THE EFFECTIVENESS OF UV AERATOR IN REDUCING THE NUMBER OF AIR GERMS IN THE LABORATORY OF ENVIRONMENTAL HEALTH DEPARTMENT CAMPUS 7 SEMARANG HEALTH POLYTECHNIC OF MINISTRY OF HEALTH

Sabrina Nur Hanifah *), **Tri Cahyono** **), **Agus Subagiyo** ***)

Department of Environmental Health Purwokerto, Health Polytechnic of the Ministry of Health Semarang, Jl. Raya Baturaden KM 12 Purwokerto, Indonesia

Abstract

*[**The Effectiveness of UV Aerator in Reducing The Number of Air Germs in The Laboratory of Environmental Health Department Campus 7 Semarang Health Polytechnic of Ministry of Health**] **Introduction: Background**, laboratory for student practicum activities has the potential to cause air pollution from the activities of students entering and leaving the room. This causes the potential for the transmission of Airborne Diseases which are transmitted through airborne microbiology. Efforts to reduce the number of air germs include ultraviolet radiation (UV). The study aims to determine the effectiveness of UV Aerator in reducing the number of air germs. **Method** used in this research is quasi eksperimental research design with the-nonequivalent control group pre test-post test design. **The results** of checking the air germs count in the treatment room obtained an average number of air germs 681.5 CFU/m^3, the control room obtained an average of 786.5 CFU/m^3, there was no significant difference in the number of air gemrs in the treatment group before and after UV Aerator activation (p = 0.113), there was no significant difference in the number of air germs in the control group without UV Aerator (p = 0.4). **Conclusion,** the effectiveness of UV Aerator in reducing the number of air germs in the treatment gorup average (-26,64%), the control group average (22,18%). **Suggestion,** need to increase the suction power of the pump in order to accelerate the circulation of room air.*

Keywords: *The Number of Air Germs, Laboratory, Environmental Health*

*)Author E-mail: sabrinanurhf@gmail.com
**)Corresponding Author 1 E-mail: tricahyono37@yahoo.co.id
***) Corresponding Author 2 E-mail: agusgiyo@yahoo.co.id

1. Introduction

According to PP No. 66 of 2014 concerning Environmental Health, Environmental Health Quality Standards and health requirements are stipulated on environmental media which include water, air, soil, food, facilities and buildings, vectors and disease-carrying animals (1). Air can be grouped into: outdoor air and indoor air. Indoor air is the air in a building (residential, school, restaurant, hotel, hospital, office) occupied by a group of people with different health levels for at least one hour (2). According to the EPA (Environmental Protection Agency of America) indoor air quality is 2-5 times worse than outdoor air, which causes air pollution in a room.

Various methods are used to overcome the problem of airborne germs in order to minimize, inhibit & kill airborne germs, including sterilization, disinfection (application of chemicals/disinfectants such as alcohol and chlorine), control using filtration, and control using ultraviolet (UV) radiation and sunlight ionization rays(3). Ultraviolet (UV) light has the ability to affect the functioning of the cell nucleus of microorganisms. When the cell nucleus material (RNA/DNA) is disturbed after contact with UV light, the bacteria become inactive or die, because microorganisms are unable to perform vital cellular functions. The type of UV light that can affect germs or bacteria is UV C which has a wavelength of 200 to 280 nm or more. The contact time to effectively destroy microorganisms is not less than one second. The principle is that when in contact with UV light, microorganisms die (4).

UV Aerator as an alternative in controlling the number of airborne germs. This tool consists of 3 main components, namely a UV lamp, a suction pump, and an aeration tank, each of which functions to kill microorganisms, suck air and aerate the air in the water.

The results of Nur Latifah Prajawanti's research (2018) in the R2 classroom of the Environmental Health Department of the Health Poltekkes of the Ministry of Health Semarang, the results of the examination of the air germ numbers in the control room obtained an average air germ number of 217.92 colonies/hour/feet^2 while in the treatment room the results obtained were the average number of airborne germs is 150.25 colonies/hour/feet^2. The results of Sita Imania's research (2019) showed that the results of the examination of air germ numbers in the control room obtained an average air germ number of 10429.83 CFU/m^3 while in the treatment room the average air germ number was 1611.25 CFU/m^{3}The results of the calculation of % reduction in airborne germ numbers in the control room averaged 71.29% while the effectiveness of NOS sterilization in reducing airborne germ numbers was -21.147%.

