

EFFECT OF LEMONGRASS EXTRACT DOSAGE ON AIRBORNE GERM REDUCTION IN DORMITORY ROOMS

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ABSTRACT

Effect of Lemongrass Extract Dosage on Airborne Germ Reduction in Dormitory Rooms. Air problems are problems that require special attention in human welfare and health. This condition can cause various risks of disease due to poor air quality. Observation results show that the condition of the men's bedrooms in the dormitory is very dirty, students rarely clean their rooms and some students smoke in the room. Initial test results showed that the room humidity was 73%, the room temperature was 31°C and the air germ count was 1.500 colonies/m³. These various factors can influence the number of air germs, so the room needs to be disinfected. One natural ingredient that can be used as a disinfectant is lemongrass stems, because they contain flavonoids such as quercetin, alkaloids, saponins, tannins and polyphenols. The aim of this research was to determine the most effective dose of kitchen lemongrass extract as a natural disinfectant in reducing the number of room air germs. This type of research is Quasi Experimental with a Non Equivalent pretest-posttest Group approach. First, the room is checked for air germ numbers before (pre), then intervention is carried out with kitchen lemongrass extract disinfectant liquid and waited for 1 hour, and finally the air germ numbers are checked after (post). Based on the research results, it can be concluded that among the three disinfectant doses of kitchen lemongrass extract. The 5% dose is the most effective dose in reducing the number of airborne germs with a reduction percentage of 1.033.3 colonies/m³ (65.40%) and meets quality standards.

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INTRODUCTION

Humans depend heavily on clean air for daily activities, especially in enclosed spaces such as homes or dormitories. Polluted air can cause various health problems, including allergies, acute respiratory infections (ARI), and Sick Building Syndrome (SBS). The quality of indoor air is indicated by low microbial counts. The Indonesian government, through the Ministry of Health Regulation No. 2 of 2023, has set the indoor air microbial quality standards at less than 700 colony-forming units per cubic meter (CFU/m³) and free of pathogenic microorganisms [1]. Although people often assume that indoor air is safer, a WHO study (2006) revealed that indoor air can be more polluted than outdoor air. Sources of pollution include building conditions, cleanliness, ventilation, temperature, humidity, and occupant behaviors such as smoking. [3]

The Indonesian government has regulated indoor air quality improvement through Ministry of Health Regulation No. 2 of 2023 regarding the Implementation of Government Regulation

No. 66 of 2014 on Environmental Health, including guidelines for indoor air sanitation that specify microbiological limits at $<700 \text{ CFU/m}^3$ and free from pathogenic microbes.

Generally, people believe indoor environments are safer from harmful pollutants. However, scientific evidence shows that indoor air pollution can be worse than outdoor air [2]. Indoor air pollution sources include building conditions, room arrangement, floor condition, ventilation cleanliness, temperature, humidity, as well as occupant behaviors like smoking and airborne microorganisms contamination [3].

The Polytechnic of Health Ministry of Health Yogyakarta continuously strives to improve services for students, including providing facilities to support the Tri Dharma of Higher Education activities. One such facility is the student dormitory. Observations revealed that the male dormitory rooms at the Polytechnic are very dirty, students rarely clean their rooms, windows are not opened daily, and some students smoke inside the rooms. These factors influence the microbial count in the indoor air.

Microbial counts exceeding the established quality standards warrant attention as they may cause allergies [4–7], acute respiratory infections [4,6–8], and Sick Building Syndrome (SBS) [9–14]. Risk control measures include room disinfection. Disinfectants used to kill microorganisms such as bacteria and viruses can be chemical or natural. Natural disinfectants are preferred due to their environmentally friendly properties and fewer side effects. Lemongrass (*Cymbopogon citratus*) extract is one such natural disinfectant.

Lemongrass leaves and stems contain active compounds such as alkaloids, saponins, tannins, phenols, and flavonoids that serve as disinfectants. According to Venxon (2018), lemongrass oil contains geranial (citral a) at 42.11%, neral (citral b) at 34.78%, and myrcene at 13.17% [15]. Research by Nisyak, Amanda, and Azizah (2020) on room fresheners containing lemongrass oil at a 2.5% concentration showed that disinfection was not yet optimal due to the low concentration (45%) of lemongrass oil used.

A preliminary test conducted on Monday, December 18, 2023, in the male dormitory room at the Polytechnic showed an initial microbial count of $1,500 \text{ CFU/m}^3$. After treatment with 5% lemongrass extract, the microbial count dropped to 560 CFU/m^3 , a 62.6% reduction.

