The Effectiveness of Sansevieria Plants in Improving Indoor Air Quality (IAQ) in Rooms at Binawan University

Anna Suraya [1]*, Khoirunnisa Meila Putri[1], Abdul Fallah Saepudin[1], Bivo Stevano[1], Meydiana Dwi Lestari[1], Sandi Hariansyah[1], Denny Firmansyah[1], Sahuri Sahuri[1], Defi Arjuni[1], Yunita Sari Purba[1], Husen Husen[1]

[1] Occupational Safety and Health, Faculty of Health Science and Technology, Binawan University, 13630, Jakarta, Indonesia

anna.suraya@binawan.ac.id

Abstract. Binawan University, located in a densely trafficked area, is at risk of experiencing decreased Indoor Air Quality (IAQ) due to exposure to pollutants from vehicle emissions and other sources of contamination. This study aims to evaluate the effectiveness of Sansevieria sp. in improving IAQ at Binawan University, particularly in reducing the concentrations of PM 2.5, formaldehyde, total volatile organic compounds, carbon dioxide, and carbon monoxide. An experimental design with a pre-test and post-test approach was employed. Seven rooms at Binawan University were selected as the study sites, and air quality measurements were conducted before and after the intervention involving the placement of Sansevieria plants over a 14-day period. The data were analyzed using one-way ANOVA to identify significant differences in IAQ parameters before and after the intervention, followed by post hoc testing to determine which groups showed significant changes. The results indicated a significant reduction in the Indoor Air Quality Index following the placement of Sansevieria, particularly associated with a decrease in PM 2.5 levels. However, no significant changes were observed in the levels of HCHO, TVOC, CO_2, or CO during the intervention period. The one-way ANOVA showed a statistically significant difference in IAQ before and after the intervention ($F = 3.613$, $p = 0.038$), and post hoc testing confirmed that significant improvements occurred in several rooms. This study suggests that Sansevieria sp. can contribute to improving indoor air quality, especially in reducing PM 2.5. These findings may serve as a basis for implementing phytoremediation-based strategies in indoor air pollution mitigation, particularly in highly polluted urban areas such as Jakarta.

Keywords: Sansevieria sp., Indoor Air Quality (IAQ), PM 2.5, Air Pollution, Phytoremediation

A. Suraya et al. (eds.), *Proceedings of the 2nd World Conference on Health and Social Sciences (WCHSS 2024)*, Advances in Health Sciences Research 86,
https://doi.org/10.2991/978-94-6463-774-8_16

1 Introduction

Environmental pollution is the process by which pollutants enter an ecosystem, significantly degrading its quality [1]. One of the most concerning forms of environmental pollution on a global scale is air pollution. Air pollution occurs as a result of increased emissions of harmful gases and particulate matter into the atmosphere, leading to a decline in air quality to the extent that it can no longer be utilized as intended [2].

The air quality in DKI Jakarta is among the worst in the world. According to Air Quality Index (AQI) data from October 21, 2023, Jakarta recorded an air quality index of 180, ranking it as the third most polluted city globally at that time [3]. Poor air quality has been shown to contribute to an increased risk of respiratory diseases, cardiovascular disorders, and decreased productivity due to the associated health symptoms [4].

Air pollution in Jakarta has resulted in an unhealthy environment, particularly indoors. In the era of globalization, there has been a shift in lifestyle patterns, leading people to spend more time indoors, whether for work or study [5]. Consequently, indoor air quality (IAQ) has become a critical issue, as it directly impacts human health. Several key factors contribute to poor indoor air quality, including inadequate ventilation, indoor pollutants (such as building materials and electronic devices), and outdoor pollutants, such as emissions from vehicles and industrial activities [6].

Binawan University, located along one of Jakarta's major thoroughfares, faces significant challenges related to Indoor Air Quality (IAQ). The campus's proximity to high-traffic roads increases the potential for indoor air pollution, which can impact the comfort and health of students and faculty members. Several studies have indicated that vehicle emissions are among the primary sources of air pollution in urban environments, contributing to the presence of fine particulate matter (PM 2.5) and toxic gases such as carbon monoxide (CO), nitrogen dioxide (NO_2), and volatile organic compounds (VOCs), which can accumulate indoors [7].

