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RESEARCH ARTICLE

The Resistance of *Aedes aegypti* to Permethrin 0.25% Insecticide, Malathion 0.8%, and Transfluthrin 25% in the Universitas Islam Bandung Tamansari Campus

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Abstract

Massive and long term insecticide use causes resistance of mosquitos to insecticides. This research has a goal for assessing the resistance of *Aedes aegypti* to the insecticides of permethrin 0.25%, malathion 0.8%, and transfluthrin 25% in the Universitas Islam Bandung Tamansari campus. The *Aedes aegypti* resistance in the Universitas Islam Bandung Tamansari campus Bandung city to insecticides measured with the susceptibility test in September 2015. The susceptibility test to the permethrin 0.25% and malathion 0.8% insecticides implemented by using WHO standard instruments and methods. The susceptibility test to transfluthrin 25% implemented by using commercial insecticide according to the usage suggestion. The total mosquitos that died after the exposure of permethrin 0.25%, transfluthrin 25%, and malathion 0.8% for 60 minutes were 20%, 23%, and 80%. The WHO criteria state that mosquitos were still susceptible to insecticides if the death rate is 98–100%, tolerant if the death rate is 80–97%, and mosquitos are resistant if the death rate is less than 80%. In conclusion, the *Aedes aegypti* mosquitos in the Universitas Islam Bandung Tamansari campus are already resistant to the insecticides permethrin 0.25% and transfluthrin 25% and tolerant to malathion 0.8%.

Key words: *Aedes aegypti*, insecticide, resistance

Resistensi *Aedes aegypti* terhadap Insektisida *Permethrin* 0,25%, *Malathion* 0,8%, dan *Transfluthrin* 25% di Kampus Universitas Islam Bandung Tamansari

Abstrak

Penggunaan insektisida secara masif dan jangka panjang menimbulkan resistensi nyamuk terhadap insektisida. Penelitian ini bertujuan menilai resistensi resistensi *Aedes aegypti* terhadap insektisida *permethrin* 0,25%, *malathion* 0,8%, dan *transfluthrin* 25% di kampus Unversitas Islam Bandung Tamansari. Resistensi *Aedes aegypti* di kampus Unversitas Islam Bandung Tamansari Kota Bandung terhadap insektisida diukur dengan uji kerentanan pada bulan September 2015. Uji kerentanan terhadap insektisida *permethrin* 0,25% dan *malathion* 0,8% dilakukan menggunakan alat dan metode uji standar WHO. Uji kerentanan terhadap *transfluthrin* 25% dilakukan menggunakan insektisida komersial sesuai dengan anjuran penggunaan. Jumlah nyamuk yang mati dalam jangka waktu 60 menit setelah paparan *permethrin* 0,25%, *transfluthrin* 25%, dan *malathion* 0,8% berturut-turut adalah 20%, 23%, dan 80%. Kriteria WHO menyatakan nyamuk dikategorikan masih rentan terhadap insektisida jika tingkat kematiannya 98–100%, toleran jika kematiannya 80–97%, dan resisten apabila jumlah kematian nyamuk kurang dari 80%. Simpulan, nyamuk *Aedes aegypti* yang terdapat di kampus Universitas Islam Bandung Tamansari telah resisten terhadap insektisida *permethrin* 0,25% dan *transfluthrin* 25%, serta toleran terhadap *malathion* 0,8%.

Kata kunci: *Aedes aegypti*, insektisida, resistensi

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Introduction

Aedes aegypti is a mosquito that is a vector of the dengue fever disease.[1] Other than spreading the dengue fever virus, *Aedes aegypti* also spreads viruses of other diseases such as chikungunya, Zika fever, and yellow fever.[1,2]

The incidence of dengue fever in Indonesia is 26.12 per 100,000 people, with a death rate of 0.72% in 2017.[3] Dengue cases in Bandung city showed an increasing trend in 2012 and 2013.[4] One of the means of reducing the incidence of disease spread by this *Aedes aegypti* mosquito, especially dengue fever, is by controlling the vector population.[5,6] Several means implemented to control the *Aedes aegypti* population, one of which is the use of insecticides to kill adult mosquitos.[7,8] Yet, the long term use of insecticides can cause resistance. This occurs because mosquitos mutate, so they become resistant to the insecticide.[9,10]

Insecticides that are often used in Indonesia are malathion, an organophosphate group, which is used for fogging by the government. The other insecticide is the pyrethroid group, which is used as domestic insecticides.[9] As of today, there are many reports of *Aedes aegypti* resistance to malathion and pyrethroid in several countries.[10–18] Several cities in Indonesia also have already shown the resistance tendency of *Aedes aegypti* to malathion and pyrethroid.[19–21]

