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The Effect of Sansevieria Extract on Indoor Carbon Monoxide from Cigarette Smoke

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Air quality degradation can occur through changes in physical or chemical properties. Biodiversity in Indonesia can be a solution to the increasingly concerning air pollution problem. There are many types of plants that have the potential to absorb cigarette smoke air pollution, including sansevieria. Sansevieria plants can reduce both indoor and outdoor air pollution, particularly CO from cigarette smoke. Furthermore, NASA research has found evidence that this plant naturally absorbs toxic materials such as carbon dioxide, benzene, and formaldehyde. Purpose The purpose of this study was to determine the effectiveness of Sansevieria plant extract in absorbing cigarette smoke pollution, specifically CO gas. The study compared indoor CO levels from cigarette smoke with and without snake plant extract, using three replicates (or trials). Sensitivity tests showed that 1.5 grams of snake plant ethanol extract reduced carbon monoxide levels by 89.5 ppm within 15 minutes per cigarette. So it can be concluded that the extracts of the Sansevieria masoniana and trifasciata laurentii plants are useful as a solution to air pollution.

Keywords: Air pollution, Carbon Monoxide, Sansevieria

INTRODUCTION

Indonesia is Indonesia is known for its high biodiversity due to its vast territory and tropical climate, which support the growth of various plant species. Air is a vital human necessity that currently requires serious attention as part of Indonesia's National Health Development policy, where air pollution control programs are among the main priorities (Depkes RI, 2007). Air pollution poses a significant environmental health threat and is a major risk factor for both acute and chronic respiratory diseases. Outdoor air pollution continues to increase due to human activities. In low- and middle-income countries (LMICs), rapid urbanization and economic transformation contribute significantly to increasing air pollution levels, with health impacts further exacerbated by poverty (Abbah et al., 2024). Based on the Air Pollution Standard Index (ISPU) data in 2019, Indonesia was categorized from unhealthy to hazardous based on monitoring from 13 of 26 air quality stations (Dasrul & Zahara, 2020).

Air pollution is one of the leading global causes of disease, as it has widespread and serious impacts on human health, including increased cancer risk (Turner et al., 2020). Prolonged human activity in confined spaces can increase carbon monoxide (CO) levels, which may cause discomfort and disrupt health (Andrizal et al., 2020). Reducing air pollution is considered one of the most effective strategies to prevent respiratory diseases (Khwaja et al., 2023). Exposure to air pollutants such as PM10, PM2.5, SO_2, and NO has been associated with adverse respiratory outcomes in children, including the development of asthma following acute bronchiolitis (Spencer et al., 2023). During the COVID-19 pandemic, restrictions on human activity resulted in improved air quality in several regions, including Banjarmasin City (Agustina et al., 2022).

Globally, poor air quality contributes to millions of deaths each year. Major air pollutants include PM2.5, PM10, NO_2, O_3, CO, and SO_2. Among these, PM2.5 is considered the most harmful due to its ability to penetrate deeply into the respiratory tract and cause severe diseases. Lockdown policies implemented worldwide resulted in significant reductions in PM2.5 and NO_2 concentrations, mainly due to reduced transportation and industrial activities (Achakulwisut et al., 2016; Tobías et al., 2020). Despite these temporary improvements, air pollution continues to pose major challenges to public health, ecosystems, and sustainable development (Ogen, 2020; Muhammad et al., 2020).

Indonesia also faces increasing indoor air pollution, particularly due to cigarette smoke. Smoking has become culturally ingrained, and nicotine addiction remains difficult to control. Cigarette smoke contains approximately 4,000 chemical compounds, including nicotine, nitrogen oxides, carbon dioxide, and carbon monoxide, which are comparable to industrial pollutants. Indonesia ranks third globally in the number of smokers, with 23.21% of the population identified as active smokers in 2020 (BPS, 2020). Smoking-related diseases account for approximately 225,700 deaths annually, with smoking prevalence among adolescents continuing to rise (WHO, 2020).

