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Variations of Ovitrap Autocidal Water for Controlling Aedes Aegypti

Syukra Alhamda[1] ✉, Cici Apriza Yanti*[2], Nova Herawati[1], Debby Ratno Kustanto[2], Evi Susanti[2] Nurdin[3], Harisnal[3]
[1]Health Polytechnic, Padang, West Sumatera, Indonesia
[2]Prima Nusantara University, Bukittinggi, West Sumatera, Indonesia
[3]Fort De Kock University, West Sumatera, Indonesia

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Abstract

Dengue fever in Indonesia is still classified as a serious disease because it has increased yearly from 2011 to 2013. This study aims to determine the difference in the effectiveness of various types of water in the queue as a trap for eggs of Aedes aegypti mosquitoes in Bukittinggi. This type of research is experimental. The test used is the Anova test because the data is not normal using the Mann-Whitney test. The research sample used a sampling technique. This study uses primary data which can be seen from the number of trapped Aedes Aegypti mosquito eggs. The results showed that between the straw bales using well water and mineral water, the p-value was (0.421)>α(0.05), meaning that there was no difference between the straw-soaked line with well water and water mineral. Meanwhile, after a statistical test was carried out between the straw bales using mineral water and rainwater, the p-value was (0.008)> α (0.05), (Ho was rejected, Ha was accepted), meaning that there was a difference between the straw-soaked anthers and mineral water and rainwater. Based on the results of various types of attractants on the number of Aedes aegypti mosquito eggs trapped in the applied science laboratory of the University of Fort De Kock, Bukittinggi, the straw-soaked extract with rainwater is more effective because it produces more eggs than the extract soaked in straw with well water and extract soaked in straw with mineral water.

Introduction

Dengue Hemorrhagic Fever (DHF) is a disease caused by the dengue virus which belongs to the Arthropod-Borne virus, the genus Flavivirus, and the Flaviviridae family (Chadee & Ritchie, 2010). DHF is transmitted through the bite of mosquitoes from the genus Aedes, especially Aedes aegypti. DHF can occur throughout the year and can affect all age groups (Wong et al., 2011). The emergence of this disease is related to environmental conditions and people's behavior (Liu et al., 2023). According to WHO data (2014), Dengue hemorrhagic fever was first reported in Southeast Asia in 1954, namely in the Philippines, and then spread to various countries (Isoe et al., 2019). Before 1970, only 9 countries experienced dengue outbreaks. Still, now DHF is endemic in more than 100 countries, including Africa, America, the East Mediterranean, Southeast Asia, and the West Pacific which have the highest incidence of DHF cases (Rowe et al., 2018). The number of cases in America, Southeast Asia, and the West Pacific passed 1.2 million in 2008 and more than 2.3 million in 2010 (Sharp et al., 2019). In 2013 there were 2.35 million cases reported in America, of which 37,687 cases were severe dengue (Cahyati et al., 2017). The development of dengue cases at the global level is increasing, as reported by the World Health Organization (WHO), from 980 cases in almost 100 countries

✉ Correspondence Address:
Prima Nusantara University, Bukittinggi, West Sumatera, Indonesia
Email: ciciaprizayanti@fdk.ac.id

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in 1954-1959 to 1,016,612 cases in nearly 60 countries in 2000-2009 (Hemme et al., 2022).

Sustainable Development Goals (SDGs) is a continuous program of the MDGs which ended in 2015, consisting of 17 goals and 169 specific targets (Xue et al., 2021). One of these is Goal 3, which is to ensure healthy lives and promote well-being for all people of all ages (Leppla & De Clercq, 2019). In detail, there are 13 targets, the third target is mentioned by 2030 ending the epidemic of AIDS, tuberculosis, malaria, hepatitis, water-borne diseases, infectious diseases, and neglected tropical diseases such as Dengue Hemorrhagic Fever (DHF). Mass trapping can be a low-cost, community-based, and sustainable engagement approach, attractive to complement other tools that can be selected locally within an integrated Aedes management strategy (Jaffal et al., 2023).

To improve dengue prevention and control efforts, one option for long-term vector monitoring is the ovitrap surveillance system, which may offer information about the spatiotemporal distribution of mosquito vectors and population dynamics. Ovitrap: a low-cost, user-friendly, and efficient instrument for tracking dengue vectors (Sasmita et al., 2021). DHF in Indonesia is still classified as a serious disease because every year it has increased from 2011 to 2013. In 2014 it decreased, but in 2015 the cases increased again (CDC, 2024). In 2014, the number of DHF sufferers in Indonesia was reported as 100,374 cases with the number of deaths as many as 907 people (IR / morbidity = 39.8 per 100,000 population and CFR / mortality rate = 0.9%) and an increase in 2015 (Cahyati et al., 2017). In 2015 The number of DHF patients who reported was 1,071 people (IR / morbidity = 50.75 per 100,000 population and CFR / mortality rate = 0.83%) (Cahyati et al., 2022).