Based on this background, the study aims to analyze the effect of various doses of lemongrass extract at concentrations of 3%, 4%, and 5% as a natural disinfectant to reduce indoor microbial air counts, providing an effective and environmentally friendly solution for maintaining healthy air quality.

MATERIALS AND RESEARCH METHODS

This quasi-experimental study uses a non-equivalent pretest-posttest group design. The study site is the male dormitory rooms at the Polytechnic of Health Ministry of Health Yogyakarta. Nineteen rooms with dimensions of 4 m length, 3.5 m width, and 2.8 m height (room volume 39.2 m^3) were used as treatment locations.

Air samples were collected before and after treatment using an MAS-100 air sampler to measure microbial counts in colony-forming units per cubic meter (CFU/m^3). Each treatment was repeated six times for each dose. Samples were analyzed in the Microbiology Laboratory of the Polytechnic.

Treatments involved spraying lemongrass (*Cymbopogon citratus*) extract disinfectant at concentrations of 3%, 4%, and 5% using an aerosol-based fogger. The extract used had a certificate of analysis (COA) verifying authenticity and safety.

Data were recorded into dummy tables and analyzed using SPSS for Windows. Normality and homogeneity tests were conducted with Shapiro-Wilk. If data were normally distributed and homogeneous, One-Way ANOVA was used to assess significant differences among treatment groups.

RESEARCH RESULTS AND DISCUSSION

Before disinfection, room temperature and humidity were measured as environmental factors influencing microbial growth. Room temperatures ranged from 30.76°C to 30.98°C, with the highest average temperature in the 5% dose group (30.98°C). Relative humidity ranged from 73% to 75%, highest in the 4% dose group. These conditions are optimal for bacterial growth.

Table 1. Room Temperature Measurement Results Before Treatment

Repetition number	Temperature Measurement (°C)		
	3%	4%	5%
1	30,5	31,5	31,4
2	31,1	31,0	31,0
3	30,2	30,8	30,7
4	30,8	30,9	31,5
5	31,0	30,1	30,2
6	31,4	30,3	31,1
Total	185	184,6	185,9
Average	30,83	30,76	30,98

Source: Processed Primary Data, 2024

Berdasarkan Tabel 1, kondisi lingkungan fisik sebelum dilakukannya perlakuan adalah rata-rata suhu ruang kamar tidur sebelum perlakuan pemaparan cairan disinfektan ekstrak serai dapur berkisar di angka 30,76°C hingga 30,98°C.

Table 2. Measurement Results of Bedroom Room Humidity Before Treatment

Repetition number	Humidity Measurement (% RH)		
	3%	4%	5%
1	80	72	75
2	70	79	71
3	78	76	70
4	75	68	78
5	69	78	73
6	72	77	71
Total	444	450	438
Average	74	75	73

Source: Processed Primary Data, 2024

Based on Table 2, measurements of airborne microbial counts were conducted before and after treatment with lemongrass extract at concentrations of 3%, 4%, and 5%. At the 3% dose, the average microbial count decreased from 1,286.6 CFU/m³ to 636.6 CFU/m³, with an average reduction of 650 CFU/m³ or 50.11%. The 4% dose showed a decrease from 1,241.6 CFU/m³ to 478.3 CFU/m³, with an average reduction of 763.3 CFU/m³ or 61.73%. Meanwhile, at the 5% dose, there was a decrease from 1,565 CFU/m³ to 531.6 CFU/m³, with an average reduction of 1,033.3 CFU/m³ or 65.40%.

The results of airborne microbial counts in each room can be seen in the following table:

Table 3. Airborne Microbial Count Results with 3% Lemongrass Extract Disinfectant Dose

Replication	Disinfectant Lemongrass Extract Dose 3%			
	Airborne Microbial Count (CFU/m ³)		Change	
	Before (pre)	after (post)	Reduction Difference	Percentage Reduction
1	1.470	710	760	51,70
2	1.240	680	560	45,16
3	1.530	700	830	54,24
4	1.040	500	540	51,92
5	1.120	580	540	48,21
6	1.320	650	670	50,75
Total	7.720	3.820	3.900	300,68
Average	1.286,6	636,6	650	50,11

Source: Processed Primary Data, 2024

Descriptively, Table 3 shows a decrease in airborne microbial count after using 3% lemongrass extract. It can be seen that before exposure to the disinfectant, the average airborne microbial count was 1,286.6 colonies/m³, which decreased to 636.6 colonies/m³.

after exposure. Thus, the average reduction difference was 650 colonies/m³ with an average percentage reduction of 50.11%.

