

The use of *Sansevieria sp.* and *Cymbopogon nardus* extracts on humidifier modification to reduce airborne germs

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Article Info

Article history:

Received Sept 29, 2021

Revised Aug 2, 2022

Accepted Aug 30, 2022

Keywords:

Cymbopogon nardus

Germ number

Sansevieria

ABSTRACT

A humidifier including natural components such as mother-in-tongue law's (*Sansevieria sp.*) and lemongrass (*Cymbopogon nardus*) extracts is required to control room air quality. The purpose of this study was to assess the chemical composition and anti-fungal and anti-germ capability of *Sansevieria sp.* and *Cymbopogon nardus* in a room. The experimental method and One Group Pre-test Post-test Design were utilized in this investigation. To minimize airborne germs, *Sansevieria sp.* and *Cymbopogon nardus* extract were used as humidifier modification materials in this case. Concentrations of *Sansevieria sp* extract of 30%, 40%, and 50% were made available. The data was analyzed using Anovatest. The Anova test results showed that the *Sansevieria sp.* extracts with concentrations of 30%, 40%, and 50% had p-values greater than 0.05. It signifies that there was no significant or insignificant difference in the concentrations used, hence the extracts of *Sansevieria sp* and *Cymbopogon nardus* extracts had the same effective antibacterial potential in this investigation. It was determined that *Sansevieria sp* and *Cymbopogon nardus* extract as modified humidifier solution at concentrations of 30%, 40%, and 50% have the same efficacy in decreasing Germ in the room air.

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1. INTRODUCTION

Air pollution, both from motor vehicles and industrial fumes, has often emerged in big cities. Another source of air pollution comes from cooking activities that still use wood, and coal. So they produce sulfur dioxide, Nitrogen, and Particulate Matter gas which can accumulate in the environment and increase the risk of people with respiratory problems [1]. Air pollution not only emerges outdoors but also indoors which is caused by several aspects, such as the use of odor, the presence of microorganisms and smoke, as well as the use of insect repellent [2]. In relation to this, there is the term Sick Building Syndrome term which has recently emerged. The such syndrome is a condition where there is increased indoor air pollution exposes humans. Such condition is caused by several factors, such as building construction, the use of synthetic materials, the use of chemical formulas for various purposes of insecticides, facial/cosmetic treatments, pesticides, air fresheners, and cigarette smoke [3]. In this study, *Sansevieria sp* and *Scindapsus Aureus* plants were employed as media to reduce the concentration of Carbon Monoxide In relation to this topic, previous research that has been conducted has never found that sansivera can reduce the amount of airborne germ. However, a previous study conducted by Nor Hidayah A proposed that ventilation and the accumulation of potential pollutants within the indoor environment are major determinants of sick building syndromes [4].

Cymbopogon contains 30-45% citronella components, 65-90% geraniol, 11-15 percent citronellol, 3-8 percent geranyl acetate, 2-4% citronellyl acetate, citral, and kavikol. Rizkyrahadian *Sansevieria sp* is a decorative plant with a range of leaf forms and hues that is easy to grow on the home page without much maintenance [5]. This plant is cultivated because beauty of the structure and color of the leaves [6]. With the shape, color, size, and pattern of leaves Variations cause this plant to be of economic value high [7]. *Sansevieria sp* is a herbaceous plant with horizontal red rhizome roots yellow and has a height of 0.4-1.8m [8]. Leaves of mother-in-law's tongue plant is 2-6 pieces per plants, in the form of a narrow line on the base with a pointed tip [9]. This plant can be found from the plains to 1-100 meters above sea level. *Sansevieria* has been known to many people for millennia, and it was first cultivated as a decorative plant in the nineteenth century [10]. From 2000 to 2004, and again from 2004 to 2008, public interest in *Sansevieria sp* remained high. *Sansevieria sp* plants are a sophisticated attractive plant due of their unusual shape, and they are very easy to care for [11]. *Sansevieria sp* is used to embellish anything from home gardens to five-star hotels. *Sansevieria sp* plants are imported from Africa, however they have been developed in Indonesia for a long time [12].

In recent years, even in the largest and most industrialized cities, the air inside homes and other structures has been found to be more polluted than the outdoor air. People spend over 90% of their time indoors. As a result, many people may face a larger health risk as a result of exposure to interior air pollution than to outside air pollution [13]. The findings of this study may be beneficial in defining indoor air microbiological quality criteria for classrooms, which has not previously been done. This frequently leads to a condition known as "sick building syndrome" (SBS), in which structure occupants experience severe health consequences that appear to be related to the amount of time spent in the building. High amounts of carbon dioxide emitted by tenants and the creation of moisture that causes condensation in the cavity of the building walls are signs of the reason. This is how the fungus grows unnoticed and undetected [14]. In this instance, development is required to produce healthy and sustainable building environments by establishing indoor air rules that account for all indoor pollutant sources [15] since the pollutants emerged may intrude into the indoor environment, causing health risks to the occupants [16]. In general, the educational building workshops had the highest elemental contamination [17].