The laboratory for student practicum activities has the potential to cause air pollution from the activities of students entering and leaving the room. This causes the potential for the transmission of Airborne Diseases that are transmitted through microbiology in the air. When one person enters a room, the number of germs in the air will increase by 37 million germs per hour(7). The result of Herlinda's research (2018), the number of airborne germs for 3 days carried out in the Microbiology Laboratory Room of the Environmental Health Department, namely before being treated with lime juice (Citrus aurantifolia) at a dose of 10%, 20% and 30% ranged from 250 - 5750 colonies/m^3, after being given treatment ranged from 0 – 1250 colonies/m^3. The average number of airborne germs before being treated with a dose of 10% was 667 colonies/m^3 while after being treated it was 333 colonies/m^3. The average number of airborne germs before being treated with a dose of 20% was 1250 colonies/m^3 while after being treated it was 667 colonies/m3. On the first day (5 February) the examination of the number of germs before being treated with lime juice (Citrus aurantifolia) at 08.00 WIB, the number of germs in the Microbiology Laboratory room was 500 colonies/m3, after being treated at 09.15 WIB the germ number of 250 colonies/m^3 means effectiveness treatment with lime juice (Citrus aurantifolia) with a dose of 10% decreased by 50%. According to the result of Kuni Minachul Vikriyah's research (2019) in the Microbiology Laboratory of the Environmental Health Department of the Health Poltekkes, Semarang, the results of the examination of airborne germ numbers before being treated with lime peel extract ranged from 100 - 439 CFU/m^3, while after being treated with lime peel extract with concentrations of 0%, 5%, 10%, and 20% ranged from 90 – 270 CFU/m^3.

Based on the above background, the researcher is interested in conducting a research entitled "The Effectiveness of UV Aerator In Reducing The Number Of Air Germs In The Laboratory of Environmental Health Department Campus 7 Semarang Health Polytechnic of Ministry of Health".

2. Method

The type of research used is a *quasi-experimental research design with the non-equivalent control group pre-test-post-test design*. The population in this study was the Laboratory of Campus 7 Poltekkes Kemenkes Semarang, and the samples in this study were all air in the SIK3 Laboratory, PVBP Laboratory, Physics Laboratory, Laboratory of Health Promotion Campus 7 Poltekkes Kemenkes Semarang.

The independent variable in this study is UV Aerator, the dependent variable is the number of airborne germs. The confounding variables in this study were temperature, humidity, lighting, ventilation area, building volume, building materials. The control variables in this study were air conditioners and fans.

3. Result and Discussion

a. Temperature, Humidity, Lighting, Air Germ Number Before Activating UV Aerator.

Measurements of temperature, humidity, lighting, airborne germ numbers before UV activation were carried out at 10.00 WIB in 4 Laboratory rooms of the Environmental Health Department of the Health Polytechnic of the Ministry of Health Semarang, namely the SIK3 Laboratory, the Health Promotion Laboratory, the PVBP Laboratory, and the Physics Laboratory on September 1 and September 14, 2020.

1) Initial Temperature

Initial temperature measurements were carried out using an alcohol thermometer at the time of sampling the air germ numbers. The condition of the room at the time of the study was that there were 2 air conditioners with the condition on, closed ventilation, closed doors, closed windows and curtains. The average value of air temperature before the study in the treatment group was 23.70°C and the control group was 24.88°C, the standard deviation of the treatment group was 0.79°C and the control group was 1.32°C. the lowest temperature measurement is 21.78°C, and the result of the highest temperature measurement is 24.70°C. Threshold value of air temperature according to KEPMENKES No. 605/MENKES/SK/VII/2008 concerning Standards for Health Laboratory Centers and Health Laboratory Centers, which are 22-26°C.

The measurement results showed that there was 1 room that did not meet the requirements, namely the Promkes Laboratory in the control group of 21.78°C. At the time of the research, the Promkes Laboratory was the last room whose temperature was measured, while the air conditioner had been on since the beginning of the study which caused the condition of the room to be cooler than the other rooms.

This study is not the same as Linda Restu Pamuji's research (2020) which shows that only 1 classroom (9.10%) is eligible. This study is also not the same as Ernawati et al's research (2017) which showed that as many as 28 rooms had temperatures that did not meet the requirements and 62 rooms had temperatures that met the requirements.

According to Tri Cahyono (2017), oom temperature is strongly influenced by height above sea level, sunlight entering the room, humidity, indoor air distribution, ventilation, occupancy density, activities in the room, activities in and out of the room, wall materials. and floors and roofs, indoor electronic equipment, indoor furniture and linens and outdoor temperature conditions. According to Vindrahapsari (2016), room ventilation is divided into two, namely natural and artificial ventilation. Artificial ventilation in the room can be in the form of cooling fans, air conditioners, and so on. In conditions in the field, the AC that is on can function as a temperature regulator. The AC that was turned on caused the average room temperature condition of the treatment and control groups at the study site to meet the threshold value because the temperature could be regulated by the researcher.

2) Initial Humidity

The initial humidity measurement was carried out using a thermohygrometer at the time of sampling the air germ number. The average value of air humidity before the study in the treatment group was 67.25% and the control group was 66.75%, the standard deviation of the treatment group was 3.64% and the control group was 5.25%, the lowest humidity measurement results were 59.33% and the highest humidity measurement result is 71.67%. Threshold value of air humidity according to KEPMENKES No. 605/MENKES/SK/VII/2008 concerning Standards for Health Laboratory Centers and Health Laboratory Centers, which are 35 – 60%. The measurement results show that only one room that meets the requirements is the Physics Laboratory of the control group with a result of 59.33% which was measured on September 1, 2020. Other rooms that do not meet the requirements indicate that the humidity level exceeds 60%.

