BULETIN KESLINGMAS
Terbit pertama kali April 1982 Buletin Kesehatan Lingkungan Masyarakat

p-ISSN : 0215-742X
e-ISSN : 2655-8033

Buletin Keslingmas Vol.39 No.4

THE EFFECTIVENESS OF UVAERATOR IN REDUCING AIR GERMS AND DUST LEVELS

Tri Cahyono[1)], Teguh Widiyanto[2)]

1) 2) Environmental Health Departement of Purwokerto, Poltekkes Kemenkes Semarang, Indonesia

Corresponndence email : statistikan@yahoo.com

Abstract

Background, school education facilities, including higher education as a place and public facilities for formal education facilities in this country, should be a comfortable place to study. Besides functioning as a place of learning, schools can also be a threat of disease transmission . measurement number of bacteria in the air-conditioned classrooms Wulan R22 (2016) 12.167 CFU / m^3 , Nur Latifah (2018) an average of 217.92 colony / hr / ft^2 , hadita (2018) 331.6 colonies / hr / ft^2 . Research question is how is the effectiveness of UVAerator in reducing the number of air germs and dust levels in the lecture hall R22 building Campus 7 Poltekkes Kemenkes Semarang ? Research objectives is to find the effectiveness of UVAerator in reducing the number of air germs and dust levels in the lecture hall. **Research method** included a quasi-experimental design with a non-equivalent control group pre test - post test. Data collection by measuring, observational, interview. The variables were temperature, humidity, lighting, air germ count, dust content. Analysis using pairet-t test comparisons and unpaired t test data. **Result,** the average number of bacteria with no air space UVAerator in the morning is (668,00 g / m^3) and in the afternoon is (680.10 g / m^3) the difference was not significant (p = 0.873), whereas the existing space UVAerator in the morning (876.50 g / m^3) and in the afternoon (655.50 g / m^3) shows significant difference (p = 0.001). The number of room air germs that do not exist and have UVAerator is significantly different (p = 0.002), the number of room air germs that are not there and without any UVAerator is not significant (p = 0.763), while the change in the number of room air germs that does not exist and exist UVAerator has a significant difference (p = 0.015). On average PM10 space dust that has no UVAerator in the morning (12.38 ug / m^3) and in the afternoon (17.38 ug / m^3) shows significant difference (p = 0.008), whereas the existing space UVAerator in the morning (11.63 g / m^3) and day (14.50 µg / m^3) shows that the difference is not significant (p = 0.127). PM10 dust in the room that does not exist and there is no UVAerator ported, the difference is not significant (p = 0.821), the PM10 dust in the room noon and there is UVAerator, the difference shows that it is not significant (p = 0.432), while the change in room PM10 without dust and there is a difference in UVAerator significant (p = 0.004). **In conclusion,** the effectiveness of reducing the number of air germs without UVAerator on average (4.56%), with UVAerator (-24.52%), the difference was not significant (p = 0.057). The effectiveness of reducing PM10 without UVAerator, mean (60.50%), with UVAerator (38.30%), the difference was not significant (p = 0.369). **Suggestion,** , It is necessary to control the sound intensity caused by UVAerator by adding aeration bubble breakers. The pump suction power is enlarged to accelerate the circulation of room air.

Keywords*: UVAerator, air germ count, PM10 dust, environmental health*

1. Introduction

School education facilities, including higher education as a place and public facilities for formal education facilities in this country, should be a comfortable place to study (Rr, Sumiyati, 2015, p, 2). Besides as a place of learning, schools can also pose a threat of disease transmission to children if they are not managed properly (Nadia, 2012). A healthy environment has to be free from disturbances such as elements of liquid waste, solid waste, gas waste, waste that is not processed according to the requirements set by the government, disease-carrying animals, dangerous chemicals, noise that exceeds the threshold, ionizing and non-ionizing light radiation, polluted water, polluted air, and contaminated food (RI Law No 36 of 2009).

