Effect of Permethrin Concentration as Curtain Dyeing Material in Control of *Aedes aegypti L*

Gustina Indriati[1(✉)], Mades Fifendy[2], and Ristiono Ristiono[2]

[1] Biology Department, Indonesian College of Health, Padang, Indonesia
indriatigustina@gmail.com
[2] Biology Department, Faculty of Mathematica and Sains, Universitas Negeri Padang, Padang, West Sumatra, Indonesia

Abstract. Indonesia is dealing with a public health issue called Dengue Hemorrhagic Fever (DHF), which is spread by the Aedes aegypti mosquito. To manage the Aedes aegypti mosquito, the primary carrier of DHF (Dengue Hemorrhagic Fever), many measures have been taken, including fumigation using malathion for adult mosquitoes and abatization using temefos for the larval stage (young stage). In addition to employing Permethrin, the community needs help from another approach or methods to help control the Aedes aegypti mosquito. The goal of this study was to ascertain how permethrin concentration, used as a curtain dyeing agent, affected the Aedes aegypti population. At FMIPA UNP's Integrated Research Laboratory, the investigation was carried out utilizing a Randomized Block Design with six different permethrin concentration treatments and three replications. According to the findings, the concentration of permethrin affected how many Aedes aegypti mosquitoes died after coming into contact with permethrin-dyed drapes. The shortest mosquito paralysis time was discovered 24 h after immersion at a concentration of 2.0% permethrin, and the highest mortality rate was discovered at this dosage after 24 h of immersion. Permethrin-dyed curtains have a noticeable impact on reducing Aedes aegypti mosquito populations.

Keywords: DHF · Aedes aegypti · Permethrin

1 Introduction

One of the infectious diseases that affects Indonesia's public health is Dengue Hemorrhagic Fever (DHF). DHF was first reported in 1968 in Jakarta and Surabaya. In 1988 the incidence rate reached 27% and in 1993 DHF had spread to all regions in Indonesia [1]. Aedes albopictus is a potential vector for DHF however Aedes aegypti is the primary mosquito that transmits the disease. The Aedes aegypti mosquito is active in sucking blood during the day, with two peak activities, namely at 08.00–13.00 and 15.00–17.00 [2]. After sucking the blood of Aedes aegypti will look for a place to rest, both inside and outside the house such as hanging clothes, mosquito nets, curtains, or furniture located in a dark place. Until now there has been no cure and vaccine for DHF, the only way to control DHF is to break the chain of transmission by vectors. Control can be carried

M. Fadilah et al. (Eds.): IcoBioSE 2021, ABSR 32, pp. 270–274, 2023.
https://doi.org/10.2991/978-94-6463-166-1_35

out in various ways, such as using the insecticide malathion to kill adult mosquitoes and temefos for the pre-adult stage (later). These methods have not given satisfactory results, so other methods are needed to assist the DHF eradication program. WHO recommended the insecticide Permethrin to be used in mosquito control because it is safer to use, has fast insecticidal power, and lasts longer efficacy [2]. Permethrin has been widely used in malaria vector control activities as an ingredient for dyeing mosquito nets.

Mosquito nets dipped in permethrin can kill or repel mosquitoes depending on the dose used. The findings demonstrated that the group that utilized mosquito nets treated with 80 mg/m2 of permethrin had a reduction in the quantity of mosquitoes, and a decrease in parasite rates in the group of children who slept using permethrin-dipped mosquito nets at a dose of 0.6 g/m^2, using permethrin dyed nets at a dose of 0.5 g/m^2. Can reduce vector density by as much as 71% [3, 4]. In Indonesia, the use of permethrin-dyed mosquito nets has been carried out in Lampung and Irian Jaya, with the results showing that the use of permethrin-dyed nets can reduce the vector population and the number of malaria parasites. Based on this, whether permethrin can be used as a dye for curtains which is a resting place for Aedes aegypti, is based on the behavior of mosquitoes that actively suck blood during the day and rest on the curtains in the house.

