Potential of house yard plants as an alternative for dengue vector control in the tsunami area settlement of Banda Aceh City

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ABSTRACT
The rebuilding of settlements after the 2004 Aceh tsunami has created a new home environment. Human activities and behavior in managing new home environments have inadvertently contributed to creating new habitats for Aedes. One of the factors that support and limit the presence of Aedes is the plants around the house. Plants also influence mosquitoes in a place; they are known as mosquito-attracting plants and mosquito-repellent plants. This study aimed to determine the potential of house yard plants as an alternative to dengue hemorrhagic fever vector control in the tsunami settlement area of Banda Aceh City. This research is an explorative survey using 200 house yards in the tsunami area settlement of Banda Aceh City. The result of the study found two species of Aedes (Aedes aegypti and Aedes albopictus) and 63 families of house yard plants with 150 species in the tsunami area settlement of Banda Aceh City. Totally, 63 families have the potential as dengue vector repellents and 17 as dengue vector attractants. Plants in the tsunami settlements of Banda Aceh City have the potential as an alternative for controlling dengue vectors.

INTRODUCTION
Aceh Province in Indonesia experienced the most severe earthquake and tsunami disaster in 2004. After the tsunami infrastructure development occurred rapidly in Banda Aceh City. Banda Aceh City became the administrative center of Aceh Province and was the most tsunami-affected area. Residential settlement development continues to increase yearly in Banda Aceh City (Gadeng et al., 2019). The return of the community to new settlements with all the activities of daily life has created a habitat for Aedes and an explosion of cases of dengue hemorrhagic fever (DHF). Reports from the Ministry of the Health Republic of Indonesia revealed that cases of dengue fever in Aceh continued to increase after the tsunami (Ministry of Health Indonesia, 2007).

Cases of dengue fever in Banda Aceh City after the tsunami from 2005 to 2007 experienced a significant increase. The explosion of very high dengue cases occurred in 2010, with 759 cases after the return of the community to new housing in 2009 (Agustina et al., 2021).

This condition is related to the high population of Aedes and other supporting factors that caused the presence of Aedes in the tsunami’s neighborhood area of Banda Aceh City. Aedes is an invasive species that can adapt to and interact with the surrounding environment. The invasive species interactions vary in space and time and depend on local conditions (Cunze et al., 2018).

Mosquitoes exist around humans because of the availability of breeding places, eating, and resting habitats. Therefore, it is necessary to have control efforts oriented to the habitat conditions and the necessities of life for it. The life of Aedes depends on plants. Plants are resting places and sources of food for male and female Aedes aegypti and Aedes albopictus Skuse (Agustina et al., 2019). Plants can serve as attractors or repels, and each type has a different attraction. Mosquitoes come to plants because smells or colors attract them to get food (Barredo and DeGennaro, 2020).
Data collection

This research begins with a preliminary survey using an exploratory method to determine the condition of the houses in the Meuraxa Subdistrict and Syiah Kuala Subdistrict, Banda Aceh City. Purposive sampling was used to sample 200 sample houses. The selection was houses suspected of having an Aedes breeding place and plants in the yard. The collection of house yard plants involved the larva monitoring community in each village. To determine secondary metabolites that attract or repel Aedes using a literature study, all plants found in the house yards were collected and documented. The data were then summarized, and the results of the studies arranged in the tabular form of the list of secondary metabolites in plants that can function as repellents or attractants.

Data analysis

The data from this research are presented and analyzed using descriptive statistics.

Statistical analysis

Statistical analysis for calculation of graph and table data was carried out with Microsoft Excel.

RESULTS AND DISCUSSION

The results of 200 houses in the tsunami area settlement of Banda Aceh City found 150 species and 63 families of house yard plants (Fig. 2). The category of plant habitus found in the study area comprised herbs (44%), shrubs (32%), and trees (24%) (Fig. 3). The tsunami disaster caused the coast to be badly damaged, and almost all the vegetation was destroyed and lost. After the tsunami, much vegetation of the damaged coastal area naturally changed (succession), namely, the emergence of pioneer plant species such as herbs, shrubs, and trees (Suryawan, 2007).

The family’s highest number of species are from the group Araceae (14 species), Euphorbiaceae (8 species), Asparagaceae (7 species), Lamiaceae (6 species), Apocynaceae (5 species), Arecaceae (5 species), Fabaceae (4 species), Myrtaceae (4 species), Portulacaceae (4 species), Solanaceae (4 species), and Zingiberaceae (4 species) (Fig 2). Many species in this family found at the research sites are related to the COVID-19 pandemic. Restrictions on activities outside the home during the COVID-19 pandemic have provided much free time at home and made many people take up new hobbies such as caring for ornamental plants and business opportunities for buying and selling plants. Plants in pots are obtained easily by ordering through online media or direct purchase. Residents in the tsunami area of Banda Aceh City planted the Araceae family such as Aglaonema and other species because they follow trends and other aspects such as the benefits that they can filter air pollution at home and are easy to maintain (Zahara and Win, 2020).

The families Apocynaceae, Arecaceae, Asparagaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Myrtaceae, Portulacaceae, Solanaceae, and Zingiberaceae are species commonly grown by communities in tsunami areas for various needs or uses such as food crops, medicine, ornamental plants, and traditional ceremonies. Home gardens have contributed to increasing food security, social, cultural, health, and economic community (Du Toit et al., 2022; Galhena et al., 2013). Table 1 and Figure 4 shows that 63 families...
have potential as *Aedes* mosquito repellent plants. 16 families have potential as *Aedes* attractants. Analysis of the determination of the plant acting as a repellent or attractant based on the content of secondary metabolites obtained information from the literature study sought.

**Potential of house yard plants as repellent of *Aedes* spp.**

The repellants used by the public to prevent mosquito bites are synthetic repellants, one of which contains diethyltoluamide (DEET). These compounds can protect longer than other synthetic and botanical repellents. This synthetic active ingredient has health effects such as contact urticaria, skin eruptions, and encephalopathy. Plants around us have potential as insecticides, but it is necessary to identify bioactive molecules that have the effect of repelling or killing disease-transmitting vectors (Athuman et al., 2016).