According to Tri Cahyono (2017, p, 65) air pollution is the presence of gases, liquid particulates, solids, energy, or other components that exceed the highest or lowest limits, or which materials should be present but not present or vice versa. The location of air pollution is classified into three, it is emission, ambient, and room air (Esi Lisyatuti 2010, p, 2-3). Indoor air or indoor water according to the NHMRC (National Health Medical Research Council) is the trapped air inside a building (homes, schools, restaurants,

hotels, hospitals, offices) occupied by a group of people with different health levels for at least one hour. According to the EPA (Environmental Protection Agency of America) indoor air quality is 2-5 times worse than outdoor air. Air parameters are divided into three, it is the physical parameters air, chemistry air, and microbiology air. Indoor air quality greatly affects human health, almost 90% of human life is indoors (Susanna, D, et al,1998). As many as 400 to 500 million people, especially in developing countries, are dealing with indoor air (Unnes Journal of Public Health 2 (4) (2013)). The microbiological air parameter that is often used is the number of air germs, which total includes all the germs in the air (Tri Cahyono, 2017). Microorganisms will come out of their hosts (humans or animals or plants), due to coughing, sneezing, drying body fluids, or due to spores (fungi), (Tri Cahyono, 2017, h, 197).

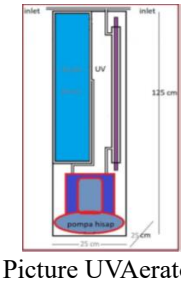
According to the research results of Wulan Cendana Arum (2016) in the classroom of the R221 building of the Department of Environmental Health, Poltekkes of the Ministry of Health, Semarang, the results of the examination of germ numbers before treatment are 08.00 WIB (morning) 11167 colonies / m^3, 12.00 WIB (noon) 13167 colony / m^3, and at 16.00 WIB (afternoon) 12167 colonies / m^3, while after treatment the concentration of 5% (morning) 2917 colonies / m^3, the concentration of 15% (noon) 2833 colonies / m^3, and a concentration of 25% (afternoon) 3677 colonies / m^3. According to the results of research by Rina Febriani (2017) in the classroom of the R2 building of the Environmental Health Department of the Ministry of Health, Semarang, the results of the examination of the air germ count for the treatment group averaged 189.50 colonies / hour / $feet^2$ while the average in the control room was 196.66 colonies. / hour / $feet^2$. The results of the average measurement of plasma ions were 120.76x104 ions / cm^3, while in the control room it was 147.95x104 ions / cm^3. The average measurement result for the plasma ion generator in the room is 53.88x104 ion / cm^3. According to the results of research by Nur Latifah Prajawanti (2018) inside the the R2 classroom building of the Environmental Health Department of the Ministry of Health, Semarang, the results of examining the air germ count in the control room obtained an average air germ count of 217.92 colonies / hour / $feet^2$ while in the treatment room it was obtained the results of the average number of air germs is 150.25 colonies / hour / $feet^2$. According to research by Hadita Deni Ayu Puspitasari (2018, h, 42) in classrooms R226, R221, R222, Department of Environmental Health, Health Polytechnic of the Ministry of Health, Semarang, the average number of air germs d R226 resulted in 331.6 colonies / hour / $feet^2$, R221 of 433 colonies / hour / $feet^2$, and R222 of 355.5 colonies / hour / $feet^2$. Azmi's research results (2019) that the number of air germs in the R22 classroom averaged 338.92 colonies / hour / $feet^2$.

Various ways have been done by humans to overcome the problem of air germ numbers in order to minimize, inhibit and banish air germs in order to reduce that number of germs in the room air that does not exceed the required limits. Ways to reduce the number of air germs include disinfection (application of chemicals / disinfectants such as alcohol and chlorine), sterilization, control with ultraviolet radiation (UV) and ionization rays and control by filtration (Jensen, 1998) (Wulan Cendana Arum, 2016, p, 2). Ultraviolet light (UV) has the ability to affect the work of the function 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 the microorganisms cannot perform vital cellular functions. The type of UV light that can affect germs or bacteria has a wavelength of 200 to 280 nm or more known as UV C, the length of time to effectively destroy microorganisms is not less than one second, in principle when in contact with UV light, the microorganisms will die (Tri Cahyono, 2017, p, 268).

