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Review Article

Zingiber officinale rosc Activity as Natural Insectiside of *Aedes aegypti* Larva

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ABSTRACT

Dengue fever is a health problem in Indonesia, especially in the Gorontalo area. One of the efforts to prevent the incidence of dengue fever is the use of natural insecticides, including red ginger. This study aimed to examine the effectiveness of red ginger (*Zingiber officinale rosc*) squeeze in eradicating the *Aedes aegypti* larva. This study was experimental study with true experiment approach, conducted in laboratory of public health department, Gorontalo State University. The samples of mosquito larvae used were 500 larva of *Aedes aegypti* 4th instar mosquitoes taken from dengue endemic areas in Gorontalo. Squeeze of red ginger was given in five concentrations: 60%, 70%, 80%, 90%, and 100%. Result showed the effect of the red ginger squeeze in eradicating the Aedes aegyepti larva in each given concentration (p-value=100). The higher concentration of red ginger squeeze used the higher larva mortality rate. The *Zingiber officinale rosc* are expected to be utilized by the community in preventing the dengue fever.

Keywords: Natural insecticide, Red ginger, Repellent

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INTRODUCTION

Dengue fever is an infectious disease caused by the Dengue virus, belongs to the group B Arthropod Borne Virus (Arboviroses) known as the genus Flavivirus, family Flavividae, and transmitted through the *Aedes Aegypti* and *Aedes Albopictus* mosquitoes (Kemenkes, 2019). In 1960 this disease spread out many countries including the World Health Organization South-East Asia and the Western Pacific region including Indonesia (WHO, 2011; Gubler DJ, 1998). This is because the ecological disturbances during and after World War II created ideal conditions for increasing the transmission of mosquito-borne diseases (Gubler DJ, 1998). WHO noted the region in Southeast Asia with the highest dengue cases was in Indonesia in the WHO stratification indicating a high number of hospitalizations and deaths due to dengue fever, especially in children (WHO, 2011).

Dengue fever is a serious global threat to mankind, especially endemic areas in the tropics and subtropics, where 40% of the world's population now lives in countries with a high risk of dengue transmission (Dehghani R and Kassiri H, 2021; Sanyaolu A, *et al.*, 2020). WHO describes cases of dengue fever worldwide every year are 50-100 million, and 250,000-500,000 cases with a mortality rate of about 24.000 people per year (WHO, 2011). Overall mortality from dengue fever in the world is 0.5%-2.0% which can reach 20% if the case has entered the dengue shock syndrome phase in the ICU/hospital (Guo C, *et al.*, 2017).

Dengue Hemorrhagic Fever (DHF) is still one of the main public health problems in Indonesia (Kemenkes, 2019). Along with increasing mobility and population density, the number of sufferers and the area of their distribution are increasing. In Indonesia, dengue fever was first discovered in the city of Surabaya in 1968, there were 58 infected people and 24 of them died, with a mortality rate (CFR) reaching 41.3% and until now it has spread widely throughout Indonesia (KKRI, 2016).

DHF cases were established with a diagnosis consisting of clinical symptoms and laboratory results indicating a decrease in platelets <100,000/mm3 and plasma leakage which was characterized by an increase in hematocrit >20%. DHF cases in Indonesia since 1968-2015 tend to continue to increase (KKRI, 2016). DHF cases reported in 2019 were 138.127 cases. This number increased compared to 2018 which was 65.602 cases. Deaths due to DHF in 2019 also increased compared to 2018 from 467 to 919 deaths (Kemenkes, 2019).

Based on data from the Ministry of Health in 2019, the provinces of North Kalimantan, East Kalimantan, and Bali are highest incident rate among 34 other provinces, which are 239, 180, 66 and 114.8 per 100.000 population respectively. Gorontalo province ranks fourth with an incidence rate of 101.53 per 100,000 population. However, assessed by the Case Fatality Rate (CFR) of each region, Gorontalo Province has a CFR of DHF of 1.88%, ranks second highest in Indonesia after Maluku Province which has the highest CFR of 2.12% (Kemenkes, 2019).