Plant parts studied for their repellent content were the roots, stems, leaves, and flowers. Research on protecting from the bites of *A. aegypti*, *Anopheles minimus* Theobald, and *Culex quinquefasciatus* Say using essential oils showed different responses from mosquito species. The group of plant essential oils used was *Zingiber cassumunar* Roxb. (Zingiberaceae), *Ocimum basilicum* L. (Lamiaceae), and *Cymbopogon nardus* L. (Poaceae). These three essential oils are effective as repellents and food inhibitors against *A. minimus*, *C. quinquefasciatus*, and *A. aegypti*. However, the period of protection against *A. Aegypti* is lower than other mosquito species (Phasomkusolsil and Soonwera, 2010). The *Z. cassumunar* essential oil consists of sabinene, b-pinene, caryophyllene oxide, and caryophyllene (Bhuiyan et al., 2008). In the basil leaf extract of *O. basilicum*, the active compounds are flavonoids, saponins, tannins, and essential oils, which are considered toxic to mosquitoes (Ramayanti et al., 2017). The stems and leaves of citronella contain a toxin, and that substance can act as a repellent (Arcani et al., 2017). Essential oil *Z. cassumunar* was tested at several concentrations showing that the higher the concentration, the higher the activity to repel mosquitoes (Yulianis et al., 2018).

Volatile oils from four plant species *Curcuma longa* L. (Zingiberaceae), *Citrus hystrix* DC. (Rutaceae), *Cymbopogon winterianus* Jowitt, and *Ocimum americanum* added with 5% the vanillin showed a repellent effect against *A. aegypti*, *Anopheles dirus* Peyton & Harrison, and *C. quinquefasciatus*. The volatile oils of turmeric, lemongrass, and basils were able to repel the three mosquito types for 8 hours, while the kaffir lime oil was effective...
Figure 2. Plant families found in study area.
in repelling mosquitoes for up to 3 hours (Tawatsin et al., 2001). One of the plants that contain biologically active ingredients and can be used as an alternative controller is turmeric. The essential oils of turmeric can be used as natural insecticides to replace chemicals to kill mosquito larvae. In addition, the essential oil is also effective as a mosquito repellent for Aedes (Aseptianova, 2019). The essential oil content in kaffir lime leaves is citronellal, citronellol, linalool, and geraniol compounds (Munawaroh and Astuti, 2010). The largest components produced in citronella oil are citronellal, citronellol, and geraniol (Eden et al., 2018). The components of basil oil (O. americanum) are linalool, neral, citral, β-caryophyllene, α-humulene, and germacrene-d (Hapsari and Feroniasanti, 2019). The compounds contained in all the plants above have the potential and act as mosquito repellents and larvicides.

**Table 1.** Families of plants that have the potential dengue vector control in the tsunami area settlement of Banda Aceh City.

| Family     | Botanical name                                      | Part of the plant is used | Secondary metabolic compounds                                                                 | Potential dengue vector control | Reference                  |
|------------|-----------------------------------------------------|---------------------------|------------------------------------------------------------------------------------------------|---------------------------------|-----------------------------|
| Acanthaceae| *Graptophyllum pictum* L. *Ruellia simplex* L.      | Leaf, Leaf                | Anthocyanin, chlorophyll, carotenoids, alkaloids, terpenoids, phenols, fiber, saponins, flavonoids, nitrogen, organic carbon, lignans, coumarins, triterpenes, sterols, phenolic glycosides, phenylethanolamines, megastigmane glycosides, benzoxazinoid glucosides | √                               | (Lestari et al., 2015)     |
|            |                                                     |                           |                                                                                                   |                                 | (Samy et al., 2015)         |
| Adiantaceae| *Adiantum capillus-veneris* L.                      | Leaf, Rhizome/roots       | Triterpenoids, hydroxy adianalone, tetrahydroxy triterpenoid epoxide (adianaldehyde), isoadianol, isoadianalone, isoglucofuranone, doxyhopane hydroxyadionone | √                               | (Al-snafi, 2015)            |
|            |                                                     |                           |                                                                                                   |                                 | (Taha and Ali, 2020)        |
| Agavaceae  | *Cordyline terminalis* (L.) Kunth                   | Leaf                      | Steroidal saponins, apogepins                                                                    | √                               | (Simmons-boyce and Tinto, 2007) |
| Alismataceae| *Echinodorus palaeofolius* Nees & Mart. JF Macbr. | Leaf                      | Tannin, flavonoid, terpenoids, phenolic                                                         | √                               | (Behera et al., 2021)       |
| Amaranthaceae| *Celosia cristata* L. *Gomphrena globosa* L. *Amaranthus hyochondriacus* L. | Leaf                      | Diterpenoid, triterpenoid, trinortriterpenoid D-laktosa, enneanortiterpenoid heksanortriterpenoid, oktanortriterpenoid | √                               | (Iwuagwu et al., 2019)      |
| Anacardiaceae| *Mangifera indica* L.                             | Flower, Fruit             | Terpenoids, benzenoids, fruktosa, humulene, myrcene (E)-caryophyllene, terpinolena              | √                               | (Gouagna et al., 2010)      |
|            |                                                     |                           |                                                                                                   |                                 | (Meza et al., 2020)         |

