Jurnal Ilmiah Kesehatan
(Journal of Health Science)
Fakultas Keperawatan dan Kebidanan | Universitas Nahdlatul Ulama Surabaya
ISSN 1978-6743
E-ISSN 2477-3948

Temephos Resistance in Prevention of Dengue Cases: Literature Review

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ARTICLE INFORMATION

Received: December 29, 2022
Revised: February 3, 2023
Available online: February 2023

KEYWORDS

Resistance, Temephos, Dengue

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A B S T R A C T

Dengue is an acute disease caused by bites from the Aedes aegypti mosquito. The decrease in the rate of dengue cases is due to the control of larval vectors using larvicide intervention. But overuse can result in resistant vectors. Temephos is a larvicide that has been circulating and used by the community for a long time. Aedes aegypti larvae are reported to be resistant in many countries. This study determined the resistence level of Aedes aegypti larvae to temephos. Scientific article searches in several databases were using keywords from 2018-2022. This research used the literature review method by searching articles from indexed journals as a source of information. Results from the synthesis of literature review found that temephos has experienced resistance in several countries, including Indonesia. The WHO standard for temephos of about 0.02 mg/L has experienced death resistance to the larvae of the Aedes aegypti mosquito. Resistance occurred due to the concentration of temephos used by the community to control dengue larvae. The results of studies with a concentration of 1% temephos have occurred mortality larvae dengue resistance. So, concentration level of temephos use has had a resistance impact on controlling dengue cases in various countries.

INTRODUCTION

Dengue fever is the most vital vector-borne disease. Dengue fever is also a sickness that causes a big problem in the community. The primary strategy for controlling dengue fever is to reduce the population of vectors using insecticides. However, insecticide packages are a contributing issue in improving vector resistance (Morales et al., 2019). Acute ailment due to the virus is spread through the bite of Aedes mosquitoes, specifically Aedes albopictus and Aedes aegypti (Hasan et al., 2016; Candra, 2010; Kraemer et al., 2015). The disease is contagious in subtropical and tropical regions, especially Central America, Southeast Asia, America, and the Caribbean, including Indonesia. It puts the world's 3.9 billion people at risk for contracting it (Candra, 2010; Sarwar, 2014; Wowor, 2017).

According to WHO, the number of dengue cases is estimated to reach 390 million yearly, of which 96 million are severe. The regions are high dengue-endemic countries, especially the United States, Southeast Asia, and the Western Pacific, where two point five billion populations, or two-fifths of the world's society, are at high risk of dengue fever. Republic of Indonesia is one of the endemic regions of dengue fever in Southeast Asia. A calculated five-hundred thousand population with dengue fever are hospitalized each year, and about 2.5 of them die. Indonesia has the second largest dengue case rank among the 30 endemic region countries (Kemenkes, 2018). 90.08% of districts/cities in Indonesia were declared endemic in 2016. Incidence Rate (IR) of dengue in 2016 amounted to 78.85 per 100,000

https://doi.org/10.33086/jhs.v15.i1.2953

populations, and a drastic decrease in 2017 to 26.12 per 100,000 populations. The top three provinces with the highest dengue deaths in 2017 were East Java, Central Java, and West Java. All districts/cities in Central Java have contracted dengue (Kemenkes, 2018; Jateng, 2017).

Vector control remains the only intervention available to prevent and control dengue transmission (WHO, 2011). One of the causes of the decrease in cases is the intensive dengue vector control efforts, mainly routine flick monitoring and larvicides using temephos (Fenisenda, 2016). But unfortunately, insecticides used for long periods can result in resistance to mosquitoes and larvae of Aedes aegypti (Istiana et al., 2012). Resistance of Aedes larvae to temephos has been revealed in Sumbawa Regency, Tasikmalaya City, DKI Jakarta, and Surabaya City (Simbawara, 2017; Fuadzy & Hendri, 2015; Setiyani et al., 2016; Mulyatno et al., 2012). Resistance to larvae has occurred in various countries including, Brazil, Colombia, Thailand, and Malaysia (Braga et al., 2005; Grisales et al., 2013; Ponlawat et al., 2005; Chen et al., 2013).

