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Monitoring The Correlation of Climatics to The Airborne Bacteria at The Manggarai Station, South Jakarta, Indonesia

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Temperature, humidity, light intensity, manggarai station, bacteria

ABSTRACT

The highest of microorganisms suspended in the air were bacteria with a percentage of 80.8%. If the intensity of bacterial exposure occurs in large quantities, it will accumulate in the respiratory tract which has the potential to trigger allergic reactions and respiratory infections. Given the problems and impacts caused by air microorganisms on public health, it is necessary to monitor the distribution of air bacteria. The purpose of this study was to determine the relationship between temperature and humidity with the number of bacteria in the Manggarai station area. Type of research is correlation. The sampling location is Manggarai Station, East Jakarta, Indonesia. The 10 sampling points in this study include the station hall, motorbike parking, prayer rooms, train platform 1-2, train platform 2-3, train platform 3-4, and train platform 5, toilet, and underpass. The results of this study included the highest number of bacteria found in the station hall 331 colonies, the highest percentage of bacterial morphology is monobacilli was 78%, the distribution of gram positive was more than gram negative with spore bacteria being more dominant than non spore. The correlation coefficient between temperature and number of bacterial colonies (0.134) and humidity with number of bacterial colonies (0.380) showed weak positive correlation, while the correlation coefficient for light intensity with the number of bacterial colonies -0.140 (very weak negative).

1. INTRODUCTION

According to Bragoszewska and Pastuszka (2018), the percentage of airborne microorganisms is 10% of the 24% of the total particles suspended in the air. Cho *et al*. (2019) reported that the highest types of microorganisms suspended in the air were bacteria with a percentage of 80.8%. The dominant bacterial phyla identified in the air were Proteobacteria (32.2%), Cyanobacteria (18.0%), Actinobacteria (16.5%), Firmicutes (15.5%), and Bacteroidetes (11.6%) (Liu *et al*., 2018).

Kallawicha *et al*. (2015) explained that bacteria are components of bioaerosols that are abundant in the air both outdoors and indoors. In addition to bacteria, other bioaerosol components are viruses, fungi, pollen, metabolites of microorganisms (mycotoxins), and endotoxins as the outer membrane of bacterial cells that are released during bacterial lysis and growth. The presence of bacteria and endotoxins as components of bioaerosols were identified as important factors affecting human health. According to Jones and Harrison (2004) bacteria have a size of 0.25–8 m. This size makes it easier for bacteria to enter the human body through inhalation of the respiratory tract. If the intensity of bacterial exposure occurs in large quantities, it will accumulate in the respiratory tract which has the potential to trigger allergic reactions and respiratory infections such as asthma, rhinitis, pneumonia, and atopic dermatitis.

Cho *et al*. (2019) reported that bacteria with a size of 5-10 m that accumulate in the upper respiratory tract can trigger rhinitis, while bacteria with a size of <5 m that accumulate in the alveoli can trigger allergic reactions. However, these reactions vary between individuals. This effect tends to be more dangerous in someone with a weakened, moderate, or weakened immune system, such as children, pregnant women, and the elderly.

Given the problems and impacts caused by air microorganisms on public health, it is necessary to monitor the distribution of air microorganisms. Monitoring can be done by conducting research on the relationship between physical quality and outdoor air bacteria, especially at stations as one of the centers of crowds in densely populated urban areas.

This research was conducted at the Manggarai Station in South Jakarta, Indonesia. This station is a transit center for trains that is full of people and is a source of spreading airborne bacteria in the outside environment through coughing, breathing, and exposure to human skin. The selection of research that focuses on outdoor air bacteria at the Manggarai station refers to previous studies which were more dominant in monitoring indoor air bacteria.

Several previous studies that examined the relationship between temperature and humidity on air microorganisms, among others, research Menteşe *et al*. (2009); Wu *et al*. (2012) ; Kumar *et al*. (2011); Bragoszewska and Pastuszka (2018) ; Cho *et al*. (2019) ; Goudarzi *et al*., (2017). The difference between this research and previous research is in terms of location, this research was conducted in Indonesia, especially at the Manggarai Station. The novelty of this research is that there has never been data on air bacteria in the outdoor environment in the Manggarai station area, East Jakarta, Indonesia, considering that research on air bacteria in Indonesia is more dominant indoors.