*Continued*
| Family       | Botanical name                      | Part of the plant is used | Secondary metabolic compounds                                                                 | Potensial dengue vector control | Reference                        |
|-------------|-------------------------------------|---------------------------|------------------------------------------------------------------------------------------------|--------------------------------|----------------------------------|
|             |                                     |                           | α-pinene, limonene                                                                               |                                |                                  |
|             |                                     |                           | α-phellandrene, p-cymene, heptane, β-pinene, ledene, α-gurjunene, limonene, γ-terpinene, careene, trans (β)-caryophyllene, monoterpenes | √                              | (Asadollahi et al., 2019)     |
| Annonaceae  | *Spondias dulcis* G.Forst            | Leaf                      | Flavonoids, triterpenes, sterols, leucoanthocyanes, polyphenols, polysaccharides                 |                                | (Alwala et al., 2010)           |
|             | *Annona muricata* L.                 | Seeds                     | Isoeugenol, ropenylguaiacol, phenylpropanoid, sesquiterpene                                     |                                |                                  |
|             | *Annona squamosa* L.                 | Leaf                      | Isoeugenol, ropenylguaiacol, phenylpropanoid, sesquiterpene                                     |                                | (Polya, 2003)                   |
|              | *Spondias dulcis* G.Forst            | Leaf                      | Linoleic acid, 3-N-butylphthalide, butylidenephthalide                                           | √                              |                                  |
|              | *Annona muricata* L.                 | Seed                      | Terpenoids, benzenoids, fruktosa                                                                |                                | (Champakaew et al., 2016)       |
|              | *Annona squamosa* L.                 | Seed                      | Terpenoids, benzenoids, fruktosa                                                                |                                |                                  |
|              | *Annona muricata* L.                 | Tuber                      | Terpenoid, alkaloid, lipofilik, flavonoid, steroid, tanin, saponin, carbohydrates               |                                | (Suparman et al., 2017)        |
|              | *Annona squamosa* L.                 | Tuber                      | Terpenoid, alkaloid, lipofilik, flavonoid, steroid, tanin, saponin, carbohydrates               |                                | (Gonathi et al., 2014)         |
|              | *Annona muricata* L.                 | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                | (Otiyenoburu et al., 2012)     |
|              | *Annona squamosa* L.                 | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Adenium obesum* (Forssk.) Roem & Schult. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Chaturantus roseus* L.              | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Allamanda cathartica* L.            | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Calotropis gigantea* (L.)W.T Aiton. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Ceropegia woodii* Schltr.            | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Anthurium crystallinum* Liden & Andre. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Anthurium plowmanii* Croat.         | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
| Araceae      | *Philodendron selloum* K. Koch.      | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Zamioculcas zamifolia* (Lodd.) Engl. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Caladium bicolor* (W.Ait.) Vent.    | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Monstera adansonii* Schott.         | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Epipremnum aureum* Lind & Andre.    | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
| Araliaceae   | *Dieffenbachia* sp.                  | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Alocasia cucculata* (Lour.) Schott. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Alocasia* sp.                       | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Homalomena rubescens* (Roxb) Kunth. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Syngonium podophyllum* Schott.      | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Alocasia sanderiana* W. Bull.       | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Epipremnum aureum* Lind & Andre.    | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Alocasia cucculata* (Lour.) Schott. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Alocasia* sp.                       | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
| Araliaceae   | *Homalomena rubescens* (Roxb) Kunth. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Syngonium podophyllum* Schott.      | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Alocasia sanderiana* W. Bull.       | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Epipremnum aureum* Lind & Andre.    | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
| Araliaceae   | *Polyscias scutellaris* (Burm.f.) Fosberg. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |
|              | *Scheflera arboricola* (Hayata) Merr. | Leaf                      | Phenylacetaldehyde, benzaldehyde and (E)-2-nonenal                                               |                                |                                  |