This study is not the same as Rizka Tiara's research (2016) which showed that of the 10 class samples examined, the humidity of all rooms did not meet the requirements. This study is also not the same as Sukma Cantika's research (2020) which showed that all samples of classroom humidity (100.00%) did not meet the requirements.

According to Tiarawati's research (2011), Room humidity above 60% results in the proliferation of pathogenic organisms and allergenic organisms. Conditions in the field showed that there was only one experiment out of eight experiments measuring humidity that met the requirements. This is because at the time of data collection, all the rooms used for the study used two AC units with the condition on. Rooms that use air conditioning have higher humidity than those that do not use air conditioning, because the treatment of the air conditioner that is often turned on and off makes the air conditioner in the room often leak which can make the humidity in the room higher (15).

3) Initial Lighting

Initial lighting measurements were carried out using a luxmeter when sampling airborne germ numbers. The average value of lighting before the study in the treatment group was 185.5 lux and the control group was 197 lux, the standard deviation of the treatment group was 7.6 lux and the control group was 10.6 lux, the lowest lighting measurement result was 178 lux, and the result of the highest luminance measurement is 212 lux. Lighting Threshold Value according to Permenkes No. 48 of 2016 which is 300-500 lux. The measurement results show that all rooms used for research do not meet the requirements. This is because the entire room used for research is covered with curtains and the lighting used is artificial lighting using lamps.

This study is same as Eka Septiana's research (2018) which shows that the lighting in the room does not meet the requirements entirely. This study is also the same as Lisa Jayanti (2014) which shows that the lighting of the entire room does not meet the requirements.

Lighting is divided into two, namely natural lighting and artificial lighting. Natural lighting is lighting produced by a natural light source, namely the sun with its strong light but varies according to hours, seasons and places. Meanwhile, artificial lighting is lighting produced by light sources other than natural light (17). In field conditions, lighting in the laboratory only relies on artificial lighting from lamps. Preferably, the windows of the room are opened so that natural light from the sun can enter the room. In addition, it can also increase the wattage of the lamps used or increase the number of lamps. The higher the light intensity, the number of microbial colonies will tend to be small, and the lower the light intensity, the more the number of microbial colonies will tend to be (18).

4) Initial Number of Air Germs

No.	Room	Treatment (CFU/m^3)	Control (CFU/m^3)
1	SIK3	794,0*	749,0**
2	Promkes	899,0*	479,0**
3	PVBP	1079,0**	659,0*

4	Fisika	944,0**	689,0*
	χ	929,0	644,0
	SD	118,1	116,2

Note:
*Measurements were made on September 1, 2020
**Measurements were made on September 14, 2020

Initial airborne germ numbers were measured using MAS (Microbiological Air Sampler). The average value of airborne germ numbers before the study in the treatment group was 929 CFU/m^3 and the control group was 644 CFU/m^3, the standard deviation of the treatment group was 118 CFU/m^3 and the control group was 116 CFU/m^3, the results of the measurement of germ numbers the lowest air is 479 CFU/m^3 and the result of the measurement of the highest air germ number is 1079 CFU/m^3. Threshold value for air germ numbers according to the Regulation of the Minister of Health of the Republic of Indonesia Number 48 of 2016 concerning Office Occupational Safety and Health Standards is <700 CFU/m^3. The measurement results showed that there were three out of eight experiments that met the requirements, namely the Control Group Health Program Laboratory with a result of 479 CFU/m^3 which was measured on September 14, 2020, the PVBP Laboratory of the control group with a result of 659 CFU/m^3 which was measured on September 1 2020, and the Physics Laboratory of the control group with the results of 689 CFU/m^3 which were measured on September 1, 2020.

This study is not the same as Citra Kusumawardhani's research (2018), which shows that as many as 5 rooms meet the requirements while the other 30 rooms do not meet the requirements. This study is also not the same as Abdullah & Hakim's research (2011) which showed that only <9% of 45 measurements of germ numbers met the requirements.

According to Didik Agus Nugroho (2016), The number of germs in a room can increase as the density of the occupants increases. From the existing data, it is known that all the rooms that meet the requirements are the control room group, namely the room that is not equipped with tools. At the time of measurement, the condition of the room was still empty and had not been influenced by the activities of the occupants because there were no activities to move tools, turn on tools, and prepare tools, so the microbiological conditions in the air did not change. There is only one control room that does not meet the requirements, namely the SIK3 Laboratory with a result of 749 CFU/m^3. The results of the researchers' observations, the SIK3 room before the measurements were carried out had activities in and out of the occupants, so that the airborne germ number exceeded the NAV. In all treatment groups, the number of airborne germs exceeded the NAV because in that room there had been activity in and out of researchers in preparing tools. Suggestions that can be given are that researchers should open windows and room curtains so that sunlight can enter, so that they can kill airborne germs in the room. Generally, microbial cells are damaged by light, especially in microbes that do not have photosynthetic pigments (4).

b. Temperature, Humidity, Lighting, Air Germ Number After Activating UV Aerator.