The purpose of this study was to determine the relationship between temperature and humidity with the number of bacteria in the Manggarai station area. The existence of data on airborne bacteria can be used as a reference in formulating better policies regarding Indonesian public health guidelines outdoors.

2. MATERIALS AND METHODS

This type of research is a correlation. The sampling location is Manggarai Station, East Jakarta, Indonesia. Samples were examined at the Microbiology Laboratory of STIKes Mitra Keluarga, East Bekasi.

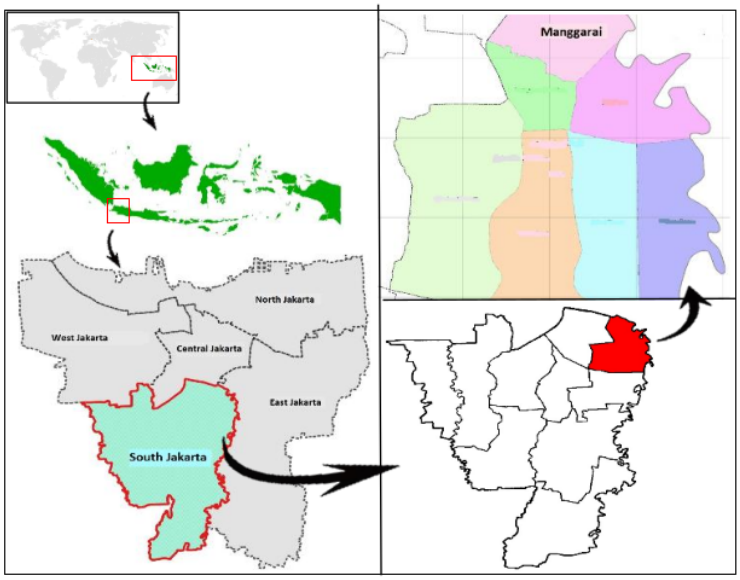


Figure 1. Map manggarai station location, south jakarta, indonesia

The instrument used in this study include Autoclave (Hirayama HG-50), Incubator (DNP), Analytical Balance (Adam), Microscope (Olympus CX22), Showcase (polytron), BSC (JSR), Hot plate and stirrer (Ika HS-10), Colony counter (KJY-020), petri dish (pyrex), bunsen's burner, Erlenmeyer (pyrex), spatula, beaker (pyrex), Thermohygrometer, Lux meter, tripod, needle loop, stirring rod, matches, dropper, object glass (sail brand) and coloring tub. The materials used in this study were 70% alcohol, spirits, aquadest, Nutrient Agar media (Himedia), Crystal violet (Be Reagent), Lugol's iodine (Merck), 95% alcohol, safranin, and Malachite Green (Riedel-De Haen).

The population in this study is the entire area of the Manggarai station. Determination of the sample area in this study using a purposive sampling technique with the criteria of a crowded area and frequently visited by passengers. The 10 sampling points in this study include the station hall, motorbike parking, prayer rooms, train platform 1-2, train platform 2-3, train platform 3-4, and train platform 5, toilet, and underpass.

The procedure of this research include pre-analytic, analytic, and post-analytic stages :

The Pre-analytic

The pre-analytic stage starts by making Nutrient Agar (NA) media to grow bacteria, measuring temperature and humidity with a thermohygrometer, light intensity with a lux meter, and taking bacterial samples at 10 points in the Manggarai station area. Each point is repeated three times on the same day and at different times, at 07.00 - 09.00 WIB. This time is the departure time of passengers at Manggarai station based on the results of a preliminary survey. The air sampling process is carried out using NA media that has been coded in the form of date, time, and location of collection placed in a predetermined sampling area with a height of 1.5 m. The NA medium was placed in an open petri dish for 10-15 minutes. The NA medium was closed again and incubated at 37°C for 2x24 hours. After incubation, the NA medium was observed and the number of bacterial colonies counted using colony counter.

The Analytic

The analytical stage is laboratory tests which include gram staining and spores. The staining results were observed using a light microscope with a magnification of 100x.

The post-analytic

The post-analytic stage is in the form of recording data on temperature, humidity, light intensity, number of bacteria, and types of bacteria based on morphology, gram, and presence of spores. All data were then analyzed by the Spearman Correlation test to determine the relationship between air physical factors such as temperature, humidity, and light intensity with the number of bacterial colonies.