Continued
| Family          | Botanical name                          | Part of the plant is used | Secondary metabolic compounds                                                                 | Potensial dengue vector control | Reference               |
|-----------------|----------------------------------------|---------------------------|------------------------------------------------------------------------------------------------|-------------------------------|-------------------------|
| Araucariaceae   | *Araucaria heterophylla* (Salisb.) Franco. | Leaf                      | Beyerene, caryophyllene oxide, α-pinene, germacrene, kaurene, 13-epi-dolabradiene, (E)-caryophyllene, caryophyllene oxide, (E)-β-farnesene, rimuene, dolabradiene, copaene, gurjunene, α-cadinene, sandaracopimara, 15-diene | √                             | (Verma et al., 2014)   |
|                 | *Cyrtostachys lakka* Becc.              |                           |                                                                                                 |                               |                         |
|                 | *Chrysocalcarpus lutescens* H. Wendl.  |                           |                                                                                                 |                               |                         |
| Areceae         | *Rhapis excels* (Thunb.) A. Henry       | Flower                    | Limonene, cineole, trans-β-ocimene, cis-β-ocimene, linalool oxide, linalool.                    | √                             | (Stashenko and Martinez, 2018) |
|                 | *Areca catechu* L.                      |                           |                                                                                                 |                               |                         |
|                 | *Cocos nucifera* L.                     |                           |                                                                                                 |                               |                         |
| Asparagaceae    | *Sansevieria trifasciata* Hort.         |                           |                                                                                                 |                               |                         |
|                 | *Chlorophytum comosum*                  | Leaf                      |                                                                                                 |                               |                         |
|                 | (Thunb.) Jacques                        |                           |                                                                                                 |                               |                         |
|                 | *Chlorophytum amanitense* Engl.         |                           |                                                                                                 |                               |                         |
|                 | *Asparagus setaceus* (Kunth) Jessop.    |                           |                                                                                                 |                               |                         |
|                 | *Agave gigantea* (Vent.) D. Dietr       |                           |                                                                                                 |                               |                         |
|                 | *Dracaena marginata* Lam.               |                           |                                                                                                 |                               |                         |
|                 | *Dracaena reflexa* Lam.                 |                           |                                                                                                 |                               |                         |
| Asphodelaceae   | *Aloe vera* L.                          | Leaf                      |                                                                                                 | √                             | (Lubis et al., 2018)   |
|                 | *Helianthus annus* L.                   | Leaf                      |                                                                                                 |                               |                         |
|                 | *Chromolaena odorata* (L.) R.M. King & H. Rob. | Leaf                  |                                                                                                 |                               |                         |
|                 |                                           | Leaf                      |                                                                                                 |                               |                         |
| Asteraceae      | *Tegetes erecta* L.                     | Leaf                      |                                                                                                 | √                             | (Choudhri et al., 2018) |
|                 | *Chromolaena odorata* (L.) R.M. King & H. Rob. | Flower                |                                                                                                 |                               |                         |
|                 |                                           | Leaf                      |                                                                                                 |                               |                         |
| Balsaminaceae   | *Impatiens balsamina* L.                | Leaf                      |                                                                                                 | √                             | (Hariyanto et al., 2018) |
|                 |                                           | Leaf                      |                                                                                                 |                               |                         |
| Begoniaceae     | *Begonia* sp.                           | Leaf                      |                                                                                                 | √                             | (Murugesan et al., 2016) |
|                 |                                           | Leaf                      |                                                                                                 |                               |                         |
| Bromeliaceae    | *Ananas comosus* L.                     | Leaf                      |                                                                                                 | √                             | (Oliveira-Júnior et al., 2017) |
|                 | *Cryptanthus* sp.                       |                           |                                                                                                 |                               |                         |
|                 | *Neoregelia* sp.                        |                           |                                                                                                 |                               |                         |
|                 | *Aechmea* sp.                           |                           |                                                                                                 |                               |                         |
| Family         | Botanical name                                                                 | Part of the plant is used | Secondary metabolic compounds                  | Potensial dengue vector control | Reference                          |
|----------------|--------------------------------------------------------------------------------|----------------------------|------------------------------------------------|--------------------------------|-----------------------------------|
| Cactaceae      | *Opuntia cochenillifera* (L.) Mill. *Echinocactus grusonii* Hildm. *Euphorbia trigona* Mill. | Stem                       | Flavonoid, steroid, phenolic, anthocyanins     | √                               | (Alves et al., 2017)               |
|                |                                                                              |                            | Carbohydrates, proteins, amino acids, steroids, alkaloids, phenolics, flavonoids, tannins, terpenoids | √                               | (Kanase and Vishwakarma, 2018)    |
| Cannaceae      | *Canna indica* L.                                                           | Leaf                       | Flavonoid, alkaloid, tannin, saponin, steroid   | √                               | (Marini and Sitorus, 2019)        |
| Caricaceae     | *Carica papaya* L. *Cnidoscolus aconitifolius* Mill. *Rhooe discolor* L’Her. *Tradescantia pallida* (Rose) D.R. Hunt. *Callisia fragrans* (Lindl) *Woodson.* | Leaf                       | Alkaloid, carbohydrate, glycosides, tannins, steroid, flavonoids, saponins | √                               | (Nikam et al., 2013)               |
| Commelinaceae  | *Ipomoea aquatic* Forssk.                                                    | Leaf                       | Flavonoids, amino acids, alkaloids, lipids, steroids, saponin, phenols, reducing sugar, tannins, β-carotene, glycosides | √                               | (Malakar and Choudhury, 2015)     |
| Convolvulaceae |                                                                              |                            | Fenol, flavonoid, tannin, saponin, alkaloid, α-amyrin acetate, friedelin, glutinol, dotriacantanol, phytol, stigmasta, β-sitosterol, isorhamnetin, dihydroxypropyl tetradecanoate, eriodictyol, gallic acid, quercetin, kaempferol-3-O-rutinoside, isovitexin | √                               | (Singh et al., 2019) (Saleh et al., 2014) |
| Crassulaceae   | *Kalanchoe pinnata* L.                                                       | Leaf                       | Terpinen-4-ol                                  | √                               | (Giatropoulos et al., 2013)       |
|                |                                                                              |                            | β-sitosteryl, β-glucopyranoside, palmitate, hydroxy-trans-cinnamate esters, hydroxy-cis-cinnamate esters, β-sitosterol, unsaturated triacylglycerols, methyl fatty acid esters, flavan 3-ols, flavanones, flavanone, flavone, isoflavones, biflavonoids, methyltetrahydrohinokiflavone | √                               | (Santos et al., 2015) (Afifi et al., 2021) |
