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Effectiveness of mosquito trap with sugar fermentation solution attractant in mosquito control

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Abstract

Background: Dengue Hemorrhagic Fever (DHF) is a disease caused by the bite of the *Aedes Aegypti* mosquito which is infected with the dengue virus. The way to control the mosquito population is by using mosquito traps with attractant media.

Purpose: To evaluate the effectiveness of a granulated sugar fermentation solution as an attractant for controlling mosquitoes.

Method: A experimental approach, specially focusing on Posttest Only Control Group Design. The study took place from March to June 2024, in Penurunan Village, Bengkulu. The independent variable was type of attractant in mosquito traps while the dependent variables is number of trapped mosquitoes. The analysis proceeded with a univariate test to determine the frequency distribution of characteristics mosquito trap, followed by bivariate analysis using one way anova dan bonferroni test with the single-blind innovation method. All analyses were conducted using SPSS 24.

Results: The results showed the number of mosquito larvae with fermented bait at 25% concentration was 64 larvae, at 35% concentration was 154 larvae, at 45% concentration was 141 larvae, and in the control group was 9 larvae. The total number of larvae obtained was 368 larvae. One Way Anova test showed a significant difference with a p value = 0.001 (<0.05).

Conclusion: Fermented sugar solution with concentrations of 25%, 35%, 45% is effective as an attractant to protect mosquitoes.

Keywords : Fermentation; Mosquito Trap; Sugar.

INTRODUCTION

Today, many infectious diseases have been overcome and some have even been eradicated thanks to technological advances in overcoming biological environmental problems that are closely related to infectious diseases. However, the problem of infectious diseases is still felt by most of the population of developing countries. Mosquitoes are insects that act as vectors of disease (Agustin, Tarwotjo, & Rahadian, 2017). Mosquito-borne diseases are very detrimental to urban and rural communities. Some diseases caused by mosquitoes

are Dengue Fever (DHF), Filariasis (elephantiasis), Malaria, Chikungunya and Encephalitis. From year to year, cases of mosquito-borne diseases are increasing and causing many deaths (Rukmana, Nurtjahya, & Suwito, 2022).

Dengue Hemorrhagic Fever (DHF) is one of the public health problems in Indonesia where this disease is caused by the Dengue virus that infects humans through the bite of the *aedes aegypti* mosquito, until now there is no cure and vaccine for this disease, so vector control must be further

improved. DHF can occur not only in residential areas but also in schools, offices, and industries (Apriyanto, & Hardiyanti, 2022).

The number of breeding sites causes the mosquito population to increase. Various chemical and natural control efforts have been carried out in several areas. Various larvicides and insecticides have been used to kill larvae and adult mosquitoes, but the active ingredients or synthetic chemical compounds used as insecticides will cause resistance in mosquitoes due to frequent exposure to these substances or compounds (Suyudi, Fatiqin, & Salim, 2018). A method for mosquito control other than insecticides is the use of mosquito traps. These traps utilize natural mechanisms, making them safer and more environmentally friendly. The use of mosquito traps with attractant media installed on bottles favored by *Aedes aegypti* can be done as an effort to reduce the population of the vector that causes dengue fever (Bangun, 2017).

An attractant is something that has an attraction to insects (mosquitoes) either chemically or visually (physically). Attractants can be used to influence behavior, monitor vector density or reduce mosquito populations directly without disturbing other animals and humans, and leave no residue on food or foodstuffs (Jannah, 2018).

Globally, dengue cases reported to WHO have increased more than eightfold over the past twenty years, from 505.430 cases in 2000 to more than 2.4 million in 2010 and 4.2 million in 2019. High numbers of dengue cases in Asia were reported in Bangladesh (101.000), Malaysia (131.000), Philippines (420.000), Vietnam (320.000). Indonesia, the number of cases of mosquito-borne diseases including Dengue Fever (DHF) was reported at 129.650 cases with 1.071 deaths, Chikungunya was reported at 2.282 cases, Filariasis (elephantiasis) at 13.032 cases, Malaria was reported at 217.025 Malaria positives. In 2022 there were 143.176 cases of dengue fever with a death toll of 1.236 cases (Fitriani, Anwar, & Hendrawati, 2023).

Based on the above, need to find alternative methods for controlling dengue fever vectors (DBD) that are safe for users and the surrounding environment. There are three methods of mosquito control that are currently being carried out, namely physical, chemical and biological, physical is usually done by installing wire on gauze at the ventilation. Biological or biological control is carried out through the use of mosquito-eating fish, chemical control can be done by fumigation/fogging and even the use of

mosquito repellent, and mosquito coils (Hasanah, Sukanto, & Novianti, 2017).

Chemical control is still favored by the community because the results can be direct and fast in killing adult mosquitoes. However, the use of chemicals or insecticides simultaneously can make mosquitoes resistant to the chemicals so that chemically it becomes useless, in addition to making mosquitoes resistant to the use of insecticides can pollute the environment and be dangerous to humans and other living things. One method that can reduce the mosquito population without the use of insecticides is by using mosquito traps with simple tools without any effects on humans and also will not cause negative impacts on the (Lala, & Suprijandani, 2018).