Table 4. Airborne Microbial Count Calculation Results with 4% Lemongrass Extract Disinfectant

Replication	Disinfectant Lemongrass Extract Dose 4%			
	Airborne Microbial Count (CFU/m ³)		Change	
	Before (pre)	after (post)	Reduction Difference	Percentage Reduction
1	1.360	550	810	59,55
2	1.280	410	870	67,96
3	1.450	670	780	53,79
4	990	350	640	64,64
5	1.090	440	650	59,63
6	1.280	450	830	64,84
Total	7.450	2.870	4.580	370,41
Avreange	1.241,6	478,3	763,3	61,73

Source: Processed Primary Data, 2024

Descriptively, Table 4 shows a decrease in airborne microbial colonies after using 4% lemongrass extract disinfectant. Before disinfection exposure, the average airborne microbial count was 1,241.6 colonies/m³, and after disinfection exposure, it decreased to 478.3 colonies/m³. Thus, the average reduction difference was 763.3 colonies/m³, with an average percentage decrease of 61.73%.

Table 5. Results of Airborne Microbial Counts with 5% Lemongrass Extract Disinfectant

Replication	Disinfektan Estrak Serai Dosis 5%			
	Airborne Microbial Count (CFU/m ³)		Change	
	Before (pre)	after (post)	Reduction Difference	Percentage Reduction
1	1.210	450	760	62,80
2	2.470	730	1.740	70,44
3	1.330	500	830	62,40
4	1.590	580	1.010	63,52
5	1.370	480	890	64,96
6	1.420	450	970	68,30
Jumlah	9.390	3.190	6.200	392,42
Rata-rata	1.565	531,6	1.033,3	65,40

Source: Processed Primary Data, 2024

Descriptively, Table 5 shows a decrease in airborne microbial counts after using 5% concentration lemongrass extract disinfectant. Before exposure to the disinfectant, the average airborne microbial count was 1,565 colonies/m³, which decreased to 531.6 colonies/m³ after exposure. Thus, the average reduction difference was 1,033.3 colonies/m³, with an average percentage decrease of 65.40%.

The following is a graph showing the average number of airborne microbial colonies before and after exposure to disinfectant fluid using lemongrass extract (*Cymbopogon citratus*) at concentrations of 3%, 4%, and 5%.

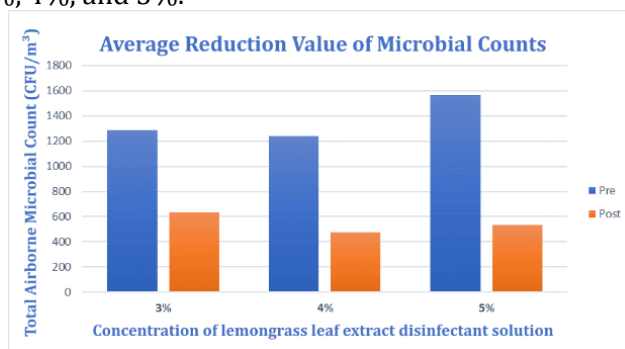


Figure 1. Average Reduction Value of Microbial Counts

Descriptively, these results show that all doses of lemongrass extract were able to reduce airborne microbial counts in the room. The effectiveness of reduction increased with higher concentrations of the disinfectant used. The 5% dose provided the best results in reducing the number of airborne microbial colonies, approaching the established quality standard threshold. These results strengthen the hypothesis that a higher concentration of active compounds can enhance the disinfectant power of lemongrass extract in indoor applications. Based on the results, there was a decrease in airborne microbial counts after room disinfection using lemongrass extract. The most effective lemongrass extract dose for reducing airborne microbial counts was 5%. The average reduction difference at this dose was 1,033.3 colonies/m³ or 65.40%. The significant reduction at the 5% dose occurred because higher and more concentrated doses produce more phytochemical compounds, which have the potential to kill airborne microbes. Therefore, lemongrass extract at a 5% dose can be used as an alternative to reduce airborne microbial counts indoors. This aligns with research by Nisyak, Amanda, and Azizah (2020) which found that room fresheners containing 2.5% lemongrass oil reduced *Staphylococcus aureus* colonies in the air by up to 45%.