Efforts to improve indoor air quality can be implemented through various means, one of which is the utilization of plants with air-purifying properties. One such plant known for its phytoremediation capability is Sansevieria sp. (snake plant). Research has shown that Sansevieria can absorb a range of airborne pollutants, including formaldehyde (HCHO), carbon dioxide (CO_2), and fine particulate matter (PM 2.5), while also enhancing oxygen concentrations indoors (Wolverton et al., 1989; Kim et al., 2018) [8,9]. Therefore, this study aims to evaluate the effectiveness of Sansevieria in improving IAQ at Binawan University and to provide scientific recommendations for air pollution mitigation strategies within academic environments.

2 Methods

This study employs an experimental design with a pre-test and post-test approach to evaluate the effectiveness of Sansevieria sp. (snake plant) in improving Indoor Air Quality (IAQ) at Binawan University. This approach allows for the measurement of changes in air quality parameters before and after the intervention, which involves placing Sansevieria plants in designated indoor spaces.

The study is conducted at Binawan University, Jakarta, a location characterized by high levels of air pollution due to vehicle emissions. The selected rooms for the study are those with high activity levels, limited ventilation, and close proximity to major roadways. The research sample consists of seven rooms within the university campus, each exhibiting different characteristics in terms of ventilation, size, and exposure to air pollution.

The study measures both independent and dependent variables. The independent variable is the placement of Sansevieria sp. in the indoor environment for a specific period. The dependent variables include changes in indoor air quality (IAQ) parameters, specifically PM 2.5 (Particulate Matter 2.5), formaldehyde (HCHO), total volatile organic compounds (TVOC), carbon dioxide (CO_2), and carbon monoxide (CO).

The research is conducted in several phases. The first phase involves an initial pre-test measurement to determine the baseline indoor air quality before the intervention. Measurements are taken using an air quality monitor, which is capable of detecting air pollutants such as PM 2.5, HCHO, TVOC, CO_2, and CO. Data collection is performed over seven consecutive days, with three daily recordings (morning, afternoon, and evening) to capture daily fluctuations in indoor air pollution.

The second phase involves the intervention, where Sansevieria sp. plants are placed in each designated room. The number of plants is adjusted according to room size, following the guidelines from Wolverton et al. [8], which suggest an optimal plant-to-room ratio of one plant per 9 m^2. The plants are strategically positioned near pollution sources (such as printers or ventilation inlets) and in areas with good air circulation.

The third phase consists of post-test measurements, in which IAQ parameters are recorded daily for 14 days following the placement of Sansevieria plants. The same methodology as the pre-test phase is used to ensure data consistency.

Data analysis is performed using several statistical methods. Descriptive statistical analysis is utilized to examine trends in the average concentrations of PM 2.5, HCHO, TVOC, CO_2, and CO over the study period. Additionally, a one-way ANOVA analysis is conducted to determine whether there are significant differences in air quality before and after the intervention with Sansevieria plants. The data analysis is performed using SPSS version 26.

3 Results

Seven rooms were selected as intervention sites, including the Nature Lover Students Association, Students Association, Copy Center, Business Development Information System Planning, Musholla, Physiotherapy Room, and the Admission Office for New Students. Across all rooms, a reduction in the Indoor Air Quality (IAQ) Index category was observed. The levels of formaldehyde (HCHO), total volatile organic compounds (TVOC), carbon dioxide (CO_2), and carbon monoxide (CO) did not exhibit significant changes throughout the application of Sansevieria in each room. However, PM 2.5

levels showed consistent reductions over the days of Sansevieria application. The observed reduction in the IAQ Index related to Sansevieria appeared to be associated with the decrease in PM 2.5 concentrations.

The ANOVA test revealed significant mean differences in IAQ across all rooms ($F = 3.613$, $p = 0.038$), indicating that the presence of Sansevieria had a measurable impact. These findings suggest that Sansevieria can significantly improve indoor air quality (IAQ) in rooms at Binawan University.