Research question points to how the effectiveness of UVAerator in reducing the number of air germs and dust levels in the lecture hall R22 building Campus 7 Poltekkes Kemenkes Semarang. The objective is to see how effective UVAerator is in reducing the number of germs of air and dust levels in lecture halls.

2. Methods and Material

The research method included a quasi-experimental design with a non-equivalent control group pre test - post test. Data collection by measuring, observational, interview. The variables were temperature, humidity, lighting, air germ count, dust content. Analysis using pairet-t test comparisons and unpaired t test data.



Picture UVAerator

3. Result and Discussion

A. Analysis of the differences between between temperature, humidity, lighting, air germ numbers, dust levels, classrooms before and after activation of UV - Aerators

1. Temperature

In a room without UVAerator the average morning temperature is 24.10^{0}C and an average day temperature is 25,19^{0}C, there is a change in an increase of 1.09^{0}C. The morning room temperature without UVAerator is statistically different. significant (p = 0.116) with day temperature. In the room where the UVAerator has an average morning temperature of 24.39^{0}C and an average day temperature of 25.11^{0}C, there is a change in an increase of 0.72^{0}C. The morning room temperature that has UVAerator is statistically insignificant (p = 0.162) with the day temperature.

In the room without UVAerator the average morning temperature was 24.10^{0}C and the room with the UVAerator the average morning temperature was 24.39^{0}C, there was a difference of 0.29^{0}C, but statistically the difference was not significant (p = 0.512). In the room without UVAerator the average day temperature is 25.19 0 C and the room with UVAerator has an average day temperature of 25.11^{0}C, there is a difference of 0.08^{0}C, but statistically the difference is not significant (p = 0.903).

In a room without UVAerator, the average morning temperature is 24.10^{0}C and in the room with UVAerator, the average morning temperature is 24.39^{0}C, there is a difference of 0.29^{0}C. In a room with a UVAerator, the average temperature morning 24.39^{0}C and the average daytime temperature 25.11^{0}C, there was a change in the increase of 0.72^{0}C. The average change / difference in temperature without UVAerator was 0.29^{0}C, while the average change / difference in temperature without UVAerator is 0.72^{0}C, in absolute numbers there is a difference of 0.43^{0}C, but statistically the difference is not significant (p = 0.647).

The above conditions indicate that the UVAerator has no impact on room temperature, because between the UVAerators and those without the UVAerators, the conditions of morning temperature, daytime temperature and temperature changes are not significant.

2. Humidity

In a room without UVAerator, the average of humidity in the morning is 66.95% and the humidity average is 61.42% during the day, there is a change in the decrease of -5.53%. The humidity of the morning room without UVAerator was statistically significant difference (p = 0.015) with daytime humidity. In the room with UVAerator, the average humidity in the morning is 67.20% and the average humidity is 59.02% during the day, there is a change in the decrease of 8.18%. The humidity in the morning room with UVAerator was statistically significant difference (p = 0.002) with daytime humidity.

In a room without UVAerator, the average humidity in the morning is 66.95% and in a room with UVAerator, an average morning humidity is 67.20%, there is a difference of 0.52%, but statistically the difference is not significant (p = 0.939) . In the room without UVAerator the average daytime humidity was 61.42% and the room with UVAerator had an average daytime humidity of 59.02%, there was a difference of 2.40%, but statistically the difference was not significant (p = 0.507).

In a room without a UVAerator, the average humidity in the morning is 66.95% and the average humidity is 61.42% during the day, there is an increase of 5.53% change. In the room with UVAerator, the average humidity in the morning is 67.20% and the average humidity is 59.02% during the day, there is a change in the increase of 8.18%. The average change / difference in humidity without UVAerator was 5.53%, while the average change / difference in humidity without UVAerator was 8.18%, in absolute numbers there was a difference of 2.65%, but statistically the difference was not significant (p = 0.327).

The above conditions indicate that the UVAerator does not have an impact on room humidity, because between those which uses UVAerators and those without the UVAerators, the conditions of morning and day humidity changes are not significant. The result of water vapor or mist from the aeration process has no impact on the humidity of the room. The difference in humidity in the morning and afternoon is significantly different, this is not due to the influence of UVAerator. In general, humidity decreases during the day, this is due to the influence of outdoor conditions. The natural conditions of the mountains in the morning are very high in humidity, but during the day there is a decrease in humidity.