Measurements of temperature, humidity, lighting, airborne germ numbers after UV activation were carried out at 12.00 WIB in 4 Laboratory rooms of the Environmental Health Department of the Health Poltekkes Semarang, namely the SIK3 Laboratory, Health Promotion Laboratory, PVBP Laboratory, and Physics Laboratory.

1) Final Temperature

The final temperature measurement was carried out using an alcohol thermometer at the time of sampling the air germ numbers. The average value of air temperature after the study in the treatment group was 25.11°C and the control group was 24.48°C, the standard deviation of the treatment group was 0.78°C and the control group was 0.75°C. the lowest temperature measurement is 23.57°C, and the result of the highest temperature measurement is 25.87°C. Threshold value of air temperature according to KEPMENKES No. 605/MENKES/SK/VII/2008 concerning Standards for Health Laboratory Centers and Health Laboratory Centers, which are 22-26°C. The measurement results showed that the entire room in both the treatment and control groups met the requirements.

This study is not the same as Olivia Anggraeni Yuliarti's research (2019) which shows that of all samples examined only 1 class room is eligible. Conditions in the field showed that the temperature in the room in the treatment and control groups met the requirements. This is because the use of 2 AC units is on, so that the temperature in the room is maintained and does not exceed the threshold. The condition of the AC used can still function properly so that the room remains cool and not hot. In addition, because the location of the campus is in the highlands, the outdoor temperature is low and this affects the temperature in the research room.

2) Final Humidity

The final humidity measurement was carried out using a thermohygrometer at the time of sampling the air germ number. The average value of air humidity after the study in the treatment group was 60.66% and the control group was 64.29%, the standard deviation of the treatment group was 3.30% and the control group was 5.48%, the lowest humidity measurement results were 56.67% and the highest humidity measurement result is 69.33%. Threshold value of air humidity according to

KEPMENKES No. 605/MENKES/SK/VII/2008 concerning Standards for Health Laboratory Centers and Health Laboratory Centers, which are 35 – 60%. The results showed that there were three out of eight experiments that met the requirements, namely the Physics Laboratory of the control group, the PVBP Laboratory and the Physics Laboratory of the treatment group.

This study is not the same as Ernawati et al.'s research (2017) which shows that as many as 41 humidity rooms do not meet the requirements and 49 humidity rooms meet the requirements. Conditions in the field showed that the humidity of the room that met the requirements increased to three rooms, after previously during the initial measurement, only one room that met the requirements. This condition is supported by the measurement time which is getting longer, so that the humidity conditions are decreasing. The indicator of indoor air humidity is very closely related to the ventilation and lighting conditions of the room (17). The laboratory used for measuring humidity after the study had entered the daytime and the weather conditions were quite hot, so that sunlight entered the room through the ventilation gap which resulted in the final average humidity being lower than the beginning.

3) Final Lighting

The final lighting measurement was carried out using a luxmeter at the time of sampling the air germ number. The average value of lighting after the study in the treatment group was 160.7 lux and the control group was 181 lux, the standard deviation of the treatment group was 33.2 lux and the control group was 21.3 lux, the lowest lighting measurement results was 114 lux, and the highest luminance measurement result is 208 lux. Lighting Threshold Value according to Permenkes No. 48 of 2016 which is 300-500 lux.

This study is the same as Eka Septiana's research (2018) which indicates that the lighting in the room is entirely unqualified. This study is also the same as Lisa Jayanti's research (2014) which indicates that the entire room does not meet the requirements.

The lighting conditions in the research room indicate that the entire room is below the threshold value. The lighting condition of the room at the research location is artificial lighting that comes from lamps and curtains in the closed room, so that the condition of sunlight from outside does not have a significant impact.

4) Final Number of Air Germs

No.	Room	Treatment (CFU/m^3)	Control (CFU/m^3)
1	SIK3	629,0*	1079,0**
2	Promkes	704,0*	929,0**
3	PVBP	509,0**	584,0*
4	Fisika	884,0**	554,0*
	χ	681,0	786,5
	SD	157,1	258,8

Note: *Measurements were made on September 1, 2020

**Measurements were made on September 14, 2020

The final airborne germ count was measured using MAS (Microbiological Air Sampler). The average value of airborne germ numbers after the study in the treatment group was 706.5 CFU/m^3 and the control group was 786.5 CFU/m^3, the standard deviation of the treatment group was 125.2 CFU/m3 and the control group was 258.8 CFU/m^3, the lowest air germ number measurement result is 554 CFU/m^3 and the highest air germ number measurement result is 1079 CFU/m^3. Threshold value for air germ numbers according to the Regulation of the Minister of Health of the Republic of Indonesia Number 48 of 2016 concerning Office Occupational Safety and Health Standards is <700 CFU/m^3. The measurement results show that there are two out of eight trials that meet the requirements.