Resistance happens when larvae cannot be eliminated with a standard dose, or the larvae manages to avoid exposure to insecticides (Prasetyowati et al., 2016). Temephos and malathion organophosphates have become Indonesia's main insecticides for mass larvicides and fogging, respectively (Organization et al., 2009). However, the long-term use of these chemicals has contributed to the development of resistance by Ae. Aegypti (Arslan et al., 2016). This condition allows resistance to Aedes larvae due to the utilization of insecticides in abate and fogging in the elimination of dengue larvae. This study aims to describe the resistance condition of Aedes larvae to temephos use.

METHOD

The method used in this article was a literature review. The mechanism according to this method was to search for international literature using the ScienceDirect, Pubmed, and Google Scholar databases. The search was designed based on PICO examples: patient, population & problem (P), intervention, prognosis & factor (I), comparison (C) & output (O). In the initial term of resistant search, insecticides, larvicides, and temephos it produced the output of 12 international journals according to 2017 to 2022 that meet the selection criteria. Research design was a literature review article. The data used in this study is secondary data. Secondary data sources were obtained from trusted national and international journal articles with certain topics. The selection criteria include all English research journals that review temephos resistance to prevent and control dengue vectors published between January 2017 and April 2022.

Research should also deliver results measuring resistance levels, including doses of temephos at the insecticide or larvicide step to reduce dengue vectors. Good research design uses quantitative, and qualitative analysis by examining the temephos resistence in an area. Exclusion criteria are non-original publications such as abstracts, but articles with ambiguous titles and abstracts from all selected

publications are reviewed and evaluated. Once the abstract inclusion criteria are met, the journal will be thoroughly re-screened to find the correct journal results.

RESULT

The results of the literature review can be explained as follows:

Table 1. Completeness of Important Reports

No	Author, Country, & Title	Methods & Locations	Results	Accreditation Journal
1	Diego Morales, Ecuador, *Resistance Status of Aedes Aegypti to Deltamethrin, Malathion, and Temephos in Ecuador*	A descriptive study & 14 locations on the Pacific coast and Amazon basin regions of Ecuador	MRA-734 Mosquitoes from all the places revealed resistance to deltamethrin & susceptibility to malathion. Then, the larvae of Aedes mosquitoes confirmed resistance to temephos in five of the fourteen places analyzed.	Scopus/ 3rd quartile
2	Sébastien Boyer, Cambodia, *Resistance of Aedes aegypti (Diptera: Culicidae) Populations to Deltamethrin, Permethrin, and Temephos in Cambodia*	This study characterized the insecticide resistance status of Ae aegypti from rural and urban locations in Cambodia	All the subject populations a decrease mortality charge to temephos in comparison with the touchy stress with Resistance ratio 50 (RR50) varying from 3.3 to 33.78 and RR90 from 4.2 to forty-seven as compared with the sensitive pressure, demonstrating a generalized resistance of larvae to the temephos in Cambodia	Web of Science Group and Scopus/ 2nd quartile
3	Hasanuddin Ishak, Indonesia, *Resistance Status in Aedes Aegypti Strain from North Toraja, Indonesia to Malathion and Temephos Insecticides*	This type of research is a quasi-experiment. Assays to determine resistance status was conducted using WHO standard method	Aedes aegypti mosquitoes (high-level endemic pressure) adults turned resistant to Malathion zero at eight percent, & which showed tolerance to Malathion five concentrations. It contrast, Aedes larvae were susceptible to Temephos at one percent. Aedes aegepti (non-endemic pressure) had been liable to Malation zero point eight percent, Malathion five percent & Temephos one percent.	Scopus in 2018/ 4th quartile
4	Dessy Triana, Indonesia, *Entomological Parameters and Characterization of Insecticide Resistance in Dengue Vector Aedes Aegypti Larvae from Bengkulu*	This study utilized experimental & cross-sectional with post-control only design	Mortality of larvae after twenty-four hours with more than one awareness of temephos indicatory of high resistance. Entomological indicators for house items, CI (container index), & box pupa index (CPI) in Gedang village Street & Lingkar Barat village were envisioned: seven percent, twelve percent for house items & one point ninety-seven percent, three-point forty three percent for CI, and five percent, two percent for CPI, respectively.	Scopus/ 4th quartile