| Cupressaceae   | *Thuja orientalis* L.                                                        | Leaf                       | Steroids, clerodane diterpenes, quinones, cyanidins, phenolics, diarylheptanoids | √                               | (Salehi et al., 2019)             |
| Dioscoreaceae  | *Dioscorea japonica* Thunb.                                                  | Rhizome                    | Hexanal , limonene, β-pinene, (E)-β-Ocimene, (E)- linalool oxide, (E)- β-farnesene, glucose, galaktoce, rhamnose, fruktoce, maltoce, sukroce | √                               | (Nyasembe et al., 2012)           |
| Euphorbiaceae  | *Acalypha hispida* Burm.f. *Codiaeum variegatum* (L.) A. Juss. *Jatropha curcas* L. *Manihot esculenta* Crantz. *Pedilanthus tithymaloides* (L.) Poit. *Pedilanthus pringlei* Robins *Euphorbia milii* Des. Moul. *Escoecaria cochinchinensis* Lour. | Leaf, Flower               | Alkaloids, tannins, flavonoid, saponins, glycosides, terpenoids, sterol | √                               | (Idris et al., 2014)              |
| Family         | Botanical name                                                                 | Part of the plant | Secondary metabolic compounds                                                                 | Potencial dengue vector control | Reference                                      |
|---------------|--------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------|
| Fabaceae      | *Caesalpinia pulcherrima* (L.) Swartz.                                           | Leaf, Flower      | Linalool oxide, β-ocimene, 2-hexenol, hexanal, benzaldehyde, β-myrcene, indole                  | √                               | (Nyasembe et al., 2018)                       |
|               | *Tamarindus indica* L.                                                           | Leaf              | Cyanogenic glucosides (prunasin, linamarin, lotaustralin, proacacipetalin), alkaloid (indole, erythrina) | √                               | (Wink, 2013)                                 |
|               | *Vigna sinensis* (L.) Savi ex Hausskn.                                           | Leaf, Flower      | Phenols, glutathione, β-aminosobutyric acid, β-sitosteran                                        | √                               | (Liu et al., 2019)                           |
|               | *Macroptilium atropurpureum* (Moc. & Sesse ex DC.) Urb.                         | Leaf              | Succrose, raffinose, galactinol, glucose, fructose, inositol                                      | √                               | (Muller et al., 1997)                        |
| Gesneriaceae  | *Episcia reptans* Mart.                                                          | Leaf              | Linalool, neral, sitra, mentol isokariofilen, α-humulen, menthol, isomenthene, cineole, pine, limonene | √                               | (Phasomkusolsil and Soonwera, 2010)          |
|               |                                                                                 | Leaf              | Neomenthol, eukaliptu, p-cimene, γ-terpinene, α-terpinene, α-dihuen, E-α bergamotene, methyl eugenol, E-β ocmene | √                               | (Ramayanti et al., 2017)                     |
|               |                                                                                 | Leaf, Flower      | Linalool oxide, β-ocimene, 2-hexenol, hexanal, benzaldehyde, β-myrcene                            | √                               | (Nyasembe et al., 2018)                      |
| Gnetaceae     | *Gnetum gnemon* L.                                                              | Leaf              | Linalool, neral, sitra, mentol isokariofilen, α-humulen, menthol, isomenthene, cineole, pine, limonene | √                               | (Fajar et al., 2019)                         |
|               | *Colesus atropurpureus* (L.) Benth. *Clerodendrum thomsoniae* Balf.f.           | Leaf, Flower      | Benzopryrene, alkaloid, flavonoid, saponin, tannin, Quinone, triterpenoid, Glycoside, Coumarin     | √                               | (Ervina et al., 2019)                        |
| Lamiaceae     | *Coleus atropurpureus* (L.) Benth. *Clironia tenuifolia* Balf.f.                | Leaf, Flower      | Carbohydrates, glycosides, quinones, steroids, flavonoids, naphthoquinone derivatives, Aliphatic, triterpenes, sterols, Phenolic, coumarins, xanthones | √                               | (Sharma and Goel, 2018)                      |
|               | *Mentha piperita* Balf.                                                         | Leaf, Flower      | Neomenthol, eukaliptu, p-cimene, γ-terpinene, α-terpinene, α-dihuen, E-α bergamotene, methyl eugenol, E-β ocmene | √                               | (Phasomkusolsil and Soonwera, 2010)          |
|               | *Ocimum africanum* Lour.                                                        | Leaf, Flower      | Benzopryrene, alkaloid, flavonoid, saponin, tannin, Quinone, triterpenoid, Glycoside, Coumarin     | √                               | (Fajk et al., 2019)                          |
|               | *Orthosiphon aristatus* (Fr. et Balf.)                                          | Leaf              | Benzopryrene, alkaloid, flavonoid, saponin, tannin, Quinone, triterpenoid, Glycoside, Coumarin     | √                               | (Ervina et al., 2019)                        |
|               | *Plectranthus amboinicus* (Lour.) Spreng.                                        | Leaf, Flower      | Carbohydrates, glycosides, quinones, steroids, flavonoids, naphthoquinone derivatives, Aliphatic, triterpenes, sterols, Phenolic, coumarins, xanthones | √                               | (Phasomkusolsil and Soonwera, 2010)          |
| Lauraceae     | *Cinnamomum burmannii* (Nees. & T. Nees) Blume.                                 | Leaf, Bark        | Linalool oxide, β-ocimene, 2-hexenol, hexanal, benzaldehyde, β-myrcene                            | √                               | (Fajk et al., 2019)                          |
|               |                                                                                 | Leaf              | Trans-cinnamaldehyde, cinnamyl acetate, cinnamal alcohol, trans-cinnamic acid, α-Linoleic acid, α-Copaene | √                               | (Ervina et al., 2019)                        |
|               |                                                                                 | Leaf, Flower      | Benzopryrene, alkaloid, flavonoid, saponin, tannin, Quinone, triterpenoid, Glycoside, Coumarin     | √                               | (Phasomkusolsil and Soonwera, 2010)          |
| Lythraceae    | *Lawsonia inermis* L.                                                            | Leaf, Fruit       | Carbohydrates, glycosides, quinones, steroids, flavonoids, naphthoquinone derivatives, Aliphatic, triterpenes, sterols, Phenolic, coumarins, xanthones | √                               | (Phasomkusolsil and Soonwera, 2010)          |
| Malvaceae     | *Hibiscus rosa-sinensis* L.                                                      | Leaf, Flower, Root| Flavonoid, alkaloid, triterpenes, phenolic                                                        | √                               | (Ferreira et al., 2019)                      |
|               | *Waltheria indica* L.                                                            | Leaf              | Benzopryrene, alkaloid, flavonoid, saponin, tannin, Quinone, triterpenoid, Glycoside, Coumarin     | √                               | (Fajk et al., 2019)                          |
|               |                                                                                 | Leaf              | Linoleic acid, octadecenoic acid                                                                | √                               | (Onyenekwe et al., 2013)                     |
| Marantaceae   | *Calathea sp.*                                                                   | Leaf              | Saponin, tannin, fenolic                                                                        | √                               | (Hidayatullah et al., 2015)                  |
| Moraceae      | *Ficus benjamina* L.                                                            | Leaf              | Flavonoid, alkaloid, saponin, steroid, tannin, terpenoid                                        | √                               | (Hikma and Ardiansyah, 2018)                 |
|               | *Ficus carica* L.                                                               | Leaf              | Alkaloids, flavonoids, saponins, steroids, tannins, phenolics, terpenoids                        | √                               | (Aliyu et al., 2016)                         |
| Moringaceae   | *Moringa oleifera* L.                                                           | Leaf              | Alkaloids, saponins, flavonoids, polyphenols, reducing sugars                                   | √                               | (Onyenekwe et al., 2013)                     |
| Musacea       | *Musa paradisiaca* L.                                                           | Stem              | Alkaloids, saponins, flavonoids, polyphenols, reducing sugars                                   | √                               | (Onyenekwe et al., 2013)                     |
| Family        | Botanical name               | Part of the plant is used | Secondary metabolic compounds                                      | Potensial dengue vector control | Reference                                      |
|--------------|------------------------------|---------------------------|-------------------------------------------------------------------|---------------------------------|------------------------------------------------|
| Myrtaceae    | Syzygium aqueum (Burm.f.) Alston. | Leaf                      | Fenolat, flavonoid, tannin, saponin, alkaloid, flavonoid          | ✓                               | (Rahayu et al., 2021)                         |
|              | Syzygium oleina Wight.        | Leaf                      | Alkaloid, flavonoid, tannin, terpenoid, fenol, saponin            | ✓                               | (Ranjana et al., 2021)                       |
|              | Syzygium cumini L. Psidium guajava L. | Leaf                      | Phytosterols, terpenes, carbohydrates, linalool                   | ✓                               | (Abarca-Vargas and Petricevich, 2018)         |
|              | Nephrolepis sp.               | Leaf                      | Alkaloids, bibenzyls, phenanthrenes, stilbenoids, flavonoids, saponins, anthocyanins, polysaccharides glycosides, tannins, coumarin, quinine, steroids, terpinoids, saponin, anthroquinone | ✓                               | (Teoh, 2016)                                 |
|              | Cymbidium chloranthum Lind.   | Leaf                      | Phenolic, 4-allyl phenylacetate, isoeugenol, eugenol              | ✓                               | (Alighiri et al., 2018)                      |
