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Lethal concentration (LC₅₀, 90, and 98) and lethal time (LT₅₀, 90, and 98) at various temephos concentrations of *Aedes aegypti* L. larvae

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Abstract

Aedes aegypti mosquito is a vector of dengue which is still a public health problem in Indonesia. Temefos is the most common larvae used to control *Ae. Aegypti*. The study aimed to determine the lethal concentration (LC₅₀, 90, and 98) and lethal time (LT₅₀, 90, and 98) so that the temephos concentration and time can be known in controlling the *Ae. Aegypti* larvae. This research method is an experiment according to the WHO standard on *Ae. aegypti* larvae as many as 25 individuals each treatment using temephos insecticide with a concentration of 0.003 mg/L, 0.006 mg/L, 0.012 mg/L and 0.025 mg/L. The results of the study is LC₅₀, LC₉₀ and LC₉₈ respectively were 0.008 mg/L; 0.015 mg/L and 0.018 mg/L. Furthermore, LT₅₀, LT₉₀ and LT₉₈ respectively were 34.808 hours; 57.197 hours and 70.688 hours.

Keywords: *Aedes aegypti*, mosquito, insecticide, Indonesia

1. Introduction

Dengue hemorrhagic fever (DHF) is caused by a dengue virus transmitted by the *Aedes aegypti* mosquito vector which spreads rapidly. Based on data over the past 50 years, dengue cases have increased 30 times with the increase in the geographical expansion of a country, especially from cities to rural locations [18]. DHF cases in Indonesia in 2018 totaled 65.602 cases, with a total of 467 deaths [12]. DHF case reports are highest in areas with high population density, such as in the provinces of Java, Bali, and Sumatra. The incidence of DHF in the Sumatra region, especially in the Province of West Sumatra is reportedly high every year [12]. Pariaman City is one of the cities in West Sumatra that has reported dengue cases reaching 119 cases [5].

Eradication of *Ae. Aegypti* larvae is an appropriate strategy in DHF vector control programs throughout the world [14]. The program of prevention and controlling of dengue fever has been carried out by the government, one of which is chemical control [10]. The insecticide that is often used in Indonesia is Abate. The use of abate in Indonesia has been in 1976. Four years later, in 1980, temephos 1% (abate) was determined as part of the *Ae. Aegypti* mass eradication program in Indonesia [3, 4, 10, 14]. Temefos is an organophosphate group recommended by the WHO to kill mosquito larvae in the population's clean water supply. Although control has been carried out using temephos with concentrations recommended by WHO, the use of temephos as a synthetic larvicide in the DHF control program is no longer able to suppress vector populations in the DHF endemic areas [7, 14, 19, 20]. The recommended temephos concentration by WHO in 1981 was 0.025 mg/L [14] while in 2016 it was 0.012 mg/L [20]. The larvae stage usually lasts 2-6 days [10]. Temephos can control larvae in 2-6 days, so the larvae do not become adult mosquitoes and cannot transmit the dengue virus, thereby reducing the spread of dengue fever.

Therefore the importance of this research is to determine Lethal Concentrations (LC₅₀, 90, and 98) and Lethal Time (LT₅₀, 90, and 98) of each concentration tested, to know each time needed for each concentration used. This research is expected to know the temephos concentration and the right time in controlling *Ae. Aegypti* larvae which will support the vector control process locally in Pariaman Tengah District, Pariaman City, and West Sumatra.

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2. Material and Methods

This research method is an experiment according to the WHO standard [20] against *Ae. aegypti* larvae as many as 25 individuals each treatment using temephos insecticide with a concentrations of 0.003 mg/L, 0.006 mg/L, 0.012 mg/L and 0.025 mg/L. The place of sampling is in Pariaman Tengah District, Pariaman City. This research was conducted at the Laboratory of Animal Physiology Research, Department of Biology, Faculty of Mathematics and Natural Sciences, Andalas University, Padang. While the biochemical assay was carried out at the Biomedical Laboratory, Faculty of

Medicine, Andalas University, Padang. Lethal Concentration (LC₅₀, 90, and 98) and Lethal Time (LT₅₀, 90, and 98) is sought is the result of the death of 50%, 90% and 98% of *Ae. aegypti* larvae. Determination of the value is done by probit analysis [6] using SPSS 16 computer programs.

3. Results and Discussion

Based on probit analysis, it can be seen the correct Lethal Concentration (LC) in controlling *Ae. aegypti* larvae in Pariaman City, as shown in Table 1.

