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OVIPOSITION BEHAVIOR OF *AEDES AEGYPTI* IN DIFFERENCE COLORED WATER CONTAINER AT PAGUTAN SUBDISTRICT, MATARAM CITY

MunawirSazali[1], Syafrina Sari Lubis[2]

[1]Biology Education Study Program, Faculty of Tarbiyah and Teacher Training, Mataram State Islamic University, Indonesia
[2]Biology Study Program, Faculty of Science and Technology, Ar-Raniry State Islamic University Banda Aceh, Indonesia

*Email: sazali.bione@uinmataram.ac.id

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Abstract: Dengue fever is an endemic disease that is transmitted from *Aedes* sp. bites. The spread epidemic disease of dengue fever in an area was caused highest vector dengue virus population, it's bolstered by water containers as canister oviposition of *Aedes aegypti* at differentpositions (indoor and outdoor). Water containershave been foundin residence areas such as bathtubs, wells, disposal plastic, crockery, etc. This study aims to investigatethe oviposition process *Ae. aegypti* populations at PagutanSubdistrict in Mataram City. The research was explanatory in prevention community trial research. Based on data egg collection was known oviposition behavior of the mosquito, it was attracted to dark-colored water containers at the indoor and outdoor positions. The difference inthe color of the water container and position was significant difference ($p=0.000<0.05$), There was a significant difference dark color of the water container at an indoor position (1,607eggs mosquitoes) and outdoor position (375 eggs mosquitoes). The bright and white color water container at an indoor position, and significantly differentfromthe dark, bright, and white color at an outdoor position. Oviposition behavior of dengue vector viruses was developed as biological control of *Aedes* sp. based on the color of the water container.

Keywords: *Aedes aegypti, Mosquitoes Controlling, Oviposition Behavior, Difference Colors of Water Container*

INTRODUCTION

Dengue Fever is a type of arbovirus disease transmitted through mosquito bites, among which *Aedes aegypti* is included[1][2]. Dengue Fever is widely found in tropical and subtropical regions with a global incidence of 50 million cases per year[3][4]. According to the World Health Organization, it is estimated that approximately 50-100 million cases of dengue virus infection occur each year, with nearly half of the world's population living in areas where the dengue vector is endemic[5].

The West Nusa Tenggara Province reported in 2011 a total of 630 cases of dengue fever infection with 6 fatalities[6]. Subsequent years have seen fluctuations in the increase of dengue fever cases. In 2012, there were 827 cases, followed by a dramatic increase to approximately 1,600 cases in 2013. In 2014, there was a decrease to 872 cases, followed by around 1,300 cases in 2015. The year 2016 saw a significant increase to 3,171 cases, and by mid-2017, there were 1,258 cases reported. Based on the historical trend of dengue virus spread, it is evident that there is still a possibility of an increase in dengue fever cases in the coming years[6][7].

The increase in dengue fever infections in residential areas is inseparable from various interconnected factors[8][9]. Seasonal changes from dry to rainy season result in numerous water stagnations that potentially support the life cycle of the primary vector, *Ae. aegypti* mosquitoes[10][11][12]. Regardless of environmental factors, the lifestyle patterns of people in densely populated residential areas greatly determine the proliferation of the dengue fever vector. This is because Ae. aegypti mosquitoes are commonly found in residential areas with poor environmental sanitation[13][14].

One key strategy in dengue fever vector control programs is to reduce the transmission of dengue virus vectors to humans[15][16][17]. Controlling the spread of Ae. aegypti in residential areas has been attempted through large-scale insecticide use, often without proper control. However, numerous health problems in humans, non-target organisms, and environmental pollution have arisen due to the ineffectiveness of thermal fogging in controlling dengue virus spread[18][19].

Therefore, alternative control measures for dengue virus vectors that are safer and more efficient are needed.[20]previously conducted an investigation comparing the colors of water containers on *Ae. triseriatus* mosquito oviposition behavior in New York. Hence, researchers aim to extend this study by examining various differences in water container colors in the PagutanSubdistrict,Mataram, to control the initial spread of *Ae. aegypti* populations at the immature stage[21].

