

Comparison of Lime Juice (*Citrus aurantifolia S.*) and Starfruit Juice (*Averrhoa bilimbi L.*) on decreasing the Number of Air Germs in H. Andi Sulthan Daeng Radja Bulukumba Hospital

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ABSTRACT

Care room where access is easier, which triggers the presence of air which is quite high. Existence of air germs should be minimized through more economic control measures such as lime (*Citrus aurantifolia S.*) and starfruit (*Averrhoa bilimbi L.*). The aim of this study was to compare lime juice (*Citrus aurantifolia S.*) and starfruit juice (*Averrhoa bilimbi L.*) on decreasing the number of air germs. Research is a quasi-experimental; *pretest-post test one group design* approach. Sample in this study was all the number of air germs in Bougenville's Care Room. Data were analyzed using *paired t test* and *unpaired t test*. Results showed there were differences before and after giving treatment of lime juice and starfruit juice with concentrations of 25%, 50%, 75% with p values of each concentration smaller than 0, 05 and there is no difference in the number of air germs after giving of lime juice (*Citrus aurantifolia S.*) with starfruit juice (*Averrhoa bilimbi L.*) with a p value of each concentration greater than 0, 05. To the hospital to maintain air quality in each care room to minimize the number of air germs.

Keywords: Lime, Star fruit, Concentration, Air Germ Number, Care Room

INTRODUCTION

In developing countries the problem of indoor air pollution is less attention when compared to outdoor air quality (ambient air quality).^[7] Pollution of outdoor air

(ambient) and indoors is responsible for around 7 million deaths globally per year. In the Western Pacific region alone, around 2.2 million people die each year.^[17] Indoor pollution can occur in offices, school rooms, transportation facilities, shopping places, residential homes and hospitals.^[7]

One room that needs to be considered in indoor air pollution is the Hospital. The hospital is a very complex medical service unit. The complexity is not only in terms of types and types of diseases that must get the attention of doctors to enforce the diagnosis and determine curative efforts, but also the presence of various types of medical equipment from simple to modern ones.^[2] Based on data from a number of countries, it can be estimated that every year, hundreds of millions of patients worldwide are exposed to nosocomial infections. The burden of nosocomial infections is several times higher in low- and middle-income countries than in high-income countries.^[16]

Transmission of microorganisms in the air can affect the number of germs, such as the *S. Aureus* and *S. Pyogenes* bacteria in hospitals which are very serious global public health problems today in countries with limited resources.^[4] Research conducted by Bekkari, et al (2016) shows that space in public hospitals is at The city of Fez, Morocco, showed the identification of types of bacteria, with a predominantly negative *Staphylococcus* (48%), and

followed by *Bacillus* sp (14%), *S. aureus* and *A. salmonicida* (8%) respectively, *P. vesicularis* (5 %). Other bacteria such as *Lactobacillus*, *P. putrificiens*, *Streptococcus*, *A. hydrophila*, *S. liquificiens*, *P. serratia*, *S. rubidaea* and *Stenotromonas*. These germs are microbial reservoirs that can pose a risk infection for hospitalized patients.^[1]

H. Andi Sulthan Daeng Radja Hospital is a type B Hospital belonging to the Regional Government of Bulukumba Regency that has a vision of becoming a Quality, Professional and Prosperous Referral Hospital and one of its mission is to provide fast, appropriate, safe, comfortable and affordable services. Data obtained from the hospital in 2017 showed the results of the air germ number test that the Emergency Room (IGD) was 2,564 CFU/m³, the delivery room was 744 CFU/m³, the Neonatal Intensive Care Unit (NICU) was 272 CFU/m³, Intensive Care Unit (ICU) space of 332 CFU/m³, Operation Komer (OK) of 248 CFU/m³ and bougenville's care room corridor of 600 CFU/m³ has not met the standards required by Decree of the Minister of Health of the Republic of Indonesia Number : 1204/Menkes/SK/X/2004 concerning hospital environmental health requirements.

