THE DIFFERENCES ANALYSIS OF TEMPERATURE, SALINITY, AND DISSOLVED OXYGEN OF *Aedes aegypti* BREEDING PLACE WATER IN ENDEMIC AND NON-ENDEMIC AREAS

Nurul Hidayah[1], Dwi Rahmawati[2]

[1]Nursing Study Program, Sari Mulia University, Banjarmasin
[2]Education Midwifery Program, Sari Mulia University, Banjarmasin

Corresponding Email: hiragi_12@yahoo.com

Abstract: The study aims to determine differences in water quality of breeding sites in endemic and non-endemic areas. The method used is quantitative observational analytic with a case control study design. Case group was water parameters in endemic areas and the control group is in non-endemic areas. 43 samples of breeding water were taken from each area then water quality measurements were carried out. Data were analyzed using independent t-test. The results obtained mean temperature in endemic areas 27.51 ± 0.739 ^{o}C, salinity 2,544 ± 0.638 gr/l, and DO 7,253 ± 1,097 mg/l. The mean temperature in non-endemic areas is 25.7 ± 1.124 ^{o}C, salinity is 2.472 ± 2.365 gr/l, and DO is 6.479 ± 1.059 mg/l. P-value of statistical tests of differences in temperature, salinity, and DO parameters in endemic and non-endemic areas are 0.000, 0.266, and 0.001. It was concluded that temperature and DO parameters in endemic areas proved to be significantly different from those in non-endemic areas. However, for salinity variables there are no significant differences.

Keywords: Aedes aegypti, dissolved oxygen, salinity, temperature

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a dangerous disease that is transmitted to humans through the bite of Aedes aegypti mosquitoes infected with dengue virus. This disease can cause death in a short time and often cause outbreaks.[1] DHF is often found in tropical and sub-tropical regions throughout the world. This disease has become a serious public health problem in the world.[2]

Data from all over the world shows that Asia is the first in the number of DHF sufferers every year. Meanwhile, from 2003 to 2012, the World Health Organization (WHO) recorded Indonesia as the country with the highest DHF cases in Southeast Asia and experienced increased disease fluctuations in 2011-2012.[2]

In 2014, recorded DHF patients in 34 provinces amounted to 71,668 people and 641 of them died (CFR = 0.89%). This figure is slightly lower than the previous year (2013) with a total of 112,511 people and 871 deaths (0.77%). Although in general there was a decrease in cases, there were still provinces that experienced an increase in the number of dengue cases, one of which was the Province of South Kalimantan.[3]

The Province of South Kalimantan was stated in the status of DHF outbreaks in 2015. The number of dengue patients in 2015 experienced a significant increase compared to 2014. In 2014, of 13 districts/cities in South Kalimantan Province obtained 663 cases of DHF with 17 people died. Whereas in January 2015, there were 1,106 cases with 13 people died. This number continues to increase until the end of 2015.[4]

The region with the highest number of dengue cases in South Kalimantan Province is Banjar Regency. The incidence of DHF in the region in February 2015 was 167 cases and was designated as an outbreak area. This is because there was an increase in cases more than 10 times compared to the number of cases in 2014, which were 56 cases.[5]

Banjar Regency includes 17 sub-districts with 23 health centers. Among these health centers, 11 health centers were identified with DHF endemic areas (47.8%). Endemic areas with the highest DHF cases were in Martapura District with 66 cases in February 2015.[5]

The data above shows that DHF is a problem that requires control measures so that the incidence of the disease does not continue to increase. One of the efforts to control DHF is to break the transmission chain by controlling the vector Aedes aegypti. Until now, it is known that pre-mature breeding sites of Aedes aegypti (larvae) are in water reservoirs. Based on the results of Damanik's research[6], it was found that the highest average number of larvae (68.89) was in well water. This shows that the most favorite place for Aedes aegypti mosquitoes based on the type of water source is well water.

The survival of larvae is inseparable from the adequacy of food (organic substances available in water) and a situation that is conducive to its development. In this case, it relates to the water quality of the breeding place.

Water quality is one of the important factors determining the existence of life in water which is determined based on observations of various physical and chemical parameters.[7] One of the water physics parameters that play a role in the development of DHF vector is temperature. The results of the Damanik study[6], obtained results of the water temperature of the breeding site was 27.6 ^{o}C. This temperature is still within the optimum temperature range for the development of Aedes aegypti larvae, causing the highest average number of larvae found in the breeding water. This research is supported by the research of Afolabi, et al[8], it is known that the average temperature of the water where the Aedes aegypti mosquitoes breed is between 26.5 ^{o}C to 29.3 ^{o}C.