The working principle of this mosquito device is to attract mosquitoes to enter the trap and prevent them from getting out again. The raw material for the mosquito device used in this study is by using a plastic bottle with a granulated sugar ferment solution as an attractant. An attractant is something that has an attraction to insects (mosquitoes) both chemically and visually (physically), while a granulated sugar ferment solution is one of the attractants that mosquitoes like. The fermentation of granulated sugar and yeast produces carbon dioxide (CO₂) when reacted with glucose, so that the fermentation of sugar produces several chemical compounds such as ethanol, lactic acid, and hydrogen (Nur Wahidah, Yuniarti Hasan, & Yety Hanurawaty, 2021).

RESEARCH METHOD

A experimental approach, specially focusing on Posttest Only Control Group Design. The study took place from March to June 2024, in Penurunan Village, Bengkulu. The independent variable was type of attractant in mosquito traps while the dependent variables is number of trapped mosquitoes.

The research began with preparing the tools and materials used, namely plastic bottles, black plastic, scissors, spoons, stationery, pans, scales, sugar as an attractant, water, and yeast. The preparation stage started with the process of making the plastic bottles, which involved cutting the marked parts of the bottles using a marker. The cut parts were then attached in a reversed position (the bottle mouth facing the opposite direction) and secured with tape to prevent water leakage.

The implementation stage involved setting up mosquito traps that had been prepared, with each trap labeled with concentrations of 25%, 35%, 45%, and

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control. Using a measuring cup, 200 ml of water was taken and mixed with a yeast solution. Subsequently, a washed cloth was used to line the traps. About 1 gram of yeast was applied to the cloth that had been soaked in the yeast solution. The traps were placed in predetermined locations. The traps were left for two observation periods, and during the second observation, the number of mosquitoes trapped was counted. The number of mosquitoes caught was recorded for each yeast solution concentration: 25%,

35%, 45%, and control. This process was repeated six times.

The analysis proceeded with a univariate test to determine the frequency distribution of characteristics mosquito trap followed by bivariate analysis using one way anova dan bonferroni test with the single-blind innovation method. All analyses were conducted using SPSS 24. This research has obtained permission from the Research Ethics Committee of the Health Polytechnic of the Ministry of Health in Bengkulu with number: KEPK. BKL/306/05/2024.

RESEARCH RESULTS

Table 1. Frequency Distribution of the Number of Mosquito Larvae Trapped

Repetition	Control	Intervension		
	Sugarless	Fermentation sugar 25%	Fermentation sugar 35%	Fermentation sugar 45%
1	1	13	38	25
2	1	22	37	49
3	2	3	34	13
4	2	4	21	14
5	0	12	10	16
6	3	10	14	24
Total	9	64	154	141
Mean	1.5	10.67	25.67	23.50

Based on table 1, the number of mosquito larvae obtained varied across different concentrations of fermented water. At a concentration of 25%, the total number of larvae was 10.67. At a 35% concentration, 154 larvae were obtained, with a mean value of 25.67. At 45% concentration, 141 larvae were collected, with a mean value of 23.5. In the control group, only 9 larvae were observed, with a mean value of 1.5. Overall, the total number of larvae collected across all conditions was 368.

Table 2. One Way Anova Test Results Number of Mosquito Larvae Caught in Sugar Fermentation

Repetition	Mean	SD	95% CI	p-value
25%	10.67	6.919	3.41 – 17.93	0.001
35%	25.67	12.275	12.79 – 38.55	
45%	23.50	13.487	9.35 – 37.65	
control	1.50	1.049	.40 - 2.60	

Table 2 show the results of the one-way innovation test showed a p-value of 0.001, which means there was a significant difference.

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Tabel 3. Bonferroni Test Results for the Number of Mosquito Larvae Caught in Sugar Fermentation

Group	Repetition	Result	
		Mean	p-value
25%	35%	-15.000	.090
	45%	-12.833	.204
	Control	9.167	.718
35%	25%	15.000	.090
	45%	2.167	1.000
	Control	24.167	.002
45%	25%	24.167	.204
	35%	-2.167	.1000
	Control	22.000	.005

Based on Table 3, a significance (Sig.) value of less than 0.05 indicates a significant difference, whereas a value greater than 0.05 indicates no significant difference. The implementation rate of 35% with a control difference of 24.1 resulted in a Sig. value of 0.002, indicating a significant difference. Similarly, an implementation rate of 45% with a control difference of 22.0 yielded a Sig. value of 0.005, also indicating a significant difference.