Table 1. indoor Air Quality in Binawan University's Rooms

Rooms	Parameter	Pre Intervention	Intervension Time			
			First Week		Second Week	
Nature Lover Students Association	Temperature	25 °C	25 °C	25 °C	26 °C	26 °C
	Humidity	65%	60%	62%	61%	60%
	HCHO	0,172 mg/m^3	0,133 mg/m^3	0,097 mg/m^3	0,118 mg/m^3	0,154 mg/m^3
	PM2,5	201 $\mu g/m^3$	215 $\mu g/m^3$	198 $\mu g/m^3$	164 $\mu g/m^3$	77 $\mu g/m^3$
	TVOC	0,645 mg/m^3	0,437 mg/m^3	0,431 mg/m^3	0,434 mg/m^3	0,600 mg/m^3
	CO	2 ppm	2 ppm	2 ppm	2 ppm	2 ppm
	CO2	896 ppm	812 ppm	810 ppm	810 ppm	800 ppm
	AQI	78 (Serious)	79 (Serious)	78 (Serious)	76 (Serious)	38 (Slight)
Students Association	Temperature	26 °C	25 °C	23 °C	23 °C	23 °C
	Humidity	58%	61%	59%	66%	61%
	HCHO	0,051 mg/m^3	0,096 mg/m^3	0,121 mg/m^3	0,160 mg/m^3	0,153 mg/m^3
	PM2,5	465 $\mu g/m^3$	329 $\mu g/m^3$	253 $\mu g/m^3$	233 $\mu g/m^3$	145 $\mu g/m^3$
	TVOC	0,051 mg/m^3	0,250 mg/m^3	0,250 mg/m^3	0,487 mg/m^3	0,425 mg/m^3
	CO	0 ppm	0 ppm	0 ppm	2 ppm	2 ppm
	CO2	400	402	398	824	805
	AQI	97 (Serious)	87 (Serious)	82 (Serious)	80 (Serious)	73 (Moderate)
Copy Center	Temperature	27 °C	25 °C	26 °C	25 °C	27 °C
	Humidity	63%	65%	61%	64%	58%
	HCHO	0,125 mg/m^3	0,093 mg/m^3	0,091 mg/m^3	0,079 mg/m^3	0,116 mg/m^3

	PM2,5	334 µg/m³	146 µg/m³	153 µg/m³	147 µg/m³	61 µg/m³
	TVOC	0,432 mg/m³	0,536 mg/m³	0,474 mg/m³	0,278 mg/m³	0,273 mg/m³
	CO	2 ppm	2 ppm	2 ppm	0 ppm	0 ppm
	CO2	813 ppm	806 ppm	823 ppm	417 ppm	73 ppm
	AQI	87 (Serious)	73 (Moderate)	74 (Moderate)	73 (Moderate)	33
Business Development Information System Planning	Temperature	23 °C	23 °C	26 °C	25 °C	21 °C
	Humidity	67%	68%	58%	56%	61%
	HCHO	0,093 mg/m³	0,075 mg/m³	0,070 mg/m³	0,116 mg/m³	0,073 mg/m³
	PM2,5	214 µg/m³	118 µg/m³	103 µg/m³	49 µg/m³	40 µg/m³
	TVOC	0,723 mg/m³	0,571 mg/m³	0,436 mg/m³	0,306 mg/m³	0,425 mg/m³
	CO	2 ppm	2 ppm	2 ppm	0 ppm	1 ppm
	CO2	942 ppm	926 ppm	814 ppm	437 ppm	434 ppm
	AQI	81 (Serious)	79 (Serious)	45 (Slight)	28 (Slight)	25 (Good)
Musholla	Temperature	26 °C	26 °C	26 °C	26 °C	25 °C
	Humidity	67%	61%	62%	67%	64%
	HCHO	0,240 mg/m³	0,208 mg/m³	0,199 mg/m³	0,214 mg/m³	0,102 mg/m³
	PM2,5	32 µg/m³	29 µg/m³	28 µg/m³	35 µg/m³	20 µg/m³
	TVOC	0,712 mg/m³	0,578 mg/m³	0,572 mg/m³	0,358 mg/m³	0,250 mg/m³
	CO	2 ppm	2 ppm	2 ppm	1 ppm	0 ppm
	CO2	935 ppm	852 ppm	849 ppm	600 ppm	400 ppm
	AQI	60 (Moderate)	52 (Moderate)	49 (Slight)	31 (Slight)	25 (Good)
Physiotherapy	Temperature	26 °C	22 °C	22 °C	23 °C	22 °C
	Humidity	53%	56%	51%	56%	52%
	HCHO	0,092 mg/m³	0,082 mg/m³	0,092 mg/m³	0,066 mg/m³	0,074 mg/m³
	PM2,5	49 µg/m³	39 µg/m³	28 µg/m³	28 µg/m³	17 µg/m³
	TVOC	0,250 mg/m³	0,250 mg/m³	0,250 mg/m³	0,250 mg/m³	0,250 mg/m³
	CO	0 ppm	0 ppm	0 ppm	0 ppm	0 ppm
	CO2	400 ppm	399 ppm	398 ppm	400 ppm	398 ppm