Indoor air quality has become a major concern as a result of technological advancements in thermal windows and buildings, which have grown more energy-efficient yet result in sealed structures, which can dramatically raise pollutants concentrations, posing significant health risks [18]. The phenomena of air quality, particularly indoors, has an impact on the comfort and health of the occupants. As a result, it must be in conformity with the applicable requirements, which means that no contaminants in unsafe amounts should be present. In this example, around 80% or more of the residents of a room were bothered by the indoor air quality. As a result, optimal thermal comfort and acceptable indoor air quality (IAQ) are regarded as critical factors for room occupants [19]. However, the quality of indoor air microbiology also affects the health of residents.

The United States Environment Protection Agency states that lung, heart, and cancer diseases, which are difficult to treat and cause mortality, account for 40% of long-term unhealthy indoor air exposure to humans. This can occur in a room in a house, office, vehicle, school, and others whose air is not healthy. According to the American Industrial Hygiene Association, the problem of air pollution starts from a small part of fungal spores which are actually harmless, but its colonies of fungi and germs can develop when they are in conducive condition. Spores will be released in the air and inhaled by humans when the fungus is on the surface. A previous study carried out by Jung, CC in 2016 measured the levels of carbon dioxide (CO₂), total volatile organic compounds (TVOC), particulate matter with an aerodynamic diameter less than 2.5 μm (PM_{2.5}), as well as the bacteria and fungi in the subjects' work-places [20]. The pollutant effects were divided by median resulting that individuals with higher Body Mass Index have higher cardiovascular disease risk when they are exposed to poor indoor air quality (IAQ) [21].

To reduce and control indoor air pollution, a technology that can reduce chemical or microbiological pollutants is needed. The results of another previous study by [21] stated that the *Sansevieria sp sp* extract was effective in reducing the amount of germs and fungi in the room air [21]. Based on the Phytochemical test that has been conducted, it was proven that there were active substances contained in *Sansevieria sp sp* extract [22]. Based on the Phytochemical test that has been conducted, it was proven that there were active substances contained in *Sansevieria sp* extract [22]. These active substances are Saponins, Steroids, and Triterpenoids which are anti-bacterial and very helpful in controlling room air quality, especially from microbiological elements. In addition, Pamopol [19] conducted a research resulting that the maximum CO₂ concentration was above the suggested level for occupants' comfort. Simple ventilation procedures and the placement of a number of *Sansevieria trifasciata* (*S. trifasciata*) plants were used to improve the IAQ, with the goal of lowering CO₂ concentrations and saving energy. However, the research only shows a reduction in CO pollution; our goal is to show that sansievera can reduce the quantity of airborne pathogens.

The essential oil contained in Lemongrass Extract is biologically active as a natural antifungal, antibacterial and antimicrobial. The dose of citronella oil (*Cymbopogon nardus Rendle*) used determines the activity of citronella oil in inhibiting the growth of the fungus to be tested. Another study by Chanthai *et al.* [23]. explained that essential oil from *Cymbopogon nardus extract* is an interesting alternative to control indoor microbial contaminants. The principal herbs in Indonesia include *Sansevieria sp trifasciata* and *Sansevieria cylindrica*, which contain many bioactive components that may be used as antibacterial agents. As a result, the purpose of this study was to assess the antibacterial activity of *Sansevieria sp* [24].

Furthermore, based on the research of Rusmiati [21], when *Sansevieria sp* sp extract was used as an antifungal, it could reduce the levels of fungi/mold in the room by 50%. However, this study categorized the concentration of *Sansevieria sp* sp to 30%, 40%, and 50% as an antifungal and the anti-airborne germ. In addition, *Cymbopogon nardus extract* 0.1% was also used in the humidifier modification [25]. The purpose of this study was to evaluate the chemical composition and potential of *Sansevieria sp* sp and *Cymbopogon nardus* as anti-fungal and anti-germ substances in the room [26].

2. RESEARCH METHOD

The study used the post-test only control group design to test the ability of Sansieverasp and *Cymbopogon nardus* extracts by using a humidifier as a spray tool. Humidifiers use ultrasonic waves to break water into water vapor. As a modification, the water used was replaced with extracts of Sansieverasp and *Cymbopogon nardus*. The samples used were *Sansevieria sp* extract 30%, 40%, and 50% and *Cymbopogon nardus* 0.1%, which were put into a humidifier in the room. The test was carried out three times so that the sample was divided into 54. In addition, the number of germs in the room was measured using a micro air sampler (MAS), while temperature and humidity were measured using a thermometer and hygrometer.