DISCUSSION

Mosquito traps using fermented palm sugar attractants captured more mosquitoes than traps without the attractant (control). This is due to the reaction between palm sugar and yeast during fermentation, producing ethanol and CO₂, a chemical compound highly attractive to mosquitoes. The higher the CO₂ production, the more mosquitoes are attracted and trapped. CO₂ is a powerful mosquito attractant that stimulates the sensory receptors of *Aedes aegypti* mosquitoes (Ambiya, Martini, & Pradani, 2020). Yeast, as a microorganism, requires suitable nutrients and an environment for survival, with sugar being its preferred substrate. Adding sugar triggers yeast activity, resulting in CO₂ production. The CO₂ produced from yeast and sugar fermentation mimics CO₂ from the respiration of living organisms, attracting mosquitoes that detect CO₂, body radiation, and sweat odors from living beings (Prabandari, Darwati, & Suyono, 2022).

Palm sugar is used because its glucose content is more easily fermented by *Saccharomyces cerevisiae** in yeast compared to granulated sugar. Additionally, palm sugar has a sweetness level 10% higher than granulated sugar and contains a slight acidity due to organic acids, producing a distinctive

acidic and caramel-like aroma. When fermented with yeast, this aroma is enhanced, generating a characteristic smell that acts as a mosquito attractant (Ambarita, Sitorus, Ni'mah, Marini, Rahayu, & Oktavia, 2019). The unique smell produced by palm sugar fermentation is detected by mosquito antennae, which contain sensilla equipped with one or more bipolar olfactory receptor neurons (ORNs). ORNs are located at the dendrite tips and axon terminals, responsible for detecting chemical compounds. These sensory nerves transmit chemical impulses as electrical responses from the peripheral regions to the antennal lobe, the primary processing center in the brain. Odor molecules, after entering the sensillum through cuticular pores, pass through lymph fluid to reach the dendrites. Most odor molecules are highly volatile and relatively hydrophobic, aiding in their detection (Sari, Octaviana, & Wijayanti, 2017).

Based on the results of observations at the research location, a positive complement was found for larvae from fermented water of sweet curry. According to this study, mosquitoes have been able to reproduce perfectly, which is indicated by the discovery of mosquito larvae from the complement placed in the room, namely water from fermented sweet curry can be more effective in terms of mosquito control compared to the complement that uses plain water. The study revealed an increase in the number of mosquito larvae across four observation points with varying concentrations of fermented curry attractant. At 25% concentration, larvae counts were 12, 11, 16, and 25. At 35% concentration, counts were 26, 24, 45, and 59. At 45% concentration, counts were 22, 18, 35, and 66. The control group showed 2, 0, 4, and 3 larvae, respectively. Based on these results, it was concluded that the mosquito attractant with a 35% concentration

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was more effective than those with 25%, 45%, or the control in managing mosquito populations.

This aligns with the study which demonstrated that the use of sugar fermentation attractants in trapping devices resulted in a higher number of trapped mosquitoes compared to standard trapping devices without attractants (Sa'adah, Isnawati, & Noraida, 2018). The attractant compounds CO₂ and ammonia influence the olfactory nerves of *Aedes* mosquitoes (Deutocerebrum), and compounds such as CO₂, lactic acid, and octenol are highly effective attractants for mosquitoes, detectable from a distance of 7–30 meters (Saputra, Gemala, & Oktarizal, 2022). The more sugar used, the better the fermentation process, leading to increased ethanol and CO₂ production. Consequently, higher concentrations of palm sugar fermentation result in a greater number of trapped mosquitoes. This is consistent with the findings who concluded that a 35% sugar concentration is the most effective for attracting mosquitoes to traps (Muin, Hermayanti, Kaswina, Ajib, Utami, Daming, & Istiqamah, 2022).

Research on the effectiveness of sugar fermentation as a mosquito attractant at varying concentrations of 0%, 5%, 25%, and 35% revealed that the highest number of trapped mosquitoes occurred at a 35% sugar fermentation concentration, while the lowest was at 15% (Haqiqi, & Hikmawati, 2019). The increase in trapped mosquitoes was attributed to the higher amount of sugar fermented, leading to increased production of CO₂, bioethanol, and energy. As more sugar is available for fermentation by yeast, the output of ethanol and CO₂ rises, which correlates with an increase in trapped mosquitoes (Ghoniatussiltmi, & Sukendra, 2022).

Higher sugar concentrations provide more substrate for yeast metabolism, resulting in higher metabolite production, including ethanol and CO₂. The fermentation process also generates energy, warming the solution and its surroundings. This warm temperature attracts mosquitoes and contributes to the capture of *Aedes aegypti* mosquitoes (Pratiwi, Rosa, Priyambodo, & Tugiyono, 2020). Another factor affecting the number of trapped mosquitoes is the experimental environment. The use of air conditioning reduced temperature and humidity, preventing the dispersion of CO₂ gas produced by the fermentation. As a result, the CO₂ could not reach the mosquito sensors, limiting their ability to locate the source and enter the trap, even when high levels of CO₂ were produced (Sunu, 2019).

CONCLUSION

The results showed the number of mosquito larvae with fermented bait at 25% concentration was 64 larvae, at 35% concentration was 154 larvae, at 45% concentration was 141 larvae, and in the control group was 9 larvae. The total number of larvae obtained was 368 larvae. One Way ANOVA test showed a significant difference with a p value = 0.001 (<0.05).

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