The research has been conducted an ethical feasibility test by the Ethical Committee for Research health of Jakarta III Ministry of Health Polytechnic (KEPK-PKKJ3) with certificate ethic No. KEPK-PKKJ3 / 5 /II /2019

3. RESULTS AND DISCUSSION

3.1. Results

The results of examination bacteria after 2x24 hours incubation in this study showed that all areas showed the growth of bacterial colonies on petri dishes containing NA media. The results of the growth of bacterial colonies can be seen in **Figure 2.**

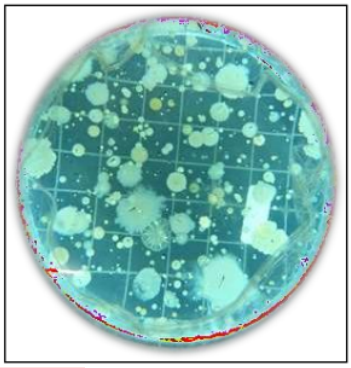


Figure 2. Bacterial colonies on NA media placed at the Manggarai station

The results of the calculation of the number of bacterial colonies after incubation of 2x24 NA media placed in 10 areas of Manggarai station in this study can be seen in **table 1.**

Table 1. The results of the calculation of the number of bacterial colonies

No	Areas	Colonies (CFU's)
1	The station hall	331
2	motorbike parking	189
3	Woman prayer rooms	33
4	Man prayer rooms	11
5	train platform 1-2	224
6	train platform 2-3	128
7	train platform 3-4	134
8	train platform 5	220
9	Woman toilet	169
10	Underpass	210

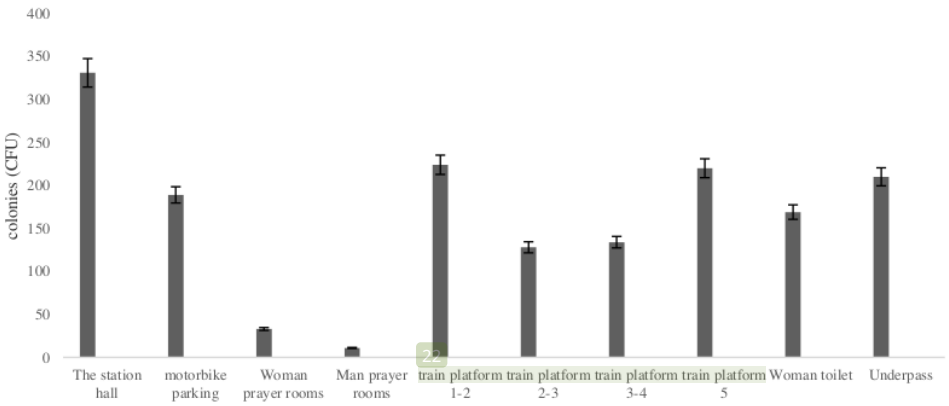


Figure 3. The number of bacterial colonies at Manggarai station

Table 1. shows that the average interval of the number of bacterial colonies found in 10 areas at the Manggarai station is between 11-331 colonies. The lowest number of bacterial colonies were found in the man prayer room as many as 11 colonies, while the highest was found in the hall area as many as 331 colonies (**Figure 3**). The distribution percentage of the number of bacteria based on their morphology can be seen in **Table 2** and **Figure 4**.

Tabel 2. The distribution percentage of the number of bacteria based on their morphology

Areas	Percentage of the number bacteria (%)								
	Monobacilli	*Diplobacilli*	*Streptobacilli*	*Coccobacilli*	*Monococci*	*Diplococci*	*Streptococci*	*Staphylococci*	*Sarcina*
The station hall	14	2	6	0	4	2	0	4	0
motorbike parking	12	7	7	1	8	5	10	10	1
Woman prayer rooms	3	0	0	0	1	0	0	0	0
Man prayer rooms	6	8	8	2	2	0	0	7	0
train platform 1-2	10	3	3	1	2	1	1	7	1
train platform 2-3	1	2	2	4	2	1	0	2	0
train platform 3-4	4	1	1	0	8	0	1	7	0
train platform 5	9	1	1	0	6	1	4	7	0
Woman toilet	7	1	1	0	7	1	2	4	0
Underpass	12	2	2	0	6	2	0	12	0
Total	78%	27%	31%	8%	46%	13%	18%	60%	2%