Care rooms are somewhat different compared to other spaces; care rooms must be kept clean to avoid the spread of pathogenic bacteria. The care room is also a room where access is easier than the kitchen room so that it can trigger the presence of germs in the air that are high enough and can potentially cause airborne disease transmission that is harmful to public health, such as nosocomial infections.^[18] Therefore, the presence of germs in the air must be minimized through systematic and continuous control efforts. Efforts to control the reduction in germ numbers include ozone sterilization and sterilization using *Ultra Violet* (UV) and aerosol use. One alternative to reducing germ numbers that is easily available is more economical and safe for humans namely lime plants (*Citrus*

aurantifolia S.) and starfruit plants (*Averrhoa bilimbi* L.). Lime (*Citrus aurantifolia* S.) and starfruit (*Averrhoa bilimbi* L.) as family medicinal plants used in the community, both for spice cooking and for medicine.

Lime (*Citrus aurantifolia* S.) contains flavonoids which are used to prevent fungi and bacteria. The effect of lime juice (*Citrus aurantifolia* S.) as an antibacterial can inhibit the growth of *E. coli*, *S. haemolyticus* and *S. aureus*.^[11] Based on research conducted shows lime juice (*Citrus aurantifolia* S.) has antibacterial properties against *S. aureus* and *K. pneumoniae* bacteria in vitro with an ideal concentration of 90%. Whereas wuluh starfruit is a plant whose fruit is acidic and contains natural chemicals that have an antibacterial effect, namely, flavonoids.^[15] Based on the results of a study conducted the extract of starfruit (*Averrhoa bilimbi* L.) at a concentration of 10% was able to inhibit the growth of *S. aureus*, while at a concentration of 30% it was able to kill *S. aureus*.^[14] The purpose of this study was to compare lime juice (*Citrus aurantifolia* S) and starfruit juice (*Averrhoa bilimbi* L.) to decrease the number of air germs at H. Andi Sulthan Daeng Radja Bulukumba Hospital. The purpose of this study was to compare lime juice (*Citrus aurantifolia* S) and starfruit juice (*Averrhoa bilimbi* L) on decreasing the number of air germs in H. Andi Sulthan Daeng Radja Bulukumba Hospital.

MATERIALS AND METHODS

Design and Research Location

This research is a quasi-experimental one with *pretest-post test one group design* approach that is by measuring before treatment given and after treatment according to the concentration of 25%, 50%, 75%, with the observation time of 2 hours 30 minutes after being treated. The research location was carried out by Bougenville's Care Room at H. Andi Sulthan Daeng Radja Bulukumba Hospital

Materials and tools

The materials used in this study include lime, starfruit, Aquades, 70% alcohol. The tools used in this study include measuring cups, alarm cups, scales, diffuser (sprayers), knives, filters, blenders, mixer pipettes, orange squeezer. Making Concentration of Juice of Lime and Starfruit, namely: Lime juice and starfruit juice with a concentration of 25% is to dissolve 25 ml of each lime juice and starfruit juice into 75 ml of distilled water so that it gets 100 ml for each limejuice and starfruit juice. For concentration 50%, for dissolving 50 ml each of lime juice and starfruit juice into 50 ml of distilled water so as to obtain 100 ml for each of lime and starfruit. While for the concentration of 75% for dissolving 75 ml of each lime juice and starfruit juice into 25 ml of distilled water so that it gets 100 ml for each juice of lime and starfruit.

Population and Samples

The population and samples in this study were all numbers of air germs in the Bougenville's Care Room at H. Andi Sulthan Daeng Radja Bulukumba Hospital caught in the cup. Samples in the study were drawn by chance (*accidental sampling*) members of the population, namely how to obtain samples based on coincidence or the number of air germs taken when conducting research.