3. Lighting

In a room where there is no UVAerator, the average morning light is 156.50 lux and the daylight average is 143.50 lux, there is a change in the decrease of 13.00 lux. The morning room lighting without UVAerator was statistically insignificant (p = 0.459) with daylight. In the room that has UVAerator, the average morning lighting is 183.50 lux and the average daylight is 161.20 lux, there is a change in the decrease of 22.30 lux. The room lighting in the morning with UVAerator was

statistically not significant (p = 0.062) with daylight.

In a room where there is no UVAerator, the average morning lighting is 156.50 lux and in the room with UVAerator, the average morning light is 183.50 lux, there is a difference of 27.00 lux, but statistically the difference is not significant (p = 0.339). In a room where there is no UVAerator, the average daytime lighting is 143.50 lux and the room with UVAerator averages 161.20 lux of daylight, there is a difference of 17.70 lux, but statistically the difference is not significant (p = 0.465).

In a room where there is no UVAerator, the average morning light is 156.50 lux and the daylight average is 143.50 lux, there is a change of 13.00 lux. In the room that has a UVAerator, the average morning lighting is 183.50 lux and the average daylight is 161.20 lux, there is a change of 22.30 lux. The average change / difference in lighting without UVAerator is 13.00 lux, while the average change / difference in lighting without UVAerator is 22.30 lux, in absolute numbers there is a difference of 9.30 lux, but statistically the difference is not significant (p =0.644).

The above conditions indicate that the UVAerator does not have an impact on room lighting, because between the UVAerator and those without the UVAerator, the morning lighting conditions, the day lighting and the changes in lighting are not significant. UVAerator does not produce significant light. The light produced by UVAerator is only a UV indicator lamp. The UV light does not come out freely into the ambient air, because the UV lamp tube is covered with chromium metal so that it does not radiate into the room. Changes in lighting from morning to afternoon, due to the influence factor of outside sunlight that is reflected into the room through the plastic cover of the vent or through the curtains. In the morning, at 9.00 in the morning, the sunlight is still faint into the room, at noon at 12 it is bright enough to enter the room.

4. Sound Intensity

In a room where there is no UVAerator, the average morning sound intensity is 67.02 dB and the average day sound intensity is 65.80 dB, there is a decrease in the amount of 1.22 dB. The sound intensity of the morning room without UVAerator was statistically insignificant (p = 0.611) with the intensity of the noon sound. In the room with UVAerator, the average morning sound intensity is 65.77 dB and the average daytime sound intensity is 70.32 dB, there is an increase of 4.55 dB. The intensity of the sound in the morning room with UVAerator was statistically significant difference (p = 0.007) with the intensity of the noon at noon.

In a room without UVAerator, the average morning sound intensity was 67.02 dB and in the room with UVAerator, the average morning sound intensity was 65.77 dB, there was a difference of 1.25 dB, but statistically the difference was not significant (p = 0.547). In a room without UVAerator, the average daytime sound intensity is 65.80 dB and in the room with UVAerator, the average daytime sound intensity is 70.32 dB, there is a difference of 4.52 dB, statistically the difference is significant (p = 0.031).

In a room without a UVAerator, the average morning sound intensity was 67.02 dB and the afternoon sound intensity was 65.80 dB, there was a change of 1.22 dB. In the room with UVAerator, the average morning sound intensity is 65.77 dB and the average daytime sound intensity is 70.32 dB, there is a change of 4.55 dB. The average change / difference in sound intensity without UVAerator is -1.22 dB, while the average change / difference in sound intensity without UVAerator is 4.55 dB, in absolute numbers there is a difference of 5.77 dB, in test terms the difference was statistically significant (p = 0.043).

The above conditions indicate that the UVAerator has an impact on the sound intensity of the room, because between the UVAerators and those without the UVAerators, the conditions for morning sound intensity, daytime sound intensity and sound intensity changes are significantly different. In the room that has UVAerator, the sound intensity goes up quite high, while the one without UVAerator tends to decrease the sound intensity. Sound intensity reduction is needed for the aeration bath, as a result of air bubbles caused by blowing air into the water. Damping can be done by lining the aeration tub with foam, then placing it in an empty tub, so that the sound intensity is muffled in the foam and the tub is restained.