This study is not the same as Mahya Fatia's research (2020) which shows that only two of the 19 rooms are eligible. Conditions in the field showed that the number of airborne germs that met the requirements were the SIK3 Laboratory in the treatment group and the PVBP Laboratory in the treatment group, and the other six treatments did not meet the requirements. We recommend that the laboratory clean the room at least 1 time a day using a disinfectant, and open the ventilation so that air circulation can run smoothly, and clean the air conditioner.

c. Differences in Temperature, Humidity, Lighting, Air Germ Numbers Before and After Activation of The UV Aerator

1) Differences in Temperature Before and After Activation of The UV Aerator

The results of the Paired T test in the treatment group obtained a significant value of p = 0.061, then p> 0.05, which means there was no significant difference in temperature in the treatment group before and after the activation of the UV Aerator. The results of the Paired T test of the control group obtained a significant value of p = 0.126, then p> 0.05 which means that there is no significant difference in temperature in the control group that does not have a UV Aerator.

Conditions in the field showed that the overall average temperature in the treatment group and control group met the requirements. This is due to the location of the campus in the highlands, so the temperature at the study site tends to be low. The use of air conditioning in the laboratory room also affects the temperature conditions in the room, because the air conditioner used is still working optimally. The main principle of air conditioning machines is to transport heat from one location to another. In the context of buildings, the task of the

air conditioner is to lift excess heat from inside the room to outside the room so that the temperature conditions in the room remain stable and do not exceed the threshold value (24). Based on the above results, it is known that there is no significant difference between the temperature before and after the activation of the UV Aerator. The use of the UV Aerator has no effect on the condition of the laboratory room temperature.

2) Differences in Humidity Before and After Activation of The UV Aerator

The results of the Paired T test in the treatment group obtained a significant value of p = 0.105, then p> 0.05 which means that there is no significant difference in humidity in the treatment group before and after the activation of the UV Aerator. The results of the Paired T test of the control group obtained a significant value of p = 0.005, then p <0.05, which means that there is a significant difference in humidity in the control group without a UV Aerator.

Conditions in the field indicate that the overall average humidity in the treatment group and control group has not met the requirements because it still exceeds the threshold value. The research location is in the highlands, resulting in the average humidity in the treatment and control groups still exceeding 60%. The Laboratory of Campus 7 Poltekkes Kemenkes Semarang also has a high density of vegetation because the conditions around the laboratory are overgrown with plants, causing the water vapor content around the laboratory to be high. Based on the research data above, it is known that there is no significant difference between humidity before and after activation of the UV Aerator. The use of a UV Aerator has no effect on the humidity conditions of the laboratory room, because of the decrease in humidity that occurs as a result of outdoor conditions.

3) Differences in Lighting Before and After Activation ofTthe UV Aerator

The results of the Paired T test in the treatment group obtained a significant value of p = 0.309, then p> 0.05, which means there was no significant difference in lighting in the treatment group before and after the activation of the UV Aerator. The results of the Paired T test of the control group obtained a significant value of p = 0.290, then p> 0.05 which means there is no significant difference in lighting in the control group without a UV Aerator.

Conditions in the field showed that the overall average lighting in the treatment group and control group did not meet the requirements because the results were below the threshold value and there was a decrease in the final lighting. In general, the longer the time of the study, the lighting increased due to the presence of sunlight. The results showed that the average final lighting result in the treatment and control groups was lower than the initial lighting, so there was no effect on the measurement time because the lighting in the laboratory only relied on artificial lighting from lamps, while the windows and curtains were closed. The UV Aerator does not emit light, only flickers from the UV lamp but it has no effect on the lighting in the laboratory room. Based on the research data above, it is known that there is no significant difference between the lighting before and after the activation of the UV Aerator.

4) Differences in Air Germ Numbers Before and After Activation ofTthe UV Aerator

Room	Treatment		Control	
	Pre	Post	Pre	Post
SIK3	794,0	629,0	749,0	1079,0
Promkes	899,0	704,0	479,0	929,0
PVBP	1079,0	509,0	659,0	584,0
Fisika	944,0	884,0	689,0	554,0
$\bar{X}$	929,0	681,5	644,0	786,5

The results of the Paired T test in the treatment group obtained a significant value of p = 0.113, then p> 0.05, which means that there was no significant difference in the number of airborne germs in the treatment group before and after the activation of the UV Aerator. The results of the Paired T test of the control group obtained a significant value of p = 0.4, then p> 0.05 which means that there is no significant difference in the number of airborne germs in the control group without a UV Aerator.

From the statistical calculations above, it can be seen that there is no difference in the number of airborne germs between rooms that use tools and rooms without tools. However, in absolute numbers there was a decrease in the average number of airborne germs in the treatment group of 247.5 CFU/m^3, so the average was 681.5 CFU/m^3. This result has met the Threshold Value for the number of airborne germs according to the Regulation of the Minister of Health of the Republic of Indonesia Number 48 of 2016 concerning Office Occupational Safety and Health Standards, which is <700 CFU/m^3, but is still relatively high. Meanwhile for the control group there was an increase in the number of airborne germs by 142.5 CFU/m^3. This condition is because the research room has been carried out by researchers in and out of the room to take measurements, so that the number of airborne germs increases.