Based on data from the Early Alert and Response System of Gorontalo Provincial Health Office, the incidence of DHF ranks the highest for diseases often experience extraordinary events (KLB), which is 14 times in 2016 (Dinkes, 2020). In Gorontalo Regency, there was an increase in cases of dengue fever from 2017 to 2019. There were 151 cases and 3 people died in 2017, and in 2018, it increased to 244 cases with 4 people died. Data from Gorontalo District Health Office on February 2019 had 217 cases, one of them died from dengue fever (Dinkes, 2020).

This vector-borne viral disease spreads rapidly and poses public health and economic challenges requiring various prevention and control techniques (Sabir MJ, *et al.*, 2021). In general, an epidemic of dengue fever can occur in the presence of vector mosquitoes (usually *Aedes aegypti*), dengue virus, and a group of susceptible human hosts (CDC, 2009). Environmental factors such as rainfall, air temperature and humidity also affect the spread of DHF (Nugraha F, *et al.*, 2021). In addition, human mobility also brings the dengue virus into motion, allowing it to spread to a wider area. The distribution is more found in urban areas than in rural areas, including areas that have quite a lot of standing water (Zhang Y, *et al.*, 2020). The expansion of dengue fever is expected to continue to increase due to factors such as the modern dynamics of climate change, globalization, socio-economics, and also the evolution of the virus (Murray NEA, *et al.*, 2013).

Until now the dengue fever vaccine is still under development (Sanyaolu A, *et al.*, 2020; Murray NEA, *et al.*, 2013). Some of the efforts that can be done are by pursuing the habit of eradicating mosquito nests through the 3 M Plus movement, early detection of dengue cases and immediate treatment (Early diagnosis

and prompt treatment), and implementation of *Aedes aegypti* vector surveillance and control, as well as promotional efforts involving all sectors through lectures and use of digital media (KKRI, 2016; Murray NEA, *et al.*, 2013; Arkeman H, *et al.*, 2020; Ahmad ZF, 2021).

The use of insecticides in controlling disease vectors is one of the government's efforts to overcome vector-based diseases (Rivero A, *et al.*, 2010). The use of insecticides in the health sector, especially from chemicals, is still widely used in Indonesia. The various active ingredients of insecticides that are currently on the market will indirectly have an impact on health. Although in some cases, insecticides tend to cause a decrease in the number of vectors, a decrease in infectiousness, or a change in behavior, will reduce the capacity of insect vectors. On the other hand, insecticides will also increase the resistance of disease vectors, so that vectors are increasingly resistant to the use of insecticides in eradicating larva. (Rivero A, et al., 2010; Nauen R, 2007). Therefore, another approach is needed in efforts to reduce dengue vectors.

The effort used as alternative in controlling dengue vectors is the use of natural ingredients as insecticides. It is affordable and also environmentally friendly (Sharma D, *et al.*, 2021). Some natural ingredients often used as *Aedes aegypti* mosquito repellents are basil herb (*Ocimum Sanctum L*), star anise (*Illicium verum*), marigold flowers (*Tagetes erecta*), Zodia leaves (*Evodia suaveolens Scheff*), Lemongrass stalks (*Cymbopogon citratus*), *Henopodium ambrosioides, Conyza sumatrensis, Eucalyptus camaldulensis, Mentha spicata* and others (Aini R, *et al.*, 2017; Lestari E, *et al.*, 2019; Zen S and Asih T, 2017; Mirawati P, *et al.*, 2018; Azeem M, *et al.*, 2019). Another natural ingredient that has an insecticidal effect against mosquitoes is red ginger (Hamada HM, *et al.*, 2018). The study focus in examining red ginger in the form of oil combined with cloves of garlic (*Allium sativum*). So far, there is no research has been found on how repellent the red ginger squeeze is. Red ginger is a natural ingredient that is simply growing in Gorontalo. The squeeze method is also interesting to assess its effectiveness since it is familiar to apply in the community. So this study aims to assess how the insecticidal activity of red ginger juice as a repellent for *Aedes aegypti* mosquito larva.

MATERIALS AND METHODS

This research is an experimental study using a True Experiment approach, where *Aedes aegypti* larvae are given direct treatment by inserting red ginger squeeze. The treatment was given with a completely randomized design approach since the experimental unit was homogeneous. The treatments were given in five different concentrations, namely 60%, 70%, 80%, 90%, and 100%. This research was conducted in February 2021.

