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LITERATURE REVIEW STUDY: EFFECTIVENESS OF ATTRACTANS IN CONTROLLING THE AEDES AEGYPTI

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ABSTRACT

Background : Aedes aegypti mosquito which is the main cause of dengue fever cases until now it has become a major problem for public health, as well as causing social impacts, especially the number of sufferers which from year to year continues to increase and is increasingly widespread in both developed and developing countries. One method of controlling the incidence of dengue hemorrhagic fever is the use of attractants in controlling the population of the aedes aegypti mosquito.

Aim: Study literature review was conducted to determine the effectiveness of attractants in controlling the aedes aegypti.

Methods: The literature search method is carried out using accredited national journals and reputable international journals as well as Scopus indexed journals. The data base used is from Google Scholar, PubMed/NCBI, Up-to-date, Springer, Wiley On Library, Scient Direct, MedRxiv, DOAJ, MDPI and JAMA Network.

Result: There were 1654 journals which were then filtered based on related titles and 520 journal titles were found. Based on the research variables, there were 377 journals that were excluded because there were no appropriate variables related to the effectiveness of attractants in controlling the Aedes aegypti , so that there were 143 journals remaining. Based on the research method used, 50 journals did not use the Cross sectional study, cohort, experimental study, quasi-experimental, and field research methods so that the remaining 93 journals were then re-filtered based on access and journal index to obtain as many as 13 journals.

Conclusion: The results of a review of the analyzed journals found that the use of attractants was very effective in controlling the Aedes aegypti mosquito population.

Keywords: Attractants, Aedes Aegypti, Mosquito

INTRODUCTION

Mosquitoes are a deadly infectious disease transmission [1], more than 100 species of viruses that cause infection have been reported to be transmitted through mosquito bites [2]. One of the main diseases and a burden on the government in both developing and developed countries is dengue hemorrhagic fever (DHF) which is transmitted to humans through the bite of the Aedes aegypti mosquito [3]. Globally, about 40% (2.5 billion) of the world's population live in areas at risk of DHF. The World Health Organization (WHO) estimates that 50-100 million people are infected annually, including 500,000 cases of

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dengue infection and 22,000 deaths. Around >70% of the population at risk of DHF globally comes from countries in the Southeast Asia and West Pacific region.

In other countries such as Japan, there are also very high dengue cases [4], more than 80 percent of cases are in the city of Tokyo and transmission is through the bite of Aedes Agypti. Aedes aegyptiis widely distributed in India, Pakistan and Sri Lanka. Indonesia and Thailand accounted for the majority of cases and trials of dengue vaccines have been carried out in Thailand, Indonesia, the Philippines, Malaysia and Vietnam [5]. Transmission of dengue virus, particularly in India and Sri Lanka, has increased substantially over the last few decades [6], it is estimated that more than 180,000 cases were reported from India in 2017 [7].

Indonesia is a dengue endemic area in Southeast Asia. Based on the 2014 Indonesian Health Profile data, there were 100,347 cases of dengue fever in 34 provinces (IR: 39.80/100,000 population), 907 of them died (CFR: 0.90%). Provinces with the highest DHF morbidity rates in 2014 were Bali (IR: 204.22), East Kalimantan (IR: 135.46) and North Kalimantan (IR: 128.51) per 100,000 population. of controlling aedes aegypti mosquito is the installation of a mosquito trapattractantmedia. The use of antractants has been proven to be effective in reducing mosquito populations [8]. Attractants can be used to control mosquito populations without causing harm to humans or other animals and leaving no residue on food ingredients [9].

The World Health Organization (WHO) recommends vector control measures for Aedes mosquitoes by implementing source reduction strategies, larvicides, biological control, and installing intensive mosquito traps. In Indonesia, efforts to control mosquito-borne diseases that are often used are insecticides, but uncontrolled use of insecticides results in mosquito resistance [10,11,12,13].

One method of controlling the Aedes aegypti mosquito without insecticides is the use of egg traps (Ovitrap). The ovitrap method has succeeded in reducing the number of vectors in several countries and is able to detect the presence of the Aedes aegypti mosquito [14]. The use of ovitrap and the addition of attractant substances (chemicals, semichemicals and organic substances) can attract mosquitoes to lay eggs [15]. The use of mosquito attractants (attractants) inserted into the trap is one of the environmentally friendly and cost-effective control efforts. Ovitrap has been proven to be used successfully to control DHF in endemic areas.