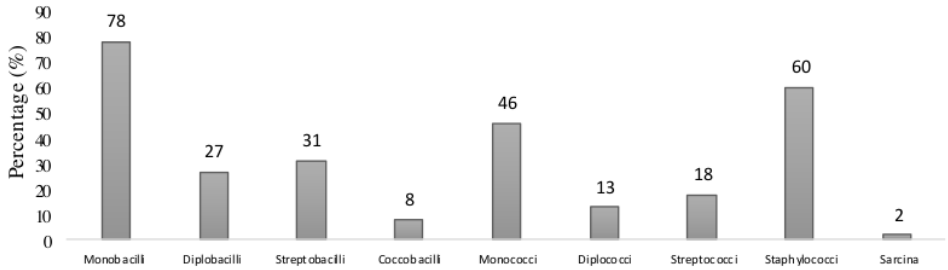


Figure 4. Diagram of the percentage number of bacterial colonies based on morphology

Table 2. show that there are 9 bacterial morphologies found in 10 areas of the Manggarai station, namely monobacilli, diplobacilli, streptobacilli, cococobacilli, monococci, diplococci, streptococci, staphylococci, and sarcina. The percentage of bacterial morphology that had the highest number was monobacilli, while the lowest was sarcina (**Figure 4**).

The results of the distribution of the number of bacteria based on gram staining can be seen in **Table 3**. and **Figure 5**.

Table 3. Distribution of bacteria based on gram staining

Area	Gram	
	Positive	**Negative**
The station hall	12	6
motorbike parking	19	7
Woman prayer rooms	2	2
Man prayer rooms	9	5
train platform 1-2	12	6
train platform 2-3	11	2
train platform 3-4	13	6
train platform 5	17	9
Woman toilet	1	15
Underpass	1	22

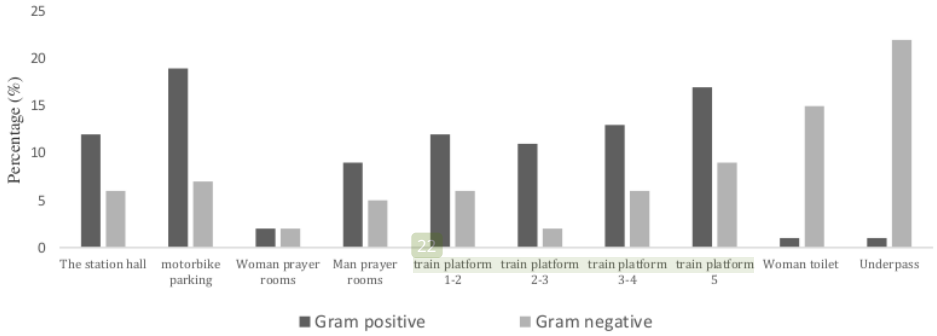
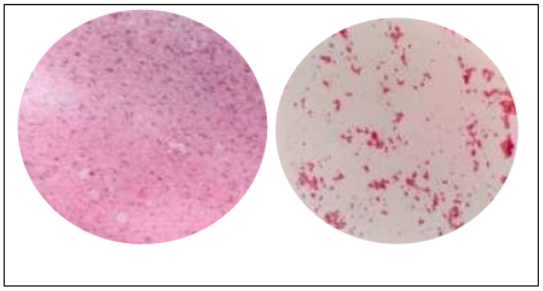


Figure 5. Distribution of bacteria based on gram staining



A **B**

Figure 6. Gram-positive (A) and Gram-negative (B) bacteria.

In this study, the number of bacterial colonies based on the presence/absence of spores showed that the number of bacteria that did not have spores was more dominant than bacteria that had spores. The results of the number of bacterial colonies based on the presence or absence of spores are shown in **table 4** and **figure 7**.

Table 4. The number of bacterial colonies based on spores.

Area	Spora	
	Spore	Non-spore
The station hall	12	6
motorbike parking	12	14
Woman prayer rooms	3	1
Man prayer rooms	6	8
train platform 1-2	9	9
train platform 2-3	5	8
train platform 3-4	3	16
train platform 5	3	23
Woman toilet	5	11
Underpass	11	12