In addition to the physical parameters, several chemical parameters of water have

also been shown to influence the development of Aedes aegypti larvae such as salinity and Dissolved Oxygen (DO). Salinity (dissolved salts) and DO (amount of dissolved oxygen) proved to have a significant correlation with the development of Aedes aegypti larvae. This is based on the results of research conducted by Rao[9] on the characteristics of breeding sites obtained results that salinity parameters have a p-value <0.001 or there is a significant correlation with the presence of Aedes aegypti larvae.

An area is designated as an endemic area due to DHF cases every year in a row. This is thought to be related to the potential water of Aedes aegypti which is potential for breeding vectors, whereas non-endemic areas of DHF are thought to have characteristics of water that is not potential. However, no research has been conducted on this matter. Therefore, it is necessary to conduct research on the differences in water quality where Aedes aegypti breeds between endemic and non-endemic areas in Banjar Regency, South Kalimantan Province.

RESEARCH METHODS

This research is an observational analytic quantitative research with a type of case control study design. Case group is parameters of water in endemic areas and control is a parameter of water in non-endemic areas.

Samples were taken by purposive sampling technique. Based on the results of the preliminary survey, 56 samples were obtained which matched the inclusion criteria and 43 control sites were obtained for the control group. In order to have the same ratio of samples between case and control groups (1: 1) then the number of samples for each group is as many as 43 places, the total sample is 86 places.

The tools were 250 ml dipper, glass/plastic storage containers (bottles) 600 ml, pipette, and cooler box 8 L size. The material was H2SO4 as a sample preservative.

The data were analyzed using independent t-test to determine the differences between each water parameter studied in endemic and non-endemic areas.

RESULTS AND DISCUSSION

The study was conducted in Tanjung Rema Darat Village (endemic area) and Tanah Abang Village (non-endemic area). The results showed that the breeding sites of Aedes aegypti mosquitoes in endemic areas were mostly dark (70.7%) (figure 1A), did not have a lid (63.4%) (figure 1B), and were located inside the house (95.1%) (figure 1C). The characteristics of breeding sites in non-endemic areas are mostly bright colors (85.4%) (figure 1A), have a lid (90.2%) (figure 1B), and are located inside the house (68.3%) (figure 1C).

The results showed that the characteristics of containers in the case group were more potential as a breeding place for Aedes aegypti mosquitoes. This can result in an increase in the number of DHF spreader vectors and can be attributed to the occurrence of dengue cases that always occur every year in the region. Thus, Tanjung Rema Darat Village is called an endemic area.

Chemical and physical parameters of water examined in this study were pH, salinity, and Dissolved Oxygen at the Aedes aegypti breeding site. The mean temperature in endemic areas is 27.51 ± 0.739 ^{o}C, salinity is 2.544 ± 0.638 gr/l, and DO is 7.253 ± 1.097 ppm (table 1). The mean temperature in non-endemic areas is 25.7 ± 1.124 ^{o}C, salinity is 2.472 ± 2.365 gr/l, and DO is 6.479 ± 1.059 ppm (table 2).

Table 1. Temperature, Salinity, and Dissolved Oxygen in Endemic Area

No	Parameter	Mean	SD	Min	Max
1	Temperature (°C)	27,51	0,798	26	29
2	Salinity (gr/l)	2,544	0,638	1,7	3,7
3	DO (ppm)	7,253	1,097	3,7	9,1

Table 2. Temperature, Salinity, and Dissolved Oxygen in Endemic Area

No	Parameter	Mean	SD	Min	Max
1	Temperature (°C)	25,70	1,124	24	28
2	Salinity (gr/l)	2,472	2,365	0,2	6,6
3	DO (ppm)	6,479	1,059	4,1	8,3

Based on the data obtained it is known that the average temperature and salinity in endemic areas is higher than in non-endemic areas. Likewise with the mean dissolved oxygen (Figure 2).

The results of statistical tests found that the parameters of temperature and salinity were not normally distributed so that the data obtained could not be continued analyzed by the parametric independent t-test. Alternative test used is non-parametric test with Mann-Whitney test. DO data is normally distributed and further analysis with independent t-test.

Based on table 3, it is known that there are significant differences between mean temperature and DO in endemic and non-endemic areas. However, for the average salinity there is no difference between endemic and non-endemic areas.

Water temperature is one of the environmental factors that influence larvae proliferation and there is a statistically significant difference between endemic and non-endemic areas. The Garcia-Sancez[10] study found that a good temperature range for mosquitoes to breed was 27-30 °C.