5. Air Germs Numbers

In a room where there is no UVAerator, the average number of germs in the morning is 668.00 µg / m^3 and the average number of germs during the day is 680.10 µg / m^3 , there is a change in the increase of 12.10 µg / m^3 . The number of room germs in the morning without UVAerator was statistically insignificant (p = 0.873) with the number of day germs. In the room with UVAerator, the average number of germs in the morning was 876.50 µg / m^3 and the average number of day germs was 655.50 µg / m^3 , there was a change in the decrease of 221.00 µg / m^3 The number of room germs in the morning with UVAerator was statistically significant difference (p = 0.001) with the number of day germs.

In the room that no UVAerator average

number of bacteria in the morning 668.00 ug / m^3 and the existing space UVAerator average number of bacteria in the morning 876.50 ug / m^3 , there is a difference of 108.50 g / m^3 , but statistically the difference was significant (p = 0.002). In the room without UVAerator the average number of daytime germs is 680.10 µg / m^3 and in the room with UVAerator, the average number of daytime germs is 655.50 µg / m^3 , there is a difference of 24.60 µg / m^3 , however statistically the difference was not significant (p = 0,763).

In a room where there is no UVAerator, the average number of germs in the morning is 668.00 µg / m3 and the average number of germs during the day is 680.10 µg / m^3 , there is a change in the increase of 12.10 µg / m^3 . In the room with UVAerator, the average number of germs in the morning was 876.50 µg / m^3 and the average number of day germs was 655.50 µg / m^3 , there was a change in the decrease of 221.00 µg / m^3 . The average change / difference in the number of germs that no UVAerator amounted to 12.10 g / m^3 , while the average change / difference in the number of germs that no UVAerator amounted to 221.00 g / m^3 , there is a difference in the absolute number of 233, 10 µg / m^3 , but statistically the difference was significant (p = 0,015).

The above conditions indicate that the UVAerator has an impact on the number of room germs, because between the UVAerators and those without the UVAerators the conditions for the morning germ numbers, the afternoon germ numbers and the changes in the germ numbers. In a room with a UVAerator, the reduction in air germs was more significant than in a room without a UVAerator. The decrease in the number of air germs in the room without UVAerator is more due to natural factors, such as the formation of O3 as a result of the fixation of the sun that is getting hotter, so that O3 entering the room reduces the number of germs.

6. PM10 Dust Level

In the room that had no UVAerator average PM10 morning 12.38 ug / m^3 and average PM10 lunch 17.38 ug / m^3 , a change in a gain of 5.00 mg / m^3 . PM10 in the morning room without UVAerator was statistically significantly different (p = 0.008) with PM10 at noon. In the room with UVAerator, the average PM10 in the morning was 11.63 µg / m^3 and the average PM10 at noon was 14.50 µg / m^3 , there was an increase of 2.88 µg / m^3 . The PM10 in the morning room with UVAerator was statistically insignificant (p = 0.127) with PM10 at noon.

In the room that no UVAerator average PM10 morning 12.38 ug / m^3 and the existing space UVAerator morning PM10 average 11.63 g / m^3 , there was a difference of 0.75 g / m^3 , but in test the difference was statistically insignificant (p = 0.821). In the room that no UVAerator average PM10 lunch 17.38 ug / m^3 and the existing space UVAerator average PM10 noon to 14.50 g / m^3 , there was a difference of 2.88 g / m^3 , but in test the difference was statistically not significant (p = 0,432).

In the room that had no UVAerator average PM10 morning 12.38 ug / m^3 and average PM10 lunch 17.38 ug / m^3 , a change in a gain of 5.00 mg / m^3 . In the room with UVAerator, the average PM10 in the morning was 11.63 µg / m^3 and the average PM10 at noon was 14.50 µg / m^3 , there was an increase of 2.88 µg / m^3 . Mean changes / differences in PM10 were no UVAerator of 5.00 g / m^3 , while the average change / difference in PM10 were no UVAerator of 2.88 g / m^3 , in absolute figures there is a difference of 2.22 g / m^3 , but statistically the difference was significant (p = 0.004).