RESEARCH METHODS

The research was conducted from December 2020 to January 2021. Initial observations of *Ae. aegypti* mosquito eggs and larvae were carried out in 46 households, with 25 households found to be positive for the presence of *Ae. aegypti* larvae. These locations were designated as observation samples. The locations were determined in the Kebon Lauk

Village, Pagutan Subdistrict, Mataram, with residential conditions that were unorganized and still had water containers belonging to residents which had the potential as breeding sites for *Ae. aegypti* mosquitoes.

This study employed an explanatory research approach aimed at explaining the position and effect of each variable in the study[22],utilizing a preventive community trial design. The design aimed to produce preventive measures by observing the oviposition behavior of Ae. aegypti mosquitoes in water containers, considering the color specifications of the containers both indoors and outdoors. Water container colors were categorized into three colors: dark (black to brown), bright (red and yellow), and white.

The results of *Ae. aegypti* mosquito egg identification was tabulated in a Standard Deviation (±SD) table. Subsequently, statistical analysis was conducted using PAST Version 2.17 at a significance level of 0.05 (p = 0.05) and a confidence level of 95% (α = 0.05). To observe the differences in the number of *Ae. aegypti* mosquito eggs among the different container colors, a T-test was performed. Furthermore, a test of data distribution and variance was conducted, followed by a two-way analysis of variance (Two-way ANOVA) to observe the oviposition behavior of Ae. aegypti mosquitoes concerning the differences in water container colors indoors and outdoors.

RESULTS AND DISCUSSION

The results of oviposition behavior response of various mosquito species (data not shown) to differences in the color of water containers varied significantly, with Ae. aegypti mosquito eggs are found in each water container within a week. The attraction behavior of mosquitoes to deposit eggs in each water container appeared to be more pronounced in containers with darker colors. The collection of mosquito eggs indoors in dark-colored water containers yielded a total of 1,607 eggs, compared to 660 eggs in light-colored containers, and 375 eggs in white containers. The collection of *Ae. aegypti* eggs outdoors were not as substantial as indoors, as shown in Table 1.

Table 1. Results of *Ae. aegypti* mosquito egg collection in water containers of residents in Pagutan Subdistrict with variations in color and location

Observation Duration	**Indoor Water Container Color**			**Outdoor Water Container Color**			**Total**
	Dark	Light	White	Dark	Light	White	
Week One	310	132	72	110	112	41	776
Week Two	337	117	51	97	73	37	712
Week Three	224	81	59	84	67	33	548
Week Four	274	112	84	96	54	39	659
Week Five	280	125	67	89	67	28	656
Week Six	182	93	42	101	51	30	499
Total egg count	**1.607**	**660**	**375**	**576**	**424**	**208**	

The collection results of *Ae. aegypti* mosquito eggs appear to vary in each observation. Fluctuations in rainfall are one of the determining factors affecting the collection of Ae. aegypti eggs in residents' water containers. In September, rainfall intensity began to be visible, although it was relatively low. This continued from October to December 2020, and further increased in January 2021, resulting in numerous puddles of water that potentially served as breeding sites for *Ae. aegypti* mosquitoes.

Table 2. Average temperature, humidity, rainfall, and rainy days in Mataram City, West Nusa Tenggara Province, Year 2020-2021.

Month	**Rainfall (mm)**	**Rainy Days**	**Temperature (oC)**	**Humidity (%)**
August	3.00	2	30.5	81
September	5.00	1	32.0	79
October	34.00	4	32.6	82
November	315.00	13	32.2	86
December	323.00	19	31.2	84
January (2021)	114.00	9	32.4	84

Based on the observations, it can be assumed that differences in the color of water containers induce different behaviors in the oviposition habits of *Ae. aegypti* mosquitoes[23][24]. Water containers with dark colors (black to brownish) yielded the highest average collection of mosquito eggs after 6 (six) observations, which is closely related to the preference of *Ae. aegypti* mosquitoes for dark colors as resting places before flying to feed on human blood, compared to lighter colors[25].