Cigarette smoke consists of approximately 85% gaseous substances and 15% particulate matter, with carbon monoxide being one of the most hazardous components. Passive smokers are therefore encouraged to seek effective and environmentally friendly mitigation strategies. One potential solution is the use of plants with phytoremediation capabilities, such as Sansevieria, commonly known as mother-in-law's tongue. Sansevieria has thick, succulent leaves that facilitate gas absorption and pollutant reduction. Several studies have shown that Sansevieria is capable of absorbing various air pollutants and reducing indoor CO_2 and CO levels (Das et al., 2019; Ali et al., 2024).

In addition to its phytoremediation potential, Sansevieria possesses bioactive compounds such as flavonoids, phenols, saponins, and alkaloids, which exhibit antioxidant and antimicrobial activities. These compounds are capable of neutralizing free radicals and may contribute to the degradation of toxic gases such as carbon monoxide (Rihanah & Minarni, 2020; Riksanto, 2021). Previous studies have reported that extracts of Sansevieria trifasciata can reduce carbon monoxide levels from cigarette sidestream smoke (Dewatisari et al., 2020). However, comparative studies examining the effectiveness of different Sansevieria species extracts in reducing cigarette smoke-induced CO pollution remain limited.

Therefore, this study aims to evaluate the effectiveness of leaf extracts from Sansevieria masoniana and Sansevieria trifasciata laurentii as potential solutions to indoor air pollution caused by cigarette smoke, specifically in reducing carbon monoxide levels. (Dewatisari, W.F., et al. 2020).

METHODS

This study uses an analytical observational design with a cross-sectional approach, which was carried out at the Putri Cempo Final Disposal Site (TPA), Surakarta, in October 2024. The research population consisted of all waste pickers in the Putri Cempo Landfill area. Sampling was carried out by purposive sampling method. Sampling was based on the informal and unregistered nature of the waste pickers population and to target participants who met the criteria with specific experience. The following are the inclusion criteria set: (1) waste pickers who have worked at the landfill for at least one year, (2) willing to participate, and (3) have signed an informed consent sheet. A total of 46 respondents met these criteria. Dependent variables are compliance with personal hygiene and the use of Personal Protective Equipment (PPE), while independent variables include age, gender, and education level.

Data were collected using a structured questionnaire filled out through direct interviews by researchers, consisting of 3 sections covering respondent characteristics, personal hygiene practices, and PPE use. Respondents' compliance was assessed using a questionnaire containing 5 questions related to PPE compliance and 7 questions related to compliance with personal hygiene. If the respondents answered 'yes' ≥50% questions were categorized as 'adequate'. The questionnaire was adapted from (Al-Khatib et al., 2020; Assemie et al., 2021; Mardu et al., 2019) and tested the validity and reliability of 20 waste pickers in different locations by showing a Cronbach's alpha value of 0.82.

Data analysis was performed using Fisher's exact test, as the data did not meet the assumptions required for the chi-square test. A $p<$ value of 0.05 is considered statistically significant. This research has received ethical approval from the Research Ethics Committee of the Faculty of Medicine, Sebelas Maret University, Surakarta (Protocol ID: 200/01/08/2024; September 9, 2024). Ethical procedures include giving written consent, ensuring the validity of questionnaires, and maintaining strict confidentiality of all participant data.

Research Design

This study employed a quantitative experimental approach using a quasi-experimental design. The study aimed to compare carbon monoxide (CO) levels in air contaminated by cigarette smoke before and after treatment with extracts from Sansevieria masoniana and Sansevieria trifasciata laurentii.

Research Type

Independent variables: Type of Sansevieria extract (S. masoniana and S. trifasciata laurentii).

Dependent variable: Reduction of carbon monoxide (CO) levels. Controlled variables: Duration of cigarette smoke exposure, extract concentration, drying time (48 hours), and measurement time intervals.

Research Location

The research was conducted from June to July 2023 at the Laboratory of the Faculty of Health Sciences, Universitas Islam Lamongan, and the Testing Services Unit (ULP) of the Faculty of Pharmacy, Universitas Airlangga Surabaya.