This *Aedes aegypti* mosquito absorbs viruses that are present in the victim's blood and contaminates it to other persons when the female *Aedes aegypti* mosquito absorbs blood to develop her eggs.[22,23] The mosquito's character is to absorb blood in the daytime. If *Aedes aegypti* is disturbed when it is absorbing blood, this mosquito can bite more than one person, so there is a potential to move the virus from the victim to many persons at once.[22] The Universitas Islam Bandung campus is a place of activities for students, lecturers, and other employees who spend time in the day. There is also not a free area of *Aedes aegypty* adult female.[24] Therefore, the campus has a potential to be a place for dengue fever transmission.[25]

This research has a goal for finding the resistance of *Aedes aegypti* in the Universitas Islam Bandung Tamansari campus to permethrin 0.25% and transfluthrin 25% which are type 1 pyrethroid group insecticides that many people use, and malathion 0.8% which is an insecticide that is still used by the Bandung Health Agency in the eradication of *Aedes aegypti* adult mosquitos massively through fogging.

Methods

The resistance of *Aedes aegypti* mosquitos in the Universitas Islam Bandung Tamansari campus Bandung city to insecticides is measured with the susceptibility test in September 2015. The female *Aedes aegypti* mosquitos aged 5 days are obtained from the egg cultivation from the ovitrap which is spread in the Universitas Islam Bandung Tamansari campus environment. The susceptibility test of the *Aedes aegypti* mosquitos in the Universitas Islam Bandung Tamansari campus to the permethrin 0.25% and malathion 0.8% insecticides was implemented by using instruments and methods that correspond with the World Health Organization (WHO) standards. Twenty five mosquitos were contacted for 60 minutes in the insecticide contact tube, then moved into the collector tube and placed in fresh air for 24 hours (holding). For the holding period, the mosquitos are fed with sugar solvents in the cotton placed in the surface of the collector tube.[26]

The susceptibility test to transfluthrin 25% was implemented by using commercial insecticides in corresponding with the usage suggestion. A single spray commercial insecticide which consists of transfluthrin 25% was sprayed for one time in a room measured at 30 m^3 and spread for 60 minutes to 25 adult female *Aedes aegypti* mosquitos from the Universitas Islam Bandung campus, then the mosquitos are moved into the fresh air and provided food (holding). The transfluthrin spread was also provided to mosquitos farmed in the laboratory as a positive control.[27]

The mosquitos that died in the 24 hour holding period were counted and showed in the table form. The susceptibility tests to permethrin 0.25%, malathion 0.8%, and transfluthrin 25% were each implemented three times, so the total mosquitos which were contacted to insecticide are 75 mosquitos for each test.

Results

The results of the susceptibility test of the female *Aedes aegypti* mosquitos to the permethrin 0.25%, transfluthrin 25%, and malathion 0.8%

Table The Susceptibility Test of the Female *Aedes aegypti* Mosquitos to the Permethrin 0.25%, Transfluthrin 25%, and Malathion 0.8%

Insecticides	Mosquitos (n=75)
Permethrin 0.25%	
Died	15 (20%)
Not died	60 (80%)
Transfluthrin 25%	
Died	17 (23%)
Not died	58 (77%)
Malathion 0.8%	
Died	60 (80%)
Not died	15 (20%)
Control (–)	0

in the Universitas Islam Bandung Tamansari campus can see in the Table. The total mosquitos that died after the exposure of permethrin 0.25%, transfluthrin 25%, and malathion 0.8% for 60 minutes were 20%, 23%, and 80%.

The WHO criteria state that mosquitos are still susceptibility to insecticides if the death rate is 90–100%, tolerant if the death rate is 80–97%, and stated as resistant if the death rate is less than 80%. Therefore, the *Aedes aegypti* mosquitos in the Universitas Islam Bandung Tamansari campus are already resistant to the insecticides permethrin 0.25% and transfluthrin 25% and tolerant to malathion 0.8%.

Discussion

The resistance of *Aedes aegypti* mosquitos to pyrethroid insecticides has already occurred widely. Several pieces of research in Indonesia such as in Samarinda, Yogyakarta, Central Java province and also in several countries stated that local mosquitos are already resistant to permethrin 0.25%.[12–18,20,21] This has also happened in the environment of Universitas Islam Bandung, which is the *Aedes aegypti* mosquitos are already resistant to permethrin 0.25% and transfluthrin 25%.