|              | Dendrobium aggregatum Roxb.   | Leaf                      | Phenolic, 4-allyl phenylacetate, isoeugenol, eugenol              | ✓                               | (Alighiri et al., 2018)                      |
|              | Cymbodium sp.                 | Flower                    | Phenolic, 4-allyl phenylacetate, isoeugenol, eugenol              | ✓                               | (Alighiri et al., 2018)                      |
| Oleaceae     | Jasminum sambac (L.) Aiton.   | Leaf                      | Monoterpene (methyl jasmonate)                                    | ✓                               | (Xu et al., 2014)                            |
|              | Olea europaea (Mill.) L.       | Leaf                      | Alkaloids, bibenzyls, phenanthrenes, stilbenoids, flavonoids, saponins, anthocyanins, polysaccharides glycosides, tannins, coumarin, quinine, steroids, terpinoids, saponin, anthroquinone | ✓                               | (Teoh, 2016)                                 |
|              | Averrhoa bilimbi L. Averrhoa carambola L. | Leaf, Fruit             | Saponin, tannin, steroid, flavonoid, alkaloids, carbohydrates, phenols | ✓                               | (Hasim et al., 2019)                         |
|              | Pandanus amaryllifolius Roxb. | Leaf                      | Alkaloids, saponin, flavonoids, tannin, polifenol                 | ✓                               | (Cahyadi et al., 2016)                       |
|              | Saurops androgynus L.         | Leaf                      | Alkaloids, flavonoids, phenols, terpenoids, glycosides            | ✓                               | (Fikri and Purnama, 2020)                    |
|              | Piper batle L.                | Leaf                      | Phenolic, 4-allyl phenylacetate, isoeugenol, eugenol              | ✓                               | (Alighiri et al., 2018)                      |
|              | Piper crocatum Ruiz & Pav.    | Leaf                      | Phenolic, 4-allyl phenylacetate, isoeugenol, eugenol              | ✓                               | (Alighiri et al., 2018)                      |
|              | Cymbopogon nardus (L.) Rendle. Elesineindica sp. | Leaf, Stem, Flower       | α-pinene, limonene, p-Cymene, nonanal, benzyaldehyde, α- and β-pinene, 3-carene, caryophyllene, limonene, nonanal | ✓                               | (Wondwosen et al., 2017)                     |
|              | Portulaca oleracea L.         | Leaf                      | Phenolic alcohols, aldehydes, hydroxylicinic acids, alcohols, acylquinic acids, cinnamic acid amides, coumarins, flavonoids, lignans, naphthoquinones, amino acids, tetrahydroisoxquinoline, terpenoids, alkaloids, phenolic acids, coumarins, β-carot acid polysaccharides, ω-fatty acid | ✓                               | (Balabanova et al., 2020)                    |
|              | Portulacaria grandiflora Hook. | Leaf                      | Phenolic alcohols, aldehydes, hydroxylicinic acids, alcohols, acylquinic acids, cinnamic acid amides, coumarins, flavonoids, lignans, naphthoquinones, amino acids, tetrahydroisoxquinoline, terpenoids, alkaloids, phenolic acids, coumarins, β-carot acid polysaccharides, ω-fatty acid | ✓                               | (Balabanova et al., 2020)                    |
|              | Portulacaria afra (L.) Jaq. | Leaf                      | Phenolic alcohols, aldehydes, hydroxylicinic acids, alcohols, acylquinic acids, cinnamic acid amides, coumarins, flavonoids, lignans, naphthoquinones, amino acids, tetrahydroisoxquinoline, terpenoids, alkaloids, phenolic acids, coumarins, β-carot acid polysaccharides, ω-fatty acid | ✓                               | (Balabanova et al., 2020)                    |
|              | Iresine herbstii Hook.        | Leaf                      | Phenolic alcohols, aldehydes, hydroxylicinic acids, alcohols, acylquinic acids, cinnamic acid amides, coumarins, flavonoids, lignans, naphthoquinones, amino acids, tetrahydroisoxquinoline, terpenoids, alkaloids, phenolic acids, coumarins, β-carot acid polysaccharides, ω-fatty acid | ✓                               | (Balabanova et al., 2020)                    |
|              | Punica granatum L.            | Leaf                      | Phenolic alcohols, aldehydes, hydroxylicinic acids, alcohols, acylquinic acids, cinnamic acid amides, coumarins, flavonoids, lignans, naphthoquinones, amino acids, tetrahydroisoxquinoline, terpenoids, alkaloids, phenolic acids, coumarins, β-carot acid polysaccharides, ω-fatty acid | ✓                               | (Balabanova et al., 2020)                    |
|              | Ziziphus mauritiana Lam.      | Leaf                      | Phenolic alcohols, aldehydes, hydroxylicinic acids, alcohols, acylquinic acids, cinnamic acid amides, coumarins, flavonoids, lignans, naphthoquinones, amino acids, tetrahydroisoxquinoline, terpenoids, alkaloids, phenolic acids, coumarins, β-carot acid polysaccharides, ω-fatty acid | ✓                               | (Balabanova et al., 2020)                    |
|              | Rosa sp.                      | Flower                    | Linalool, geraniol, citronellol                                    | ✓                               | (Rosnaeni and Hendranata, 2010)              |
| Family          | Botanical name                                      | Part of the plant is used | Secondary metabolic compounds                                                                 | Potensial dengue vector control | Reference                      |
|----------------|-----------------------------------------------------|---------------------------|------------------------------------------------------------------------------------------------|---------------------------------|---------------------------------|
| **Rubiaceae**  | *Morinda citrifolia* L. *Gardenia augusta* Merr.   | Seed                      | Alkaloid, saponin, tannin, glycoside                                                          | √                               | (Setya and Harningsih, 2019)    |
|                |                                                     | Flower                    | sesquiterpene (γ-elemene, α-farnesene, β-farnesene, trans-farnesol)                           |                                 | (Polya, 2003)                   |
| **Rutaceae**   | *Citrus hystrix* DC. *Citrus aurantifolia* (Christm.) | Leaf                      | Sitronelal, sitronelol, linalool, geraniol                                                     | √                               | (Tawatsin et al., 2001)         |
|                | *Murraya koenigii* (L.) Spreng.                     |                            |                                                                                                |                                 | (Manawaroh and Astuti, 2010)    |
|                |                                                     |                            |                                                                                                |                                 | (Adrianto et al., 2014)         |
| **Sapindaceae**| *Dimocarpus longan* Lour.                          | Leaf                      | Alkaloids, glycoside, saponin, carboxylic acids, flavanoids, flavonols, terpenoids             | √                               | (Govindarajanan and Sivakumar, 2012) |
| **Sapotaceae** | *Manilkara kauki* (L.) Dubard *Mimosops elengi* L. | Leaf, Bark, Root          | Alkaloids, tannin, carboxylic acids, flavanoids, flavonoids, terpenoids                        |                                 | (Pratiwi et al., 2021)         |
|                |                                                     |                            |                                                                                                |                                 | (Singh et al., 2015)            |
| **Scrophulariaceae** | *Russelia equisetiformis* Schltdl. & Cham. | Leaf                      | Alkaloids, flavonoids, saponins, tannins, steroids, terpenoids                               |                                 | (Riaz et al., 2012)            |
| **Solanaceae** | *Capsicum annuum* L. *Solanum melongena* L.        | Flower                    | sesquiterpene (γ-elemene, α-farnesene, β-farnesene, trans-farnesol)                           |                                 | (Polya, 2003)                   |
|                | *Solanum lycopersicum* (L.) *Solanum torvum* Sw.   | Leaf                      | sesquiterpene (γ-elemene, α-farnesene, β-farnesene, trans-farnesol)                           |                                 | (Polya, 2003)                   |
| **Thymelaeaceae** | *Phaleria macrocarpa* (Scheff.) Boerl. | Fruit                    | Terpen (isopropenoid), alkaloid, benzofenon, quercetin, mahkoside, benzophenone, mangiferin | √                               | (Alara et al., 2016)           |
|                |                                                     |                            | Terpenoids, flavonoids, lignans, sterols, polyphenols, Phytol, pentadecaneone, α-philanthren, isoelemicin, linalool, mentadiene, ethyl hexanoate, Benz aldehyde |                                 | (Handayani et al., 2021)       |
| **Urticaceae** | *Pellonia annamica* Gagnep.                        | Leaf                      | d-α-peladren, d-sabien, cineol bornol, zingiberen, trimeron sesquiterpen alcohol, α-atlanton, γ-atlanton, sabinine, b-pinene, caryophyllene oxide, caryophyllene | √                               | (Ibrahim et al., 2018)         |
| **Zingiberaceae** | *Alpinia galanga* L. *Zingiber officinale* Rose, *Curcuma longa* L. *Kaempferia galanga* L. | Leaf                      | sesquiterpene (γ-elemene, α-farnesene, β-farnesene, trans-farnesol)                           | √                               | (Aseptianova, 2019)            |
|                |                                                     |                            |                                                                                                |                                 | (Phasomkusolsil and Soonwera, 2021) |
|                |                                                     |                            |                                                                                                |                                 | (Bhuiyan et al., 2008)          |
The community has traditionally used *Tagetes minuta* L. (Asteraceae) to repel mosquitoes. The essential oil from *T. minuta* showed the presence of limonene, camphene, and verbenone as the main constituents. The essential oil of *T. minuta* is effective in repelling mosquitoes (Athuman et al., 2016). *Mentha piperita* L. (Lamiaceae) oil has potential as a larvicidal and repellent of *A. aegypti* (Manh and Tuyet, 2020). The *M. piperita* oil contains pulegone, menthone, menthol, carvone, 1,8-cineole, limonene, and β-caryophyllene (Singh and Pandey, 2018).