The results showed that the average temperature in endemic areas was in the category of good or optimal temperature for mosquitoes to breed (27.51 °C), while the temperature in non-endemic areas was not included in this category (25.70 °C). According to Rueda in Ridha[11], water temperature has an effect on feeding activity and the rate of egg development into larvae, larvae become pupae, and pupae become imago. Temperature factors are related to evaporation in containers.

The length of time that Aedes aegypti eggs hatch depends on the optimal temperature. Cooked eggs will immediately hatch when exposed to water. However, these eggs will not hatch if the temperature in the container ranges from 10-15 °C, unless raised at a temperature of 27-30 °C.[12]

In addition to temperature, DO parameters also proved to be significantly different between endemic and non-endemic areas. Although there are differences, it can be seen from the average dissolved oxygen in each region that it is still in the potential category for Aedes aegypti mosquitoes to breed (5.02-7.82 ppm). Rao's research[9] found that there was a relationship between dissolved oxygen levels and larvae density (correlation coefficient = 0.9071). This is in line with the results of Gopalakrishnan's study[13], that there is a positive relationship between dissolved oxygen levels and larvae density (correlation coefficient = 0.46).

Larvae are also affected by DO. Dissolved oxygen can meet the larval oxygen demand in the breeding water and as a marker that food sources for larvae are available. Oxygen levels dissolved in water depend on the vegetation in the waters. This is because the vegetation in water conducts photosynthesis. Photosynthesis process in the waters will affect the presence of DO in water, so that it will affect the density of mosquito larvae at the breeding site.[14]