2 Methodology

The study was conducted in the Integrated Research Laboratory for 2 months using a Randomized Block Design (RBD) with 7 treatment concentrations (0.05%, 0.1%, 0.2%, 0.5%, 1.0%, 2.0% and control) and 3 repetitions. For the residual power of permethrin, a contact bio-assay test was carried out at 24 h, 7 days, 14 days, 21 days, 28 days, and 2 months. Measurement of data was carried out by calculating the percentage of mortality of the test mosquitoes, which were then transformed into Arcsin-Vx after the bio-assay test. Then the homogeneity test was carried out, if the result were homogeneous, statistical analysis of the Analysis of Variance (ANOVA) was used at the 5% level.

Tests were carried out on 15 Aedes aegypti females who were full of blood and left in contact for 30 min, after which the number of dead mosquitoes was counted (a). The surviving mosquitoes were removed and put into a paper cup and fed a 10% sugar solution on a cotton swab, then observed for 24 h. The number of mosquitoes that died during this period was counted (b). The mosquito mortality rate is calculated by the formula: number of a + number of b.

The percentage (P) of dead mosquitoes was calculated by the formula (WHO, 1975).

$$P = \frac{sum\ of\ a + amount\ of\ b}{Number\ of\ test\ mosquitoes} x100\%$$

3 Result and Discussion

3.1 Percentage of Aedes Aegypti Deaths with Contact Curtains Dyed with Permethrin

The percentage of Aedes aegypti after contact with curtains dyed with permethrin was highest at 24 h after immersion and the lowest was at 2 months after immersion. The highest percentage of mosquito mortality was at a concentration of 2% permethrin and the lowest was at a concentration of 0.05% (Table 1).

In Friedman's statistical test there is a very significant difference between the permethrin concentration treatment used in the curtains (Table 2).

In Friedman's multiple follow-up tests, it was found that there was a very significant difference between the 2.0% concentration treatment and other concentrations. The

Table 1. The average percentage of Aedes Aegypti mosquito deaths curtains dyed with permethrin.

No.	Concentration	Percentage of death *Ae. Egypty*					
		24	*7*	*14*	*21*	*28*	*2*
		hours	*days*	*days*	*days*	*days*	*months*
1	0.0%	0	0	0	0	0	0
2	0.05%	42.20	28.83	35.53	31.06	15.53	6.68
3	0.10%	46.63	35.53	31.06	28.83	15.53	8.87
4	0.20%	48.83	39.96	28.83	26.63	19.96	11.08
5	0.50%	81.06	80.00	77.76	77.76	71.06	60.00
6	1.00%	95.53	84.40	82.20	80.00	73.30	73.76
7	2.00%	100	91.06	84.40	82.16	71.06	64.40

Table 2. Effect of permethrin concentration on the mortality of Aedes aegypti

Concentration	∑ Ri	Difference					
2.00%	296.5	–					
1.00%	259.5	37.0	–				
0.50%	224.0	72.5*	35.5				
0.20%	143.0	153.5**	116.5**	81.0**			
0.10%	130.0	166.5**	129.5**	94.0**	13.0		
0.05%	96.0	200.5**	163.5**	128.0**	47.0**	34.0	
0.00%	51.0	245.5**	208.5**	173.0**	92.0**	79.0**	45.0**

∑ Ri: The average percentage Ae. Aegypti in various concentrations.
*: Significant differences at the 5% level ($p > 0.05$)
**: highly significantly differences at the level of 1% ($p > 0.01$)

percentage of Aedes aegypti mosquito mortality with a concentration of 2.0% higher than other concentrations.

A concentration of 2.0% is the highest concentration used, causing the highest mortality of Aedes aegypty mosquitoes. Permethrin concentration of 2.0% is a concentration with a fairly large active ingredient content and has a high killing power.

Mosquito An. Gambiae exposed to permethrin with a concentration of 0.5 g/m^2 can cause the death of the test mosquitoes up to 100% [5]. The decrease in insecticide potential is caused by chemical degradation, especially when exposed to direct sunlight. Also caused by environmental factors such as smoke, dust, weather, dyeing method, storage, and washing. The dyeing effect is also related to the susceptibility of mosquitoes to insecticides. Aedes aegypti mosquitoes are susceptible to permethrin-dyed mosquito nets compared to Anopheles and Culex mosquitoes.