https://doi.org/10.33086/jhs.v16.i01. 2953

	City, Indonesia			
5	Sebastien Boyer, Cambodia, *Monitoring insecticide resistance of adult and larval Aedes aegypti (Diptera: Culicidae) in Phnom Penh, Cambodia*	We tested 14 adulticides belonging to the carbamate, organochlorine, organophosphate, and pyrethroid insecticide families and three larvicides	Excessive mortality charges had been observed with carbamate, organophosphate, and organochlorine (excluding dichlorodiphenyltrichloroethane) pesticides (i.e., among 87.6 and a hundred %). In contrast, low mortality quotes had been located with all of the tested pyrethroid insecticides (i.e. Among 1 and 35%). For larvae, no resistance towards Bti turned into detected [resistance ratio (RR90<1.6)]. However, moderate resistance changed into located for temephos and spinosad (RR90<five.6).	Scopus/ 1st quartile
6	Hafiz Azhar Ali Khan, Pakistan, *Resistance Status to Deltamethrin, Permethrin, and Temephos, Along with Preliminary Resistance Mechanism in Aedes aegypti (Diptera: Culicidae) From Punjab, Pakistan*	We evaluated 12 field strains of Ae. aegypti from Punjab for resistance against deltamethrin, permethrin, and temephos, along with underlying resistance mechanisms.	For temephos, five field strains, viz. Kasur, Faisalabad, Gujranwala, Lahore, & Rawalpindi showed a high stage of resistance; five strains, viz. Sahiwal, Sheikhupura, Pattoki, Okara, & Sialkot showed moderate resistance, & traces from Sargodha & Multan showed low resistance to temephos.	Scopus/ 1st quartile

DISCUSSION

Temephos resistance has occurred in various countries in the handling and controlling dengue cases. This has been proven from research that found the occurrence of temephos resistance. In Lao Country, PDR has been using temephos as a control of dengue vectors since 1987 and is suspected to be the leading cause of moderate to high resistance cases in Aedes aegypti and Aedes albopictus mosquitoes (Marcombe et al., 2018). The results found that temephos had experienced resistance in 5 regions of the 14 regions analyzed (Morales et al., 2019). This is in line with cases of insecticide resistance in Aedes aygypti mosquitoes that have also been reported from Pakistan (Mohsin et al., 2016). Then another study also said that all populations studied had shown low mortality from temephos with sensitive strain levels based on resistance ratio 50 (RR50) varying from 3.3 to 33.78 and RR90 from 4.2 to 47 compared to sensitive strains. A statement of high generalized resistance of dengue larvae death to temephos in Cambodia (Boyer et al., 2018). The results of this study are also in line with that in Brazil, similar cases of resistance were also reported for surveillance, with RR 50 ranging from 2.5 to 4.1 for mosquito populations that are highly resistant to temephos (Dos Santos Dias et al., 2017).

In addition, still in Cambodia, there has been a moderate resistance level of temephos of RR90<5.6 (30). While in Indonesia, some studies also deliver results that show resistance to temephos. Aedes aegypti mosquitoes in high endemic strains occur cool to temephos at a concentration of 1%, and Aedes aegypti (non-endemic strain) is also susceptible in the concentration range of 1% temephos (Ishak & Ponno, 2018). This condition has also been reported there are in at least four urban populations related to cases of Aedes aegypti mosquito resistance that have also been reported in Cambodia (Boyer et al., 2018).

From other studies, the mortality rate of Aedes aegypti larvae after 24 hours from multiple concentration temephos administration has indicated high resistance. This is based on entomological indicators for HI (House Index), CI (Container Index), and CPI (Container Pupa Index) calculated at 7%, 12% for HI, 1.97%, 3.43% for CI, and 5%, 2% for CPI (Triana et al., 2021). In Pakistan, there has also been found resistance to the use of temephos. There are five places in the region with high temephos resistance: Faisalabad, Gujranwala, Kasur, Lahore, and Rawalpindi. While with moderate resistance levels also occur in five regions, including Sahiwal, Sialkot, Okara, Pattoki, and Sheikhupura (Khan & Akram, 2019). Malaysia has also reported cases of temephos resistance in the Ae mosquito. Aegypti and Ae. albopictus in some locations (Elia-Amira et al., 2018).

CONCLUSION

Based on the literature review results from six research journals, there has been resistance to temephos in controlling dengue mosquito larvae. This study results can be the main consensus to determine more appropriate methods for handling dengue fever, especially in Indonesia. Standard levels are already resistant, so it may be necessary to raise levels of temephos to kill dengue mosquito larvae. However, we need good policies to prevent another resistance in the future.

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