The oviposition behavior of *Ae. aegypti* mosquitoes tend to favor places with dark colors, greatly affected by the olfactory system's ability to recognize color, odor, and host body temperature[26][27]. Depositing eggs in dark-colored places provides the advantage of camouflage, as the eggs are predominantly black, making them difficult for predators to detect[28]. Based on this behavior, mosquitoes ensure the survival of *Ae. aegypti* eggs to develop into instar 1, 2, 3, and 4 larvae until they reach adulthood (imago)[29]. In addition to camouflage, dark colors also significantly affect the hatching rate of eggs because dark colors can retain heat from the environment, resulting in optimal hatching rates for larvae under warm conditions[30][31].

The research results conducted a test of data normality and variance homogeneity. The normality test of data distribution was performed using the One-Sample Kolmogorov-Smirnov Test. The data were normally distributed (P value 0.309), and the data variance was homogeneous (P value 0.068). Based on the normally distributed and homogeneous data, a further two-way ANOVA test was conducted to demonstrate the differences in the effect of each color of the mosquito egg-laying container placed indoors and outdoors.

Based on the analysis of data variance, the collection results of *Ae. aegypti* mosquito eggs regarding the difference in the color of water containers showed a significantly different collection amount (p=0.000). Furthermore, for observation locations categorized as indoor and outdoor, the collection results of Ae. aegypti mosquito eggs were significantly different (p=0.000), as well as the interaction between observation locations and the color of water containers was significantly different (p=0.000).

Further tests were conducted using the Scheffe test, where this test was performed to observe the specific effects of each variable on the Placement Location of containers, container color, and the interaction between the placement location of containers and container color on the total number of collected *Ae. aegypti* mosquito eggs. The means between variables and marginal means are presented in Table 3.

Table 3. Means between variables and marginal means

Location	**Container Color**			**Marginal Means**
	Dark Color	Light Color	White Color	
Indoors	267.83	110.00	62.50	146.78
Outdoors	96.17	70.67	34.68	67.17
Marginal Means	182.00	90.33	48.58	

Based on Table 3, it is observed that the marginal mean of the water container location indoors is 146.78, which is greater than the marginal mean for the water container location outdoors, which is 67.17. Thus, it can be concluded that mosquitoes prefer laying eggs in water containers indoors compared to outdoors.

The different colors of the water containers for *Ae. aegypti* egg placement is categorized into dark, light, and white as a control color. Dark colors range from black to brown, light colors include yellow, red, and blue, while white containers serve as the control color. Significantly different collection results of *Ae. aegypti* mosquito eggs were found between dark and light colors (p=0.000), with an average difference of 91.67. This indicates that dark colors attract the oviposition behavior of *Ae. aegypti* mosquitoes more than light colors. Furthermore, a significant difference was also found between dark and white container colors (p=0.000), with an average difference in egg collection of 133.42. This suggests that dark-colored water containers for egg laying are preferred by *Ae. aegypti* compared to white containers. The difference between light and white-water containers was also significant (p=0.000), with a marginal average difference of 41.75. Based on these statistical tests, it can be inferred that light-colored water containers are more attractive to Ae. aegypti mosquitoes for egg laying compared to white containers.

Based on the interaction of *Ae. aegypti* egg-laying behavior, it can be determined by examining the interaction between the color of water containers and the observation position. Dark-colored water containers located indoors significantly differ from light-colored and white water containers indoors, as well as dark, light, and white containers outdoors (p=0.000), with successive average differences of 5.83, 8.43, 6.49, 7.95, and 10.42, respectively. Furthermore, the interaction between light-colored water containers indoors significantly differs from white water containers indoors (p=0.000) and white water containers outdoors (p=0.013), with average differences of 2.59 and 4.58, respectively. However, it does not significantly differ from dark-colored water containers outdoors (p=0.950) and light-colored water containers outdoors (p=0.066), with average differences of 0.65 and 2.12, respectively. The interaction between white water containers indoors significantly differs from dark-colored water containers indoors (p=0.000) and light-colored water containers indoors (p=0.013), with average differences of -8.43 and -2.59, respectively. There is no significant difference between white water containers indoors and dark, light, and white water containers outdoors.