In West Sumatra Province, districts/cities affected by dengue have increased every year (Hemme et al., 2022). It is known the number of districts/cities, in 2014 and 2015 there were 18 districts/cities with data for dengue cases, and in 2016 there were 19 districts/cities with dengue cases (Juarez et al., 2021). In 2017 there were 19 districts/cities with dengue cases. This data shows that every district/city in the province of West Sumatra has dengue cases. The number of DHF sufferers per district/city in West Sumatra Province in 2015 was 2,282 cases with 12 deaths (IR = 45.75% per 100,000 population and CFR = 1%). In 2016 the number of cases was 3,985 with 18 cases of death (IR = 75.75% per 100,000 population and CFR = 0.4) (Smoleroff et al., 2023).

Based on data from the last three years, the Bukittinggi City Health Office, the population of the City of Bukittinggi in 2017 with a population of 124,715 people, it was found that there were 380 cases of Dengue Hemorrhagic Fever (DHF) in the last three years (Hajirasoulihaa et al., 2012). In 2017, there were 69 cases and 106 cases in 2016 and the lowest incidence was in 2017 with 69 cases. In 2018 DHF cases increased to 115 cases. Meanwhile, in 2019 from January to June, the number of cases was 106. Thus the morbidity rate increased in 2017 compared to 2016 and 2017(Mahdalena & Komaria, 2021). It is estimated that DHF will still tend to increase and spread more widely (Djiappi-Tchamen et al., 2022). This is because the dengue infectious vectors are widespread both in residential and public places (Acevedo et al., 2021). Apart from that, population density, population mobility, and urbanization have increased in the last 3 decades (Figurskey et al., 2022; Liu et al., 2023). The high incidence of DHF is still needed so efforts to control mosquitoes are needed so that an alternative in environmental management is needed to prevent DHF besides PSN, which is to prey on a device called an oviposition trap (ovitrap). This method has been proven to be successful in reducing the vector density in Singapore by placing 2,000 ovitraps in dengue-endemic areas. One of the ovitrap modifications, namely the autocidal ovitrap model adds the number of trapped eggs. (Djiappi-Tchamen et al., 2022).

Ovitrap is used to detect the manifestation of mosquitoes in new areas that have been previously eradicated. This tool was developed by Fay and Eliason in 1966 and distributed by the CDC. The standard ovitrap is a plastic cup 350 milliliters, 91 milliliters high, and 75 millimeters in diameter painted black on the outside and filled with water ¾ part. And given a layer of paper, wooden slats, or bamboo as a place to lay eggs (Ovitrap). Ovitrap can help control dengue fever vectors as well as produce monitoring data that is more specific, economic, and sensitive than the traditional Aedes index.(Acevedo et al., 2021).

The tillers used are those that come from plant waste, namely straw. So far, only known straw can be used as animal feed and fertilizer, even though straw can also be an anti-mosquito agent (Mackay et al., 2013). From the results of the straw soaking for a week, it will produce carbon dioxide (CO_2) compounds, anomic gases, and octenol which are easily recognized and can stimulate the olfactory nerves of mosquitoes (Lok CK, Kiat NS, 1977). Gases are gases produced by humans and animals when breathing which in fact can help mosquitoes to find prey (Juarez et al., 2021). Carbon dioxide (CO_2) is a colorless gas whereas ammonia has a distinctive pungent odor, and octenol is a chemical substance like alcohol (Barrera et al., 2014). Just like carbon dioxide gas, when we breathe, humans and animals also emit ectenol (Liu et al., 2023.) The types of ovitrap material that can be used can be of various kinds, such as the results of research conducted in Jati village in April 2014, the number of positive ovitrap contains Aedes spp eggs which occupy each ovitrap media, there are variations in the number of Aedes spp eggs contained in ovitrap media (Smoleroff et al., 2023). The number of eggs trapped during the 6 observations was 3,090 eggs. The highest number of eggs in the ovitrap is found in straw (Figurskey et al., 2022).

From the results of the study, it is known that soap wastewater does not allow Aedes mosquitoes to live and grow compared to sewage water, dug wells, and water from the Drinking Water Company (PAM). This is because of the factors that affect the resistance and growth of Aedes spp mosquitoes, the pH contained in the soap wastewater is alkaline, namely 12.8. The degree of acidity (pH) of brooding water is a critical factor in determining the survival and growth of Aedes spp. Aedes mosquitoes cannot survive or die when $pH < 3$ and ≥ 12 (Xue et al., 2021). Aedes is not able to develop into adult mosquitoes. In addition to pH, the survival and growth of mosquitoes also depend on the presence of plankton in SGL water and less tap water (3 and 2 types) compared to mixed water such as sewer water (Smoleroff et al., 2023). Brooding of PAM water has almost the same results as breeding water from dug wells. This situation is caused because even though the pH of PAM water is neutral, mosquito mortality is also high. After all, it contains chlorine ($Ca OCl_2$) which is a disinfectant (Mackay et al., 2013).