According to [17], phytochemicals in lemongrass stalk extract (*Cymbopogon citratus*) include flavonoids such as quercetin, alkaloids, saponins, tannins, polyphenols, some of which have been shown to have antibacterial activity. Saponins can interact with sterols in bacterial membranes, potentially causing protein leakage and affecting certain bacterial enzymes. Saponins also work by disrupting bacterial cell membranes, lowering membrane potential and damaging membrane integrity, which leads to abnormal bacterial cell function and lysis [18].

Tannins at high concentrations exhibit antibacterial activity. Their mechanism involves dissolving lipids in bacterial membranes and reducing membrane tension, altering membrane permeability and disrupting bacterial cell functions, eventually causing bacterial lysis. Tannins can also destruct or deactivate bacterial genetic material, inhibit chitin synthesis, and interfere with ion and molecule transport across bacterial membranes. Furthermore, tannins reduce cell wall size and impair membrane permeability, hindering bacterial survival. Tannins inhibit enzymes such as DNA topoisomerase and reverse transcriptase, preventing bacterial cell formation. This comprehensive mechanism enables lemongrass stalk extract (*Cymbopogon citratus*) to kill bacteria [19].

Flavonoids, a class of polyphenols, inhibit the growth of bacteria, fungi, and viruses. Their antibacterial mechanism includes inhibiting cytoplasmic membrane function, nucleic acid synthesis, and bacterial energy production by preventing ATP hydrolysis, which blocks ATP synthesis in bacterial cells (Górniak, Bartoszewski, and Króliczewski, 2019). Previous studies showed these compounds can kill Gram-positive bacteria such as *Enterococcus faecalis*, *Staphylococcus aureus*, and *Propionibacterium acnes*, as well as Gram-negative bacteria like *Proteus mirabilis*, *Proteus vulgaris*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* [21]. However, this study did not further investigate specific bacteria types affected by the lemongrass extract disinfectant.

In the 5% dose group, the post-test microbial count in the second replication was 730 colonies/m³, which still exceeds the maximum limit set by standards. This is influenced by factors such as indoor smoking, poor cleanliness, inadequate ventilation, and room temperature and humidity.

Room temperature and humidity greatly affect bacterial growth in the air. In this study, humidity ranged from 73% to 75%, and temperature ranged from 30.76°C to 30.98°C, values within the optimum range for bacterial growth. This is consistent with Ginting et al. (2022), who found that increased humidity correlates with increased airborne microorganisms.

To minimize and kill microorganisms including bacteria and airborne germs, maintaining good ventilation, regularly opening bedroom windows, and keeping the room clean, along with routine room disinfection, are necessary measures. Disinfection is a key solution to improve indoor air quality by reducing high microbial counts.

Natural disinfectants are recommended because they are environmentally friendly and have minimal side effects. This is consistent with Aulia (2018), who concluded that natural disinfectants like essential oils can yield results comparable to commercial chemical disinfectants in reducing microbial counts.

Using lemongrass extract (*Cymbopogon citratus*) as a natural disinfectant has advantages over chemical disinfectants. It poses no health risks to humans due to its natural origin. Additionally, the preparation of the disinfectant is simple, mixing lemongrass extract with clean water, resulting in a disinfectant with a characteristic lemongrass aroma. Nevertheless, this study shows that 5% lemongrass extract has not yet achieved a 100% reduction in airborne microbes. Therefore, further research with higher doses or combination formulations is recommended to improve efficacy and broaden the antimicrobial spectrum. This study serves as a promising initial step in developing natural plant-based disinfectants to maintain healthy and safe indoor air quality.

CONCLUSIONS AND RECOMMENDATIONS

This study demonstrates that lemongrass extract (*Cymbopogon citratus*) is effective in reducing airborne microbial counts in the male dormitory rooms at Poltekkes Kemenkes Yogyakarta. Average reductions in airborne microbial counts were 50.11%, 61.73%, and 65.40% for 3%, 4%, and 5% doses, respectively. The 5% dose proved most effective, with an average reduction of 1,033.3 colonies/m³, approaching the microbiological air quality threshold. These results indicate that lemongrass extract has potential as a natural disinfectant alternative for controlling indoor air quality.

The management of Poltekkes Kemenkes Yogyakarta dormitories is advised to use 5% lemongrass extract as an effective, environmentally friendly natural agent to reduce airborne microbial counts. Improving room cleanliness and ventilation—such as regularly opening windows and maintaining sanitation—is also necessary. Further research is recommended with higher doses or combination formulas to optimize the effectiveness of air disinfection comprehensively.

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