The statistical tests above indicate that the difference in the color of water containers affects the oviposition behavior of *Ae. aegypti* mosquitoes. The attraction of *Ae. aegypti* mosquitoes areaffected by several physical and chemical factors known as attractants. This attraction can be triggered by specific compounds such as CO_2, ammonia, fatty acids, octanol, and other compounds, while physical factors can be attributed to color and temperature[32]. The attraction to these compounds and physical factors has been found because mosquitoes, in general, have the genetic ability to recognize hosts based on the scent, color, and temperature emitted by their hosts.

The oviposition behavior of *Ae. aegypti* mosquitoes can serve as the basis for controlling *Ae. aegypti* in the environment. The data on *Ae. aegypti* mosquito egg collection from various colored water containers and positions indicate that Ae. aegypti mosquitoes are more likely to lay eggs in dark-colored water containers indoors compared to light-colored and white water containers, both indoors and outdoors. The behavior of egg laying and the development stages of immature *Ae. aegypti* can be controlled[33][34]. Therefore, controlling the egg-laying behavior of this dengue virus vector can be considered an early preventive measure before human infection occurs. Another development from this research could provide valuable information for the community to condition water containers both indoors and outdoors, aiming to minimize potential breeding sites for *Ae. aegypti* mosquitoes.

CONCLUSION

The conclusion drawn from the observations and discussions above is that the oviposition behavior of *Ae. aegypti* is affected by the color of water containers. Containers with dark colors, both indoors and outdoors, yielded the highest mosquito egg collections. Therefore, as a preventive measure, communities should avoid using dark-colored water containers. This study represents an initial investigation that necessitates further research in subsequent studies. It is hoped that other researchers can explore various new developments to obtain more comprehensive information regarding the oviposition behavior of *Ae. aegypti* mosquitoes.

REFERENCES

[1] Hasyimi, M. (1993). Aedes aegypti sebagai Vektor Demam Berdarah Dengue Berdasarkan Pengamatan di Alam. Artikel Ekologi Kesehatan, III(02), 16–18.

[2] Kraemer, M. U. G., Sinka, M. E., Duda, K. A., Mylne, A. Q. N., Shearer, F. M., Barker, C. M., Moore, C. G., Carvalho, R. G., Coelho, G. E., Bortel, W. Van, Hendrickx, G., Schaffner, F., Elyazar, I. R. F., Teng, H., Brady, O. J., Messina, J. P., Pigott, D. M., Scott, T. W., & Smith, D. L. (2015). The global distribution of the arbovirus vectors Ae. aegypti and Ae. albopictus. ELIFE-Epidemiology and Global Health, 4, 1–18. http://doi.org/10.7554/eLife.08347.

[3] Hadi, U. K., Soviana, S., & Gunandini, D. D. (2012). Aktivitas nokturnal vektor demam berdarah dengue di beberapa daerah di Indonesia Nocturnal biting activity of dengue vectors in several areas of Indonesia. *Jurnal Entomologi Indonesia*, *9*(1), 1–6. doi.org/10.5994/jei.9.1.1.

[4] Tuan, L. Van, Van, N. T. T., Thi, P., Nga, T., Duong, L., Quan, M., & Duoc, P. T. (2017). Seasonal Distribution of Dengue Fever in the Central Highlands Region, Vietnam (2010-2015). *American Journal of Epidemiology and Infectious Disease*, *5*(1), 8–13. doi.org/10.12691/ajeid-5-1-2.

[5] Chan, M. (2012). Global strategy for dengue prevention and control 2012-2020. In W. Team (Ed.), *WHO* (2nd ed., pp. 1–3). WHO Library Cataloguing-in-Publication Data.

[6] Dinas-Kesehatan-NTB. 2017. *PROFIL KESEHATAN Provinsi Nusa Tenggara Barat Tahun 2016*, 2017th ed. Mataram.

[7] Dinas-Kesehatan-RI. 2023. *Laporan Tahunan 2022 Demam Berdarah Dengue*..

[8] Dinas-Kesehatan-NTB. 2018. *PROVINSI NUSA TENGGARA BARAT TAHUN 2017*.

