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Household Insecticide Use In Relation To *Aedes* Spp. Resistance In Gampong Lampaseh Aceh Tahun 2025

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ABSTRACT

The improper use of household insecticides can reduce vector susceptibility and potentially lead to the emergence of resistant mosquito populations. In Lampaseh Village, most residents routinely spray insecticides indoors as an effort to prevent mosquito nuisance. However, despite regular spraying, residents continue to report the presence of mosquitoes. The number of Dengue Hemorrhagic Fever (DHF) cases in this area is relatively low, yet cases are reported every year. This indicates that the threat of Aedes mosquitoes as vectors of the dengue virus has not been completely eliminated and that control efforts still require serious attention. This study is descriptive in nature, aiming to illustrate household insecticide use patterns and identify the resistance status of Aedes sp. mosquitoes through laboratory-based Susceptibility Tests. Data on insecticide use were collected through interviews with 86 households, while resistance testing was conducted on 75 adult mosquitoes. Findings are presented in narrative and percentage form. The results showed that the application of household insecticides was not fully in line with recommended practices. The majority of respondents reported using aerosol sprays (40%), which pose a risk of excessive application. Most spraying was conducted at night (81.40%), whereas the peak biting activity of Aedes aegypti occurs in the morning and late afternoon. In terms of frequency, the majority (58.14%) did not spray daily. Nevertheless, the Susceptibility Test demonstrated that mosquitoes remained susceptible to cypermethrin, with a mortality rate of 100%. In conclusion, the reduced effectiveness of insecticides in the field is not caused by mosquito resistance but is more likely influenced by suboptimal application practices. Simple preventive measures such as maintaining environmental sanitation, draining water containers, and eliminating stagnant water remain more effective strategies to disrupt the mosquito life cycle.

Keywords: **Resistensi, Aedes, Susceptibility test**

INTRODUCTION

Vector-borne diseases remain a major public health problem in Indonesia, with relatively high morbidity and mortality rates, and they have the potential to cause outbreaks and/or epidemics as well as significant economic losses to communities.[1] Mosquitoes are insects of which several species have been confirmed as disease vectors. Two species of the genus *Aedes*, namely *Aedes aegypti* and *Aedes albopictus*, have been confirmed as vectors of dengue fever, chikungunya, and Zika virus infection.[2]

Several preventive approaches include directing interventions toward humans as hosts, studying the interactions between humans and mosquitoes, and targeting the mosquitoes themselves. Vector control is often the preferred strategy because it can reduce or even eliminate mosquito populations directly without posing risks to human health. This approach comprises three main types of control: chemical, environmental, and biological methods.[3]

At the household level, various types of insecticides are commercially available, and their use varies across different locations. Each insecticide formulation contains different active ingredients; therefore, the greater the variety of insecticides used by communities, the higher the diversity of synthetic active ingredients released into the environment where household insecticides are applied.

The continuous use of a single type of insecticide over a prolonged period can lead to the development of resistance in target insects.[4]

One of the major challenges in the effectiveness of insect control is resistance. Frequent contact between insects and insecticides used for control can lead to the development of physiological resistance. Therefore, assessing vector susceptibility to insecticides is a crucial step in planning and evaluating mosquito control programs, particularly those involving the use of insecticides against *Aedes* spp. Factors contributing to household insecticide resistance include the continuous use of the same products, inappropriate dosing, and genetic factors of the insects. Patterns of household insecticide use indicate that many communities rely repeatedly on the same products for mosquito control, raising concerns about the emergence of insecticide resistance.[5]

Insecticides are substances containing chemical compounds used to kill insects and pests.[7] Community-based vector control through the use of household insecticides represents one of the preventive measures to reduce mosquito bites. Many individuals prefer household insecticides for controlling dengue vectors due to their ease of use and the immediate, visible results they provide.[8] Various types of insecticides are available on the market, ranging from coils, lotions, aerosols, sprays, to electric formulations, with diverse brands and active ingredients.[9]

Insecticide resistance is a serious challenge in vector control efforts. Therefore, early detection and continuous monitoring of insecticide resistance are essential. Failure of insecticide-based vector control is often associated with the development of resistant vector populations. When resistance levels are high, a prolonged period is required to restore susceptible insect populations. Consequently, the implementation of detection methods that are simple, rapid, and accurate is critically important.[10]

In Indonesia, dengue cases reached approximately 143,000 by the end of 2022. Nationally, the reported number of dengue cases is substantially lower than the estimated incidence of dengue in Indonesia. Bhatt et al. (2013) estimated that the number of symptomatic dengue cases in Indonesia reached 7,590,213 cases, which is approximately 50 times higher than the number of cases reported in 2022. According to the Head of the Disease Prevention and Control Division (P2P) of the Aceh Provincial Health Office, Dr. Iman Murahman, as reported by *Kompas*, the number of dengue hemorrhagic fever cases in Aceh was 2,176 in 2023 and increased to 3,400 cases in 2024.[6]

Based on a preliminary survey conducted in Gampong Lampaseh Aceh, it was found that many residents routinely apply indoor insecticide spraying as a measure to prevent mosquito nuisance. However, an interesting observation was reported by several residents: despite regular spraying, mosquitoes continued to appear over time. Some residents even reported that after spraying, mosquitoes appeared weakened or fell to the floor, but shortly thereafter resumed flying as usual, seemingly unaffected by the insecticide.