Method of collecting data

The data obtained from the measurement and direct observation study consisted of measurements of air germ numbers before and measurements of air germ numbers after treatment. Three rooms were given treatment of lime juice with different concentrations in each room using a diffuser, for a concentration of 25% given in room 3, a concentration of 50% was given in room 2, and a concentration of 75% was given in room 1. The other three rooms treated with different concentration of starfruit juice in each room using a diffuser, for a concentration of 25% given in room 7, a concentration of 50% was given in room 6, and a concentration of 75% was given in

room 4 and repetition was done 3 times in 3 days.

The instruments used in this study were *Microbiology Air Sampler* for air germ numbers and *Diffuser* for spreading the treatment of lime and starfruit into the air around the room. Measurement the number of air germs in ward do by officer expert Laboratory Hall Technique Environmental Health and Control Accredited class I Disease (BTKL-PP) in Makassar.

Data analysis

The analysis in this study consisted of univariate and bivariate analysis. Univariate analysis was performed on each variable from the results of the study. Bivariate analysis is an analysis to determine the interaction of two variables both cooperatively, correlatively and associatively. The statistical test used is a *paired t* test and *unpaired t* test.

RESULTS

Germ number before and after treatment of lime juice

Figure 1 shows that the number of air germs after being given treatment of lime juice has decreased. The first and second repetitions at each concentration obtained the number of air germs that did not meet the standards set by Decree of the Minister of Health of the Republic of Indonesia Number: 1204/Menkes/SK/X/2004. While the third repetition has decreased according to the standard set at 200-500 CFU/m³.

This can be influenced by the mobilization of visitors in each room that cannot be controlled and other elements, namely the physical quality of air in the room (temperature, lighting, humidity) for air germs that do not meet the requirements. Whereas the third repetition fulfills the requirements because there are no patients and visitors who enter each of these rooms. Seen in Figure 1. It also shows that the average reduction percentage is different for each concentration. The highest concentration average percentage decrease is 75% concentration of 37% and lowest at 25% concentration of 25%.

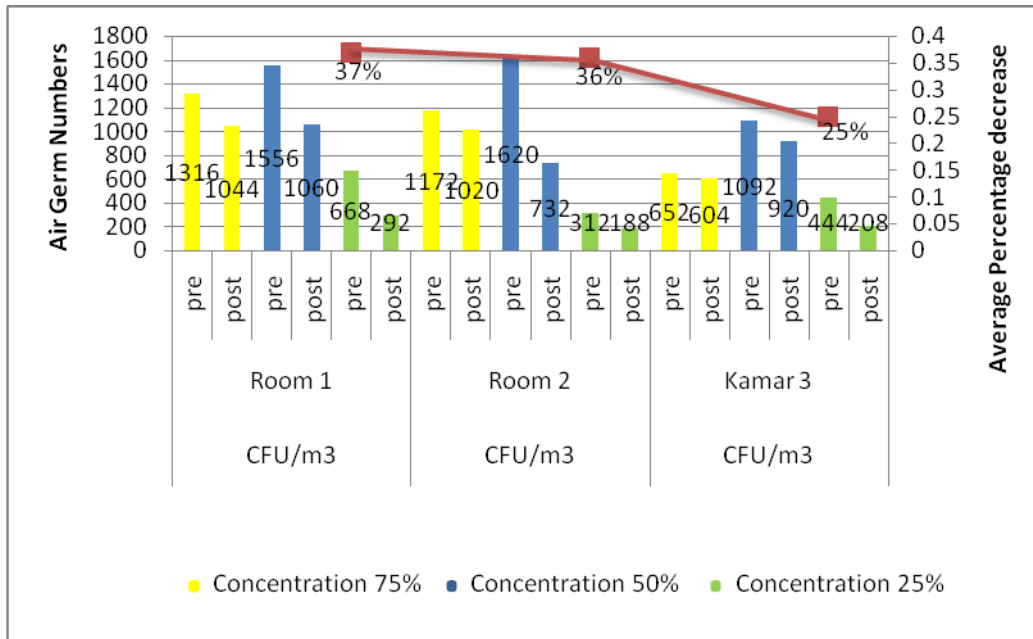


Figure 1. Germ number before and after treatment of lime juice in Bougenville's care room at H. Andi Sulthan Daeng Radja Bulukumba Hospital in 2019

