustainable campus environmental management.

METHODS

Research Design

This study used a qualitative descriptive approach supported by field measurements, including ambient air sampling, total suspended particulate (TSP) concentration testing, and microplastic content testing. The research was conducted during the dry season and on weekdays. Microplastic sampling was performed using TSP collection because TSP sampling can capture larger particles compared with PM_{10} and $PM_{2.5}$ fractions. TSP can collect particles with diameters between 100 μm and 0.1 μm, with high collection efficiency for small particles according to the sampling procedure used in this study.

This study aims to provide a comprehensive analysis of the status of microplastic contamination in university campus environments, integrating the latest global data and specific case studies in Indonesia. The specific objectives of this study are:

1. Quantifying Abundance: Providing comparative data on the concentration of microplastics in the air around campus.
2. Physicochemical Characterization: Analyzing the morphological profile (shape, size, color) and chemical composition of microplastic polymers to identify dominant emission sources.
3. Health and Environmental Risk Evaluation: Assessing potential ecological impacts and human health risks (especially through inhalation and dust ingestion) to the campus population.
4. Strategic Recommendations: Formulating science-based policy recommendations for sustainable campus management to minimize the plastic footprint.

Research Target and Sampling Sites

The research aimed to determine the extent of microplastic distribution and abundance in ambient air around the campus. The study was conducted at three locations within the Mendalo Campus of Universitas Jambi: the forest behind the Mendalo Campus, the main gate of the Mendalo Campus, and the campus waste disposal site (TPS). These locations were selected because they represent different potential sources of airborne microplastic contamination, including green area deposition, vehicle-related activity, and waste accumulation.

Research Procedure

The study included ambient air sampling, TSP concentration testing, and microplastic content testing. Supporting data were collected in the form of meteorological conditions, including temperature, humidity, air pressure, wind direction, and wind speed, as well as data on the total number of vehicles entering and leaving the campus area. Sampling was conducted using a High Volume Air Sampler (HVAS) with an 8-hour TSP sampling period on weekdays. The filters used were Whatman Glass Microfibre Filters measuring 20.3 x 25.4 cm. During sampling, the air flow rate and temperature were monitored and recorded hourly. The air flow rate was maintained within the range of 1.1-1.7 m3/minute in accordance with the applicable standard.

After TSP sampling using the HVAS device, meteorological data were recorded, and filter paper weight was measured before and after sampling. The TSP concentration was calculated based on the gravimetric principle according to the relevant Indonesian National Standard procedure. Microplastic abundance analysis was then conducted to identify the number and characteristics of microplastics captured in the samples.

Instruments and Data Collection Techniques

The microplastic analysis method was adapted from previous microplastic-air research [1]. The collected ambient air samples were transferred into 500 ml beakers and mixed with 300 ml sodium chloride (NaCl) solution to separate dust and microplastics. The samples were stored at room temperature for 6 hours. After that, 20 ml H_2O_2 were added, and the samples were left for 48 hours to allow separation and digestion of interfering materials. The separated surface microplastics were filtered using Whatman filter paper and subsequently identified using a digital microscope.

Microplastic characteristics were observed using a digital microscope because the instrument allows the observed objects to be recorded, stored, and processed easily [12]. The filtered sample was placed in a Petri dish on the microscope stage. The light intensity and focus

were adjusted using the microscope controls, and observation was conducted using 10x objective magnification. The microscopic images obtained were recorded and stored by the connected computer.

Data Analysis Technique

Microplastic abundance analysis was conducted by identifying microplastic particles under a digital microscope and calculating the number of particles per particulate weight. The abundance value was expressed as particles/g. Microplastics were classified based on morphological type, including fragment, fiber, and film, and were further described based on color and visual characteristics observed from the microscope images. The resulting data were interpreted descriptively to explain potential sources and implications of airborne microplastic exposure in the campus environment.

RESULTS

Meteorological Conditions and Sampling Locations

The analysis of microplastic abundance and characteristics in ambient air around the campus included supporting observations on meteorological conditions and vehicle activity. Sampling was conducted by considering areas with different activity intensities and potential pollutant sources. The observation points consisted of the Mendalo Campus Forest, the Mendalo Campus Main Gate, and the Mendalo Campus Waste Disposal Site.

Sampling location 1 was the forest behind the Mendalo Campus of Universitas Jambi, located at coordinates Lat -1.61828° and Long 103.51599°. Meteorological measurements at this location were conducted on September 24, 2025, including temperature, humidity, air pressure, wind speed, and wind direction. The highest temperature was 33°C at 12:00-13:00 WIB, and the lowest temperature was 29°C at 09:00 WIB. Humidity ranged from 64.8% to 70.6%, air pressure ranged from 29.54 to 29.65 mmHg, and wind speed ranged from 0.8 to 1.9 m/s.

Sampling location 2 was the main gate of the Mendalo Campus, located at coordinates Lat -1.608058° and Long 103.519716°. Meteorological measurements at this location were conducted on September 25, 2025. The highest temperature was 35°C at 11:00-16:00 WIB, and the lowest temperature was 31°C at 09:00 WIB. Humidity ranged from 54.1% to 73.2%, air pressure ranged from 29.53 to 29.75 mmHg, and wind speed ranged from 0.9 to 1.4 m/s. This location represented an area with high mobility and vehicle activity.

Sampling location 3 was the Mendalo Campus waste disposal site (TPS), located at coordinates Lat -1.609892° and Long 103.520816°. Meteorological measurements were conducted on October 6, 2025. The highest temperature was 30°C at 11:00-13:00 WIB, and the lowest temperature was 29°C at 09:00 WIB. Humidity ranged from 65.3% to 78.1%, air pressure ranged from 29.60 to 29.79 mmHg, and wind speed ranged from 0.8 to 1.8 m/s. This location represented an area influenced by waste accumulation and possible plastic degradation sources.