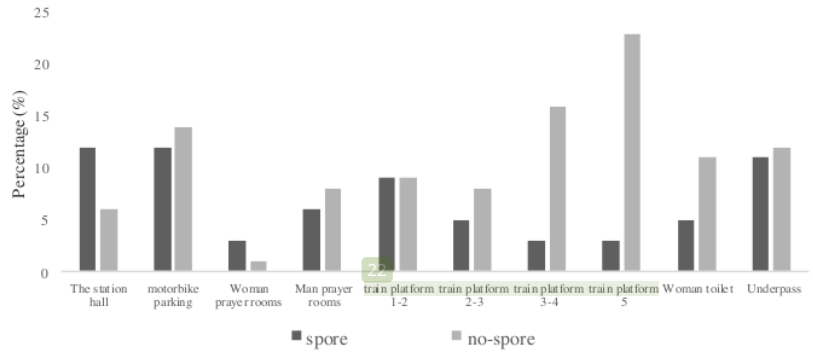


Figure 7. Diagram of the distribution of bacteria based on the presence of spores

The results in **table 4** and **figure 8** show that the percentage of bacteria that have spores in the hall (67%), motorbike parking (46%), women's prayer room (75%), men's prayer room (43%), platform 1-2 (50%), platform 2-3 (38%), platform 3-4 (16%), platform 5 (12%), women's toilet (31%), and underpass (48%), while the percentage of bacteria that did not have spores in the hall (33%), motorbike parking (54%), women's prayer room (25%), men's prayer room (57%), platform 1-2 (50%), platform 2-3 (62%), platform 3-4 (84%), platform 5 (88%), women toilets (69%), and underpass (52%). The microscopic picture of the structure of spore and non-spore bacteria can be seen in **Figure 8.**

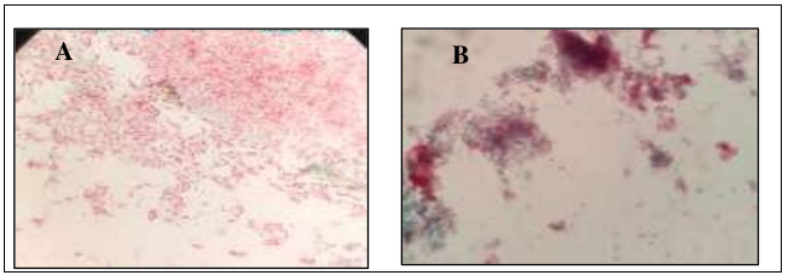


Figure 8. Spore bacteria (a) and bakteri non-spore bacteria (b) (1000x).

In this study, measurements of physical factors at Manggarai Station were carried out simultaneously with air sampling at Manggarai Station. Measurement of physical factors was carried out at 10 sampling points at Manggarai Station. The data obtained consisted of temperature, humidit, and light intensity which can be seen in **table 5.**

Table 5. Results of measuring physical factors

Area	Temperature (°C)	Humidity (%)	Light Intensity (lux)
The station hall	31.8	63	405
motorbike parking	32.4	61	9324
Woman prayer rooms	30.1	64	1015
Man prayer rooms	29.8	66	83
train platform 1-2	31.6	63	3613
train platform 2-3	31.7	62	4100
train platform 3-4	32.1	60	2865
train platform 5	31.8	61	3057
Woman toilet	31	63	260
Underpass	31.1	63	67

Table 5. shows that the interval of the average temperature is between 29.8°C-32.4°C, humidity 60%-66%, and light intensity 83-9324 lux. The results of statistical tests on the correlation of physical factors of air quality toward the number of bacterial colonies using the Spearman correlation test with a 95% significance level can be seen in **table 6.**

Table 6. Correlation test results of temperature, humidity, and light intensity on the number of bacterial colonies

Test variable	Result	correlation coefficient
Temperature with the number of bacterial colonies	p = 0,000	r = 0,134
Humidity with the number of bacterial colonies	p = 0,000	r = 0,380
Light Intensity with the number of bacterial colonies	p = 0,000	r = -0,141

Table 6. shows that all test variables produce a p-value <0.05 or that there is a correlation between physical factors of air quality and the number of bacterial colonies. The correlation coefficient value between temperature and the number of bacterial colonies and humidity with the number of bacterial colonies showed a weak positive correlation, respectively 0.134 and 0.380, while the correlation coefficient (r) for light intensity with the number of bacterial colonies was -0.140 or classified as correlation. very weak negative.

3.2. Discussion

The results of the Spearman correlation test in this study showed that there was a correlation between temperature and the number of bacterial colonies at the Manggarai station (P<0.05). However, this correlation is included in the very weak category (r=0.134). The results of this study are in accordance with the research of Bragoszewska and Pastuszka (2018); Saadati *et al*. (2022) reported that there was a positive correlation between air temperature and the number of bacterial colonies.