Germ number before and after treatment of starfruit juice

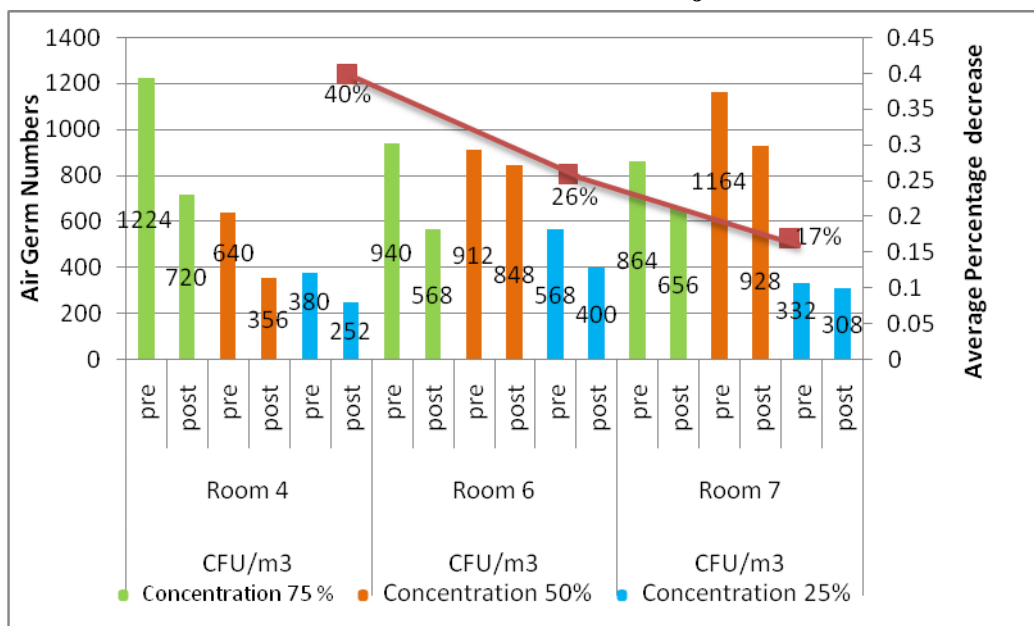


Figure 2. Germ Number before and after treatment of starfruit juice in Bougenville's Care Room at H. Andi Sulthan Daeng Radja Bulukumba Hospital in 2019

In figure 2. Shows that the number of air germs after being given treatment of the starfruit juice has decreased. The first repetition of each concentration is obtained by the number of air germs that have not met the standards set by Decree of the Minister of Health of the Republic of Indonesia Number:

1204/Menkes/SK/X/2004. The second repetition at the concentration of 50% and 25% obtained the number of air germs that did not meet the standard and the concentration of 75% was obtained by the number of air germs that met the standard, from 640 CFU/m³ to 356 CFU/m³, while the third repetition decreased according to the

standard has been determined by Decree of the Minister of Health of the Republic of Indonesia Number: 1204/Menkes/SK/X/2004 namely 200-500 CFU/m³.

This can be influenced by the mobilization of visitors in each room that can not be controlled as well as other elements, namely the physical quality of indoor air (temperature, lighting, humidity) on the air germ figures are not eligible. Whereas the third repetition fulfills the requirements because there are no patients and visitors who enter each of these rooms and the number of air germs on the second repetition in room 4 meets the requirements

due to signs of visitor mobilization and only patients in the room. Seen in Figure 2. It also shows that the average reduction percentage is different for each concentration for the treatment of starfruit juice. The highest average concentration of percentage decrease is 75% concentration by 40% and the lowest concentration at 25% by 17%.