In the treatment group, the whole room showed a decrease in the number of airborne germs due to the presence of a UV Aerator. In the control group, the SIK3 Laboratory and Promkes laboratory room increased the number of airborne germs due to the influence of occupant activities. When measuring the number of airborne germs using MAS, researchers from the laboratory are in the room until the measurement is complete. The number of airborne germs in the classroom is influenced, among others, by the number of occupants, occupant activities, temperature, humidity, dust particles carried by the occupants of the room or entering through the window and the condition of the curtains that have never been cleaned causing dust and air microbes to stick. (25). In the control group of the PVBP Laboratory room, the number of airborne germs decreased because in this room the ventilation conditions were open, so that sunlight could enter the room which resulted in a decrease in the number of airborne germs. In the Physics room, the decrease in the number of airborne germs occurred because when measuring the number of airborne germs using the MAS, the laboratory did not wait in the room and only put down the equipment and then left the room so that there was no activity from the occupants.

Airborne germ numbers that tend to be high are also caused by the absence of cleaning and maintenance of laboratory rooms during the COVID-19 pandemic, closed curtains so that sunlight cannot enter the room to kill microbes, air conditioning conditions that are not cleaned regularly, limited power. pump suction, and the UV Aerator tool is only on for 2 hours so that the work of the tool to reduce the number of air germs is not optimal. Based on the research data above, it is known that there is a decrease in the number of airborne germs in the room with a UV Aerator, but statistically the difference is not significant.

d. The Effectiveness of UV Aerator in Reducing The Number of Air Germs

Room	Treatment Group Effectiveness	Control Group Effectiveness
SIK3	-20,78%	44,06%
Promkes	-21,69%	93,95%
PVBP	-52,82%	-11,38%
Fisika	-6,35%	-19,59%
$\bar{X}$	-26,64%	22,18%

Based on the data from the calculation of the effectiveness of UV Aerator listed in table above with the effectiveness formula:

$$\frac{(Post\ Air\ Germ\ Numbers - Pre\ Air\ Germ\ Numbers)}{Pre\ Air\ Germ\ Numbers} \times 100\%$$

The value of the effectiveness of the SIK3 Laboratory room for the treatment group (-20.78%) control (44.06%), Laboratory Health Promotion treatment group (-21.69%) control (93.95%), Laboratory PVBP treatment group (-52, 82%) control (-11.38%), Physics Laboratory treatment group (-6.35%) control (-19.59%). The effectiveness of UV Aerator to reduce the number of airborne germs in the treatment group (-26.64%) and the control group (22.18%). Negative results in the treatment group indicate that there is a decrease in the number of airborne germs. From these results, it can be said that the UV Aerator has been effective in reducing the number of airborne germs until the value of the air germ number is below the NAV, but the air germ number is still relatively high.

According to Sita Imania Barokawati (2019) regarding the Effectiveness of Nos Sterilization in Reducing Air Germ Numbers in Classrooms at SDN Karangmangu, Baturraden District, Banyumas Regency in 2019, the effectiveness of NOS sterilization in reducing airborne germ numbers was obtained (-21.147%). According to Ririh Puspitasari (2016) on the Effectiveness of the Use of Germicidal Ultraviolet Lamps on Reducing Airborne Germ Rates in the Emergency Installation at Mandiraja 2 Public Health Center, Mandiraja District, Banjarnegara Regency.

The UV Aerator is able to circulate air for 190 liters per minute, while the tool is only turned on for 2 hours. Of the four laboratory rooms used for research, the tool is able to circulate room air by 11.21% - 16.08%, and the time needed to circulate room air as a whole is 12.44 hours - 17.84 hours. We recommend that the suction power of the pump on the UV Aaerator be enlarged in order to speed up air circulation in the room. According to Soetarto (2008) in Sita Imania (2019), the decrease in the number of bacteria is greater if the sterilization time of ultraviolet light is carried out longer because ultraviolet light is known to be one of the rays with radiation power that can be lethal to organisms. The effectiveness of UV rays in reducing the number of airborne germs is influenced by, among others: lighting, length of exposure, whether or not the condition of the lamp is good and the amount of dust around the lamp. UV rays can kill only microorganisms that are directly exposed to UV light, for surfaces that are not reached by UV rays the presence of certain microorganisms will not be killed (5). In terms of practicality, this tool cannot be said to be practical and easy to carry, because the material of this tool is wood so it tends to be heavy and cannot be carried by one person. The

components that make up the tool are easy to obtain and environmentally friendly.