The above conditions indicate that the UVAerator does not have an impact on the room PM10, because between the existing UVAerator and those without the UVAerator the conditions for PM10 in the morning, PM10 in the afternoon and the changes in PM10 are almost the same. PM10 dust conditions tend to rise from morning to afternoon, this is due to the evaporation of water particles and the presence of hot particles starting to float in the air. The conditions in the room without UVAerator were higher during the day, while those with UVAerators had low daytime dust levels, because some of the dust was caught by the UVAerator during aeration.

B. The Effectiveness of UV - Aerators In Reducing Germs And Dust levels

1. Air Germ Numbers

The results of the calculation of the effectiveness of changes in the number of air germs in a room where there is no UVAerator varies from one replication to another. In replications 1, 4, 5, 6, 9 and 10, there was a decrease in the number of air germs, indicated by the negative effectiveness rate, but in reverse in the 2, 3, 7 and 8 replications there was an increase in the number of air germs. The total replication rate increased by 4.56%. In the room that has UVAerator, as a whole, there is a decrease in the number of germs, all the calculated effectiveness numbers show negative numbers. The total replication rate decreased by 24.52%. Statistically, there was a difference in effectiveness between those without UVAerator and those without UVAerator (p = 0,057).

2. PM10 Dust Level

The results of the calculation of the effectiveness of PM10 dust changes in a room where there is no UVAerator varied from one replication to another. In the second replication, there was a decrease (-8.70%) of PM10 dust, indicated by the negative effectiveness rate , but on the other hand there was an increase in PM10 dust. The total average of all replications increased PM1 dust by 60.50%. In the existing space UVAerator also varies from one replication to another. In replication 1 and 7, there was a decrease in PM10 dust, indicated by a negative effectiveness rate, but in reverse in replications 2, 3, 4, 5, 6, 8, 9 and 10 there was an increase in PM10 dust. The total average of all replications increased PM1 dust by 38.30%. In statistical tests, there was no significant difference in effectiveness between those without UVAerator and those without UVAerator (p = 0,369).

4. Conclusion

The effectiveness of the room reduces the number of air germs that do not have UVAerator on average (4.56%), with UVAerator (-24.52%), the difference (29.08%), the difference is not significant (p = 0.057). The room effectiveness reduced PM10 without UVAerator on average (60.50%), with UVAerator (38.30%), the difference (22.20%), the difference was not significant (p = 0,369).

Need to control the sound intensity generated by UVAerator by adding aeration bubble breakers. There needs to be an additional filter on the UVAerator so that the mist of the aerated water does not add moisture to the air. The pump suction power is enlarged to accelerate the circulation of room air.

5. Acknowlegdement

Health Polytechnic of the Ministry of Health of Semarang

6. References

Alexandra Widyanareswari. 2010. Kualitas udara mikrobiologis ruang kelas studi kasus gedung perkuliahan A dan K FTUI. Skripsi. Depok : Fakultas Teknik Program Studi Teknik Lingkungan. https://anzdoc.com/queue/. Diakses pada 28 Februari 2019 pukul 01:11 WIB.

Azwar, Azrul, 1981, *Pengantar Ilmu Kesehatan Lingkungan,* Jakarta : Mutiara.

Badan Standar Nasional Pendidikan RI. 2011. Rancangan Standar Sarana dan Prasarana Pendidikan Tinggi Program Pascasarjana dan Profesi. Jakarta: Badan Standar Nasional Pendidikan RI

Cahyatri Rupisianing Candrasari, dan J Mukono. 2013. *Hubungan Kualitas Udara Dalam Ruang Dengan Keluhan Penghuni Lembaga Pemasyarakatan Kelas IIA Kabupaten Sidoarjo.* Jurnal. Surabaya : Fakultas Kesehatan Masyarakat Universitas Air Langga. http://journal.unair.ac.id/. Diakses pada 22 Oktober 2018 pukul 08.58 WIB.