Table 1: Lethal Concentration (LC) *Ae. aegypti* larvae against temephos for 48 hours of observation

LC	Temefos concentration (mg/L) ± SE
50	0.008 ± 0.0005
90	0.015 ± 0.0012
98	0.018 ± 0.0018

Lethal Concentration (LC) 50% indicated that to kill 50% of *Ae. aegypti* larvae in Pariaman temephos needed with a concentration of 0.008 mg/L, then to kill 90% of *Ae. aegypti* larvae temephos needed temephos with a concentration of 0.015 mg/L and to kill 98% of *Ae. aegypti* larvae temephos needed temefos with a concentration of 0.018 mg/L (Table 1). The toxicity value can be expressed in the form of Lethal Concentration (LC) [2, 5]. LC can estimate concentrations that have a lethal effect on an organism. The higher the value of the toxicant concentration the more the number of organism deaths can be seen with the greater LC value [15].

Based on Table 1 the larvae population of *Ae. aegypti* could be effectively controlled with 98% mortality at a concentration of 0.018 mg/L or 1.5 times higher than the WHO diagnostic concentration (0.012 mg/L). This means that the high number of dengue cases in Pariaman City, especially in Pariaman Tengah District allegedly caused by larvicide temephos was no longer able to control the population of *Ae. aegypti* larvae with a predetermined concentration. Besides, the high density of mosquito populations in Pariaman City can also be a trigger for high dengue cases.

Lethal Time (LT) was a standard time measurement of a medium that can kill test animals. Therefore, based on probit analysis it can be seen the correct Lethal Time (LT) in controlling *Ae. aegypti* larvae in Pariaman City.

To find out the time needed for each concentration tested as shown in Table 2.

Table 2: Lethal Time (LT₅₀, 90 and 98) of *Aedes aegypti* larvae against temephos at various concentrations

Concentrations	Lethal Time	Time (hours)
0.003 mg/L	LT ₅₀	34,808
	LT ₉₀	57,197
	LT ₉₈	70,688
0.006 mg/L	LT ₅₀	30,353
	LT ₉₀	53,288
	LT ₉₈	67,108
0.012 mg/L	LT ₅₀	18,883
	LT ₉₀	35,328
	LT ₉₈	45,237
0.025 mg/L	LT ₅₀	13,852
	LT ₉₀	21,972
	LT ₉₈	26,865

Probit analysis aims to determine the right lethal time (LT) temephos in controlling *Ae. aegypti* larvae in Pariaman City (Table 2). Probit analysis was a calculation method to get the value of toxicity of an insecticide against experimental insects. The toxicity value could be expressed in the form of lethal time (LT) [2, 6].

Table 2 shown that the greater the temephos concentration given and LT was also less. Conversely, if the concentration of temephos was given the smaller the LT was also greater. The highest LT₅₀ was at concentration 0.003 mg/L with 34.808 hours, while the lowest was at a concentration of 0.025 mg/L which was 13.852 hours. The highest LT₉₀ was at concentration 0.003 mg/L with 57.197 hours, while the lowest LT₉₀ was at a concentration of 0.025 mg/L which was 21.972 hours. LT₉₈ highest, at a concentration of 0.003 mg/L to 70.688 hours, meaning that LT₉₈ lowest was found in concentrations of 0.025 mg/L which was 26.865 hours (Table 2).

The lethal time (LT) at a concentration of 0.012 (WHO diagnostic concentration in 2016) has an LT₅₀ was 18.883 which means that to kill 50% of the test larvae population takes 18.883 hours, then LT₉₀ was 35.328 means to kill 90% of the test larvae population it takes 35.328 hours, while LT₉₈ was 45.237 means that to kill 98% of the test larvae population it takes 45.237 hours. The smaller the LT₅₀, 90 and 98 mean the better so the time needed to kill the *Ae. aegypti* larvae is getting faster, so that time efficiency was achieved [8].

The relationship between temephos concentration and mortality was thought to be related to the burden of larvicide concentration of temephos contained in the larvae. Larvae that get high temephos concentrations have faster work to kill larvae when compared to larvae that are treated with lower concentrations of temephos [1].

4. Conclusions

The conclusion of this study is LC₅₀, LC₉₀ and LC₉₈ respectively were 0.008 mg/L; 0.015 mg/L and 0.018 mg/L. Furthermore, LT₅₀, LT₉₀, and LT₉₈ respectively were 34.808 hours; 57.197 hours and 70.688 hours.

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