Mosquito larvae samples were collected in West Limboto District, Gorontalo Regency, which is an endemic area of dengue fever. The selected larva sample was the fourth instar *Aedes aegypti* mosquito larvae so that the larvae used were homogeneous. The selection of the fourth instar larvae is because at this stage the size is larger than in another stage and its defense system is considered to be stronger. The experiment was carried out at the Laboratory of the Department of Public Health, Gorontalo State University and it was assisted by a laboratory assistant.

The test was carried out by providing 5 containers to put red ginger extract, each container was labeled with a concentration namely 60%, 70%, 80%, 90%, and 100%. The squeeze was given adjusted to the concentration. Then, in each container, 20 fourth instar *Aedes aegypti* larvae were added. The container contained the mosquito larvae is covered with gauze, labeled and observed for 24 hours. After 24 hours observed at the certain concentration, some *Aedes aegypti* larva was exterminated effectively. To get more accurate results, it is repeated in the next day. The experiment was repeated 5 times for each concentration. The flow of the experiment is shown in *Figure 1*.

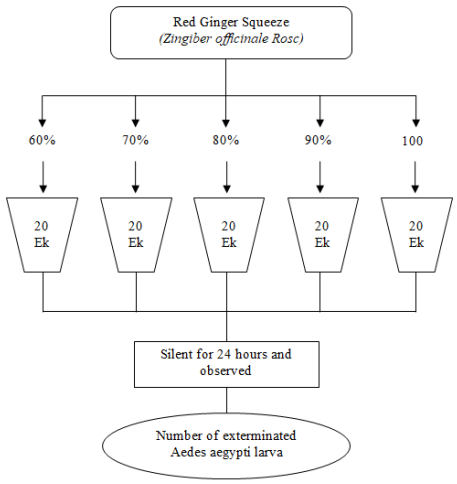

Figure 1: Experiment flow

The observations were recorded by the laboratory assistant through the observation sheet. Data were analyzed using One Way ANOVA with the help of SPSS 26 computer application.

RESULTS AND DISCUSSION

The experimental data were analyzed using test of normality to assess the data distribution. The results indicated that the data are normally distributed with p-value=0.814 (>=0.05). Since they were normally distributed, then One-Way ANOVA test was carried out. The results of One-Way ANOVA are shown in *Table 1*. The result showed there was a significant difference in extermination of *Aedes aegypti* larvae between the five concentration groups with p-value=0.000<=0.05 (95% CI). Then a follow-up test (Post hoc Games-Howell) was conducted to assess which groups had a different number of deaths in each group *(Table 2)*.

Table 1: Differences in number of larvae between concentration groups

Concentration	Mean	F	p-value
60%	8.6	84.5	0.00
70%	11.2	-	-
80%	13.6	-	-
90%	16.6	-	-
100%	19.4	-	-

Table 2: Comparison of each group

Concentration		p-value	95% Confidence interval	
			Lower	Upper
60%	70%	0.024	-4.83	-0.37
	80%	0.001	-7.49	-2.51
	90%	0	-10.49	-5.51
	100%	0	-13.07	-8.53
70%	60%	0.024	0.37	4.83
	80%	0.036	-4.63	-0.17
	90%	0	-7.63	-3.17
	100%	0	-10.09	-6.31
80%	60%	0.001	2.51	7.49
	70%	0.036	0.17	4.63
	90%	0.02	-5.49	-0.51
	100%	0	-8.07	-3.53

90%	60%	0	5.51	10.49
	70%	0	3.17	7.63
	80%	0.02	0.51	5.49
	100%	0.018	-5.07	-0.53
100%	60%	0	8.53	13.07
	70%	0	6.31	10.09
	80%	0	3.53	8.07
	90%	0.018	0.53	5.07

The results of further test analysis showed that all groups had a significant difference in the number of deaths of *Aedes aegypti* larva with other groups with p-value<=0.05. The average difference in larva extermination is shown in *Figure 2*.