This resistance occurs because of the long term use of permethrin, so there is a mutation in the sodium duct, which causes a reduction of nerve sensitivity to pyrethroid in what is known as knockdown resistance (kdr). This mutation occurs because of a single polymorph nucleotide, which produces the leucine substitution in the fenilalanin in the 1014 position (L1014F). This resistance to pyrethroid becomes higher if there is an additional mutation of M918T in the relation with L1014F (M918T and L1014F), this is known as the super-kdr phenotype.[9,17]

The reduction of *Aedes aegypti* susceptibility to malathion also has occurred widely. The mosquitos *Aedes aegypti* mosquitos in Central Java province and also in several countries are reported to be resistant to malathion 0.8%.1[3,15,17,18,20,21] Even though the *Aedes aegypti* mosquitos in the Universitas Islam Bandung environment has not been being resistant to malathion 0.8%, it has been already tolerant. This occurs because of the long term use of malathion as a mass insecticide in controlling the plague of the dengue fever disease in the long term, so mutation occurs which causes an improvement of the metabolism to malathion by α- and β-esterases and cytochrome oxidase.[17,18]

This resistance causes a new problem in vector control, which causes a constant amount of high dengue fever occurrence numbers, specifically in Bandung city. The flying range of these mosquitos are only about one hundred meters, yet advanced transportation means causes an increase of *Aedes aegypti* movement.[6,23,28] This causes the spread of mutated mosquitos and the widening of mosquito resistance to insecticides. Because of that, the control of the *Aedes aegypti* population needs to be more viable by an eradication movement of mosquito nests and not only with insecticide use.

Conclusions

Aedes aegypti mosquitos in the Universitas Islam Bandung Tamansari campus are already resistant to the insecticides of permethrin 0.25% and transfluthrin 25% and tolerant to the malathion 0.8% insecticide.

Conflict of Interest

The authors declare no conflicts of interest.

References

1. Hotez PJ, Murray KO. Dengue, West Nile virus, chikungunya, Zika-and now Mayaro?. PLoS Negl Trop Dis. 2017:11(8):e0005462.
2. Patterson J, Sammon M, Garg M. Dengue,