Extracts were made in the Herbal Materia Medica Batu laboratory, Surabaya, and Surabaya City Health Laboratory, and material testing were applied in the classrooms of the environmental health department, health polytechnic of the ministry of health, Surabaya. The application of the formula for extracts of mother-in-law's tongue and lemongrass in the classroom is carried out using a humidifier in an area with a volume of $1 \times 1 \times 1 \text{ m}^3$ as shown in Figure 1.



Figure 1. Sampling with Microbiological air sampler

The procedure of this research can be seen in Figure 2. It is covering the preparation of extracts of *Sanseivera sp* and *Cymbopogon nardus*; Sampling of indoor air in a miniature room was carried out before being exposed to a humidifier containing extracts of Sansieverasp and *Cymbopogon nardus*. Let stand for 24 hours, then take a sample to count the number of bacteria; The operation of the humidifier in a miniature room is carried out by filling the humidifier with Sansieverasp extract at different concentrations of 30%, 40%, and 50%, and 10% *Cymbopogon nardus* extract; Humidifiers operate by heating water to produce water vapor. As a modification of the water used in humidifiers, a distilled extract of 'mother-in-law' flax/bowstring (*Sanseivera sp*) was used; After 24 hours, take a sample of indoor air by placing Nutrient Agar in Micro Water and send it to the Laboratory to check the number of bacteria.

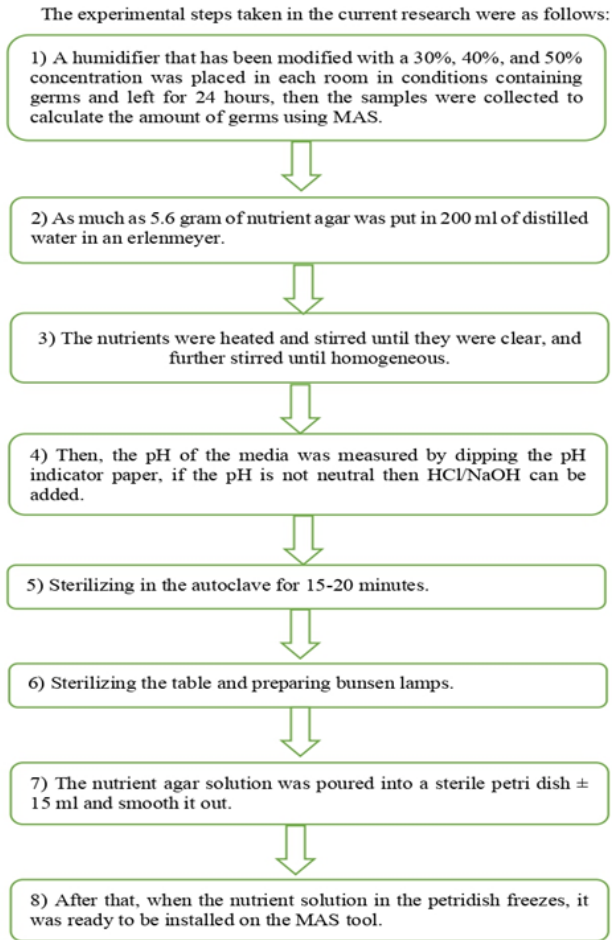


Figure 2. Research flow

3. RESULTS AND DISCUSSION

Figure 3 shows the results of the germ of room air calculation before and after using *Sansevieria sp* spextract found a decrease in the number of germs after *Sansevieria sp* spextract with a concentration of 30% and *Cymbopogon nardus* 0.1% with an exposure time of 3 hours. room air decreased by an average of 12.2 CFU/m3 (79.3%).

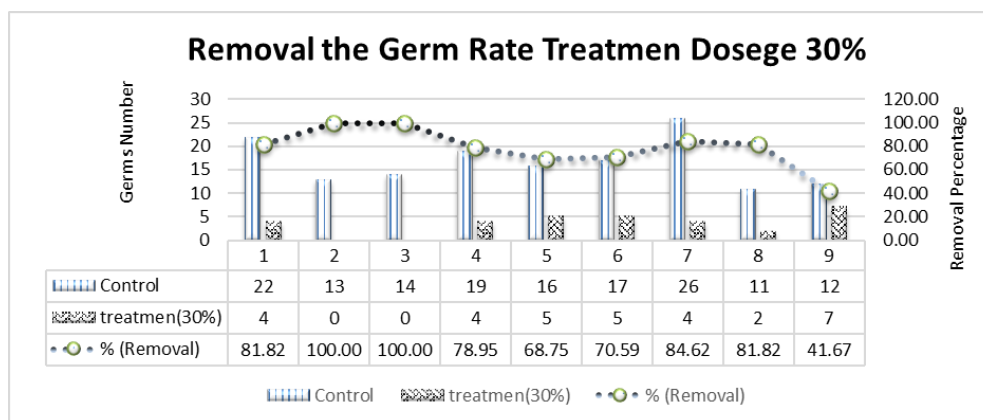


Figure 3. Differences of germ in room air before and after using *Sansevieria sp* 30% and *Cymbopogon nardus* 0.1% as a modified humidifier solution

Figure 4 shows the results of calculating germs in the room air before and after using *Sansevieria spsp* extract with a concentration of 40% and *Cymbopogon nardus* 0.1% in a Humidifier with an exposure time of three hours. The measurement results found that the decrease in germs in the room air was 14.6 CFU/m3 (74.24%).