	AQI	29 (Slight)	(Slight)	24 (Good)	20 (Good)	18 (Good)
Admission of New Students	Temperature	26 °C	25 °C	25 °C	22 °C	23 °C
	Humidity	60%	54%	54%	56%	55%
	HCHO	0,105 mg/m³	0,131 mg/m³	0,132 mg/m³	0,088 mg/m³	0,065 mg/m³
	PM2,5	86 μg/m³	37 μg/m³	39 μg/m³	35 μg/m³	26 μg/m³
	TVOC	0,336 mg/m³	0,571 mg/m³	0,573 mg/m³	0,250 mg/m³	0,250 mg/m³
	CO	1 ppm	2 ppm	2 ppm	0 ppm	0 ppm
	CO2	525 ppm	845 ppm	845 ppm	401 ppm	401 ppm
	AQI	40 (Slight)	32 (Slight)	33 (Slight)	25 (Good)	18 (Good)

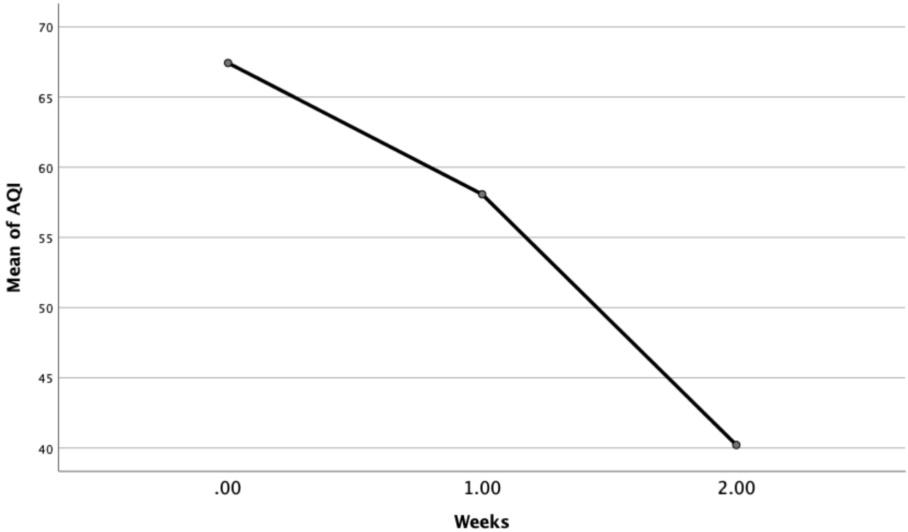

Fig. 1. The Average Indoor Air Quality Index Over Two Weeks of Sansevieria Application in Rooms at Binawan University.

4 Discussion

The findings of this study suggest that placing Sansevieria in indoor environments has a measurable impact on improving indoor air quality (IAQ), particularly in reducing PM 2.5 levels. The IAQ index was significantly improved in all selected rooms after Sansevieria intervention, as demonstrated by the ANOVA test ($F=3.613$, $p=0.038$). These results align with previous studies that highlight the air-purifying capabilities of indoor plants, particularly in absorbing particulate matter (PM), volatile organic compounds (VOCs), and carbon dioxide (CO_2) [8,10] (Wolverton et al., 1989; Sriprapat & Thiravetyan, 2013).

While parameters such as HCHO (formaldehyde), TVOC (total volatile organic compounds), CO_2, and CO did not exhibit significant changes, PM 2.5 levels consistently decreased over time. This finding suggests that Sansevieria may contribute more effectively to particulate matter filtration rather than gaseous pollutant absorption. A study by Kim demonstrated that indoor plants, including Sansevieria, can significantly reduce PM concentrations through both physical filtration and phytoremediation mechanisms [9].

The observed lack of significant changes in CO_2 and VOCs could be attributed to several factors. One possible explanation is room ventilation conditions. If ventilation was already optimized, the additional effect of Sansevieria on air quality might be minimal. Another factor could be the plant's absorption limitations. While Sansevieria is known for its ability to absorb CO_2, its impact might be more evident in environments with higher initial concentrations, as suggested by Aydogan and Montoya [11].

Sansevieria has been widely recognized for its ability to absorb airborne pollutants through stomatal uptake and microbial activity in the rhizosphere [12]. The significant reduction in PM 2.5 levels observed in this study may be attributed to two primary mechanisms. First, fine particles may physically deposit on the plant surface, where they adhere to leaves and are subsequently washed off or absorbed. Second, electrostatic attraction may play a role, with plant surfaces interacting with airborne particulates and reducing their concentration in indoor air, a process noted by Dela Cruz [13].