METHODS

In this study, secondary data is used as a database which is not data obtained directly from observations but is taken from data from previous research that has been carried out. The data sources used are accredited national journals and reputable international journals as well as Scopus indexed journals. The data base used is from Google Scholar, PubMed/NCBI, up-to-date, Springer, Wiley On Library, Scient Direct, MedRxiv, DOAJ, MDPI and JAMA Network. Articles or journals that match the inclusion and exclusion characteristics are collected and then analyzed. The journal criteria taken are also

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research published in the last five years or from 2016 to 2021 and can be accessed full text in pdf and scholarly (peer reviewed journal).

Table 1

Inclusion and exclusion

Criteria	Inclusion	Exclusion
Problem	National and international journals from different databases and related to the same problem formulation, namely the effectiveness of attractants in controlling the Aedes aypti mosquito population	. National and international journals from different databases but have different problem formulations
Study design	Cross sectional study, cohort, experimental study, quasi-experimental, laboratory and field research	In addition to cross-sectional study, cohort, experimental study, quasi-experimental, laboratory and field research
Years of publication	Journals published from 2016 to 2021	Journals published before 2016
Index journals	International journals indexed by scopus / reputed journals or national journals indexed by garuda	In addition to international journals indexed by scopus / reputable journals or national journals indexed by garuda
Access	Journals that can be accessed in full text	Journals that cannot be accessed in full text
besides	Indonesian and English	Indonesian and English

RESULTS

After collecting and selecting journals from September 2021 to January 2022 using the search engines that have been determined, namely Google Scholar, PubMed/NCBI, UpToDate, Springer, Wiley On Library, Scient Direct, MedRxiv, DOAJ, MDPI and JAMA Network. Found as many as 1654 journals which were then filtered based on related titles and obtained as many as 520 journal titles. Furthermore, selection was made based on research variables where there were 377 journals that were excluded because there were

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no appropriate variables related to the effectiveness of attractants in controlling the Aedes aypti so that there were 143 journals which were then filtered based on the research method used. It was found that 50 journals did not use the method of cross sectional study, cohort, experimental study, quasi-experimental, and field research so that the remaining 93 journals were then re-filtered based on journal access and journal indexes so that as many as 13 journals were obtained. Data based and the journal selection process can be described in the following tables and charts:

Table 2

Data based and the number of articles obtained through search engines

Keyword Search	Databased	Number of Articles
1. Effectiveness Of Attractants 2. Attractants In Controlling The Aedes Aegypti Mosquito 3. Attractants and Aedes Aegypti	Google Scholar	720 Articles
	PubMed/NCBI	39 Articles
	UpToDate	140 Articles
	Springer	219 Articles
	Wiley On Library	56 Articles
	Scient Direct	411 Articles
	MedRxiv	18 Articles
	DOAJ (Directory of Open Access Journals)	33 Articles
	MDPI	14 Articles
	JAMA Network	4 Articles

From a literature search using search keywords, namely effectiveness of attractans, attractants in controlling the aedes aegypti mosquito, attractants and aedes agypti found 720 articles from google scholar, 39 articles from searches on PubMed/NCBI, 140 articles from the UpTodate, spinger as many as 219 articles, wiley on library 25 article, scientific direct 411 article, Med Rxiv 18 articles, DOAJ 33 articles, MDPI 14 articles and 4 articles from JAMA Network.

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Figure 1

Literature Search Process Journal of the Effectiveness of Attractive Types Mosquito Populations Aedes Aegypti