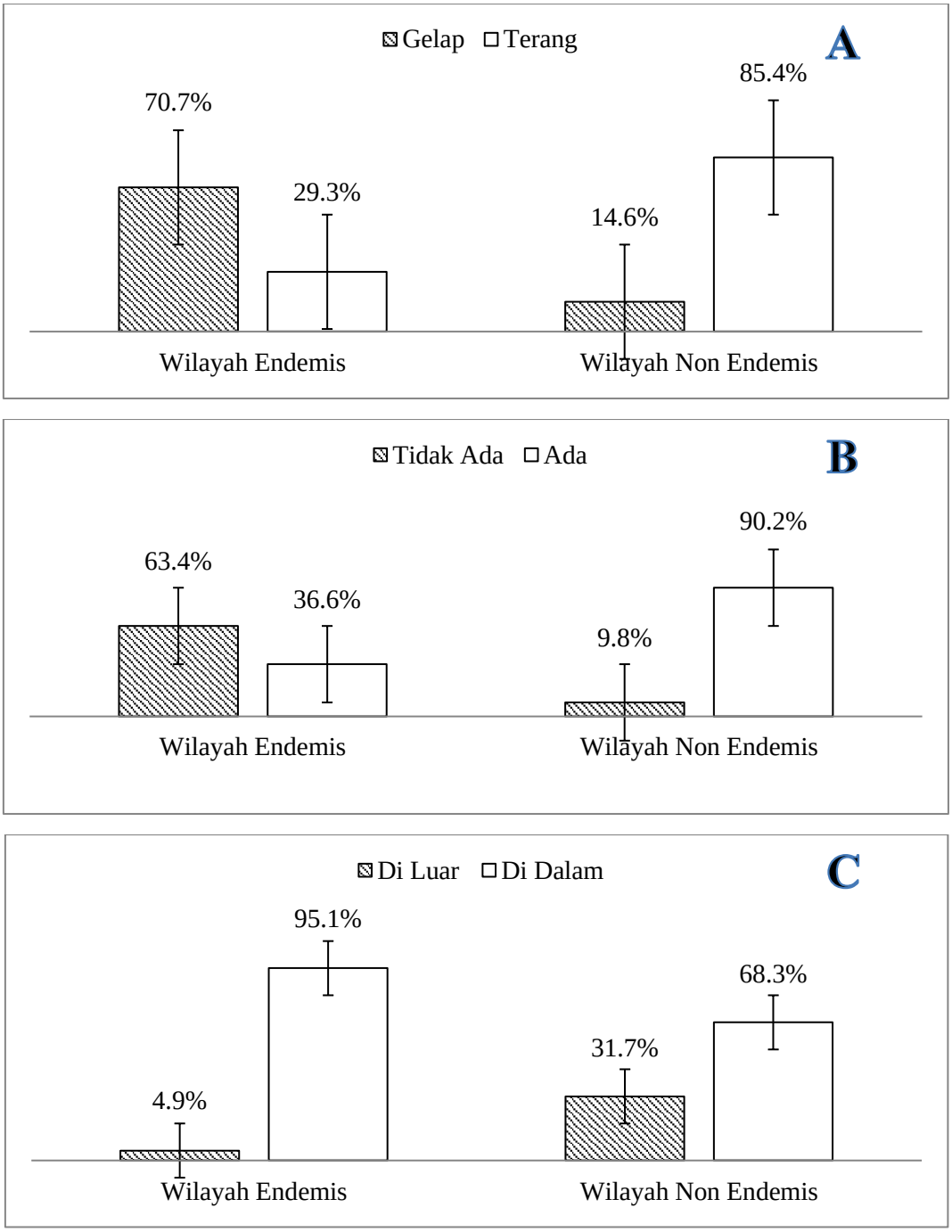

Figure 1. Characteristics of containers/breeding sites for Aedes aegypti mosquitoes are based on color (A), presence of cover (B), and location (C) according to proportion and standard error in each region, which are endemic and non-endemic.

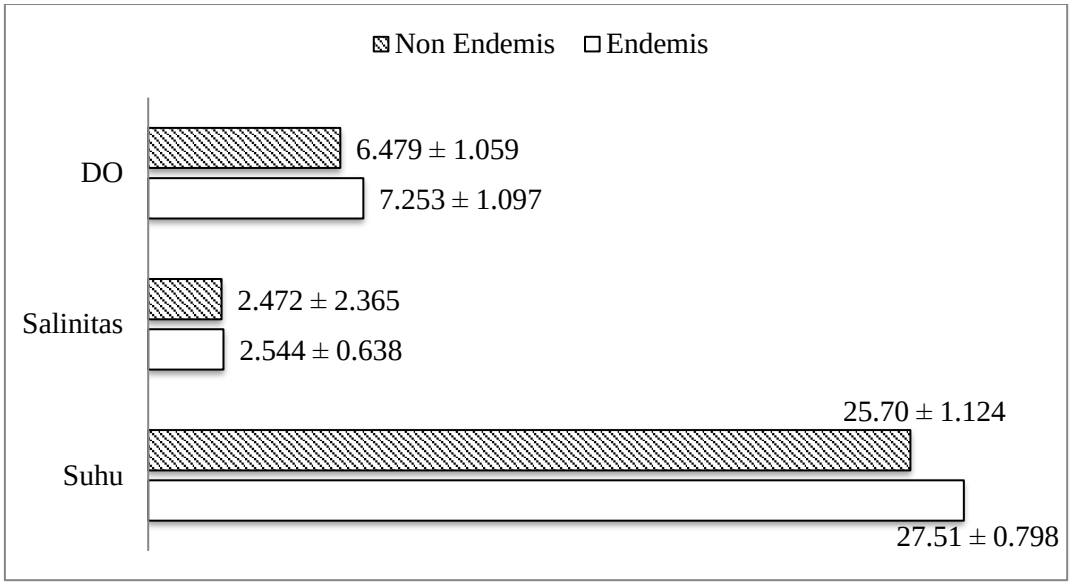

Figure 2. Comparison of mean values of temperature, salinity, and DO in endemic and non-endemic areas

Temperature and DO parameters in endemic areas proved to be significantly different from those in non-endemic areas. However, for salinity variables there are no significant differences. Water parameters that proved to be no difference between endemic and non-endemic areas were salinity. Salinity is one of the important factors that can attract mosquitoes to put their eggs in the water where they are breeding.

Navarro et al's research in Thangamathi[15] concluded that the higher the level of salinity, the lower the laying of eggs. Rao's research[9] found that salinity levels were positively related to larvae density. At a water salinity concentration of 4 gr/l - 6 g/l Aedes aegypti was able to develop into an adult mosquito. At a concentration of 6 gr/l the larvae can survive up to 23 days of observation without undergoing metamorphosis to become pupae[16].

The average salinity in endemic and non-endemic areas is in the range <4 gr/l. Anggraini study16 found that the range of potential salinity for Aedes aegypti mosquitoes to breed is 4 g/l - 6 gr/l and that which is not potential is <4 g/l or> 6 g/l. Based on this, the level of salinity in endemic and non-endemic areas is not potential for mosquitoes to breed.

ACKNOWLEDGEMENT

This research was supported by Ministry of Research, Technology, and Higher Education in the scheme of beginner lecturer research grant 2018.

CONCLUSIONS

Temperature and DO parameters in endemic areas proved to be significantly different from those in non-endemic areas. However, for salinity variables there are no significant differences.