The difference before and after treatment of lime juice (*Citrus aurantifolia S*)

The test used is a *paired t* test to find out the difference before and after treatment of lime juice (*Citrus aurantifolia S*). The test results are shown in table 1, as follows:

Table 1. Test of Difference Before and After Treatment of Lime juice (*Citrus Aurantifolia S.*) with Concentration of 25%, 50%, 75% in the Bougenville's Care Room at H. Andi Sulthan Daeng Radja Bulukumba Hospital

Repetition	Concentration of treatment	Air Germ Number		P-Value
		Before	After	
1	25%	652	604	0.011
		1092	920	
		444	208	
2	50%	1172	1020	0.014
		1620	732	
		312	188	
3	75%	1316	1044	0.028
		1556	1060	
		668	292	

Table 1. Can show that the results of the *t* test are *paired* for differences before and after the treatment of lime juice (*citrus aurantifolia s*) with a concentration of 25%, 50%, 75% obtained P-Value value smaller than 0.05 then it can be interpreted that there were significant differences before and after treatment with concentrations of 25%, 50%, 75%. So that it can be concluded that each concentration of lime juice (*Citrus*

aurantifolia S) can reduce the number of air germs.

Differences before and after treatment of starfruit juice (*Averrhoa bilimbi L.*)

The test used is a *paired t* test to determine the differences before and after the treatment of juice of starfruit (*Averrhoa bilimbi L.*). The test results are shown in table 2, as follows:

Table 2. Test of Difference Before and After Treatment of Starfruit Juice (*Averrhoa bilimbi L.*) with a Concentration of 25%, 50%, 75% in the Bougenville's Care Room at H. Andi Sulthan Daeng Radja Bulukumba Hospital

Repetition	Concentration of treatment	Air Germ Number		P-Value
		Before	After	
1	25%	864	656	0.001
		1164	928	
		332	308	
2	50%	940	568	0.039
		912	848	
		568	400	
3	75%	1224	720	0.043
		640	356	
		380	252	

Table 2. It can be shown that the results of the *t*- test *paired* for differences before and after the treatment of juice of starfruit

(*Averrhoa bilimbi L*) with a concentration of 25%, 50%, 75% obtained P-Value less than 0,05 (p <0,05), it can be interpreted that

there are significant differences before and after treatment with concentrations of 25%, 50%, 75%. So it can be concluded that each concentration of starfruit juice (*Averrhoa bilimbi L.*) can reduce the number of air germs.

Comparison of Differences in Air Germ Germination after Giving Lime juice (*Citrus aurantifolia S.*) with Starfruit Juice (*Averrhoa bilimbi L.*)

The test used is an unpaired t test to find out the Comparison of Differences in Air Germ Germination after Giving Lime juice (*Citrus aurantifolia S.*) with Starfruit Juice (*Averrhoa bilimbi L.*). The results of statistical tests are presented in table 3, as follows:

Table 3. Can show that the results of the unpaired t test for the comparison of the difference in air germ numbers after administration of lime juice (*Citrus aurantifolia S.*) with starfruit juice (*Averrhoa bilimbi L.*) obtained a greater P- value for

each concentration. From 0.05 ($p > 0.05$), thus it means that there is no comparison of the differences in the number of air germs after giving of lime juice (*Citrus aurantifolia S.*) with starfruit juice (*Averrhoa bilimbi L.*). The number of air germs at H. Andi Sulthan Daeng Radja Bulukumba Hospital has not met the required standards according to Decree of the Minister of Health of the Republic of Indonesia Number : 1204/Menkes/SK/X/2004 concerning the environmental health requirements of the Hospital, one of which is the Bougenville’s Care Room. In connection with this, lime juice and starfruit juice are natural controls through plants to reduce airborne germs. The results of measurements of air germ numbers in the treatment room before treatment showed a high number of air germs and the presence of identified microorganisms namely *S. Aureus*, *S. Epidermis* and *Bacillus sp.*

Table 3. Comparative Test of Differences in Air Germ Germination after Giving Lime Juice (*Citrus aurantifolia S.*) with Starfruit Juice (*Averrhoa bilimbi L.*) in the Bougenville’s care room at H. Andi Sulthan Daeng Radja Bulukumba Hospital