The study of the potential of *O. Americanum* and *Blumea alata* (D.Don) DC. (Asteraceae) extracts as a source of mosquito repellent showed that *O. Americanum* gave 100% repellency for 1.5 hours, *B. alata* for 2 hours, and a mixture of *O. Americanum* and *Blumea alata* for 2.5 hours. The *O. Americanum* extract contains linalool, neral, citral, isocaryophyllene, and humulene, while *B. alata* contains terpinene-4-ol, germacrene-D, sabine, and terpinen-4-ol. The compound components contained in both types of plants potentially have mosquito protection power (Kazembe et al., 2012). The addition of the concentration of *Evodia suaveolens* Scheff. (Rutaceae) essential oil increases the protection power as a repellent. The addition of 1.5 ml of *E. suaveolens* essential oil has 81% protection against *A. aegypti*. The ingredients in *Evodia* leaves are linalool, and pinene can repel mosquitoes such as *A. aegypti*, which causes DHF (Simaremure et al., 2017).

The infusion of the leaves of the fragrant *Pandanus amaryllifolius* Roxb. (Pandanaceae) has the power to repel the laying of the eggs of the *Aedes* spp. The optimum concentration effective for repelling mosquito eggs is in the range of 4.5 to 5 ml/l. *Pandanus* leaves have a fragrant aroma that affects preventing oviposition against *Aedes* spp. The contents of compounds in *Pandanus* are alkaloids, saponins, flavonoids, tannins, and polyphenols (Cahyadi et al., 2016). *Illicium verum* Hook.f. (Illiciaceae) contains an essential oil that can be used as a repellent of *A. aegypti*. The results showed that the clove flower essential oil at concentrations of 10%, 20%, 30%, 40%, and 50% was able to protect against the bites of *A. aegypti* for 1–2 hours. The contents of the essential oil of the clove flower are cineole, linalool, and limonene. The clove flower extract contains the linalool compound that has mosquito repellent properties from the distinctive aroma it produces. The linalool compound is a kind of stable alkali. The clove flower oil often is used as a fragrance for soaps and perfumes. Mosquitoes do not like the aroma of the clove flower essential oil and linalool compounds because they cause irritation to the mosquito’s body parts and damage the mosquito’s nervous system (Lestari et al., 2019). The *Pogostemon cablin* Benth (Lamiaceae) oil has major (patchouli alcohol) and minor (patchoulen, guaien, sychellen, and caryophyllene) components. These minor components can potentially act as repellants or as attractants to insects. The activity of *Culex* sp. using patchouli oil showed that the repellency activity had better protection than synthetic DEET (Nidianti et al., 2014).