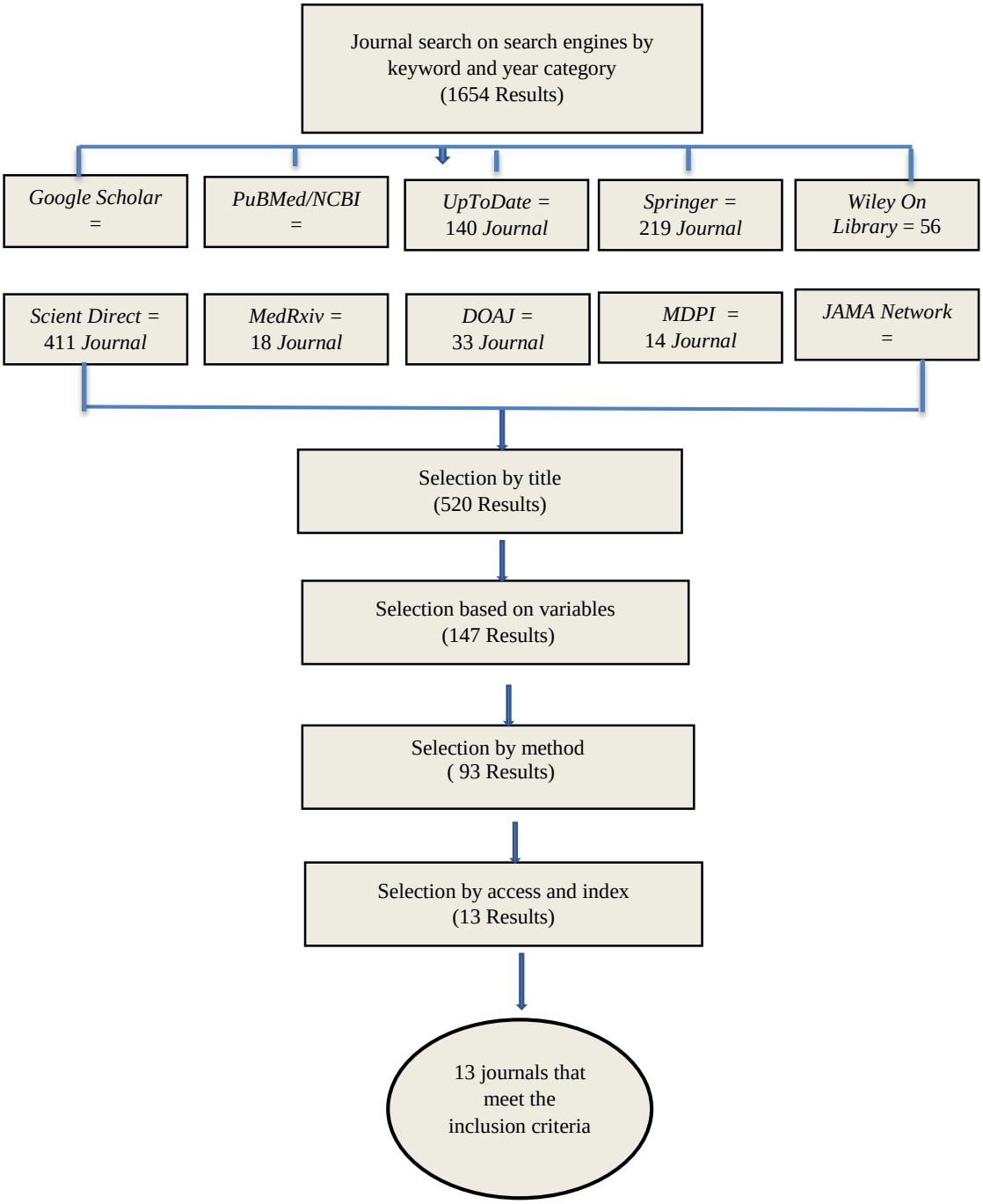

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Table 3

List of journals included in the review according to inclusion criteria

No.	Year and author	Title	Publisher	Research Methods Research	Results
1	2016 Wahidah A, Martini and Hestiningsih R [9]	Effectiveness of Types of Attractants Used in Ovitrap as an Alternative for DHF Vector Control in Bulusan Village	Public Health Journal	Quasi-experimental design with post-test only control group	The results of the Kruskal-Wallis analysis with p value = 0.058 showed no difference between the number of mosquito eggs trapped by various types of attractants. The number of eggs trapped in the ovitrap was 436 eggs. The percentage of Aedes aegypti mosquitoes was 78.22%, higher than Ae. Albopictus which is only 21.78%.
2	2016 Prasetyo A, Yulianto A [23]	Use of Lethal Ovitrap with Various Types of Attractants for Mosquito Control	Journal of Forikes Sound Health Research	Quasi-experimental design with post test only control group	The number of Aedes mosquito larvae caught by lethal ovitrap without attractant was between 13 – 15 tail. The highest number of Aedes mosquito larvae was caught in the lethal ovitrap containing attractants between 30 – 95 tails for indoors and between 9 – 44 tails for outside house There is a significant difference in the effectiveness of lethal ovitrap (number of captured Aedes sp mosquito larvae)