Citra Kusumawardhani Unika Putri. 2018. *Faktor Lingkungan Fisik yang Berhubungan dengan Angka Kuman Udara di Ruang Rawat Inap Kelas I, II,dan III RST Wijayakusuma Purwokerto Tahun 2018*. Skripsi. Purwokerto : Jurusan Kesehatan Lingkungan Politeknik Kesehatan Kemenkes Semarang.

Devi Nur Vidyautami, Haryono Setiyo Huboyo, dan Mochtar Hadiwidodo. Vol 4, no. 1 2015. Pengaruh Penggunaan Ventilasi (AC dan Non AC) dalam Ruangan Terhadap Keberadaan Mikroorganisme Udara (Studi Kasus : Ruang Kuliah Jurusan Teknik Sipil Universitas Diponegoro). Semarang : Teknik Lingkungan Universitas Diponegoro. https://ejournal3.undip.ac.id/. Diakses pada 28 Februari 2019 pukul 02:19 WIB.

Diana Arisanti. 2004. *Efektivitas Sterilisasi Menggunakan Sinar Ultraviolet Terhadap Penurunan Angka Kuman Udara Di Ruang Operasi IBS RSUD Tugurejo Semarang*. Skripsi. Semarang : Fakultas Kesehatan Masyarakat Universitas Diponegoro. http://eprints.undip.ac.id/. Diakses pada 3 April 2019 pukul 09.29 WIB.

Dyah Moriska Candra. 2012. *Studi Komparasi Jumlah Angka Kuman Udara Ruang Perawatan Kenanga Kelas 2 Dan 3 Di Rsud Prof. Dr. Margono Soekarjo Purwokerto Tahun 2012*. Skripsi. Purwokerto: Jurusan Kesehatan Lingkungan Politeknik Kesehatan Kemenkes Semarang.

Eka Septiana. 2018. *Faktor-faktor yang Berhubungan dengan Angka Kuman Udara di Ruang Rawat Inap Rumag Sakit Paru Dungus Madiun.* Madiun : Prodi Kesehatan Masyarakat Stikes Bhakti Husada Mulia Madiun.

Fardiaz, SK,1992, *Polusi Air dan Udara,* Yogyakarta: Kanisus,

Hadita Deni Ayu Puspitasari. 2018. *Pengaruh Perasan Daun Lidah Mertua (Sansevieria trifasciata prain) Terhadap Angka Kuman Udara Di Ruang Kelas R226, R221 dan R222 Jurusan Kesehatan Lingkungan Politeknik Kesehatan Kemenkes Semarang Tahun 2018*.

Skripsi. Purwokerto : Jurusan Kesehatan Lingkungan Politeknik Kesehatan Kemenkes Semarang.

Haryoto Kusnoputranto, 1986, *Kesehatan Lingkungan,* Jakarta: Departemen Pendidikan dan Kebudayaan, Universitas Indonesia Fakultas Kesehatan Masyarakat

Indah Denas Tiarawati. 2011. *Kualitas udara mikrobiologis di fasilitas penjara dan resiko yang ditimbulkan (Studi kasus : Rutan Salemba)*. Skrispi. Depok : Fakultas Teknik Universitas Indonesia. http://lib.ui.ac.id/. Diakses pada 27 Februari 2019 pukul 00:06 WIB.

Lara Sati, Evi Sunarsih, dan A. Fickry Faisya. 2015. *Hubungan Kualitas Udara dalam Ruangan Asrama Santriwati dengan Kejadian Ispa di Pondok Pesantren Raudhatul Ulum dan Al-Ittifaqiah*. Palembang : Fakultas Kesehatan Masyarakat. Universitas Sriwijaya.

Lud Waluyo. 2004. *Mikrobiologi Umum*. Malang : Universitas Muhammadiyah Malang

M Tahir Abdullah. dkk. 2011. *Jurnal Lingkungan Fisik dan Angka Kuman Udara Ruangan di Rumah Sakit Umum Haji Makassar, Sulawesi Selatan*. Makassar : Fakultas Kesehatan Masyarakat Universitas Hasannudin. http://journal.fkm.ui.id/. Diakses pada 17 Oktober 2018 pukul 20.38 WIB.

Mangku Sitepoe. 1997. *Usaha Mencegah Pencemaran Udara*. Jakarta : PT Grasindo.