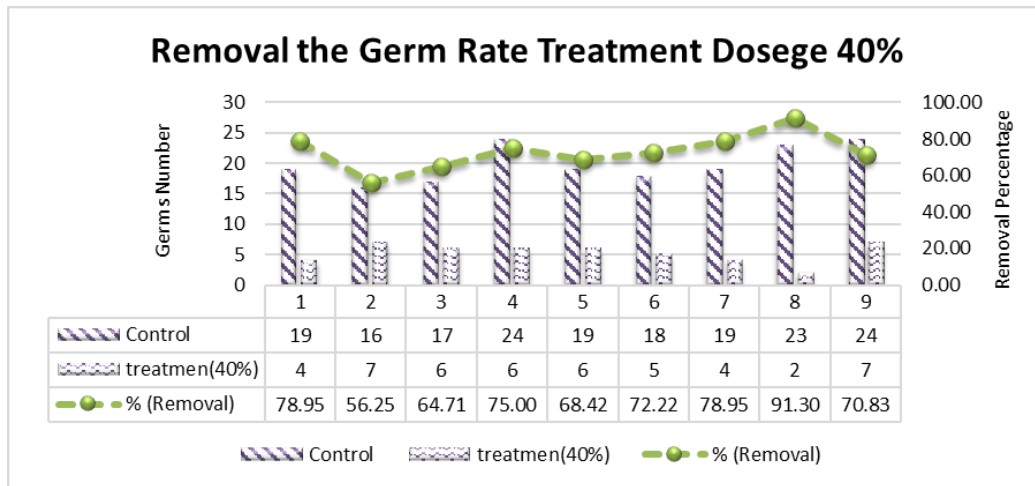


Figure 4. Differences of germs in room air before and after using *Sansevieria sp* 40% and *Cymbopogon nardus* 0.1% as a modified humidifier solution

Figure 5 shows the results of calculating germs in the room air before and after using *Sansevieria sp* extract at a concentration of 50% and *Cymbopogon nardus* 0.1% in a Humidifier with an exposure time of 3 hours. From the measurement results, the difference in room air germs before (pre) and after (post) treatment using *Sansevieria sp* extract at a concentration of 50% and *Cymbopogon nardus* 0.1% as a modified humidifier solution of 11.2 CFU/m3 (65.11%).

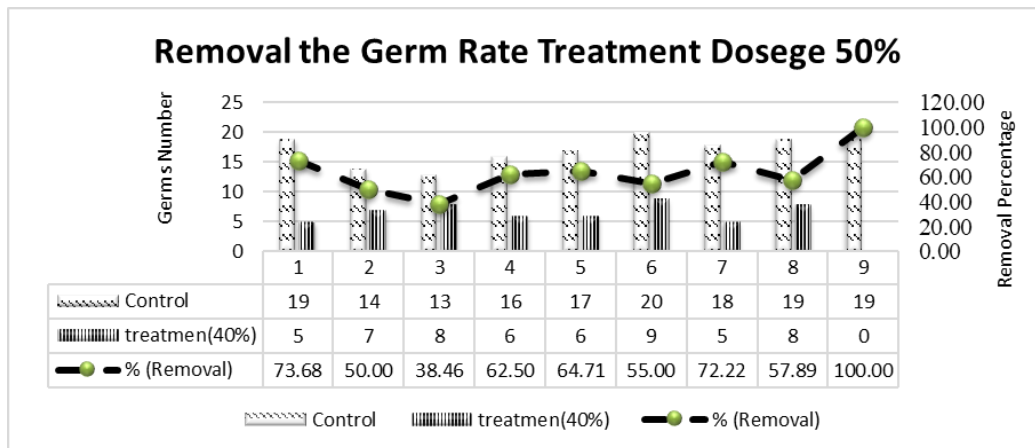


Figure 5. Differences of germs in the room air before and after using *Sansevieria sp* at the concentration of 50% and *Cymbopogon nardus* 0.1% as a modified humidifier solution

The results of statistical tests showed that the extract of *Sansevieria sp* at a concentration of 30% and *Cymbopogon nardus* 0.1% reduced germs by 78.2%. In comparison, at a concentration of 40%, it reduced germs by 74.24%, and at a concentration of 50%, it reduced germs by 65.11%. Furthermore, the LSD test was carried out to determine the most effective modification in reducing the number of germs by comparing the extract of *Sansevieria sp* used. The results obtained at concentrations of *Sansevieria sp* extract 30%, 40%, and 50% had a p-value >0.05, meaning there was no significant or significant difference.