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					between treatment (p = 0.008 and p = 0.007).
3	2017 Saepudin M, Hadiasaputro S, Suwando A, Suharto o [24]	The effect of Rekattidiri ovitrap towards aedes aegypti larval density	International journal of public health science (IJPHS)	Quasi-experimental design, time series experimental design with Control group	The results showed larval density index in the intervention area decreased each ie HI from 26% to 3%, CI of 6.95% to 2.19%, and BI from 29% to 13%. The number of larvae trapped in ovitrap rekattidiri ie 70% (12,770 larvae) more than the standard ovitrap in the control and intervention, namely: 17% (3,057 larvae) and 13% (2,334 larvae). It is concluded that there are significant modifications Rekattidiri ovitrap against larval density index (HI p-value: 0.025, CI p-value: 0.052, BI value of p: 0.04) and there are differences between the mean larvae trapped in Rekattidiri ovitrap and standard ovitrap with p value: 0.001.
4	2017 Azmi N, Hajimi and Anwar T [25]	The Effectiveness of Various Types of Solutions as Attractants Against the Number of Aedes Aegypti Mosquitoes Attached to the	Equatorial Sanitarian Journal	Quasi-experimental research design with Posttest with a control group (Postest Only With	Results The study showed the number of trapped mosquitoes that were more effective, namely water attractants, had an average of 19.5 tails. The calculated F value is 91,693 significant p = 0.000 (p <0.05). The post-hoc test showed that ovitraps treated with

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				Control Group Design)	10% sugar solution attractant with 10% tapai solution did not experience a significant difference in p value = 0.268 (p>0.05)
5	2017 Scott Fiorenza no et al [17]	Evaluations Of Dual Attractant Toxic Sugar Baits For Surveillance And Control Of Aedes Aegypti And Aedes Albopictus In Florida	Parasites & Vector Journal Parasitology Research	Experiments Study	Ae. Aegypti mosquitoes were more attracted to 1% LA and 1% O compared to the fruit-based toxic sugar bait alone. Both species of mosquito consumed more fruit-based non-toxic bait (ASB) and ATSB than the D-ATSB. For both species, percent mortality bioassays indicated D-ATSB controlled mosquitoes, as compared to non-toxic control, but not more than the fruit based ATSB.
6	2017 Fikrig et al [18]	Assessment Of Synthetic Floral – Based Attractants And Sugar Baits To Capture And Female Aedes Aegypti	Parasites & Vector Journal	Experimental study	Results from the attraction assays indicated that the ATSB solution of guava and mango nectars was the most promising lure candidate for males ; unlike the floral-based attractants tested, it performed significantly better than the water control. it failed to attract significantly more male, nulliparous female, or gravid female Ae. Aegypti than water controls when presented

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					inside a Gravid Aedes Trap.
7	2018 Suman SD [26]	Evaluation of enhanced oviposition attractant formulations against Aedes and Culex vector mosquitoes in urban and semi-urban areas	Parasitology Research	Field study and experimental	Aedes-attractant collected 1.6-fold more larvae (101.2 ± 10.5 larvae/trap) than the control, and Culex-attractant collected 1.27-fold more larvae (151.2 ± 12.5 larvae/trap) than the control, resulting in 0.8 and 0.7 oviposition attraction indices (OAIs), respectively. Regression analysis indicated that the Aedes-attractant was more stable than the Culex-attractant. Location and time did not alter the efficacy of these attractants.
8	2018 Liu Hiu, Dixon D, Bibbs CS, Xue RD [27]	Autocidal Gravid Ovitrap Incorporation with Attractants for Control of Gravid and Host-Seeking Aedes aegypti (Diptera: Culicidae)	Journal of Medical Entomology	Cohort study	The AGO baited with the BG lure captured a significant number of host seeking female Ae. aegypti. This finding indicates that the combination of AGO with BG lure could enable the trap to control female Ae. aegypti mosquitoes representing either host-seeking or gravid physiological states.
9	2018 Chaiphongpachara T, Sumchung K,	Larvicidal and Adult Mosquito Attractant Activity of Auricularia auricula-judae Mushroom	Journal of applied pharmaceutival science	Laboratory and experimental study	The results of the activity as larvicidal with the A. auricula-judae extract on both species investigated herein of mosquitoes did not affect Ae. aegypti larvae,

