

47. The susceptibility of aedes aegypti to cypermethrin

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The Susceptibility of *Aedes Aegypti* to Cypermethrin Used in Vector Control Programs of Dengue Hemorrhagic Fever

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ABSTRACT

Background: Cypermethrin is an insecticide commonly used in dengue vector control program. Reasonably different levels of susceptibility in mosquitoes of *Aedes aegypti* in the two districts of Central Java Indonesia are suspected to occur as a result of using cypermethrin continuously.

Method: The study was conducted using a survey method to the community to take samples of *Aedes aegypti* eggs after becoming an adult female mosquito toward the susceptibility of 0.05% cypermethrin.

Results: The results showed that the mosquito *Aedes aegypti* in Kebumen are resistant to the insecticide 0.05% cypermethrin. Similarly, the mosquito *Aedes aegypti* in Banyumas also is immune to the same insecticide.

Conclusion: Mosquitoes in the district of Kebumen and Banyumas regency are resistant to the insecticide of 0.05% cypermethrin. It is suggested for health agencies to conduct periodic evaluations (3-5 years) on the effectiveness of pesticides used, especially in areas with high endemicity status so that control can be applied efficiently.

Keywords: vulnerability, *Aedes aegypti*, cypermethrin

INTRODUCTION

The number of cases of DHF (Dengue) always fluctuate annually ⁽¹⁾. Various efforts to control dengue vector has been implemented either physically, chemically or biologically. Physical controls in Indonesia are commonly known as the practice of 3M, (*Menguras, Menutup, Mengubur-* to drain, to shut, to bury namely mosquito nest elimination using 3 M (drain, close and bury or destroy) that remove the tub or toilet, shut the water reservoirs (buckets, drums, jars) and bury or destroy the used goods such as cans, tires, plastic, and others. This method, however, has not worked satisfactorily proved by the number of dengue cases are still common ⁽²⁾.

Some vector control method has been widely known and used by the dengue control program at the central level in the areas of environmental management,

biological control, chemical control, community participation, protection of individuals and the rule of law. Control of Dengue is primarily intended to break the chain of transmission, i.e., the vector control. The dengue vector control in endemic areas which are not targeted will not be sustainable and has not been able to break the chain of transmission. This may due to the method adopted referring to the data/information vectors as well as still rely on the use of insecticides.

One of the efforts to control the vector is through cut transmission by killing adult mosquitoes quickly with insecticide application or known by the term fogging. It is still often found fogging is performed not in appropriate dose, not to the right target and not based on a scientific basis. This triggers the occurrence of resistance in addition to the fact that some places use the same insecticide group in a long time. Insect resistance

to insecticides commonly occurs after 2-20 years of use. Cypermethrin is insecticides often used in dengue vector control programs in each district in Central Java in recent years and ironically this substance is found no longer useful as the mosquito has been resistant⁽³⁾ besides to 0.8% malathion and 0.25% permethrin⁽⁴⁾.

Kebumen and Banyumas are two districts in the southern part of Central Java province which includes using cypermethrin in the last three years. Kebumen is a county located in the lowlands and by the Indonesian Ocean, while Banyumas is situated in the highlands and bordered by the beach. Their geographical and topographical differences that allow growth, the joy of life and adaptability of mosquito *Aedes aegypti* can be different as well. Cypermethrin associated with the use of insecticides may have different levels of vulnerability in the mosquito *Aedes aegypti* in the two districts as a result of using cypermetrin continuously.

METHODOLOGY

This type of research is observational research with cross sectional approach by conducting surveys to endemic areas of dengue fever in the district of Kebumen and Banyumas in Central Java province, Indonesia.

Samples were the *Aedes aegypti* obtained from the highest dengue cases in Kebumen (districts of Sempor) and Banyumas (the District of South Purwokerto). Adult mosquitoes collected by hatch (rearing) obtained through the installation of ovitrap across the two

districts. The number of mosquitoes used in research is 125 each region bringing the total number of mosquitoes = 125 head x 2 areas = 250 *Aedes aegypti* adult female mosquitoes. Tests were carried out by using WHO standard kit equipment such as susceptibility test set consisting of three pairs of test tubes and three pairs of control tubes. Test tube comprises of a tube collector mosquito (risela oil-coated paper) and the tube contact insecticides (coated paper impregnated).