Concentration of treatment	Air Germ Number		P-Value
	After treatment (Lime juice)	After treatment (starfruit juice)	
25%	604	656	0.855
	920	928	
	208	308	
50%	1020	568	0.888
	732	848	
	188	400	
75%	1044	720	0.287
	1060	356	
	292	252	

DISCUSSION

The difference before and after the treatment of lime juice (*Citrus aurantifolia S.*) and the treatment of starfruit juice (*Averrhoa bilimbi L.*) with concentrations of 25%, 50%, 75% against decreasing air germ numbers

Measurements made in this study were before and after treatment with concentrations made varied, namely 25%, 50%, 75% by using distilled water as a solvent. Each concentration in each room is different and the results of measurement of germ numbers before and after treatment are different in each room for three repetitions (days). Based on table 1 it can be seen that

there are differences before and after giving of lime juice with a concentration of 25%, 50% and 75%. It can be interpreted that the number of air germs decreases in each concentration.

The results of this study are in line with those conducted which showed that there was a decrease in the total number of germs on the floor of the Class III Inpatient Room at Al-Ihsan Regional General Hospital Bandung after being given a lime solution with a concentration of 25%, 30 %, 35%.^[12]

In contrast to research conducted invitro which shows that five microorganisms (*P. aeruginosa*, *S. aureus*, *E. coli*, *Klebsiella sp.* and *Proteus mirabilis*) has a inhibitory

concentration of 25% and 50% in lime juice with an average diameter zone inhibition range from 18 mm to 25 mm.^[8] The results of the same study were also carried out showing that lime juice has an inhibitory effect on the growth of *S. aureus* bacteria with various concentrations of 25%, 50%, 75%, 100% and there is influence duration of contact with bacterial growth where the bacteria did not grow after the first 5 minutes of contact and followed by the following minutes with 100% lime juice.^[11]

The role of lime in this study is very useful in the health sector, one of which is a decrease in the number of germs. Lime juice contains chemical compounds including flavonoids, tannins, essential oils, saponins and citric acid.^[9] The chemical content acts as an antibacterial that can inhibit or kill germs. Antibacterial activity in the chemical compounds of lime causes changing protein molecules and damaging bacterial cells, inhibits nucleic acids and interferes with the binding of hydrogen to nucleic acids and disrupts cell membrane stability and decreases causing bacterial cell death.

Whereas for the starfruit juice in Table 2. shows there are differences before and after administration of the treatment with concentrations of 25%, 50% and 75%. It can be interpreted that the number of air germs decreases in each concentration. Research conducted *in vitro* found that the extract of starfruit with a concentration of 10% and 20% can inhibit the growth of *S. aureus* bacteria and concentrations of 30%, 40% and 50% there is no the number of colonies of bacteria *S. aureus* grown on the media of *Blood Agar Plate*.^[14] This is in line with research conducted which shows that starfruit juice has an antibacterial activity resulting in starfruit juice inhibiting or killing *P. aeruginosa* and *S. epidermidis* bacteria at a concentration of 75%.^[3] Different results of research conducted show that the inhibition of bacterial activity such as *E. coli* and *S. aureus* which is more effective is found in younger extracts to fight bacteria.^[6]

Decreasing the number of air germs is caused by active compounds in the starfruit which are antibacterial. Fruit extracts of starfruit contain active compounds such as citric acid, saponins, phenol compounds and flavonoids including phenol compounds.^[10]

These compounds act as antibacterial by changing cell permeability, changing protein molecules, impaired cell membrane function can cause bacterial cell death. The composition of the starfruit such as flavonoids, tannins, saponins and triterpenoids which have the ability to form complex denatured bacterial proteins through hydrogen bonds which causes the structure of cell walls and cytoplasmic membranes to become unstable so that bacterial cells lose their biological activity and make cell permeability function lysis which causes bacterial cell death.^[13]

This study uses a diffuser that contains lime juice and starfruit juice which is spread into the air of each room so that the decrease in germ numbers obtained cannot see the type of bacteria that dies. Decreasing the number of germs whose average percentage has not reached 50%, it is necessary to increase the concentration of juice to the maximum so that the process of decreasing the number of germs can meet the desired standard.