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	Chansukh K [28]	Extract on Aedes aegypti (L.) and Culex sitiens Wiedemann			though with Cx. sitiens mosquitoes, the mushroom extract slightly eliminated larvae at all concentrations. The results with the A. auricula-judae extract on adult mosquito attractant activity at three concentrations showed at 10-5 g/mL, the most attraction took place followed by 10-6 g/mL and 10-4 g/mL, respectively (11.66 ± 0.57 vs. 7.00 ± 1.00, 11.33 ± 0.57 vs. 6.66 ± 0.57, and 9.33 ± 0.57 vs. 6.00 ± 1.00 mosquitoes, respectively). A. auricula-judae extract is not equal to that of octanol, it was effective in attracting more than half of Ae. aegypti mosquitoes as dengue vector (58.33%).
10	2019 Faridah Lia, Albert C, Fauziah N [3]	Effectiveness Of Various Mosquito Attractant Solutions To Control Mosquito Population	Global Medical & Health Communication	Quasi experimental design conducted	The analysis was performed using Kruskal-Wallis test followed by the Dunn test. The result of the Kruskal-Wallis test indicates the difference of effectiveness of each solution ($p<0.05$). Based on the results of the Dunn test, the most significant difference found in the solution of wood shavings with the vegetable waste solution

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					and the solution of wood shavings with corn straw ($p<0.05$)
11	2020 Ambiya Z, Martini, Pradani YF [29]	Adult Mosquitoes Trapped in Different Types of Attractants in Tembalang Village Semarang City	Aspirator Journal	Experimental with the PostTest Only Control Group Design method.	The types of attractants that are most preferred by mosquitoes are brown sugar yeast (73.37%) and white sugar yeast (26.62%). The density of mosquitoes in Tembalang District is low at 1,375 with the most mosquito populations found are Aedes spp (44.3%) and Culex spp (55.7%). Based on the location of catching, more mosquitoes were caught indoors (59%).
12	2020 Nur Athen MH, Nazri CD, Siti Nazrina C [30]	Biossay studies on the reaction of Aedes aegypti & Aedes albopictus (Diptera: Culicidae) on different attractants	Saudi journal biological science	Laboratory and experimental study	No choice assay indicated both Aedes species have significant attraction to the papaya and pineapple extract ($p<0.005$). In choice assay, Ae. albopictus is revealed to be equally attracted to the papaya and pineapple peel extracts ($p > 0.05$) while Ae. aegypti is significantly attracted to the papaya peel extract ($p < 0.05$).
13	2021 Kim DY, Leepaser t T,	Evaluation of Musquito attractants candidates using a high – throughput	Insects Journal	Laboratory strains and field populations	ITSS assay results showed that KU-lure #1 elicited the greatest percent attraction for pyrethroid-resistant and -susceptible Ae. aegypti.

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	Bangs MJ [31]	screening system for aedes aegypti (L.) Culex quinquefasciatus Say. And Anopheles minimus Theobald (Diptera : Culicidae)			KU-lure #6 elicited the strongest attractive response for pyrethroid-susceptible and -resistant Cx. quinquefasciatus and pyrethroidsusceptible An. minimum. The response to the lures from each species was independent of the pyrethroid susceptibility status (Ae. aegypti, p = 0.825; Cx. quinquefasciatus, p = 0.056). However, a significant difference in attraction to KU-lure #6 was observed between diurnal and nocturnal mosquitoes (Cx. quinquefasciatus vs. Ae. aegypti, p = 0.014; An. minimus vs. Ae. aegypti, p = 0.001).

DISCUSSION

The results of the literature review obtained are related to the effectiveness of attractants in controlling the Aedes aegypti mosquito. Mosquito vector control using the trap method is an alternative designed to reduce mosquito populations [16]. Several research review results show that related to the use of attractants such as the use of chemicals such as l-lactic and 1-octen-3-ol [17], synthetic flora as an attractant base material has been shown to significantly reduce the number of mosquito vectors as phenylacetaldehyde, phenylethyl alcohol, linalool oxide, and acetophenone [18], Plant tissue, sedpods, ripe fruits, flora and extra floral [19]. The use of attractants from various trials that have been carried out is very effective in controlling Dengue Hemorrhagic Fever (DHF) vectors.

The results of the research reviewed showed that Ovitrap tapai solution as a vector control method for the Aedes aegypti mosquito was safe because it is made from natural ingredients that are safe for humans and the environment. In addition, L-lactate (1%) and 1-octen-3-ol (1%) added to fruit-based sugar baits can also increase the attractiveness of Aedes aegypti and have future implications in mosquito trapping methods. Attractants

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can be used to detect, estimate, and control mosquito populations in urban and semi-urban areas.