Cymbopogon nardus is considered noteworthy among several others existing plant species which have medicinal properties, due to its pharmacological potential, including as antiviral, antibacterial, antifungal, and anti-trypanosomal activities [27]. There are many bacteria in the air which is possibly carried by dust or blown by wind or dry saliva residue. These bacteria include *Bacillus sp*, *Staphylococcus sp*, *Pneumonia*, *Coloform*, Hepatitis Virus, and *Clostridium sp*. According to the purpose of this study, the extracts of *Sansiviera sp* at concentrations of 30%, 40%, and 50% as well as *Cymbopogon nardus* extract 0.1% in a humidifier can reduce the germ in the air of a room. Furthermore, based on the results of phytochemical tests, *Sansiviera sp* contains saponins, flavonoids, and alkaloids which have function as antioxidants. Meanwhile, *Cymbopogon nardus* contained active ethanol such as flavonoids, polyphenols and saponins and essential oils as anti-microbial. In addition, Naik *et al.* [28]. claimed that *Cymbopogon* extract is anti-bacterial against *Escherichia coli*, *Bacillus cereus*, *Bacillus subtilis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa* and *Staphylococcus aerus*. Saputra *et al.* also explained that *Cymbopogon nardus* has bactericidal activity (BA), anti-fungal, anti-free radicals, waste degradation (agricultural, faecal), insect repellents, and natural staple preservation benefits [29]. Therefore, the properties owned by *Sansiviera, sp* and *Cymbopogon nardus* can reduce the germs and bacteria in the indoor air at optimum temperature and humidity conditions. Another research also further found that essential oil contained in *C. nardus* was significantly higher in its leaves followed by sheath, flowers and roots [30].

The decrease of germs in the room air is due to the adsorption capacity of *Sansevieria*. According to the results of research by Tahir *et al.* *Sansevieria* extract can absorb pollutant elements in the air such as lead, fungi and bacteria [31]. The results of the Wicaksono study [32] showed that the combination of *Sansevieria sp* and *Cymbopogon* plants that were dried for 48 hours effectively inhibited the rate of microbial growth. Room temperature ranging from 27-30 °C and room humidity ranging from 78-90% are the optimum conditions for the growth of microorganisms. Bacterial cells can grow rapidly at this temperature and at temperatures below or above they can still reproduce even though not much. According to Pelczar, there are several factors that determine the number and type of microorganisms, for example the source of microorganisms (soil, sea, humans (sneezing), the resistance of the type of microorganisms to physical conditions such as temperature, humidity and sunlight, the number and activities, and the external environment. In the bacterial growth phase, the presence of *Cymbopogon nardus* extract in the indoor air can disrupt the growth phase, which was originally a logarithmic phase, is then become a stationary phase, or even a death phase. In addition, lemongrass essential oil shows a wide spectrum of biological activities. These activities include high antibacterial and remarkable antifungal activities which allows the lemongrass oil as a potential food preservative.

Furthermore, based on the work of wolfereton environmental service, *Sansevieria sp* leaves has the ability to absorb 0.938 micrograms per hour. Therefore, an adult *Sansevieria sp trifasciata* with 5 leaves is already enough to clean contaminants in a 100 m³ room. Another specialty of *Sansievera sp* is its ability to withstand a wide range of temperatures and bright light.

3.1. Decreasing germ numbers

According to [33], the potential active compounds contained in the *Sansievera* and *Cymbopogon nardus* extracts such as saponins, flavonoids and alkaloids have the functions of antioxidants which are capable of reducing microorganisms in the air. In addition, anti-microbial substances contained in flavonoids also contribute to it. The tannins contained in it also function to reduce the formation of microbial substrate compounds and form tannin compounds with other toxic metals.

Furthermore, Kesumayadi *et al.* [33] showed that in addition to saponins, flavonoids, steroids, and triterpenoid, *Sansievera sp* extracts also contain other ingredients of alkaloids and polyphenols. Alkaloids are a group of phenolic compounds that are abundant in nature. Alkaloid compounds react to fungus-*C. Albicans* by damaging cell walls. These compounds can also enter the nucleus of yeast cells.

Furthermore, flavonoid compounds are phenolic compounds that have a role as disinfectants. The flavonoids work the same as saponins, which is by inhibiting the bacterial growth, by denaturing bacterial proteins which causes the cessation of metabolic activity of bacterial cells. The cessation of metabolic activity which then results in cell death. *Sansevieria trifasciata prain* extract and *Cymbopogon nardus* can inhibit the growth of germ. The results showed that the concentration of 30%, *Sansevieria sp* sp extract and 0.1% *Cymbopogon nardus* lowered germs by an average of 78.2%, while at a concentration of 40%, the average decrease in germs was 74.24%, and at a concentration of 50%, the average decrease in germs was 65.11%.