Weaknesses in this study, the initial room that will be used for research is the classroom in Building R2 which is used as a place for admin of online lectures, but the researcher did not get permission from the campus so that the researcher changed the research location in the laboratory. There are six laboratories in the Department of Environmental Health, including the Physics Laboratory, Health Promotion Laboratory, SIK3 Laboratory, PVBP Laboratory, Microbiology Laboratory, and Chemistry Laboratory. The researcher did not use the Microbiology Laboratory and the Chemistry Laboratory as a place of research, because there were no air conditioners and fans in the two laboratories. Another weakness is that there is no student lecture activity in the laboratory room that is used as a research location due to the COVID-19 pandemic conditions so that researchers cannot observe one of the common factors that causes an increase in the number of airborne germs, namely the activity of residents.

Weaknesses in this study, the initial room that will be used for research is the classroom in Building R2 which is used as a place for online lecture admins, but the researcher did not get permission from the campus so that the researcher changed the research location in the laboratory. There are six laboratories in the Department of Environmental Health, including the Physics Laboratory, Health Promotion Laboratory, SIK3 Laboratory, PVBP Laboratory, Microbiology Laboratory, and Chemistry Laboratory. The researcher did not use the Microbiology Laboratory and the Chemistry Laboratory as a place of research, because there were no air conditioners and fans in the two laboratories. Another weakness is that there is no student lecture activity in the laboratory room that is used as a research location due to the COVID-19 pandemic, so researchers cannot observe one of the common factors that causes the increase in airborne germ numbers, namely the activity of residents.

4. Conclusion

The average initial temperature of the treatment group was 23.70°C, the control group was 24.88°C, the initial humidity of the treatment group was 67.25%, the control group was 66.75%, the initial lighting was 185.5 lux, the control group was 197.0 lux, the initial airborne germ number in the treatment group was 929.0 CFU/m^3 the control group was 644.0 CFU/m^3.

The average final temperature of the treatment group was 25.11°C, the control group was 24.48°C, the final humidity of the treatment group was 60.66%, the control group was 64.29%, the final lighting was 160.7 lux, the control group was 181.0 lux, the final airborne germ number in the treatment group was 681.5 CFU/m^3 the control group was 786.5 CFU/m^3. There was no significant difference in temperature in the treatment group before and after activation of the UV Aerator ($p = 0.061$), there was no significant difference in temperature in the control group without a UV Aerator ($p = 0.126$).

There was no significant difference in humidity in the treatment group before and after activation of the UV Aerator ($p = 0.105$), there was a significant difference in humidity in the control group without a UV Aerator ($p = 0.005$). There was no significant difference in lighting in the treatment group before and after activation of the UV Aerator ($p = 0.309$), there was no significant difference in lighting in the control group without a UV Aerator ($p = 0.290$). There was no significant difference in the number of airborne germs in the treatment group before and after activation of the UV Aerator ($p = 0.113$), there was no significant difference in the number of airborne germs in the control group without a UV Aerator ($p = 0.4$). The effectiveness of the UV Aerator in reducing the number of airborne germs is (-26.64%).

5. Suggestion

For the laboratory, it is necessary to clean and disinfect the laboratory room at least once a day, open the curtains in the laboratory so that sunlight can enter the room. For further researchers, it is necessary to increase the suction power of the pump on the UV Aaerator so that it can accelerate the circulation of room air, the need to add a filter to the UV Aerator so that the aeration of water vapor does not add to the humidity of the air.

6. References

1. Permenkes RI. PERATURAN PEMERINTAH REPUBLIK INDONESIA NOMOR 66 TAHUN 2014 TENTANG KESEHATAN LINGKUNGAN. Jakarta: Departemen Kesehatan Republik Indonesia; 2014.
2. Lisyastuti E. “Jumlah Koloni Mikroorganisme Udara Dalam Ruang dan Hubungannya Dengan Kejadian Sick Building Syndrome (SBS) Pada Pekerja Balai Besar Teknologi Kekuatan Struktur (B2TKS) BPPT Di Kawasan Puspiptek Serpong Tahun 2010.” Tesis. 2010;1–55.
3. Arum; WC. Pengaruh pemakaian perasan daun jeruk nipis (Citrus aurantifolia) terhadap angka kuman udara ruang kelas