This situation has raised concerns among community members regarding whether the insecticides they use are insufficiently effective or whether other factors may be involved. It also prompts the question of whether mosquito populations may have developed reduced susceptibility or resistance to the chemical compounds used?

On the other hand, although the number of dengue hemorrhagic fever (DHF) cases in this village remains relatively low, cases are consistently reported each year. This indicates that the threat posed by *Aedes* mosquitoes as vectors of dengue virus has not been fully eliminated, and control efforts still require serious and sustained attention.

Based on these finding, this study was conducted to further examine patterns of household insecticide use within the community and to explore the potential occurrence of *Aedes* spp. mosquito resistance to commonly used insecticides. It is expected that the findings of this study will provide clearer insights and serve as a basis for the development of more effective mosquito control strategies in the future.

RESEARCH METHODS

This study employed a descriptive research design aimed at describing patterns of household insecticide use and assessing the resistance of *Aedes* spp. mosquitoes to insecticides using a susceptibility test. The study population comprised all households using insecticides in Gampong Lampaseh, Aceh, totaling 820 households, as well as all *Aedes* spp. larvae found in households within the study area. The study sample size was determined using the large-sample proportion formula, as follows $n = \frac{Z^2 \cdot p \cdot (1-p)}{e^2}$ accordingly, the minimum sample size required for this study was 86 households. *Aedes* spp. larvae were collected from water storage containers located within the selected households.

The survey on patterns of household insecticide use was conducted in Gampong Lampaseh, Meuraxa District, Banda Aceh City. The susceptibility test was performed at the Class I Quarantine Center Laboratory of Banda Aceh in May 2025. The instruments used in this study included a structured questionnaire to obtain information on insecticide use from respondents and the WHO susceptibility test observation sheet to record the effects of insecticide exposure on *Aedes* spp. mosquitoes at different observation times, specifically knockdown at 60 minutes and mortality at 24 hours.

Data obtained from the questionnaire were processed manually by summing respondents' answers for each item. The processed data were then presented in frequency distribution tables describing patterns of household insecticide use among respondents. Data from the WHO susceptibility test were analyzed by calculating the percentage of knockdown at 60 minutes and mortality at 24 hours. Abbott's formula was applied to correct mortality rates when deaths occurred in the control group in order to minimize bias. Interview data were analyzed using descriptive quantitative methods and presented as frequency and percentage distributions.

Resistance status was determined based on the percentage of mosquito mortality after a 24-hour observation period. Mortality rates ≥ 98% were classified as susceptible, mortality rates of 90–97% indicated possible resistance, and mortality rates < 90% were classified as resistant.

RESULTS AND DISCUSSION

The results of the study on household insecticide use showed that 40% of respondents used spray applications, while 3.49% applied insecticides in lotion form. Aerosol insecticides commonly contain active ingredients such as pyrethroids, which exhibit neurotoxic effects on adult mosquitoes. When sprayed in enclosed spaces, aerosols are effective in killing flying or resting mosquitoes, thereby reducing mosquito populations in the short term. However, aerosol use does not affect mosquito larvae, meaning that the primary source of the mosquito life cycle remains uninterrupted. Without complementary larval control measures, such as source reduction (3M Plus) or larvicides, new mosquito populations will continue to emerge.

Table 1. Methods of Household Insecticide Use

Aplication methods	Participants	
	N	%
Coil	30	34,88
Electric type	14	16,28
Spray	31	36,05
Lotion	3	3,49
Multiple types	8	9,30
Frequency	**86**	**100**

* Source: Primary data

The study results indicated that the majority of respondents applied household insecticides in the evening (81.40%), followed by the afternoon (16.28%), with the least application occurring during the daytime (1.16%). This timing is considered suboptimal, as *Aedes* spp. mosquitoes are most active in the morning and late afternoon.