Method

This research is experimental in which Aedes aegypti mosquitoes receive direct treatment. The Aedes aegypti mosquito is put into the observation cage with a size of 50 cm x 30 cm x 30 cm and then put in a straw soaking with mineral water, soaking straw with rainwater, soaking the straw with well water. The study design was a non-randomized posttest-only control group design. The design of grouping the sample members in the experiment from the control group was not done randomly or randomly. This research was conducted at the Central Science Laboratory of the University of Fort De Kock Bukittinggi in March 2022.

The object of this research is the Aedes aegypti mosquito egg. This research was conducted with 3 treatments with 6 repetitions. By using 20 Aedes aegypti mosquitoes for each treatment. The length of the study was 1 month, and observations were made every day. Once a week the number of mosquito eggs was calculated for each attractant. Methods of conducting research: a. Prepare observation cages of 3 cages containing 15 females Aedes aegypti mosquitoes and 5 males. b. After that, prepare the straw as a source of food for the male mosquitoes and put it in each observation cage. c. After everything is finished, prepare 3 pieces of attractants / ovitrap (used bottles that have been wrapped with black powder). e. Then enter mineral water, rainwater, and dug well water into the attractant/ovitrap. Observed each observation cage and recorded the number of mosquito larvae trapped in the ovitrap once a week. Data analysis to determine the differences in the types of straw-soaked water with mineral water, rainwater, and dug well water on the number of trapped Aedes aegypti eggs. And the Mann Whitney test because the data are not normally distributed, with alpha 5% and CI 95%. If $p \leq$ alpha 0.05 it means, there is a difference.

Results and Discussion

The research was conducted at the Central Science Laboratory of the University of Fort De Kock. The extract was made from 22 July to 5 August 2022. The straw-soaked extract. The mosquitoes used for research were male and female mosquitoes. Male mosquitoes aim to fertilize female mosquitoes, female mosquitoes lay eggs after sucking blood from mice in the cage. Measurement of air temperature during the study, which was measured using a thermometer, the air temperature during the study was 27°C. Measurement of air humidity during the study was measured using the air humidity hygrometer when the study was 70% to 71%. The usefulness of different types of traps on the number of trapped Aedes aegypti mosquito eggs shows different numbers. This figure is obtained from observations that are repeated 9 times.

The average number of mosquito eggs that are mostly trapped in the straw immersion with 97.56 rainwater value of 1.13, the lowest number of eggs is 96 and the highest is as many as 99 Aedes aegypti mosquito eggs. The lowest mosquito eggs are trapped in the straw using mineral water, a value of 1,900 SD with the lowest eggs of 21 and the highest eggs being 27 pieces. The decrease in rainfall and rainy days reduces the number of natural and artificial clean water reservoirs (TPA) scattered around settlements. This condition is a natural process of controlling the mosquito population. On the other hand, the existing Aedes mosquito population cannot continue the regeneration process optimally because of the presence of deadly egg traps (Barrera et al., 2023).

In obtaining Aedes spp eggs, mineral water has a higher number of eggs than pool water. This indicates that Aedes spp mosquitoes like to lay their eggs in mineral water. As is known, mosquito eggs hatch and turn into larvae which need a medium to grow and develop to the next stage, namely pupa. The mineral water content can be used by larvae as a medium for growth (Jaffal et al., 2023). Furthermore, the tendency of the Ae.aegypti mosquito to lay eggs in groundwater is the second option. Ae. Aegypti mosquito tendencies in choosing a place to lay eggs in a combination of groundwater media is believed to be because the organic matter content in groundwater media is the second highest after straw-soaking water (Boekoesoe & Ahmad, 2022).