Based on the results of the study, the number of mosquito eggs caught through attractants was more than without using attractants. The results showed that during one week the number of eggs obtained using the attractant could reach 436 eggs. Other types of attractants are straw soaking water, tape yeast water and tiger shrimp soaking water, the results show where the most mosquito eggs trapped in straw soaking water are 126 eggs, of all ovitraps installed outside the house (an average of 5 eggs per year) and indoors (average 3 eggs per ovitrap). Tape yeast water attractant can produce trapped eggs as many as 70 eggs. With an average of 4 eggs per ovitrap installed outside the house. The minimum number of eggs caught was 2 eggs from ovitrap which was located outside the house, while for ovitrap which was installed inside the house, no eggs were caught.

Other analysis results showed that the number of Aedes mosquito larvae caught by lethal ovitrap without attractant was less than using attractant. Mosquito larvae caught lethal ovitrap with the highest variety of attractants were inside the house and this means that the activity of laying mosquito eggs occurred more outside the house. The results showed larval density index in the intervention area decreased each ie HI from 26% to 3%, CI of 6.95% to 2.19%, and BI from 29% to 13%. The number of larvae trapped in ovitrap rekattidiri ie 70% (12,770 larvae) more than the standard ovitrap in the control and intervention, namely: 17% (3,057 larvae) and 13% (2,334 larvae). It is concluded that there are significant modifications Rekattidiri ovitrap against larval density index (HI p-value: 0.025, CI p-value: 0.052, BI value of p: 0.04) and there are differences between the mean larvae trapped in Rekattidiri ovitrap and standard ovitrap with p value: 0.001. Use of ovitrap Rekattidiri with attractant can be used as an additional alternative in dengue vector control method. Rekattidiri ovitrap is a complete modification, compared with ovitrap designed by some previous researchers. Ovitrap serves a three-in-one, the first serves as an autocidal ovitrap for collecting observation data vector density and the potential for vertical transmission/vertical in an area. Both functions are also as an adhesive/sticky ovitrap.

Their adhesive on the upper side of the inner ovitrap catches female Aedes gravid. In accordance with the habits of the mosquito Aedes females gravid looking containers for nesting. So this model is very sensitive and suitable for use in epidemiological surveys and further study in the laboratory against several species of mosquitoes caught in sticky, so the integrated vector control programs and early detection of transmission can be done more quickly.

The types of attractants that mosquitoes like the most are brown sugar yeast and white sugar yeast. The brown sugar yeast attractant was preferred by mosquitoes compared to other attractants tested. The results showed that the brown sugar fermented solution was preferred by mosquitoes to lay eggs. Brown sugar fermentation produces CO2 gas and causes a distinctive odor that can function as a mosquito attractant. The characteristic odor will be captured by the sensilla on the mosquito antenna which

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contains ORNs (olfactory receptor neurons). These sensory nerves transmit chemical impulses in the form of electrical responses by carrying olfactory information from the periphery to the antenna lobes, which are the first stopping sites in the brain.

Previous research has shown that papaya attacks several species of mosquitoes. For example, a 2019 field study by Sissoko et al. used plant bait glue net traps (GNTS) to study the attractiveness of the Aedes aegypti mosquito on twenty different plants. After that, the results showed that papaya is one of the plants that can attract male and female Aedes aegypti mosquitoes. Malmgren (2015) used a similar method to identify the attractiveness of wild mosquitoes in six local plant species. Research shows that papaya attracts the Culex and Anopheles mosquito species. In addition, the oriental fruit fly Dacus dorsalis H, the melon fruit fly Dacus cucurbitae C, and the Mediterranean fruit fly Ceratitis capitata also attract papaya [20]. However, the use of fruit waste as mosquito attractant is limited despite the fact that studies on mosquito attractant is limited despite the fact that studies on mosquito preferences were tested using various fruits. The fruit waste such as the peel is commonly disardered and not being fully utilized. Additionally, fruit peels are commonly studied for their antioxidant and antimicrobial potentials [21,22].

CONCLUSION

The results of a literature review found that the use of attractants was very effective in controlling dengue hemorrhagic fever (DHF) vectors. The use of attractants that can reduce the population of Aedes aegypti mosquitoes is the use of chemicals such as l-lactic and 1-octen-3-ol, synthetic flora, plant tissue, sedpods, ripe fruits, flora and extra floral. Another type of attractant is Ovitrap tapai solution as a method of controlling the Aedes aegypti mosquito vector which is safe to do because it is made from natural ingredients that are safe for humans and the environment. Brown sugar yeast is also the most preferred type of attractant for mosquitoes. Of the three types of attractants, namely straw immersion water, tape yeast water and tiger prawn soaking water, the most trapped mosquito eggs were straw soaked water.

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