Several prior studies have demonstrated similar findings regarding the role of Sansevieria in improving indoor air quality. Torpy et al. (2017) found that the inclusion of Sansevieria in office environments led to a measurable decrease in PM concentrations over time [14]. Similarly, Pettit et al. reported that indoor plants could significantly lower PM 2.5 levels, with broad-leafed species like Sansevieria being among the most effective at filtering fine particulate matter from indoor air [15].

The results of this study suggest that Sansevieria can be an effective and low-cost strategy to enhance indoor air quality in environments such as classrooms, offices, and healthcare settings. Incorporating plants into building design could serve as a supplementary approach to existing ventilation and air filtration systems, particularly in settings where mechanical ventilation is limited. However, further research is necessary to quantify the long-term effectiveness of such interventions and to determine whether the observed improvements in indoor air quality are sustained over extended periods. Future studies should also explore the comparative efficiency of different plant species in removing specific pollutants, as well as assess the impact of plant density, considering that the number of plants per square meter may influence their air-purifying capacity.

5 Conclusion

In conclusion, this study provides empirical evidence that placing Sansevieria in indoor spaces significantly improves IAQ by reducing PM 2.5 levels. While no significant changes were observed in CO_2 or VOCs, the findings highlight the potential of phytoremediation as a natural air filtration method. Future studies should explore optimal placement strategies and plant combinations for maximum IAQ benefits.

References

[1] (PDF) TEORI KESEHATAN LINGKUNGAN. ResearchGate n.d. https://www.researchgate.net/publication/368987230_TEORI_KESEHATAN_LINGKUNGAN (accessed March 21, 2025).
[2] Ambient (outdoor) air pollution n.d. https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health (accessed March 21, 2025).
[3] IQAir | Yang Pertama dalam Kualitas Udara n.d. https://www.iqair.com/id/ (accessed March 21, 2025).
[4] Kampa M, Castanas E. Human health effects of air pollution. Environ Pollut 2008;151:362–7. https://doi.org/10.1016/j.envpol.2007.06.012.
[5] Sundell J. On the history of indoor air quality and health. Indoor Air 2004;14 Suppl 7:51–8. https://doi.org/10.1111/j.1600-0668.2004.00273.x.
[6] Wargocki P, Sundell J, Bischof W, Brundrett G, Fanger PO, Gyntelberg F, et al. Ventilation and health in non-industrial indoor environments: report from a European multidisciplinary scientific consensus meeting (EUROVEN). Indoor Air 2002;12:113–28. https://doi.org/10.1034/j.1600-0668.2002.01145.x.
[7] Zhang J, Smith KR. Indoor air pollution: a global health concern. Br Med Bull 2003;68:209–25. https://doi.org/10.1093/bmb/ldg029.
[8] Wolverton BC, Johnson A, Bounds K. Interior Landscape Plants for Indoor Air Pollution Abatement. 1989.

[9] Kim H-H, Yeo I-Y, Lee J-Y. Higher Attention Capacity After Improving Indoor Air Quality by Indoor Plant Placement in Elementary School Classrooms. The Horticulture Journal 2020;89:319–27. https://doi.org/10.2503/hortj.UTD-110.
[10] (PDF) Phytoremediation of Formaldehyde by Plant Stems. ResearchGate 2024. https://doi.org/10.21203/rs.3.rs-225204/v1.
[11] Aydogan A, Montoya LD. Formaldehyde removal by common indoor plant species and various growing media. Atmospheric Environment 2011;45:2675–82. https://doi.org/10.1016/j.atmosenv.2011.02.062.
[12] Matheson S, Fleck R, Irga PJ, Torpy FR. Phytoremediation for the indoor environment: a state-of-the-art review. Rev Environ Sci Biotechnol 2023;22:249–80. https://doi.org/10.1007/s11157-023-09644-5.
[13] Dela Cruz M, Christensen JH, Thomsen JD, Müller R. Can ornamental potted plants remove volatile organic compounds from indoor air? A review. Environ Sci Pollut Res Int 2014;21:13909–28. https://doi.org/10.1007/s11356-014-3240-x.
[14] Green wall technology for the phytoremediation of indoor air: a system for the reduction of high CO2 concentrations | Request PDF. ResearchGate 2024. https://doi.org/10.1007/s11869-016-0452-x.
[15] (PDF) Reducing indoor air pollution through applied botanical biofiltration. ResearchGate, n.d.