R221 jurusan Kesling Purwokerto tahun 2016. 2016; Available from: http://repository.poltekkes-smg.ac.id/index.php?p=show_detail&id=2719&keywords=wulan+cendana+arum
4. Cahyono T. Penyehatan Udara. 2017.
5. Prajawanti NL. Efektivitas Shokivi Desinfection Terhadap Penurunan Angka Kuman Udara Pada Ruang kelas Gedung R2 Lantai 2 Kampus 7 Poltekkes Kemenkes Semarang Tahun 2020. 2018.
6. Barokawati SI. Keefektifan Nos Sterilization Terhadap Penurunan Angka Kuman Udara Pada Ruang Kelas SDN Karangmangu Kecamatan Baturraden Kabupaten Banyumas Tahun 2019. 2019.
7. Linggarsih. Efektivitas Lampu Ultraviolet Intensitas 2,53 Lux Terhadap Penurunan Angka Kuman Udara Dengan Variasi Waktu 30 Menit Dan 60 Menit.
8. Herlinda. Pengaruh Pemakaian Air Perasan Jeruk Nipis (Citrus Aurantifolia) Terhadap Jumlah Angka Kuman Udara Di Ruang Laboratorium Mikrobiologi Jurusan Kesehatan Lingkungan Purwokerto Tahun 2018. 2018;
9. Vikriyah KM. Efektivitas Ekstrak Kulit Jeruk Nipis Terhadap Penurunan Angka Kuman Udara Di Ruang Laboratorium Mikrobiologi Jurusan Kesehatan Lingkungan Purwokerto Tahun 2019. 2019.
10. Pamuji LR. Faktor Yang Berhubungan Dengan Angka Kuman Udara Di Sekolah Dasar Negeri Se-Wilayah Kerja Puskesmas Baturraden 2 Kabupaten Banyumas Tahun 2020. Poltekkes Kemenkes Semarang; 2020.
11. Ernawati D, Gunawan AT, Budiono Z. Faktor-Faktor Yang Berhubungan Dengan Kondisi Suhu Dan Kelembaban Ruang Keluarga Di Dusun Kotayasa Desa Kotayasa Kecamatan Sumbang Kabupaten Banyumas Tahun 2016. Bul Keslingmas. 2017;36(4):437–45.
12. Vindrahapsari RT. Kondisi Fisik dan Jumlah Bakteri Udara pada Ruangan AC dan Non AC di Sekolah Dasar (Studi Sekolah Dasar Sang Timur Semarang). Univ Muhammadiyah Semarang [Internet]. 2016; Available from: http://repository.unimus.ac.id/51/1/FULLTEXT 1.pdf
13. Putri SCG. Faktor-Faktor Yang Berhubungan Dengan Angka Kuman Udara Di Sekolah Dasar Negeri Kecamatan Purwokerto Selatan Kabupaten Banyumas Tahun 2020. 2020;
14. Tiarawati ID. Kualitas Udara Mikrobiologis Di Fasilitas Penjara Dan Resiko Yang Ditimbulkan (Studi Kasus : Rutan Salemba). 2011;
15. Tri Purnamasari, Suharno S. Hubungan Faktor Lingkungan Fisik Dan Standar Luas Ruangan Dengan Kualitas Mikrobiologi Udara Pada Ruang Perawatan Rumah Sakit Bhayangkara Pontianak. 2017;1–10.
16. Septiana E. Faktor-Faktor Yang Berhubungan Dengan Angka Kuman Udara Di Ruang Rawat Inap Rumah Sakit Paru Dungus Madiun. 2018;1–26.
17. Jayanti L. Faktor Yang Mempengaruhi Kualitas Sanitasi Ruang Rawat Inap RSUD Syekh Yusuf Kabupaten Gowa. 2014;
18. Ismadiar Rachmatantri, Mochtar Hadiwidodo HSH. Pengaruh Penggunaan Ventilasi (Ac Dan Non-Ac) Terhadap Keberadaan Mikroorganisme Udara Di Ruang Perpustakaan. J Chem Inf Model. 2019;53(9):1689–99.
19. Kusumawardhani C. Angka Kuman Udara Di Ruang Rawat Inap Kelas I, II dan III RST Wijayakusuma Purwokerto Tahun 2018. 2018;38(1204):204–17.
20. Abdullah MT, Hakim BA. Lingkungan Fisik dan Angka Kuman Udara Ruangan di Rumah Sakit Umum Haji Makassar, Sulawesi Selatan. Kesmas Natl Public Heal J. 2011;5(5):206.
21. Didik Agus Nugroho, Budiyono N. Faktor-Faktor Yang Berhubungan Dengan Angka Kuman Udara Di Ruang Rawat Inap Kelas III RSUD Dr. Moewardi Surakarta. 2016;4(4):900–6.
22. Yuliarti OA. Faktor Yang Berhubungan Dengan Angka Kuman Udara DI SD Negeri Karangmangu Kecamatan Baturraden Kabupaten Banyumas Tahun 2019. 2019.
23. Nafisah MFW. Faktor-Faktor Yang Berhubungan Dengan Angka Kuman Udara di Taman Kanak-Kanak Se-Wilayah Puskesmas Purwokerto Timur II Kabupaten Banyumas Tahun 2020. 2020;
24. Satwiko P. Fisika Bangunan. Yogyakarta: Andi; 2009.
25. Febriani R. Pengaruh Penggunaan Ion Plasma Terhadap Penurunan Angka Kuman Udara Di Ruang Kelas Gedung R2 Jurusan Kesehatan Lingkungan Politeknik Kesehatan Kemenkes Semarang Tahun 2017. 2017.
26. Puspitasari R. Efektivitas Penggunaan Lampu Germicidal Ultraviolet Terhadap Penurunan Angka Kuman Udara Pada Instalasi Gawat Darurat Di Puskesmas Mandiraja 2 Kecamatan Mandiraja Kabupaten Banjarnegara Tahun 2016. 2016;2–4.