Materials and Instrumentation

The materials used included Sansevieria leaves, 96% ethanol, and a closed glass chamber containing cigarette smoke. Instruments included an oven, blender, digital scale, beaker glass, pipettes, gauze, rotary evaporator, and a CO meter for measuring air quality.

Extraction and Formulation of Sansevieria Leaf Extract

Fresh leaves of S. masoniana and S. trifasciata laurentii were washed, cut into small pieces, and oven-dried at 60°C until moisture content reached approximately 20%. The dried material was ground into powder, and 500 grams were macerated using 96% ethanol for 2 × 24 hours with periodic stirring. The filtrate was collected, filtered, and concentrated using a rotary evaporator to obtain a thick extract, which was then diluted with ethanol to achieve the required concentration.

Data Collection Procedures

Data Collection Techniques : The tools used in this study include: oven, knife, plastic containers or buckets, digital scale, graduated pipette, tweezers, Pasteur pipette, beaker glass, jars, gauze, plastic cups, paper labels, blender, and pen. The materials used are *Sansevieria* plants, 96% ethanol solution, and a closed glass chamber containing one lit cigarette (Ikewuchi, C. C., et al. 2011). A closed glass chamber measuring 20 × 15 × 30 cm was prepared and filled with cigarette smoke. The Sansevieria extract solution was placed inside the chamber, and CO levels were measured using a CO meter at 5-minute intervals from the 5th to the 15th minute after exposure (Wicaksono, R. R., & Sulistiono, E. (2021).

Data Analysis

Data on CO concentration before and after treatment were analyzed quantitatively using appropriate statistical tests to assess differences in CO levels following exposure to each Sansevieria extract.

RESULT AND DISCUSSION

Extraction Results of *Sansevieria* Plants (*Sansevieria masoniana* and *Sansevieria trifasciata laurentii*)

The maceration extraction of Sansevieria leaves using 96% ethanol followed by solvent removal with a rotary evaporator produced a viscous extract as a result of ethanol evaporation. The concentrated extract was subsequently diluted prior to experimental application. The extraction results are presented in Table 1.

Table 1.

Extraction Results of Snake Plant (Sansevieria masoniana and Sansevieria trifasciata laurentii)

Extracted Plant Species	Weight (g)	Solvent Volume (ml)	Extraction Yield (%)	Dilution (%)
Sansevieria masoniana	107.0	645	5.5	96
Sansevieria trifasciata laurentii	68.5	274	4.0	96

Based on Table 1, the extraction yield of S. masoniana (5.5%) was higher than that of S. trifasciata laurentii (4.0%). These yields are considered moderate and within the normal range for ethanol-based extraction of Sansevieria species, which has been reported to range between 4% and 7%, depending on plant moisture content, particle size, and extraction conditions. Similar yields were reported in studies on ethanol extraction of Sansevieria leaves targeting phenolic and flavonoid compounds (Adawiyah et al., 2013; Lee et al., 2024).

The use of 96% ethanol as the extraction solvent was based on its effectiveness in dissolving polar to semi-polar secondary metabolites, including flavonoids, tannins, and phenolic compounds. Ethanol is capable of forming hydrogen bonds with hydroxyl (–OH) functional groups present in these bioactive compounds, thereby enhancing extraction efficiency. High-concentration ethanol has also been reported to improve selectivity toward antioxidant compounds while minimizing the co-extraction of unwanted highly polar impurities (Lee et al., 2024).

Solvent removal was performed using a rotary evaporator at 60°C, which is a preferred method for concentrating plant extracts while preserving the integrity of heat-sensitive phytochemicals. Evaporation under reduced pressure allows ethanol to be removed at lower effective temperatures, preventing degradation of bioactive compounds. This approach has been widely validated in phytochemical purification and botanical extraction studies (Azwanida, 2015).