The results of this study indicated that the extracts of *Sansevieria sp* and *Cymbopogon nardus* are able to reduce the germs in the room air. This result is supported by the results of phytochemical tests that has been conducted, obtaining that *Sansevieria sp* and *Cymbopogon nardus* extracts contain flavonoids, alkaloids, phenols, quinones, and steroids. In this case, flavonoids which are polyphenol derivatives have antimicrobial activities. The mechanism of action of phenol derivatives is by denaturing and coagulating

microbial cell proteins. Furthermore, this study was replicated 8 times, in order to strengthen the data. The content of other compounds from the *Sansevieria sp* plant, namely the active compound glycoside pregnane, converts harmful pollutants into organic compounds [26].

The results obtained were also accepted since it is in accordance with Kesumayadi *et al.* [33], the average germ number is 6 (50% concentration), 4.87 (40% concentration) 3.36 (50% concentration) 3.36 (50% concentration), (30%) with exposure to 50% *Sansevieria sp* extract and *Cymbopogon nardus* 0.1%. These data showed that a concentration of 30% is better at reducing germ. Meanwhile, according to the chemical analysis, the main compounds of the EO were the oxygen-containing monoterpenes: citronellal, geraniol, geraniol, citronellol, and neral.

3.2. Effectiveness of *Sansevieria sp* extract

Based on the results of the analysis that has been done using the One-Way ANOVA test, we obtained a p-value of 0.000 ($p < 0.05$), so it was concluded that there was an effect of *Sansiviera sp* extracts and *Cymbopogon* on the number of germs in the room air.

Based on the results of the study, it was concluded that the concentration of *Sansiviera sp* extracts at the concentration of 30%, 40% and 50% had the same effectiveness in reducing the number of germs in the room air. This shows that at concentrations of 30%, 40% and 50%, the number of *flavonoids and alkaloids* contents are almost the same so that they have the ability to reduce the number of germs in the same room air.

In addition, the active compounds contained in *Sansivieras**sp*, namely *saponins, tannins, and alkaloids* are able to work synergistically with the active compounds in *Cymbopogon* in reducing the activity of bacteria and fungi in room air. The number of germs in the room air is affected by the concentration of the *Sansiviera sp*. This shows that the higher the concentration given, the more *tannins, saponins and alkaloids* will be received [33].

Based on the research that has been done, it was obtained that the weakness of this research is the use of a high concentration of the material, hence it is expected that the concentration will be smaller in a future application. Smaller concentration has implications for the aroma that is not strong so it does not interfere with room comfort. And also, the drawback of this study is that we did not conduct a spray test using *Sansevieria sp* and *Cymbopogon nardus* extracts. This is of course a potential new thing to be tried by other researchers. The implication of this research is the discovery of methods and materials that can be used as anti-fungal and anti-germ substances in the room.

4. CONCLUSION

Utilization of extracts of *Sansevieria sp* and *Cymbopogon nardus* with the application of using a humidifier with ultrasonic waves to break the extract into steam can reduce the number of germs in the room. a significant decrease in the number of germs occurred at a concentration of 50%. Anti-microbial test on Lidah Mertua extract are recommendations that can be given in this research.