3.2 Effect of Time on the Percentage of Death of Aedes Aegypti Mosquitoes After Exposure to Permethrin on Dyed Curtains

The percentage of Aedes aegypti mosquito mortality was higher at 24 h after immersion compared to 7 days, 14 days, 21 days, 28 days, and 2 months. This could also be due to the absorbency of the curtains so the concentration of permethrin attached to the curtains caused the death of the test mosquitoes.

Permethrin concentration of 0.2 g/m2 can paralyze the Aedes aegypti mosquito population after being exposed to dyed mosquito nets for 30 min [6]. The residual power of permethrin will decrease after 2 months of use [3], and dipped mosquito nets stored for 1 year can still kill the mosquito population up to 95% [7] (Table 3).

Permethrin is photostable so its residual power can last up to 6 months. A dose of 500 mg/m2 of the residual power of permethrin in dyed nets against Anopheles sp. Mosquitoes could last up to 6 months [8]. In a dose of 500 mg/m2, the residual power of permethrin was still quite good, even though it had been used for more than 6 months [9]. In this study, the residual power of permethrin still lasted up to 2 months of observation, this was because the curtain material used was much thicker than the mosquito net material.

Table 3. Effect of time after immersion on the percentage of mosquito mortality Aedes aegypti.

Times	∑ Ri	Difference				
24 h	305.5	–				
7 days	241.5	64.0**	–			
14 days	224.0	81.5**	17.5			
21 days	206.5	99.0**	35.0	17.5		
28 days	166.0	139.5**	75.5**	58.0**	40.5	
2 months	122.0	183.5**	119.5**	102.0**	84.5**	44.0*

∑ Ri: The average percentage of *Ae. Aegypti* time after dyeing

*: significantly different at the level of 5% ($p > 0.05$)

**: very significantly different at the level of 1% ($p > 0.01$)

In addition, the curtain material is also different from the mosquito net material.

4 Conclusion

Permethrin can kill mosquitoes and control Aedes aegypti as a vector of dengue fever, and the residual power of permethrin can last up to 2 months of observation.

References

1. S. Soerjosembodo, Program pemberantasan penyakit DBD di Indonesia, Jakarta, 1993.
2. World Health Organization, The use of imprenagted bed nets other material for vector-borne disease control, WHO/VBC. 80.98, 1989.
3. M. Fifendy, Pengaruh ekstrak daun bunga matahari (Helianthus annuus L.) terhadap Aedes aegypti, Ilmu Biomedik Universitas Indonesia, Jakarta, 1997.
4. F. Darriet, V. Robert, N. Vien, P. Carnevale, Evaluation of the efficacy of permethrin-impregnated intact and perforated mosquito nets against vectors of malaria. World Health Organization, 1984.
5. M.L. Hossain, C.F. Curtis, M.O. Smith, D.S. Ellis, Permethrin in impregnated bet net behavioral and killing effects on mosquitos. Medicine Vet. Entomology, 1989, pp. 367–376.
6. D.C. Kaushal, R. Carter, J. Rener, C. A. Grotendorst, L. H. Miller, R. J. Howard., Monoclonal antibodies against surface determinants on gametes of Plasmodium gallinaceum block transmission of malaria parasites to mosquitoes, The Journal of Immunology 131, no. 5, 1983, pp. 2557–2562.
7. Loong, K.P, Naidu S, Thevasagayam, E.S., Cheong,W.H. (1985). Evalution of Permetrin and DDT impregnated bednets against Anopheles maculatus. Southeast Asian Journal of Trop. Med. and Pub. Health 16, pp. 554–559.
8. R.W. Sutjahyono, Efektivitas kelambu yang dicelup permetrin dan lamda sihalotrin terhadap vektor malaria di tipuka, Irian Jaya, Fakultas Kedokteran Universitas Indonesia, Jakarta, 1996.
9. P. Kamol-Ratanakul, C. Prasittisuk, The effectiveness of permethrin-impregnated bed nets against malaria for migrant workers in eastern Thailand, The American journal of tropical medicine and hygiene 47, no. 3, 1992, pp. 305–309.
10. World Health Organization, Manual on practical entomology in malaria, 1975.