Effect of *Sansevieria* Plant Extracts (*Sansevieria masoniana* and *Sansevieria trifasciata laurentii*) on Cigarette Smoke Pollution

The results of the study on the effect of *Sansevieria* leaf extracts on cigarette smoke air pollution are presented below.

Table 2.

The measurement results of air quality contaminated by cigarette smoke without *Sansevieria* extraction

Control	CO Gas Concentration (ppm)
5th min	1055

Control	CO Gas Concentration (ppm)
10th min	1068
15th min	1080

As shown in Table 2, CO concentrations increased progressively over time in the control condition, indicating continuous accumulation of carbon monoxide in the enclosed chamber when no extract was applied.
The air quality measurement results for cigarette smoke contaminated air treated with *Sansevieria masoniana* extract are presented in Figure 1 below:

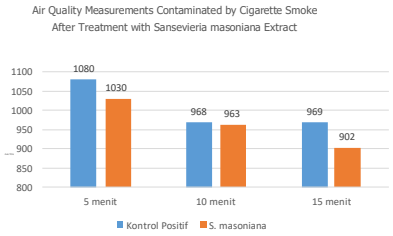

Figure 1. Air Quality Measurement Contamined by Cigaretta Smoke After Treatment with *Sansevieria masoniana* Extract

Based on the graph in Figure 1 above, the air quality measurements contaminated by cigarette smoke after treatment with Sansevieria masoniana extract during three measurements were 1030 ppm, 963 ppm, and 902 ppm, respectively. The air quality measurement results of cigarette smoke contaminated air treated with Sansevieria trifasciata laurentii extract are shown in Figure 2 below:

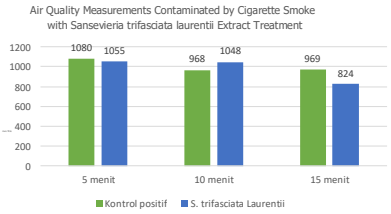

Figure 2. The air quality measurement results of cigarette smoke contaminated air treated with Sansevieria trifasciata laurentii extract

Based on Figure 2 above, the results show that the air quality contaminated by cigarette smoke treated with Sansevieria masoniana extract over three measurements yielded CO gas levels of 1030 ppm, 963 ppm, and 902 ppm. The air quality measurements for cigarette smoke-contaminated air treated with Sansevieria trifasciata laurentii extract are presented in Figure 3 below:

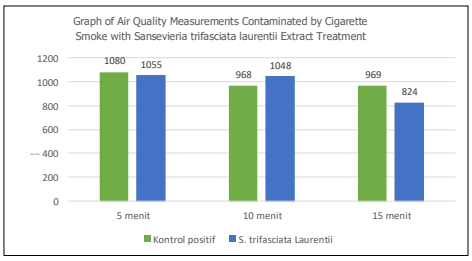

Figure 3. The air quality measurements for cigarette smoke-contaminated air treated with Sansevieria trifasciata laurentii extract

Based on Figure 3 above, the air quality measurements contaminated by cigarette smoke treated with Sansevieria trifasciata laurentii extract over three trials showed CO gas levels of 1055 ppm, 1048 ppm, and 824 ppm. From Figures 1 and 2, it can be concluded that the longer the exposure time of both Sansevieria plant extracts in the closed room contaminated by cigarette smoke, the greater the reduction in CO gas concentration within a 15-minute exposure period.

Extraction of Mother-in-Law's Tongue (Sansevieria masoniana & Sansevieria trifasciata laurentii)

The extraction of mother-in-law's tongue (Sansevieria masoniana and Sansevieria trifasciata laurentii) leaves was conducted using the maceration method with 96% ethanol as the extraction solvent. Ethanol was selected due to its suitability for extracting moderately polar bioactive compounds, particularly pregnane glycosides, flavonoids, tannins, and other phenolic constituents, which are known to play an important role in antioxidant and pollutant-reducing activity. The polarity of ethanol allows effective penetration into plant cell walls, thereby enhancing the solubilization and recovery of secondary metabolites. In addition, ethanol possesses antimicrobial properties that inhibit microbial growth during the maceration process, ensuring extract stability (Lee et al., 2024; Riksanto, 2021).