REFERENCES

- [1] D. Y. C. Leung, "Outdoor-indoor air pollution in urban environment: Challenges and opportunity," *Frontiers in Environmental Science*, vol. 2, no. JAN, pp. 1–7, 2015, doi: 10.3389/fenvs.2014.00069.
- [2] A. Janah, S. Sulhadi, and T. Darsono, "Absorption Pollutants Carbon Monoxide (CO) in the Air Using *Sansevieria sp* and *Scindapsus Aureus*," *EAI*, 2020, doi: 10.4108/eai.29-6-2019.2290383.
- [3] F. J. Kelly and J. C. Fussell, "Improving indoor air quality, health and performance within environments where people live, travel, learn and work," *Atmospheric Environment*, vol. 200, no. December 2018, pp. 90–109, 2019, doi: 10.1016/j.atmosenv.2018.11.058.
- [4] A. Norhidayah, C. K. Lee, M. K. Azhar, and S. Nurulwahida, "Indoor air quality and sick building syndrome in three selected buildings," *Procedia Engineering*, vol. 53, no. 2010, pp. 93–98, 2013, doi: 10.1016/j.proeng.2013.02.014.
- [5] I. Kumar, M. Mondal, V. Meyappan, and N. Sakthivel, "Green one-pot synthesis of gold nanoparticles using *Sansevieria sp* roxburghiana leaf extract for the catalytic degradation of toxic organic pollutants," *Materials Research Bulletin*, vol. 117, no. April, pp. 18–27, 2019, doi: 10.1016/j.materresbull.2019.04.029.
- [6] D. Rosanti, "Morphological Diversity of *Sansevieria sp*, Leaves Spread In Palembang City," *Jurnal Sainmatika*, vol. 14, no. 2, pp. 65–72, 2017, doi: 10.31851/sainmatika.v14i2.1296
- [7] I. Iinnaninengseh and J. Ayuswastika, "Growth response of in-laws tongue plants (*Sansiveria Sp*) cultivated on different types of soil growing media with bokashi fertilizer forage kudo leaves," *AGROVITAL : Jurnal Ilmu Pertanian*, vol. 2, no. 2, p. 67, 2018, doi: 10.35329/agrovital.v2i2.131.
- [8] I. Istiqamah, S. F. Hiola, and H. Karim, "Study of plant morphology of *sansevieria sp* in Makassar City," *Bionature*, vol. 19, no. 1, pp. 56–66, 2019, doi: 10.35580/bionature.v19i1.6628.
- [9] D. Yulianti, A. A. Purnama, and E. M. Brahmana, "Tambusai district, Rokan Hulu regency, Riau Province," *Jurnal Sainstek*, vol. 10, no. 2, pp. 13–19, 2018, doi: 10.31958/js.v10i1.1213
- [10] U. Nisa, "Making composite acoustic damping materials made from coconut coir fiber, banana midrib, tongue mertua and epoxy resin," *Pendidikan Fisika Fakultas Sains Dan Teknologi Universitas Islam Negeri Walisongo Semarang*, 2018. <https://eprints.walisongo.ac.id/id/eprint/9336/1/133611022.pdf>
- [11] Rapilah, A. Rahayu, and N. Rochman, "Growth of *sansevieria sp* cylindrica 'skyline' cuttings on various sizes of plant materials and composition of planting media," *Jurnal Agronida*, vol. 2, no. 1, pp. 29–36, 2016, doi: 10.30997/jag.v2i1.748.