Insect bioassay results showed that the essential oil and extract of *Nepeta parnassica* Heldr & Sart (Lamiaceae) were highly active against *Aedes cretinus* Edwards and *Culex pipiens* L.. The protective power of *N. parnassica* extracts against *A. cretinus* was for 3 hours, while for *C. pipiens* the protective power was up to 2 hours after application. Analysis essential oil *N. parnassica*, dominated by oxygenated monoterpenes, 4α,7α,7β-nepetalactone, 1,8-cineole, dichloromethane-methanol, and 4α,7β,7αβ-nepetalactone as the main constituents. The content of dichloromethane-methanol and 4αα,7α,7β-nepetalactone isolated from *N. parnassica* showed very high mosquito repellency for at least 2 hours against both types of mosquitoes. This study demonstrated the potential use of essential oil extracts, especially dichloromethane-methanol and 4αα,7α,7β-nepetalactone *N. parnassica*, as control agents for *A. cretinus* and *C. pipiens* (Gkinis et al., 2014).

The *Angelica sinensis* Oliv. (Apiaceae) extract has potential as a repellent against female *A. aegypti*. The results of the GC-MS analysis revealed that the *A. sinensis* extract contains at least 21 phytochemical compounds, and the main constituent is 3-N-butylphthalalide. The protective power of the *A. sinensis* extract provides an average protection time of 2.0–6.5 hours against *A. aegypti*. The combination of *A. sinensis* extracts with 5% vanillin can increase to 4.0–8.5 hours (Champakaw et al., 2016).

### Potential of houses yard plants as attractant of *Aedes* spp.

One of the effective biological control strategies is necessary to do by finding and identifying attractant compounds produced by plants. Attractive flowers, intense aromas, and nectar content need to find metabolites that attract or repel mosquitoes (Peach and Gries, 2020). If plant-based chemicals can be identified, especially those from plants that are attractive to mosquitoes, these plants can serve as bait in mosquito control and surveillance programs (Nyasembe et al., 2012). Each mosquito species has a

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**Figure 4.** Families of plants that have the potential dengue vector control in study area.
particular preference for plant sources of nutrients. Mosquitoes can detect general and plant-specific chemical cues within their ecological range. The ability of mosquitoes to detect chemical compounds in certain plants will find suitable host plants for them. The interaction of mosquitoes with plants provides information on mosquito control strategies that target plant-eating behavior like attractive toxic sugar baits and the resulting odor (Nyasembe et al., 2018).

The volatile compound released by the host plant is attractive to mosquitoes. This compound attracts both male and female mosquitoes. Mosquitoes prefer volatile compounds produced by plants; for example, A. gambiae can detect certain chemical compounds from plants (Pachuwah, 2016). The visual appearance of flowers and the volatile compounds released by them are cues for mosquitoes to distinguish and locate host plants. Some species of mosquitoes, such as A. gambiae, C. P. piapi, and A. aegypti, can detect and respond to certain compounds from plants, detect and respond to volatile compounds from plants. Flower volatile organic compounds are mainly composed of four chemical groups: aromatics, monoterpenes, sesquiterpenes, and fatty acid derivatives (Yu et al., 2015).

Female A. aegypti prefer ovitraps with jenu [Derris elliptica (Wall.) Benth.] leaf extract to lay their eggs compared to other ovitraps. This plant from the Fabaceae family has the potential to be an attractant to A. aegypti in the oviposition process. Methyl eugenol compounds such as sex pheromones are effective at attracting insects and influencing insect behavior, such as searching for a mate, searching for food, and laying eggs. Visual and olfactory integration affects oviposition search media behavior, but the olfactory signal is more influential than visuals. The olfactory organ of the mosquito is the sensilla (hair), and these spread all over its body surface. Sensilla are mostly in many mosquito antennae, and this organ is sensitive to the smell of chemical compounds (Wibowo and Astuti, 2015).

Analysis of the extract of Silene otites L. (Caryophyllaceae) using gas chromatography-mass spectrometry identified 35 compounds. Most of the extract compounds are monoterpenoids, fatty acid derivatives, and benzene. Phenyl acetaldehyde was the most dominant compound found in S. otites flowers. The test results of a mixture of S. otites flower aroma extract compounds on male and female Cx. p. piapi showed different responses. Oxide compounds linalool (furanoids) and linalool showed strong responses in male and female mosquitoes. The compound (Z)-3-hexenyl acetate had positive responses only from female mosquitoes. Male mosquitoes showed moderate responses to compound (Z)-3-hexenyl acetate. Female mosquitoes have a moderate reaction to benzaldehyde and methyl salicylate compounds. Meanwhile, the lilac aldehyde, lilac alcohol, and linalool oxide (pyranoid) compounds had moderate responses from both sexes of mosquitoes (Jhumur et al., 2008).

The extract Asclepias syriaca L. (Asclepiadaceae) showed significant orientation of male and female Cx. p. piapi. The mixture compounds of benzaldehyde, phenylacetaldehyde, and (E)-2-nonenal most attracted mosquito responses. Therefore, we recommend further research to examine the potential use of synthetic floral scent mixtures for monitoring or controlling disease-transmitting mosquitoes (Otioburu et al., 2012). The maiz/Zeas mays L. (Poaceae) crop contributes to the prevalence of malaria mosquitoes and exacerbates malaria transmission in sub-Saharan Africa. Pollen from corn serves as a food source for Anopheles larvae and imago. Female mosquitoes can detect breeding sites where corn pollen is abundant. The Anopheles mosquito uses olfactory cues to locate, distinguish, and select breeding sites by utilizing volatile compounds to guide it. The pollen is a source of energy and attractant mosquitoes. Pollen contains pinene, limonene, p-cymene, nonanal, and benzaldehyde compounds (Wondwosen et al., 2017).

The selections of the oviposition site strongly influence the reproductive success and population dynamics of Anopheles, a vector for malaria in female mosquitoes. Mosquitoes choose oviposition sites at different spatial scales, starting with selecting the habitat to search. Anopheles arabiensis Patton larvae were the most common species found in various grassy habitats. The highest larva density in habitats was found overgrown by Echinochloa pyramidalis (Lam.) Hitchc. & Chase (Poaceae). This condition caused the volatile compounds of E. pyramidalis grass to be more attractive than Typha (Typhaceae) and Cyperus (Cyperaceae). The preference is shown by Anopheles culicoides Coetzee & Wilkerson and A. arabiensis prove volatile grass compounds in larval habitat vegetation have an effect in the selection of oviposition sites (Asmare et al., 2017).

CONCLUSION

This study shows that various house yard plants have secondary metabolites that have the potential to control adult Aedes. Plants in the tsunami settlement area of Banda Aceh City contain secondary metabolites that function as repellents and attractants of adult Aedes. However, further testing is necessary in the laboratory to ensure Aedes’ preference for plants in the yard and the secondary metabolite content of each plant. This research information can be an alternative to Aedes control and elimination. Plants in the house yard in the tsunami settlement area of Banda Aceh City have the potential to be used as a strategy for controlling disease-transmitting vectors.

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AUTHORS’ CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

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The authors declare that there are no conflicts of interest.

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