The maceration process was repeated three times with periodic stirring to optimize compound diffusion and extraction efficiency. Following maceration, the extract was filtered using a Büchner funnel to separate the filtrate from plant residues. The filtrate was then concentrated by evaporation at 60°C using a vacuum rotary evaporator, a method widely applied to preserve heat-sensitive phytochemical compounds. Controlled evaporation under reduced pressure minimizes thermal degradation of bioactive constituents while effectively removing the solvent, resulting in a concentrated extract with maintained chemical integrity (Azmir et al., 2013).

In the carbon monoxide (CO) reduction test, the application of Sansevieria leaf extract demonstrated a mean decrease of 89.5 ppm in CO concentration originating from cigarette smoke. This finding indicates that 1.5 g of Sansevieria extract per cigarette is sufficient to significantly reduce CO levels, confirming the extract's potential as a plant-based solution for mitigating indoor air pollution caused by cigarette smoke.

Mechanism of Action of Sansevieria Leaf Extracts (Sansevieria masoniana and Sansevieria trifasciata laurentii) in Absorbing Cigarette Smoke

Sansevieria species are widely recognized for their exceptional tolerance to diverse environmental conditions, including low light intensity, temperature fluctuations, and exposure to harmful air pollutants. These plants have been reported to absorb up to 107 types of airborne pollutants, making them effective biological agents for air purification in both indoor and outdoor environments (Das et al., 2019). The pollutant absorption mechanism of Sansevieria masoniana and Sansevieria trifasciata laurentii primarily occurs through the leaf surface, where gas exchange and adsorption take place. As the plant matures, increased leaf surface area enhances its capacity to absorb and neutralize gaseous pollutants. Previous studies have shown that a Sansevieria plant with an average height of 100 cm can reduce carbon monoxide concentrations by up to 84.18%, and that several leaves are sufficient to significantly improve air quality in smoke-contaminated rooms (Adawiyah et al., 2013).

In addition to physical adsorption, Sansevieria exhibits a biochemical detoxification mechanism, whereby absorbed pollutants undergo metabolic transformation. Toxic gases such as carbon monoxide are converted into less harmful compounds through oxidation and biochemical degradation processes involving phenolic compounds and flavonoids. These phytochemicals possess strong antioxidant activity, enabling them to neutralize reactive molecules and contribute to pollutant breakdown (Rihanah & Minarni, 2020).

The findings of this study confirm that Sansevieria leaf extracts prepared via maceration using 96% ethanol retain these functional properties. The observed reduction in CO concentration demonstrates that the active compounds responsible for pollutant mitigation remain effective even in extract form, supporting previous findings that phytochemical-rich extracts can serve as an alternative to whole plants for air pollution control (Dewatisari et al., 2020). Therefore, both Sansevieria masoniana and Sansevieria trifasciata laurentii extracts show strong potential as environmentally friendly agents for reducing carbon monoxide levels in cigarette smoke.

CONCLUSION

This study confirms that leaf extracts of Sansevieria masoniana and Sansevieria trifasciata laurentii effectively reduce carbon monoxide (CO) levels produced by cigarette smoke in a closed environment. The application of 1.5 g of extract per cigarette resulted in an average CO reduction of 89.5 ppm within 15 minutes, with greater reductions observed at longer exposure times. These results indicate that Sansevieria extracts possess functional bioactive compounds capable of mitigating indoor air pollution caused by cigarette smoke, particularly carbon monoxide.

SUGGESTION

Based on these findings, Sansevieria plants or their extracts may be considered as a supportive, plant-based approach for improving indoor air quality, especially in smoke-exposed enclosed spaces. Further studies are recommended to isolate active compounds such as pregnane glycosides and to evaluate the effectiveness of Sansevieria extracts against other cigarette smoke pollutants, including particulate matter and nitrogen oxides, under real indoor conditions.

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