- [12] A. S. Nasution, "Promotive and preventive efforts to reduce the risks caused by cigarettes in Rancamaya Village," *LOGISTA - Jurnal Ilmiah Pengabdian kepada Masyarakat*, vol. 4, no. 1, p. 57, 2020, doi: 10.25077/logista.4.1.57-62.2020.
- [13] A. Biglari, V. Barzeghar, N. Zolfaghari Firouzsalari, and A. Gholampour, "Assessment of airborne bacterial and fungal communities in different wards of educational hospitals: A case study in Urmia, Iran," *Journal of Air Pollution and Health*, vol. 5, no. Autumn, pp. 209–222, 2021, doi: 10.18502/japh.v5i4.6442.
- [14] United States Environmental Protection Agency, "The Inside Story: A Guide to Indoor Air Quality," EPA, 2021.
- [15] M. Mannan and S. G. Al-Ghamdi, "Indoor-air-quality-in-buildings-A-comprehensive-review-on-the-factors-influencing-air-pollution-in-residential-and-commercial-structure2021International-Journal-of-Environmental-Research-and-Public-HealthOpen-Access.pdf," *International Journal of Environmental Research and Public Health*, 2021.
- [16] A. P. Yudison and Driejana, "Development of indoor air pollution concentration prediction by geospatial analysis," *Journal of Engineering and Technological Sciences*, vol. 47, no. 3, pp. 306–319, 2015, doi: 10.5614/j.eng.technol.sci.2015.47.3.6.
- [17] S. Arar, A. Al-Hunaiti, M. H. Masad, A. Maragkidou, D. Wraith, and T. Hussein, "Elemental contamination in indoor floor dust and its correlation with PAHs, fungi, and gram+/- bacteria," *International Journal of Environmental Research and Public Health*, vol. 16, no. 19, 2019, doi: 10.3390/ijerph16193552.
- [18] P. Spuru and P. L. Simona, "A review on interactions between energy performance of the buildings, outdoor air pollution and the indoor air quality," *Energy Procedia*, vol. 128, pp. 179–186, 2017, doi: 10.1016/j.egypro.2017.09.039.
- [19] K. Pamopol, T. Aereob, and K. Prueksakorn, "Indoor air quality improvement by simple ventilated practice and *Sansevieria sp* trifasciata," *Atmosphere*, vol. 11, no. 3, pp. 1–16, 2020, doi: 10.3390/atmos11030271.
- [20] C. C. Jung, H. J. Su, and H. H. Liang, "Association between indoor air pollutant exposure and blood pressure and heart rate in subjects according to body mass index," *Science of the Total Environment*, vol. 539, pp. 271–276, 2016, doi: 10.1016/j.scitotenv.2015.08.158.
- [21] Rusmiati; Rachmaniyah; A.T Diana Nerawati, "Research article humidifier modification with *Sansevieria sp.* extract solution to decrease indoor mold growth the results of mold number from indoor room before," *International Journal of Current Research*, vol. 12, no. 01, pp. 9695–9699, 2020, doi: 10.24941/ijcr.37733.01.2020.
- [22] R. B. Teponno, C. Tanaka, B. Jie, L. A. Tapondjou, and T. Miyamoto, "Trifasciotosides A-J, steroidal saponins from *Sansevieria sp* trifasciata," *Chemical and Pharmaceutical Bulletin*, vol. 64, no. 9, pp. 1347–1355, 2016, doi: 10.1248/cpb.c16-00337.
- [23] S. Chanthai, S. Prachakoll, C. Ruangviriyachai, and D. L. Luthria, "Influence of extraction methodologies on the analysis of five major volatile aromatic compounds of citronella grass (*Cymbopogon nardus*) and lemongrass (*cymbopogon citratus*) grown in thailand," *Journal of AOAC International*, vol. 95, no. 3, pp. 763–772, 2012, doi: 10.5740/jaoacint.11-335.
- [24] W. F. Dewatisari, L. H. Nugroho, E. Retnaningrum, and Y. A. Purwestri, "The potency of *Sansevieria sp* trifasciata and s. *Cylindrica* leaves extracts as an antibacterial against *pseudomonas aeruginosa*," *Biodiversitas*, vol. 22, no. 1, pp. 408–415, 2021, doi: 10.13057/biodiv/d220150.
- [25] E. Majewska, M. Kozłowska, E. Gruczynska-Sekowska, D. Kowalska, and K. Tarnowska, "Lemongrass (*Cymbopogon citratus*) essential oil: Extraction, composition, bioactivity and uses for food preservation - A review," *Polish Journal of Food and Nutrition Sciences*, vol. 69, no. 4, pp. 327–341, 2019, doi: 10.31883/pjfn/113152.
- [26] L. G. De Toledo *et al.*, "Essential oil of *Cymbopogon nardus* (L.) Rendle: A strategy to combat fungal infections caused by *Candida* species," *International Journal of Molecular Sciences*, vol. 17, no. 8, 2016, doi: 10.3390/ijms17081252.
- [27] L. Chiamenti, F. P. Da Silva, K. Schalleberger, M. Demoliner, C. Rigotto, and J. D. Fleck, "Cytotoxicity and antiviral activity evaluation of cymbopogon spp hydroethanolic extracts," *Brazilian Journal of Pharmaceutical Sciences*, vol. 55, pp. 1–9, 2019, doi: 10.1590/s2175-97902019000118063.
- [28] M. I. Naik, B. A. Fomda, E. Jaykumar, and J. A. Bhat, "Antibacterial activity of lemongrass (*Cymbopogon citratus*) oil against some selected pathogenic bacterias," *Asian Pacific Journal of Tropical Medicine*, vol. 3, no. 7, pp. 535–538, 2010, doi: 10.1016/S1995-7645(10)60129-0.
- [29] N. A. Saputra, H. S. Wibisono, S. Darmawan, and G. Pari, "Chemical composition of *Cymbopogon nardus* essential oil and its broad spectrum benefit," *IOP Conference Series: Earth and Environmental Science*, vol. 415, no. 1, 2020, doi: 10.1088/1755-1315/415/1/012017.
- [30] D. P. Wibowo, Y. Febriani, H. Riasari, and D. L. Aulifa, "Chemical composition, antioxidant and antibacterial activities of the essential oils of medicinal plant *Cymbopogon nardus* from Lembang West Java," *Research Journal of Chemistry and Environment*, vol. 22, no. Special Issue 1, pp. 1–4, 2018. <https://worldresearchersassociations.com/specialissuejan2018/1.pdf>
- [31] T. Ch.Muhammad, "Pathogenesis of acne vulgaris: Simplified," *Journal of Pakistan Association of Dermatologists*, vol. 20, no. 2, pp. 93–97, 2010, <https://www.jpap.com.pk/index.php/jpad/article/view/398/373>.
- [32] R. R. Wicaksono and E. Sulistiono, "Combination Extract of Lidah Mertua (*Sansevieria sp* verticilata) And Sereh (*Cymbopogon nardus* L.) Indifferent Drying as Anti-Microbial," in *5th International Seminar Of Research Month 2020*, vol. 5, pp. 1–4, 2020, doi: 10.11594/nstp.2021.0901.
- [33] I. Kesumayadi, L. A. Nanamy, E. Hartanto, and D. A. Indraswari, "The effect of anti pollutant gel from *Sansevieria sp* trifasciata on malondialdehyde level and histopathology of Rats' Liver and Lungs induced by Cigarette, Coal, and mosquito smoke," *Indonesian Journal of Pharmacy*, vol. 31, no. 4, pp. 290–296, 2020, doi: 10.22146/ijp.980.




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