Based on the table of data normality analysis results, where the value is taken in the Shapiro Wilk box, because the number of samples is small and obtained by all p-values > α (0.05), meaning that all data is normally distributed. So that the next analysis is used

Table 1. The Average Number of Aedes Aegypti Eggs on Water Variation

No	Water variation	Mean	SD	Min – Max	N
1	Rainwater	97.56	1.130	96 – 99	9
2	Mineral Water	23.11	1.900	21 – 27	9
3	Well water	24.71	3.592	21 – 29	7

Table 2. Test of Normality Data

Type of water Statistic		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		df	Sig.	Statistic	df	Sig.	
Number of mosquito eggs	Rainwater	0.208	9	0.200*	0.899	9	0.248
	Well Water	0.204	7	0.200*	0.850	7	0.124
	Mineral water	0.276	9	0.046	0.864	9	0.106

**This is a lower bound of the true significance*
a. Lilliefors Significance Correction

Table 3 Test the Difference in Water in Ovitrap

Number of mosquito egg						
			df	**Mean Square**	**F**	**Sig.**
Between Groups	(Combined)		2	15666.610	2957.494	0.000
	Linear Term	Unweighted	1	24938.889	4707.886	0.000
		Weighted	1	24938.889	4707.886	0.000
		Deviation	1	6394.331	1207.102	0.000
Within Groups			22	5.297		
Total			24			

Table 4 Test the Variation of Ovitrap Water with a Trapped Number of Eggs

Multiple Comparisons

Dependent Variable: Number of mosquito eggs

Bonferroni

(I) Type of water	(J) Jenis Air	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Rainwater	Well water	72.841*	1.160	0.000	69.84	75.85
	Mineral water	74.444*	1.085	0.000	71.63	77.26
Well water	Rainwater	-72.841*	1.160	0.000	-75.85	-69.84
	Mineral water	1.603	1.160	0.542	-1.40	4.61
Mineral water	Well water	-74.444*	1.085	0.000	-77.26	-71.63
	Well water	-1.603	1.160	0.542	-4.61	1.40

*. The mean difference is significant at the 0.05 level.

by the parametric test with the One-Way Anova test to analyze the differences in water variations used in the straw immersion.

Based on the table above, after the Anova test obtained a value of p 0,000 <α (0.05) which indicates that there is a significant difference between the number of mosquito eggs trapped in the straw immersion with the type of well water, mineral water, and rainwater. Further variations can be seen by multiple comparison tests with Bonferroni tests. Straw extract soaked in rainwater is more effective because it contains a compound that has been proven to influence the olfactory nerves of the Aedes aegypti mosquito to lay its eggs on the attractant.

Based on the above table, it is known that the use of rainwater and well water is obtained by the Mean Difference 72 and P Value 0.000 <α (0.05) means that it has been proven effectively used as a straw soaking water for the Aedes aegypti mosquito eggs. As for rainwater with mineral water, it gets a P value 0.000 <α (0.05), meaning that the two water are also proven effective to be used as straw soaking water, where the average difference is 74. Furthermore, for well water with water with water with water with water with water with water with water Rain obtained a p-value of 0,000 <α (0.05) means that the two water is also good to be used as a straw marinade water, the average difference is 72. For well water with mineral water with a p-value obtained 0.542> α 0.05 means that well water with mineral water cannot effectively be used as a straw marinade water. Test Variations in Mineral Water with Rainwater Obtained by p-value 0.000 <α 0.05, meaning that the water is also effective for use as a shedding water in the straw immersion. Finally, the variation of mineral water variations with well water obtained a p-value of 0.542 > α 0.05, meaning that the water immersion is not effective to be used as a straw water soaking water.

Straw soaking extract with rainwater is more effective as an attractant for Aedes Aegypti mosquitoes compared to straw soaking extract with well water and straw soaking extract with mineral water because well water is relatively close to surface soil, so it can be contaminated through seepage. The most common contamination is due to water depletion from human and animal waste disposal facilities which can affect larval survival (Liu et al., 2023). The survival of the larvae also depends on the presence of plankton and anthrax soaking in straw with mineral water is less popular with mosquitoes because minerals have the property of being degraded by bacteria (Zhu et al., 2019). Rainwater is more dominant in discussing the differences in water types because rainwater is statistically more significant. Rain is one of the factors that causes mosquitoes to lay eggs more often and of course, more individual mosquitoes will be produced (Hemme et al., 2022). High rainfall will cause many puddles which can become breeding places for mosquitoes (Mastrangelo et al., 2018). Rainfall in the range of 310 mm, while rainfall of 575 mm does not support the life of Ae larvae. Aegypti (Barrera et al., 2023). The increase in Aedes aegypti oviposition is known to originate from the non-volatile chemical content contained on the surface of the straw-soaking water. Rain is one of the factors that causes mosquitoes to lay eggs more often and of course, more individual mosquitoes will be produced (Leppla & De Clercq, 2019). The presence of high rainfall will cause many puddles which can become breeding places for mosquitoes. When touched by the mosquito's chemotactile sensory organ, this chemical content further stimulates the mosquito to speak. So that it produces the most eggs in the fifth repetition.

Conclusion

The results of this study are expected to be useful for the community as one of the vector controls, especially to reduce the development of the Aedes aegypti mosquito cycle naturally by using straw quantities using rainwater so that the eggs do not develop into mosquitoes so that they can reduce the incidence of DHF.

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