[9] Sazali, M., Soesilohadi, R. C. H., Wijayanti, N., & Wibawa, T. (2020b). Surveillance and oviposition behavior of Aedes aegypti based on different container colours at Mataram City. *The 6th International Conference on Biological Science ICBS*, *020007*(2260).

[10] Johansson, M. A., Dominici, F., & Glass, G. E. (2009). Local and Global Effects of Climate on Dengue Transmission in Puerto Rico. *PLoS Negl Trop Dis*, *3*(2), 1–5. doi.org/10.1371/journal.pntd.0000382.

[11] Pham, H. V, Doan, H. T. M., Phan, T. T. T., & Minh, N. N. T. (2011). Ecological factors associated with dengue fever in a central highlands Province , Vietnam. *BMC Infectious Diseases*, *11*(172), 1–6. doi.org/http://www.biomedcentral.com/1471-2334/11/172.

[12] Racloz, V., Ramsey, R., Tong, S., & Hu, W. (2012). Surveillance of Dengue Fever Virus : A Review of Epidemiological Models and Early Warning Systems. *PLoS Negl Trop Dis*, *6*(5), 1–9. doi: 10.1371/journal.pntd.0001648.

[13] Arduino, M. D. B., Mucci, L. F., Leandro, L., & Serpa, N. (2015). Effect of salinity on the behavior of Aedes aegypti populations from the coast and plateau of southeastern Brazil. *J Vector Borne Dis*, *25*, 79–87.

[14] Sazali, M., & Astuti, R. R. U. N. W. (2018). Pengendalian Vektor Demam Berdarah Menggunakan Lethal MosquitoTRAP Modification(LMM) di Kelurahan Pagutan Induk, Kota Mataram. *Jurnal Biosains*, *4*(3), 124–130.

[15] Sazali, M., Samino, S., & Leksono, A. S. (2014). Attractiveness test of attractants toward dengue virus vector (Aedes aegypti) into lethal mosquiTrap modifications (LMM). *International Journal of Mosquito Research*, *1*(4), 47–49.

[16] Tainchum, K., Polsomboon, S., Grieco, J. P., Suwonkerd, W., Prabaripai, A., Sungvornyothin, S., Chareonviriyaphap, T., & Achee, N. L. (2018). Comparison of Aedes aegypti (Diptera : Culicidae) Resting Behavior