Table 2. Time of Household Insecticide Use

Time of use		N	%	Subtotal (N)	Subtotal (%)
Single time periods	Daytime	1	1,16	85	98,84
	Evening	14	16,28		
	Night	70	81,40		
Two time periods	Morning, Evening	0	0,00	1	1,16
	Evening, Night	1	1,16		
	Morning, Evening, Night	0	0,00	0	-

Three time periods	Daytime, Evening, Night	0	0,00			
Fourt time periods	Morning, Daytime, Evening, Night	0	0,00	0		-
		86	**100**	**86**	**100**	

* Source: Primary data

The results showed that 36 households (41.86%) applied household insecticides daily, while 50 households (58.14%) used insecticides irregularly or only when mosquitoes became a nuisance. Both daily and infrequent spraying may contribute to the development of resistance if not accompanied by the elimination of breeding sites. This is because household insecticides primarily target adult mosquitoes rather than larval stages.

Table 3. Frequency of Household Insecticide Use

Usage category	Frequency (households)	Percentage (%)
Daily	36	41,86%
Not daily (only when mosquitoes are a nuisance)	50	58,14%
Frequency	**86**	**100%**

* Source: Primary data

The results of the susceptibility test using 0.05% cypermethrin demonstrated that all *Aedes aegypti* isolates remained susceptible, with a 100% mortality rate after a 24-hour holding period, as shown in Table 4.

Table 4. Susceptibility status of *Aedes aegypti* to 0.05% cypermethrin in Lampaseh Aceh, Meuraxa Subdistrict, Banda Aceh City

No	Isolat	Test Sample	Percentage Mortality (24 hours)	Status
1	*Aedes*	75	100	Rentan

*) The susceptibility status was classified according to WHO guidelines (2016), with mosquito mortality rates > 98% categorized as susceptible, 90–97% as suspected resistant, and < 90% as resistant.

Spray insecticides are available in both gas-based aerosol and manual spray formulations, with aerosol products generally containing higher concentrations of active ingredients. The community tends to apply insecticides at night, despite the peak biting activity of *Aedes aegypti* occurring in the morning and late afternoon, thereby reducing the effectiveness of vector control. This indicates that insecticide use patterns are not yet fully based on an adequate understanding of dengue vector behavior. In addition, the frequency of use also plays a significant role, as repeated exposure may increase the risk of insecticide resistance. Previous studies in Jakarta reported that the majority of households (76.51%) used insecticides daily, with an average application frequency of 5.3 times per week in East Jakarta, resulting in continuous exposure of both mosquitoes and humans to insecticides. Cypermethrin, a pyrethroid-class insecticide, is widely used in Banda Aceh in both household insecticide products and fogging activities. This insecticide is considered effective due to its rapid knockdown effect and relatively long residual activity; however, repeated use may potentially lead to the development of resistance in *Aedes aegypti*. The results of this study indicate that the mosquitoes remain susceptible to cypermethrin, with a 100% mortality rate observed.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The results of the study indicate that most community members prefer aerosol spray insecticides (40%) compared to topical formulations, which were used by only 3.49% of respondents. Aerosol products are perceived as more practical because they are easy to apply, do not produce smoke, and provide rapid effects. However, excessive or frequent spraying may contribute to environmental contamination and increase the risk of mosquito resistance. Most insecticide applications were carried out at night (81.40%), followed by the late afternoon (16.28%), with very limited use during the daytime (1.16%). This pattern is not consistent with the peak biting activity of *Aedes aegypti*, which primarily occurs in the morning and late afternoon, thereby reducing the effectiveness of control efforts. These findings suggest that insecticide use practices have not yet been fully aligned with the behavioral patterns of dengue vectors.

From the frequency perspective, more than half of the respondents (58.14%) used insecticides only when mosquitoes were perceived as a nuisance, while 41.86% applied insecticides on a daily basis. Although the frequency of use was relatively moderate, control practices that focus solely on adult mosquitoes may still contribute to the accelerated development of resistance in the future. Interestingly, the susceptibility test results demonstrated that the insecticide used remained highly effective, with mosquito mortality reaching 100%. Nevertheless, inappropriate spraying practices need to be improved to maintain long-term effectiveness and to reduce the potential risk of resistance development.

Recommendations

The community is encouraged to use insecticides according to the recommended instructions and to avoid excessive application in order to maintain their effectiveness and prevent the emergence of resistance. Non-chemical preventive measures, such as environmental sanitation, covering water storage containers, and implementing source reduction activities (PSN), should be strengthened so that reliance on insecticides can be minimized. Regular environmental management can effectively suppress mosquito breeding without excessive dependence on chemical control.

For the local Health Office and Primary Health Care Centers, it is important to conduct regular community education on proper insecticide use, raise awareness of insecticide resistance, and promote integrated vector management strategies. Routine monitoring of mosquito resistance is also necessary to inform and adjust more effective control strategies. Future research is recommended to involve wider geographic coverage, different classes of insecticides, and genetic or molecular analyses to better understand resistance mechanisms in field populations.

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