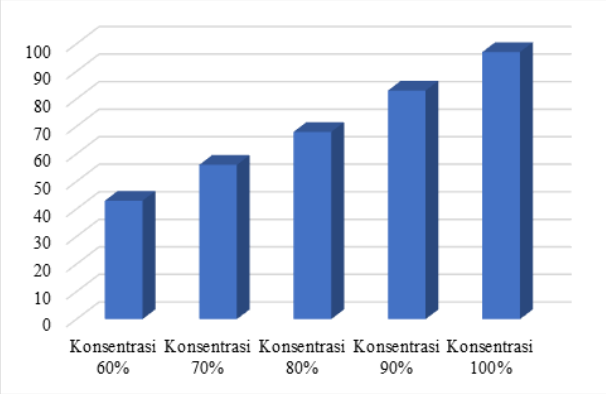

Figure 2: Extermination *Aedes aegypti* average percentage

At 60% concentration, the average larval mortality reached 43% after 24 hours. At 70% concentration, the larval mortality rate reached 56% after 24 hours. At 80% concentration, the larval mortality rate reached 68%. At the 90% red ginger concentration, the larva mortality rate reached 83%. At 100% concentration, the larva mortality rate reached 97%. The results of the analysis showed that the higher the concentration of red ginger juice, the higher the mortality rate of the *Aedes aegypti* mosquito larvae. The highest mortality of *Aedes aegypti* larva was found at a concentration of 100%, and the lowest larval mortality was found at a concentration of 60%. The same results were still obtained after five times repetition with the duration of each repetition for 24 hours.

The results showed that red ginger has repellent activity against the larvae of the *Aedes aegypti* at various concentrations. The highest larval mortality rate was found at 100% concentration. The results obtained are in line with the results of research on the insecticidal activity of oil from garlic clove (*Allium sativum*), and ginger rhizome (*Zingiber officinale*) which have insecticidal activity that can significantly lengthen larva and pupa duration. It also reduces the percentage of hatchability of deposited eggs (Hamada HM, *et al.*, 2018). Other studies have also shown that ginger can also be used as a repellent against vectors of a disease, such as cockroaches (Azhari HN, *et al.*, 2017).

Ginger (genus Zingiber) is widely used as a spice and medicinal herb throughout the world and as the main ingredient in traditional local beverages such as jamu in Southeast Asia (Yanagawa A, *et al.*, 2020). Ginger has many benefits in everyday life, including antibacterial, antiviral, antifungal activities. The content of ginger can suppress the growth of phytopathogenic growth so it can be used as a new alternative to synthetic fungicides and bactericides (Abdullahi A, *et al.*, 2020). Other studies have shown that red ginger has an anti-inflammatory effect by preventing the alteration of several levels of inflammatory cytokines/biomarkers and inhibiting hippocampal and prefrontal cortex Acetyl-Cholinesterase (AChE) and Adenosine Deaminase (ADA) activity (an important enzyme relevant in the management/prevention of neurodegenerative diseases) (Akinyemi AJ and Adeniyi PA, 2018).

Red Ginger *(Zingiber officinale rosc)* squeeze contains active compounds which are toxic to insects that can cause mortality in *Aedes aegypti* larva. According to Suramarja (2016), the active compounds in red ginger will react with the larval cell membrane and damage it, causing lysis and disrupting the permeability of the plasma membrane. This results in leakage of the cytoplasmic membrane because of the breakdown of phospholipid molecules due to H^+ ions from ginger (gingerol).

Active compounds such as essential oils in red ginger are toxic to the larvae of the *Aedes aegypti*. In nutrition content, ginger contains calories, carbohydrates, fiber, protein, sodium, iron, potassium, magnesium, phosphorus, zinc, folate, vitamin C, vitamin B6, vitamin A, riboflavin and niacin. Some of the active chemical compounds in ginger have pharmacological effects on health, including: Essential oils containing the active substances zingiberin, kamfena, lemonin, borneol, shogaol, cineol, fellandren, zingiberol, gingerol, and zingeron (Aryanta IWR, 2019). The essential oil content in ginger is 4% (Mardiansyah EA, *et al.*, 2016).

Generally, ginger contains kaempferol compounds where the kaempferol content in ginger is able to enter the larva respiratory system and damage the mitochondrial. Mitochondrial damage inhibits the electron transport process so that the energy metabolism process is disrupted and the formation of Adenosine Triphosphate (ATP) is reduced. The decrease in ATP production in the larval body results in a weak larva (Fadila R, *et al.*, 2020). Another active compound contained in red ginger is zingiberne. This compound results the release of material in cells, and interferes with the nutrient transport process by cells. The damage the cytoplasmic membrane cause the other compounds found in red ginger more freely to penetrate into the larva's body. The entry of other compounds into the larval body freely as a result of damage to the membrane tissue will caused the larva physiological functions disruption (Srikandi S, *et al.*, 2020).