on Two Fabric Types Under Consideration for Insecticide Treatment in a Push-Pull Strategy. *BEHAVIOR,CHEMICAL ECOLOGY*, *50*(1), 59–68. doi.org/http://dx.doi.org/10.1603/ME11027.
[17] Sazali, M., & Rizki, M. A. A. (2017). Uji Media Pemeliharaan Mesocyclops aspericornis dari Berbagai Kotoran Ternak Terhadap Peningkatan Produksi Copepodit. *Scripta Biologica*, *4*(4), 269–272. https://doi.org/DOI.ORG/10.20884/1.SB.2017.4.4.645.
[18] Cahyati, W. H., Sukendra, D. M., & Santik, Y. D. P. (2016). Penurunan Container Index (CI) Melalui Penerapan Ovitrap di Sekolah Dasar Kota Semarang. *Unnes Journal of Public Health*, *5*(4), 330–335.
[19] Meliyanie, G., Wahyudi, R. I., & Andiarsa, D. (2017). Impact of insecticides use in the household to the presence of larvae/pupae of aedes aegypti in Kotawarin. *Journal of Health Epidemiology and Communicable Diseases*, *2*(1), 14–18. https://doi.org/10.22435/jhecds.v2i1.5934.14-18
[20] Joseph, G., & Hoback, W. W. (2013). Color and Container Size Affect Mosquito (Aedes triseriatus) Oviposition Color and Container Size Affect Mosquito (Aedes triseriatus) Oviposition. *Northeastern Naturalist*, *20*(2), 363–371.
[21] Sazali, M., Soesilohadi, R. C. H., Wijayanti, N., & Wibawa, T. (2020). Aedes aegypti L . Controlling based on Lethal MosquitoTRAP Modification (LMM) in Mataram City. *International Conference of Science and Engineering*, *July*, 441–445.
[22] Ibrahim, A., Alang, A. H. M., Baharuddin, Ahmad, M. A., & Darmawati. (2018). *Metodologi Penelitian* (Cet. I). Gunadarma Ilmu, Goa.
[23] Sazali, M. (2014). Uji Ketertarikan Nyamuk Demam Berdarah Dengue (Aedes aegypti L.) terhadap Berbagai Jenis Atraktan ke dalam Lethal MosquiTRAP Modification (LMM) [Universitas Brawijaya]. In *Universitas Brawijaya*. https://doi.org/TES/614.58852/SAZ/u/041405806
[24] Gama, Z. P., Nakagoshi, N., & Islamiyah, M. (2013). Distribution patterns and the relationship between elevation and the abundance of Aedes aegypti in Mojokerto city 2012. *Open Journal of Animal Sciences Distribution*, *3*(4), 11–16. https://doi.org/http://dx.doi.org/10.4236/ojas.2013.34A1003.
[25] Menda, G., Uhr, J. H., Wyttenbach, R. A., Vermeylen, F. M., Smith, D. M., Harrington, L. C., & Hoy, R. R. (2013). Associative learning in the dengue vector mosquito, Aedes aegypti : avoidance of a previously attractive odor or surface color that is paired with an aversive stimulus. *The Journal of Experimental Biology*, *216*(2), 218–223. https://doi.org/10.1242/jeb.074898
[26] Vinauger, C., Lutz, E. K., & Riffell, J. A. (2014). Olfactory learning and memory in the disease vector mosquito Aedes aegypti. *The Company of Biologists*, *217*, 2321–2330. https://doi.org/10.1242/jeb.101279
[27] Kumawat, R., Singh, K. V, Bansal, S. K., & Singh, H. (2014). Use of different colored ovitraps in the surveillance of Aedes mosquitoes in an arid-urban area of western Rajasthan, India. *J Vector Borne Dis*, *52*, 320–326.
[28] Lima-Camara, T. N. de. (2010). Activity Patterns of Aedes aegypti and Aedes albopictus (Diptera : Culicidae) Under Natural and Artivicial Conditions. *Australis, Oecologia*, *14*(3), 737–744. https://doi.org/10.4257/oeco.2010.1403.09.
[29] Higa, Y., Yen, N. T., Kawada, H., Son, T. H., Hoa, N. T., & Takagi, M. (2010). Geographic Distribution of Aedes aegypti and Aedes albopictus Collected from Used Tires in Vietnam. *Journal of the American Mosquito Control Association*, *26*(1), 1–9. https://doi.org/10.2987/09-5945.1.
[30] Ifka, W., Wulandhani, S., & Hasyim, A. (2021). Analisis Kepadatan Jentik Nyamuk Aedes spp. di Pasar Tradisional Kecamatan Tallo Kota Makassar. *Jurnal Inovasi Pendidikan Dan Sains*, *2*(2), 58–62. https://doi.org/https://doi.org/10.51673/jips.v2i2.696.
[31] Wong, J., Stoddard, S. T., Astete, H., Morrison, A. C., & Scott, T. W. (2011). Oviposition Site Selection by the Dengue Vector Aedes aegypti and Its Implications for Dengue Control. *PLoS Negl Trop Dis*, *5*(4), 1–12. https://doi.org/10.1371/journal.pntd.0001015.
[32] Sazali, M. (2023). *Ko-Infeksi Virus Dengue dan Chikungunyaa pada Nyamuk Aedes aegypti L . (Diptera : Culicidae)* [Universitas Gadjah Mada]. https://etd.repository.ugm.ac.id/penelitian/detail/230857
[33] Getachew, D., Tekie, H., Gebre-michael, T., Balkew, M., & Mesfin, A. (2015). Breeding Sites of Aedes aegypti : Potential Dengue Vectors in Dire Dawa, East Ethiopia. *Hindawi Publishing Corporation*, *19*(8), 1–8.
[34] Madzlan, F., Dom, N. C., Tiong, C. S., & Zakaria, N. (2016). Breeding Characteristics of Aedes Mosquitoes in Dengue Risk Area. *Procedia - Social and Behavioral Sciences*, *234*, 164–172. https://doi.org/10.1016/j.sbspro.2016.10.231.