According to Zhong *et al*. (2016), the correlation between temperature has a weak positive correlation with the number of bacterial colonies due to the presence of too high a temperature which can also inhibit bacterial growth. This is shown in the research results of Wu *et al*. (2012) who reported that increasing the temperature of UV light can significantly reduce the number of bacterial colonies outdoors. Therefore, the correlation between temperature and the number of bacterial colonies is very weak, considering that each bacterium has varying optimum temperature characteristics.

Another factor that correlates with the number of bacterial colonies is humidity. The correlation between humidity and the number of bacterial colonies in this study resulted in a positive correlation with a weak category. The results of this study are in accordance with the research of Kallawicha *et al*. (2015)**;** Hwang and Yoon (2017) who reported that air humidity was positively correlated with the number of bacterial colonies. The difference in previous studies is that the correlation is strong, while in this study it is weak.

Hwang and Yoon (2017); Zhong *et al*. (2016); Hiwar *et al*. (2021) stated that humidity is related to the amount of water vapor in the air needed to increase cell wall strength and bacterial metabolism so that increasing air humidity can increase bacterial growth. However, humidity that is too high is often accompanied by very low temperatures that can inactivate protein enzymes that play a role in bacterial growth. Therefore, the correlation of humidity with the number of bacterial colonies often results in a weak positive correlation.

In contrast to temperature and humidity, in this study, the correlation between light intensity and the number of bacterial colonies resulted in a very weak negative correlation. The results of this study are in accordance with the research of Kamel *et al*. (2016); Fithri *et al*. (2016) who reported that light intensity was weakly negatively correlated with bacterial colonies. This is because some bacteria can have mutations that make them resistant to light exposure.

Gola *et al*. (2019) added that light intensity has bactericidal activity and plays an important role in spontaneous sterilization in natural conditions because sunlight contains ultraviolet light. Examples of bacteria that die from exposure to high light intensity are Streptococcus and other bacteria that cause respiratory tract infections.

Research result Gladka *et al*. (2021) ; Santos *et al*. (2011) ; Mohana *et al*. (2013) explained that although light intensity can inhibit the growth of some airborne bacteria, there are some bacteria that are resistant to high light intensity, such as *Micrococcus* sp. The resistance of these bacteria is obtained because some bacteria are able to form spores to survive and grow to spread to the environment without being affected by the intensity of sunlight. Therefore, the negative correlation between light intensity and the number of bacterial colonies is weak.

In this study, areas with a high number of bacterial colonies were station halls, platforms, and underpasses. The high number of bacteria is due to the fact that these three areas are the center of crowds at the station, thereby increasing the number of bacterial colonies carried by dust and humans as station users (Fang *et al*., 2007); (Maier *et al*., 2010).

The results of this study also showed that the dominant forms of airborne bacteria in the Manggarai station area were coccus and bacillus. These results are in accordance with the research of Menteşe *et al*. (2009) which states that the most common bacteria found in outdoor areas are coccus and bacillus with the dominant genus Micrococcus sp. Streptococcus sp and Bacillus sp. Goudarzi *et al*. (2017) added that in addition to the dominant fungal genus bacteria in the outdoor, among others, *Aspergillus* sp., *Penicillium* sp., and *Cladosporium* sp.

The results of this study also found the spread of the number of gram-positive and spore-forming bacterial colonies in large numbers. Kumar *et al*. (2011) explained that gram-positive bacteria are more resistant than gram-negative bacteria to high UV exposure. The resistance of bacteria to extreme environments is influenced by the presence of spores, pigments and high amounts of Guanine (G) and Cytosine (C), considering that bacteria with endospores and DNA with high G and C content are more resistant to temperature, humidity, light intensity, UV rays, chemicals, and free radicals.

The advantages of this research are the locations that have never been studied and the research variables are large in number. The limitation of this study is the identification of bacterial and fungal species in the Manggarai station area has not been carried out

4. CONCLUSIONS

This study concludes that there is a correlation between temperature, humidity, and light intensity in the number of bacterial colonies in the Manggarai station with a weak category. As for further researchers, besides analyzing the correlation between environmental factors and the number of bacterial colonies, it is also recommended to identify bacteria and fungi in the Manggarai station environment.

5. ACKNOWLEDGMENTS

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