CONCLUSION

Red ginger (*Zingiber officinale rosc*) has repellant activity against *Aedes aegypti* larva. The higher concentration of red ginger squeeze used, the higher the larva mortality rate in 24 hours. The use of ginger squeeze as a natural insecticide is expected to be applied in the community, especially in malaria endemic areas. Red ginger is effortless to obtain. Besides, it is also affordable and environmentally friendly.

REFERENCES

1. Kemenkes. Profil kesehatan Indonesia Tahun 2019. Kementrian Kesehatan Republik Indonesia. 2019.
2. WHO. Comprehensive guidelines for prevention and control of dengue and dengue haemorrhagic fever. Revised and expanded edition. World Health Organization. 2011.
3. Gubler DJ. Dengue and dengue hemorrhagic fever. Clin Microbiol Rev. 1998; 11(3): 480-496.
4. Dehghani R, Kassiri H. A review on epidemiology of dengue viral infection as an emerging disease. Res J Pharm Technol. 2021; 14(4): 2296-2301.
5. Sanyaolu A, Okorie C, Marinkovic A, Patidar R, Younis K, Desai P, *et al.* Comorbidity and its impact on patients with COVID-19. SN Compr Clin Med. 2020: 1-8.
6. Guo C, Zhou Z, Wen Z, Liu Y, Zheng C, Xiao D, *et al.* Global epidemiology of dengue outbreaks in 1990-2015: A systematic review and meta-analysis. Front Cell Infect Microbiol. 2017; 7: 317.
7. Situasi demam berdarah di Indonesia. Pusat Data dan Informasi Kesehatan Kementrian Kesehatan RI (KKRI). 2016.