Comparison of differences in the number of air germs after giving of lime juice (*Citrus aurantifolia* S) with starfruit juice (*Averrhoa bilimbi* L) at H. Andi Sulthan Daeng Radja Bulukumba Hospital

Lime juice (*Citrus aurantifolia* S) and starfruit juice (*Averrhoa bilimbi* L) are green plants that have health benefits. The results of the *unpaired t* test statistics on the comparison of differences in the number of air germs after giving of lime juice (*Citrus aurantifolia* S) with starfruit juice (*Averrhoa bilimbi* L) in the Bougenville's care room, showed that the p values of each concentration were greater than 0.05 ($p > 0.05$), which can be seen in table 3 which means there were no significant differences in the number of air germs after giving of lime juice (*Citrus aurantifolia* S) with

starfruit juice (*Averrhoa bilimbi* L) with each concentration.

This can be interpreted that the variation in the concentration of lime juice (*Citrus aurantifolia* S) with variations in the concentration of juice of starfruit (*Averrhoa bilimbi* L) has the same effect in reducing the number of air germs, because the content of the two plants has elements almost the same antibacterial chemical compounds such as flavonoids and citric acid and their similar mechanism of action that can prevent bacterial growth by changing protein molecules, disrupting cell membrane stability, bacterial energy metabolism and reducing the quality of cell membranes causing bacterial cell death.^[9]

The air microorganisms identified in this study were gram-positive bacteria such as *S. aureus*, *S. epidermis* and *Bacillus* sp. Some of these bacteria are bacteria that are often found in the air and are spread through coughing, talking and sneezing. These air microorganisms consist of the cell surface (cell membrane) that provides and removes leftover food. If the cell membrane is damaged, it can cause bacterial cell death.^[5]

Research Limitations

Lime juice and starfruit juice have almost the same chemical content, making it difficult to determine the dominant influence on the two types of plants (lime and starfruit) used.

There are no restrictions on patient visitors in the care room so that it can be one of the factors that can cause growth in air germs.

Visitor activities carried out in the treatment room such as sneezing, coughing and talking that cannot be controlled so that it can provide an opportunity for germs to spread into the air.

This study does not examine in detail the types of dead air germs from the giving of lime juice and starfruit juice used so that the results of this study are only able to see the amount of air germs and identification of these air germs.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Based on the results of research about comparison of lime juice (*Citrus aurantifolia* S.) and starfruit juice (*Averrhoa bilimbi* L) to decreasing the number of air germs in H. Andi Sulthan Daeng Radja Bulukumba Hospital, then conclusions can be drawn as follows:

There are differences before and after the giving of lime juice (*Citrus aurantifolia* S) with a concentration of 25%, 50%, 75% to decrease the number of air germs in H. Andi Sulthan Daeng Radja Bulukumba Hospital with p values for each concentration smaller from 0,05.

There are differences before and after the giving of starfruit juice (*Averrhoa bilimbi* L) with a concentration of 25%, 50%, 75% to decrease the number of air germs in H. Andi Sulthan Daeng Radja Bulukumba Hospital with a p value of each concentration smaller than 0,05.

There is no difference in the number of air germs after giving of lime juice (*Citrus aurantifolia* S) with starfruit juice (*Averrhoa bilimbi* L) at H. Andi Sulthan Daeng Radja Bulukumba Hospital with p values of each concentration greater than 0,05.

Suggestion

Based on the results and discussion in this study, some suggestions can be given as follows:

It is expected that the hospital will better maintain air quality in each care room by making various control efforts to minimize the number of germs in the air, one example of which is through lime or starfruit using a diffuser.

Further research needs to be done on the types of bacteria that die in the treatment.

Maximum addition of concentration to kill germs in the air.

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