Microplastic Abundance

Microplastic abundance analysis at the Mendalo Campus of Universitas Jambi was used to identify the number and types of microplastics captured by the HVAS device. Microplastics can be classified by shape into pellets, fragments, fibers, filaments, and foam, and can also be classified by color, including black, blue, red, and other colors [13]. Observations at each air sampling location indicated that all tested samples were positive for

microplastic contamination at varying abundance levels. The abundance of microplastics based on TSP samples is presented in Table 1.

Table 1. Microplastic abundance analysis results.

No	Location point	Number of microplastics (particles)	Particulate weight (g)	Microplastic abundance (particles/g)
1.	Campus Forest 1	42	0.0046	91.304
2.	Campus Forest 2	17	0.5104	33.307
3.	Main Gate 1	57	0.6672	85.432
4.	Main Gate 2	22	1.0995	20.009
5.	TPS 1	76	0.3323	228.709
6.	TPS 2	13	0.6047	21.498

Several types of microplastics were found in samples observed under the microscope. The high concentration of microplastics may originate from activities occurring around and within the campus, including waste accumulation and vehicle tire wear. Microplastics can also originate from road traffic emissions, particularly non-exhaust particles such as tire rubber, road marking paint, and polymers present in asphalt [14]. Therefore, both waste-related and traffic-related sources contribute to the presence of microplastics in campus ambient air.

Table 2. Shapes and images of microplastics based on type.

No	Type	Picture	Total	Description
1.	Fragment		21 particles	Hard, rigid, and colored; commonly derived from plastic bottles, containers, pipes, and degraded plastics.
2.	Fiber		183 particles	Fibrous and colored; commonly derived from synthetic clothing, textile fibers, plastic ropes, and other synthetic materials.
3.	Film		23 particles	Transparent or colored with low density; commonly derived from plastic bags and food packaging.

DISCUSSION

The results from the three locations showed that fiber was the most common microplastic form compared with fragments and films. Fiber tends to originate from clothing fibers and other synthetic materials. Fiber is one of the main airborne microplastic sources and can be released from synthetic textile materials such as polyester, nylon, and acrylic. According to Crawford and Quinn [15], fiber-type microplastics can originate from clothing residues, textile threads, and fragmented plastic ropes. In this study, fiber particles were found most frequently at the

TPS and main gate locations, which may be related to waste accumulation, waste burning, and the high intensity of campus community movement in and out of the campus area.

Film-type microplastics were found with a total of 23 particles, with the highest occurrence at the main gate sampling point. This may be because film-type microplastics are secondary plastic polymers derived from plastic bags or food packaging with low density. Because of their low density, film particles can be more easily transported by wind. Fragment-type microplastics were mostly found at the rear forest location. Fragment microplastics can be formed from degraded plastic bottles, containers, pipes, and other rigid plastic products.

The presence of microplastics in all samples indicates that the campus area is not free from airborne microplastic deposition. The forest sampling point may function as a deposition area where airborne particles accumulate on vegetation or soil surfaces. The main gate is influenced by high vehicle mobility and non-exhaust emissions, including tire wear and road dust, while the TPS is influenced by plastic waste accumulation, degradation, and possible resuspension of particles from waste-handling activities. These results support the interpretation that airborne microplastic pollution in campus environments is shaped by both local activity patterns and the physical characteristics of microplastic particles.

The findings have practical implications for sustainable campus management. Efforts to reduce airborne microplastic exposure should include improved plastic waste segregation, reduced open waste handling, stricter control of plastic packaging waste, and management of vehicle activity at campus entry points. Campus green spaces should also be maintained not only as aesthetic and ecological zones but also as areas that may intercept airborne particulate contamination. However, this study has limitations, including the limited number of sampling points, the descriptive nature of the analysis, and the absence of advanced polymer confirmation using FTIR or Raman spectroscopy. Future studies should include repeated seasonal sampling and polymer identification to strengthen source apportionment and exposure-risk assessment.

CONCLUSIONS

Based on the research entitled “Analysis of Microplastic Content in Ambient Air on the University of Jambi Campus (Case Study: Mendalo Campus),” all sampling points on the Mendalo Campus tested positive for microplastic contamination. This demonstrates that microplastic pollution is an environmental issue that can affect the campus community. Microplastic abundance varied among sampling points, with the highest value found at the TPS 1 location, reaching 228.709 particles/g. Fiber was the dominant microplastic type, followed by film and fragment, indicating that textile-related sources, waste handling, traffic activity, and degraded plastic materials may contribute to airborne microplastic contamination.

Mitigating the risk of particulate matter and microplastics at the main gate and other campus activity centers is important. A mobile-source mitigation policy could include the implementation of a low-emission zone, stricter regulation of motorized vehicle movement during peak hours, and broader use of campus public transportation, shuttle services, and cycling facilities. In addition, improved plastic waste management at the campus waste disposal site is needed to reduce particle generation and resuspension. These efforts can help reduce microplastic exposure and support the development of a healthier and more sustainable campus environment.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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AUTHOR CONTRIBUTIONS

Conceptualization, Z.N.A., F.J.A., and F.M.P.; methodology, Z.N.A.; investigation, Z.N.A.; data curation, Z.N.A.; formal analysis, Z.N.A.; writing - original draft preparation, Z.N.A.; writing - review and editing, F.J.A. and F.M.P.; supervision, F.J.A. and F.M.P. All authors have read and approved the final version of the manuscript.

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