The calculation result is determined by the provision if the results obtained mosquito mortality in the control group. If it is <5%, then it is ignored. If the death of larvae in the control group is > 20%, the research is considered failed, and the test should be repeated. The percentage protection (feeding inhibition, mortality or lockdown effect) was estimated by Abbot formula as $PE = (NC - NT)/NT \times 100\%$, where NC and NT are the number of the mosquito on control and treatment, respectively⁽⁵⁾. The mortality rate of *Aedes aegypti* is interpreted as follows:

vulnerable: if the death of the mosquito larvae is 98-100%
 tolerant: if the death of larvae mosquito is 80-97%
 resistant: when the mosquito larvae mortality is <80%

RESULTS

The insecticides used for fogging on the location of the study are described below.

Table 1. The Insecticides Used for Fogging

No.	Location	Insecticides Group	Frequency	Duration of use
1.	Kebumen Regency	Synthetic pyrethroid	1-2 times/year	> 5 years
2.	Banyumas Regency	Synthetic pyrethroid	1-2 times/year	> 5 years

Temperature measurements are carried out every day, i.e., air temperature at the test and 24 hours after testing. Temperature measurements obtained can be seen in the table below.

Table 2. Measurements of Air Temperature

Sampe1	Data Testing	Initial temperature (°C)	Temperature after 24 hours (°C)
1	Jatinegara Village	1	25
		2	25
		3	25
2	Karanglesem Sub-district	1	25.5
		2	25.5
		3	25.5

Humidity measurements were performed every 13 day, i.e., air humidity during testing and observation 24 hours after trial. The humidity measurements obtained can be seen in the table below.

Table 3. Humidity Measurement Results

Sample	Data Testing	Initial humidity(%)	Humidity after 24 hours (%)	
1	Jatinegara Village	1	77	78
		2	77	78
		3	77	78
2	Karangklesem Sub-district	1	78	78
		2	78	78
		3	78	78

The susceptibility status of *Aedes aegypti* resistance to 0.05% Cypermethrin is obtained through test or susceptibility test. The resistance test data was collected from the results of *Aedes aegypti* mosquito count which died in the 0.05% Cypermethrin, exposure group after being observed for 1x24 hours. *Aedes aegypti* mosquito resistance test result in exposure group of 0.05% Cypermethrin insecticide in Jatinegara village can be seen in the following table.

Table 4. Aedes aegypti Mosquito Resistance Test Results in Jatinegara Village

No.	Samples	Mosquitos	Death	Alive	Mortality Rate (%)	Note
1	1	20	3	17	15	Resistant
2	2	20	7	13	35	Resistant
3	3	20	7	13	35	Resistant
Average		20	5.7	14.3	28.3	Resistant

From table 4 it can be seen that the population of *Aedes aegypti* mosquitoes in Jatinegara village, Kebumen regency with 3 times test have *Aedes aegypti* mosquito death rate respectively: 1st test as much as 15%, 2nd test as much as 35%, and 3rd test as much as 35% with the average percentage of deaths is 28.3%. Thus it can be said that *Aedes aegypti* mosquitoes in Jatinegara Village, Kebumen Regency have been resistant to 0.05% Cypermethrin insecticide.

In the control group, the test was performed using three sets of test tubes. The experimental procedure is similar to the resistance test in the exposed group. What distinguishes is in the control group it applies a non-insecticide paper. The death of *Aedes aegypti* mosquito in the control group can be seen in the following table.

Table 5. Resistance Test Results Aedes aegypti mosquito in the Control Group

No.	Samples	Mosquitos	Death	Alive	Mortality Rate (%)
1	1	20	0	20	0
2	2	20	0	20	0
3	3	20	1	19	5
Average		20	0.3	19.7	1.7

Aedes aegypti mosquito resistance test result in exposure group of 0.05% Cypermethrin insecticide in Karanglesem Urban Village, South Purwokerto District, Banyumas Regency can be seen in the following table.

Table 6. Resistance Test Result of Aedes aegypti Mosquito on Exposure Group

No.	Samples	Mosquitos	Death	Alive	Mortality Rate (%)	Note
1	1	20	7	13	35	Resistant
2	2	20	5	15	25	Resistant
3	3	20	2	18	10	Resistant
Average		20	4.7	15.3	23.3	Resistant

12 Based on Table 6, it can be seen that the population of Aedes aegypti mosquito in Karangklesem village, South Purwokerto subdistrict, Banyumas regency with 3 times test have Aedes aegypti mosquito death rate: 35% in experiment 1, 25% in test 2, and check 3 as much as 10% with the average percentage of death 23.3%. Thus, it can be said that Aedes aegypti mosquito in Karangklesem Village, District of South Purwokerto,

Banyumas Regency has been resistant to 0.05% Cypermethrin insecticide

In the control group, the test was performed using three sets of test tubes. The experimental procedure is similar to the resistance test in the exposed group. What distinguishes is in the control group it applies a non-7 insecticide paper. The death of Aedes aegypti mosquitoes in the control group can be seen in the following table.