Moerdjoko. 2004. *Kaitan Sistem Ventilasi Bangunan Dengan Keberadaan Mikroorganisme Udara.* Jakarta : Jurusan Arsitektur Universitas Trisakti. http://dimensi.petra.ac.id/. Diakses pada 22 Oktober 2018 pukul 08.20 WIB.

Nadia. 2012. *Hubungan Pelaksanaan Program Usaha Kesehatan Sekolah Terhadap Perilaku Hidup Bersih dan Sehat Pada Siswa SDN 13 Seberang Padangutara Tahun 2012*. Skripsi. Padang : Universitas Andalas. http://repo.unand.ac.id/. Diakses pada 20 Oktober 2018 pukul 22:29 WIB.

Nayla Kamilia Fithri, Putri Handayani, dan Gisely Vionalita. 2016. Faktor-faktor yang berhubungan dengan jumlah mikroorganisme udara dalam ruang kelas lantai 8 Universitas Esa Unggul. Jakarta : Fakultas Ilmu-ilmu Kesehatan Universitas Esa Unggul. http://digilib.esaunggul.ac.id/. Diakses pada 27 Februari 2019 pukul 22:52 WIB.

Pelczar.J.M. dan ECS. 2008. *Dasar-Dasar Mikrobiologi*. Jakarta: Universitas Indonesia.

Rina Febriani. 2017. *Pengaruh Penggunaan Ion Plasma Terhadap Penurunan Angka Kuman Udara Di Ruang Kelas Gedung R2 Jurusan Kesehatan Lingkungan Politeknik Kesehatan Kemenkes Semarang Tahun 2017*. Skripsi. Purwokerto : Jurusan Kesehatan Lingkungan Politeknik Kesehatan Semarang.

Rizka Tiara Vindrahapsari. 2016. Kondisi fisik dan jumlah bakteri udara pada ruangan AC dan Non AC di Sekolah Dasar (Studi Sekolah Dasar Sang Timur Semarang). Skripsi. Semarang : Fakultas Kesehatan Masyarakat Universitas Muhammadiyah Semarang. http://repository.unimus.ac.id/. Diakses pada 27 Februari 2019 pukul 18:52 WIB.

Rr Sumiyati. 2015. *Tingkat Pemahaman Tentang Kesehatan Lingkungan Sekolah Pada Siswa Kelas IV Dan V SD Negeri Kembang Malang, Panjatan Kulon Progo DIY*. Skripsi. Yogyakarta : Fakultas Ilmu Keolahragaan Universitas Negeri Yogyakarta. https://eprints.uny.ac.id/. Diakses pada 18 November 2018 pukul 23:55 WIB.

Suma'mur. PK, 2009, *Higiene Perusahaan dan Kesehatan Kerja (Hiperkes),* Jakarta: CV Sagung Seto.

Taufik Nurohim. 2016. *Pengaruh Penggunaan Ion Plasma Dengan Penurunan Jumlah Angka Kuman Pada Instansi Ruang Rawat Inap I (IRNA I) RSUD Prof. Dr. Margono Soekarjo Purwokerto Tahun 2016*. Skripsi. Purwokerto: Jurusan Kesehatan Lingkungan Politeknik Kesehatan Kemenkes Semarang.

Tri Cahyono, 2017, Penyehatan Udara, Yogyakarta: Pt Andi

Vita Wiana Budi Cahya. 2016. *Faktor-Faktor yang berhubungan dengan keberadaan bakteri udara di ruang kelas (studi di yayasan mataram semarang)*. Skripsi. Semarang : Fakultas Kesehatan Masyarakat Universitas Muhammadiyah Semarang. http://repository.unimus.ac.id/. Diakses pada 27 Februari 2019 pukul 17:18 WIB.

Wulan Cendana Arum. 2016. *Pemakaian Daun Jeruk Nipis (Citrus aurantifolia) Terhadap Angka Kuman Udara Ruang Kelas R221 Jurusan Kesling Purwokerto Tahun 2016*. Skripsi. Purwokerto : Jurusan Kesehatan Lingkungan Politeknik Kesehatan Kemenkes Semarang.