REFERENCES

1. Meilson H.E. Sallata, Erniwati Ibrahim, Makmur Selomo. *Hubungan karakteristik lingkungan fisik dan kimia dengan keberadaan larva Aedes aegypti di wilayah endemis DBD Kota Makassar*. Makassar: Universitas Hasanuddin. 2014.
2. WHO. *Dengue: Data and statistic.* Regional Office for South-East Asia. 2015. (http://www.searo.who.int). Diakses tanggal 18 Mei 2017.
3. Depkes RI. *Waspada DBD di Musim Pancaroba*. Kementerian Kesehatan Republik Indonesia. 2014.

(http://www.depkes.go.id). Diakses tanggel 18 Maret 2017.
4. Dinkes Provinsi Kalimantan Selatan. *Profil Kesehatan Provinsi Kalimantan Selatan Tahun 2014*. Banjarmasin: Dinkes Provinsi Kalsel. 2014.
5. P2PL Dinas Kesehatan Kabupaten Banjar. *Data DBD Perbulan Dinas Kabupaten Banjar Tahun 2015 (Sampai Tanggal 23 Pebruari 2015)*. Martapura: Dinkes Kabupaten Banjar. 2015.
6. Damanik, Dewi D. *Tempat Perindukan yang Paling Disenangi Nyamuk Aedes aegypti Berdasarkan Jenis Sumber Air*. Medan: Universitas Sumatera Utara. 2012.
7. Khoiriyah, Rahayu Astuti, Sayono. *Perbedaan Parameter Fisika dan Kimia Air PErindukan Berdasarkan Keberadaan Jentik Aedes aegypti di Kota Semarang*. Semarang: Universitas Muhammadiyah Semarang. 2010.
8. Afolabi O. J., Simon-Oke I. A., Osomo B. O. Distribution, Abundance and Diversity of Mosquitoes in Akure, Ondo State, Nigeria. *Journal of Parasitology and Vector Biology*. 2013; Vol. 5(10): 132-136.
9. Rao, B. Bhaskar, PS Harikumar, T. Jayakrishnan and B. George. Characteristics of *Aedes (Stegomya) Albopictus* Skuse (Diptera: Culicidae) Breeding Sites. *Southeast Asian J Trop Med Public Health*. 2011; Vol. 42(5): 1077-1082.
10. Gracia-Sanchez, D. C., Pinilla, G.A., Quintero, J. Ecological characterization of *Aedes aegypti* larval habitats (Diptera: Culicidae) in artificial water containers in Girardot, Colombia. *Journal of Vector Ecology*. July 2017. Vol. 42, No. 2: 289-297.
11. Ridha, M. R., Rahayu, N., Rosvita, N. A., Setyaningtyas, D. E. The relation of environmental condition and container to the existence of the *Aedes aegypti* larvae in dengue haemorrhagic fever endemic areas in Banjarbaru. *Epidemiology and Zoonosis Journal*. Mei 2013. Vol. 4, No. 3: 133-137.
12. Yahya, Sulfa E.W. Daya Tetas dan Perkembangan Larva *Aedes aegypti* Menjadi Nyamuk Dewasa pada Tiga Jenis Air Sumur Gali dan Air Selokan. *Jurnal Vektor Penyakit*. 2017. Vol. 11 No. 1: 9-18.
13. Gopalakrishnan, Das M., Baruah I., Veer V., Dutta P. Physicochemical Characteristics of Habitats in Relation to the Density of Container-Breeding Mosquitoes in Asom, India. *J Vector Borne Dis*. 2013; Vol. 50 (3): 215-9.
14. Yusuf M., Gentur Handoyo, Muslim, Sri Yulina Wulandari, dan Heriyoso Setiyono. Karakteristik Pola Arus Dalam Kaitannya dengan Kondisi Kualitas Perairan dan Kelimpahan Fitoplankton di Perairan Kawasan Taman Nasional Laut Karimunjawa. *Buletin Oseanografi Marina*. Oktober 2012. vol. 1 63 – 74.
15. Thangamathi, P., Ananth, S., Kala, N., Maheswari, R., Gnanasoundrai, A., Nagamani, N. Seasonal variations and physicochemical characteristics of the habitats in relation to the density of dengue vector *Aedes aegypti* in Thanjavur, Tamil Nadu, India. *International Journal of Science and Nature*. 2014. Vol. 5 (2): 271-276.
16. Anggraini, T. S., Cahyati, W. H. Perkembangan *Aedes aegypti* pada berbagai pH air dan salinitas air. *Higeia Journal of Public Health Research and Development*. Juli 2017. Vol 1, No. 3: 1-10.