Table 7. Aedes aegypti Mosquito Resistance Test Result in Control Group in Banyumas Regency

No.	Samples	Mosquitos	Death	Alive	Mortality Rate (%)
1	1	20	0	20	0
2	2	20	1	19	5
3	3	20	1	19	5
Average		20	0.7	19.3	3.3

14 Based on Table 7 it can be seen that the control group mortality from Aedes aegypti mosquitoes on the 0.05% Cypermethrin insecticide resistance test in Karangklesem Subdistrict of Purwokerto Selatan District of Banyumas Regency with three times test, the control group mortality rate is 3.3%.

DISCUSSION

1 The result of temperature measurement shows that the temperature in the study room is 25-26 ° C. In general, mosquitoes will lay eggs at temperatures around 20-30 ° C, so it can potentially breed the Aedes aegypti mosquito (6).

4 The optimum temperature of mosquito breeding is between 25 ° C-27 ° C and will stop entirely at <10 ° C or > 40 ° C (7). Thus the temperature of the room in the laboratory is still in optimum condition for the heat of Aedes aegypti mosquito development. The result of initial humidity test measurement and after observed

1x24 hour gets the result between 77-78%. The need for high humidity affects mosquitoes to find moist and wet places as a place to rest or rest. At moisture less than 60%, the age of the mosquito is short (8). Humidity in the laboratory room is adjusted with moisture in place of mosquitoes to rest or to rest area, so that at the time of mosquito breeding and at the time of the testing process of mosquito in excellent condition and stable.

The test data of resistance with susceptibility test method was obtained from Aedes aegypti mosquito count which died on Cypermethrin 0.05% exposure group after observed for 1x24 hours. Aedes aegypti mosquito resistance test in 0.02% Cypermethrin insecticide group in Jatinegara village, Sempor sub-district, Kebumen regency with three times analysis has Aedes aegypti mosquito average percentage of death = 28.3%. Thus it can be said that Aedes aegypti mosquitoes in Jatinegara Village, Sempor Sub-district, Kebumen Regency have been resistant to 0.05% Cypermethrin insecticide.

In the control group, the test was performed using three sets of test tubes. The death of *Aedes aegypti* mosquitoes in the mean control group was 1.7%. Due to the control mortality <5%, it does not need to be corrected with the Abbot formula. *Aedes aegypti* susceptibility or resistance to Cypermethrin 0,05% in Karangklesem Village, District of Purwokerto Selatan, Banyumas Regency known that *Aedes aegypti* mosquito average percentage of death is 23.3%. Thus it can be said that *Aedes aegypti* mosquito in Karangklesem Village, District of South Purwokerto, Banyumas Regency has been resistant to Cypermethrin insecticide 0,05%.

Tests on the control group of *Aedes aegypti* mosquito in Karangklesem Village, District of Purwokerto Selatan, Banyumas Regency were done using three sets of the test tube. The death of *Aedes aegypti* mosquitoes in the control group was 3.3%. Due to the control mortality <5%, it does not need to be corrected with the Abbot formula.

This way, communities should not always use insecticides in mosquito control but advisable to control by methods of repair or to clean the environment such as eradication of mosquito nest.

Other researchers may conduct susceptibility studies of *Aedes aegypti* mosquitoes against other types of insecticides or similar research with different research situation to enlarge the generality.

CONCLUSION

The application of insecticides in the control of dengue vectors performed at the study sites (Kebumen and Banyumas districts) by the health authorities has found the use of synthetic pyrethroid insecticides for more than five years. This makes *Aedes aegypti* mosquitoes in Jatinegara village, Sempor sub-district, Kebumen regency has been resistant to 0.05% cypermethrin insecticide (average percentage of mosquito deaths test of 28.3%). Likewise, the results of mosquito susceptibility test using susceptibility test method showed that *Aedes aegypti* mosquito in Karangklesem village, South Purwokerto subdistrict, Banyumas district had been resistant to 0.05% cypermethrin insecticide (average of mosquito death rate percentage was 23.3%). This makes the government necessary to find an alternative to combat the mosquito as in ineffectiveness of the insecticide may

be one cause affecting the transmission of dengue fever is hard to eliminate.

Conflict of Interest: The authors have no conflict of interests related to the conduct and reporting of this research.

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