8. Sistem Kewaspadaan Dini dan Respon (SKDR) demam berdarah. Dinas Kesehatan Provinsi Gorontalo (Dinkes). 2020.
9. Laporan kasus demam berdarah provinsi gorontalo. Dinas Kesehatan Provinsi Gorontalo (Dinkes). 2020.
10. Sabir MJ, Al-Saud NBS, Hassan SM. Dengue and human health: A global scenario of its occurrence, diagnosis and therapeutics. Saudi J Biol Sci. 2021; 28(9): 5074-5080.
11. CDC. Dengue and dengue hemorrhagic fever. Centers for Disease Control and Prevention. 2009.
12. Nugraha F, Haryanto B, Wulandari RA, Pakasi TT. Studi ekologi hubungan kejadian Demam Berdarah Dengue (DBD) dengan faktor iklim di kota administrasi Jakarta Pusat, Indonesia Tahun 1999-2018. J Ilmu Kesehat Masy. 2021; 10(3): 142-148.
13. Zhang Y, Riera J, Ostrow K, Siddiqui S, Silva de H, Sarkar S, *et al.* Modeling the relative role of human mobility, land-use and climate factors on dengue outbreak emergence in Sri Lanka. BMC Infect Dis. 2020; 20(1): 649.
14. Murray NEA, Quam MB, Smith WA. Epidemiology of dengue: Past, present and future prospects. Clin Epidemiol. 2013; 5: 299.
15. Arkeman H, Kartini H, Widyatama HG. Penyuluhan dengan metode ceramah dan media digital untuk meningkatkan pengetahuan tentang demam berdarah. J Wahana Abdimas Sejah. 2020; 1(2): 109-121.
16. Ahmad ZF. The E-learning utilization on attitudes and behavior of diarrhea prevention during pandemic. Turkish J Comput Math Educ. 2021; 12(6): 231-236.
17. Rivero A, Vezilier J, Weill M, Read AF, Gandon S. Insecticide control of vector-borne diseases: When is insecticide resistance a problem? PLoS Pathog. 2010; 6(8): e1001000.
18. Nauen R. Insecticide resistance in disease vectors of public health importance. Pest Manag Sci Former Pestic Sci. 2007; 63(7): 628-633.
19. Sharma D, Singh VP, Singh RK, Joshi CS, Sharma V. Isolation and characterization of bioactive compounds from natural resources: Metabolomics and molecular approaches in evolutionary diversity as a source for anticancer molecules. Elsevier. 2021: 77-101.
20. Aini R, Widiastuti R, Nadhifa NA. Uji efektifitas formula spray dari minyak atsiri herba kemangi (*Ocimum sanctum L*) sebagai repellent nyamuk *Aedes aegypti*. J Ilm Manuntung. 2017; 2(2): 189-197.
21. Lestari E, Wahyudi BF, Ustiawan A, Dewi DI. Potensi minyak atsiri bunga lawang (*Illicium verum*) sebagai repelen nyamuk A*edes aegypti*. Balaba J. Litbang Pengendali Penyakit Bersumber Binatang Banjarnegara. 2019: 13-22.
22. Zen S, Asih T. Potensi ekstrak bunga tahi kotok (*Tagetes erecta*) sebagai repellent terhadap nyamuk *Aedes aegypti* yang aman dan ramah lingkungan. Bioedukasi Jurnal Pendidik Biol. 2017; 8(2): 142-149.
23. Mirawati P, Simaremare ES, Pratiwi RD. Uji efektivitas repellent sediaan lotion kombinasi minyak atsiri daun zodia (*Evodia suaveolens scheff*) dan Minyak Atsiri Batang Serai (*Cymbopogon citratus*) Terhadap Nyamuk *Aedes aegypti* L. Pharm J Farm Indones. 2018; 15(1): 1-15.
24. Azeem M, Zaman T, Tahir M, Haris A, Iqbal Z, Binyameen M, *et al.* Chemical composition and repellent activity of native plants essential oils against dengue mosquito, *Aedes aegypti*. Ind Crops Prod. 2019; 140: 111609.
25. Hamada HM, Awad M, El-Hefny M, Moustafa MAM. Insecticidal activity of garlic (*Allium sativum*) and ginger (*Zingiber officinale*) oils on the cotton leafworm, *Spodoptera littoralis* (Boisd.)(Lepidoptera: Noctuidae). African Entomol. 2018; 26(1): 84-94.
26. Azhari HN, Yap SS, Nour AH. Extraction and chemical compositions of ginger *(Zingiber officinale roscoe)* essential oils as cockroaches repellent. Aust J Basic Appl Sci. 2017; 11(3): 1-8.
27. Yanagawa A, Krishanti NPRA, Sugiyama A, Chrysanti E, Ragamustari SK, Kubo M, *et al.* Control of Fusarium and nematodes by entomopathogenic fungi for organic production of *Zingiber officinale*. J Nat Med. 2021: 1-7.
28. Abdullahi A, Khairulmazmi A, Yasmeen S, Ismail IS, Norhayu A, Sulaiman MR, *et al.* Phytochemical profiling and antimicrobial activity of ginger (*Zingiber officinale*) essential oils against important phytopathogens. Arab J Chem. 2020; 13(11): 8012-8025.
29. Akinyemi AJ, Adeniyi PA. Effect of essential oils from ginger (*Zingiber officinale*) and turmeric *(Curcuma longa)* rhizomes on some inflammatory biomarkers in cadmium induced neurotoxicity in rats. J Toxicol. 2018.
30. Aryanta IWR. Manfaat jahe untuk kesehatan. Widya Kesehat. 2019; 1(2): 39-43.
31. Mardiansyah EA, Umniyati SR, Iravati S. The effect of ginger essential oil (*Zingiber officinale*) as repellent towards *Aedes aegypti*. Ber Kedokt Masy. 2016; 32(10): 353-358.
32. Fadila R, Saputra RA, Khamidah N. Application of several types of rhizome powder in controlling Sitophilus oryzae L. pests in local siam mutiara rice. Trop Wetl J. 2020; 6(2): 38-43.
33. Srikandi S, Humaeroh M, Sutamihardja RTM. Kandungan gingerol dan shogaol dari ekstrak jahe merah (*Zingiber officinale rosc*oe) dengan metode maserasi bertingkat. al-Kimiya J Ilmu Kim dan Terap. 2020; 7(2): 75-81.