Zika, and chikungunya: emerging arboviruses in the new world. West J Emerg Med. 2016;17(6):671–9.
3. Kementerian Kesehatan Republik Indonesia. Profil kesehatan Indonesia tahun 2017. Jakarta: Kementerian Kesehatan Republik Indonesia; 2018.
4. Respati T, Feriandi Y, Ndoen E, Raksanagara A, Djuhaeni H, Sofyan A, et al. A qualitative ecohealth model of dengue fever (DF) in Bandung, Indonesia. Int J Trop Dis. 2018;1(1):008.
5. Respati T, Raksanagara A, Djuhaeni H, Sofyan A. Spatial distribution of dengue hemorrhagic fever (DHF) in urban setting of Bandung city. GMHC. 2017;5(3):212–8.
6. Kraemer MUG, Reiner RC Jr, Brady OJ, Messina JP, Gilbert M, Pigott DM, et al. Past and future spread of the arbovirus vectors *Aedes aegypti* and *Aedes albopictus*. Nat Microbiol. 2019;4(5):854–63.
7. Pusat Data dan Surveilans Epidemiologi, Kementerian Kesehatan Republik Indonesia. DBD di Indonesia tahun 1968–2009. Bul Jendela Epidemiol. 2010;2:1–14.
8. Marcombe S, Mathieu RB, Pocquet N, Riaz MA, Poupardin R, Sélior, S, et al. Insecticide resistance in the dengue vector *Aedes aegypti* from martinique: distribution, mechanisms and relations with environmental factors. PLoS One. 2012;7(2):e30989.
9. Kasai S, Komagata O, Itokawa K, Shono T, Ng LC, Kobayashi M, et al. Mechanisms of pyrethroid resistance in the dengue mosquito vector, *Aedes aegypti*: target site insensitivity, penetration, and metabolism. PLoS Negl Trop Dis. 2014;8(6):e2948.
10. Melo-Santos MAV, Varjal-Melo JJM, Araújo AP, Gomes TCS, Paiva MHS, Regis LN, et al. Resistance to the organophosphate temephos: mechanisms, evolution and reversion in an *Aedes aegypti* laboratory strain from Brazil. Acta Trop. 2010;113(2):180–9.
11. Stenhouse SA, Plernsub S, Yanola J, Lumjuan N, Dantrakool A, Choochote W, et al. Detection of the V1016G mutation in the voltage-gated sodium channel gene of *Aedes aegypti* (Diptera: Culicidae) by allele-specific PCR assay, and its distribition and effect on deltamethrin resistance in Thailand. Parasit Vectors. 2013;6(1):253.
12. McAllister JC, Godsey MS, Scott ML. Pyrethroid resistance in *Aedes aegypti* and *Aedes albopictus* from Port-au-Prince, Haiti. J Vector Ecol. 2012;37(2) :325–32.
13. Ishak IH, Jaal Z, Ranson H, Wondji CS. Contrasting patterns of insecticide resistance and knockdown resistance (kdr) in dengue vectors *Aedes aegypti* and *Aedes albopictus* from Malaysia. Parasit Vectors. 2015;8:181.
14. Ponlawat A, Scott JG, Harrington LC. Insecticide susceptibility of *Aedes aegypti* and *Aedes albopictus* across Thailand. J Med Entomol. 2005;42(5):821–5.
15. Kandel Y, Vulcan J, Rodriguez SD, Moore E, Chung HN, Mitra S, et al. Widespread insecticide resistance in *Aedes aegypti* L. from New Mexico, U.S.A. PLoS One. 2019;14(2):e0212693.
16. Kamgang B, Marcombe S, Chandre F, Nchoutpouen E, Nwane P, Etang J, et al. Insecticide susceptibility of *Aedes aegypti* and *Aedes albopictus* in Central Africa. Parasit Vectors. 2011;4:79.
17. Alvarez LC, Ponce G, Oviedo M, Lopez B, Flores AE. Resistance to malathion and deltamethrin in *Aedes aegypti* (Diptera: Culicidae) from Western Venezuela. J Med Entomol. 2013;50(5):1031–9.
18. Goindin D, Delannay C, Gelasse A, Ramdini C, Gaude T, Faucon F, et al. Levels of insecticide resistance to deltamethrin, malathion, and temephos, and associated mechanisms in *Aedes aegypti* mosquitoes from the Guadeloupe and Saint Martin islands (French West Indies). Infect Dis Poverty. 2017;6(1):38.
19. Lidia K, Setianingrum ELS. Deteksi dini resistensi nyamuk *Aedes albopictus* terhadap insektisida organofosfat di daerah endemis demam berdarah dengue di Palu (Sulawesi Tengah). MKM. 2008;3(2):105–10.
20. Sunaryo, Ikawati B, Widiastuti B. Status resistensi vektor demam berdarah dengue (*Aedes aegypti*) terhadap malathion 0,8% dan permethrin 0,25% di Provinsi Jawa Tengah. J Ekol Kes. 2014;13(2):146–52.
21. Widiarti, Heriyanto B, Boewono DT, Widyastuti U, Mujiono, Lasmiati, et al. Peta resistensi vektor demam berdarah dengue *Aedes aegypti* terhadap insektisida kelompok organofosfat, karbamat, dan pyrethroid di propinsi Jawa Tengah dan Daerah Istimewa Yogyakarta. Bul Penelit Kesehat. 2011;39(4):176–89.
22. World Health Organization (WHO).

Dengue guidelines for diagnosis, treatment, prevention and control. New Edition. Geneva: WHO Press; 2009.
23. Powell JR, Tabachnick WJ. History of domestication and spread of *Aedes aegypti*-a review. Mem Inst Oswaldo Cruz. 2013;108(Suppl 1):11–7.
24. Astuti RDI, Ismawati, Siswanti LH, Suhartini A. Sebaran vektor penyakit demam berdarah (*Aedes aegypti*) di kampus Universitas Islam Bandung. GMHC. 2016;4(2):82–6.
25. García-Rejón JE, Loroño-Pino MA, Farfán-Ale JA, Flores-Flores LF, López-Uribe MP, Najera-Vazquez Mdel R, et al. Mosquito infestation and dengue virus infection in *Aedes aegypti* females in schools in Mérida, México. Am J Trop Med Hyg. 2011;84(3):489–96.
26. World Health Organization (WHO). Test procedures for insecticide resistance monitoring in malaria vector mosquitoes. 2nd Edition. Geneva: WHO Press; 2016.
27. Khadri MS, Kwok KL, Noor MI, Lee HL. Efficacy of commercial household insecticide aerosol sprays against *Aedes aegypti* (Linn) under simulated field conditions. Southeast Asian J Trop Med Public Health. 2009;40(6):1226–34.
28. Boewono DT, Ristiyanto, Widiarti, Widyastuti U. Distribusi spasial kasus demam berdarah dengue (DBD), analisis indeks jarak dan alternatif pengendalian vektor di Kota Samarinda, Provinsi Kalimantan Timur. Media Litbangkes. 2012;22(3):131–7.