International Journal of Pharmaceutical and Bio-Medical Science

ISSN(print): 2767-827X, ISSN(online): 2767-830X

Volume 04 Issue 07 July 2024

Page No: 625-630

DOI: https://doi.org/10.47191/ijpbms/v4-i7-06, Impact Factor: 7.792

Eco-Friendly Larvicidal Activity of Matoa (*Pometia Pinnata)* Skin Extract against Mosquitoes

Frans Asmuruf[1], Sriyanto[1], Eva Susanty Simaremare[2], Ebrahim Sadaq[3], Yuliana Ruth Yabansabra[1]

[1]Chemistry Department, Mathematics and Natural Science Faculty University Cenderawasih, Jayapura-Papua

[2]Pharmacy Department, Mathematics and Natural Science Faculty University Cenderawasih, Jayapura-Papua

[3]Doctoral Student in Department of Pharmaceutics, School of Pharmacy, Bandung Institute of Technology (ITB), Bandung 40132, Indonesia

ABSTRACT

ABSTRACT: Using natural plants to combat diseases offers an alternative strategy for managing disease vectors transmitted by mosquitoes. One such beneficial plant is *Pometia pinnata*. Although some research has been conducted on the biological activity of *P. pinnata*, its potential as a mosquito larvicide remains unexplored. This study investigates the larvicidal efficacy of hexane extract from the skin of *P. pinnata* fruit against mosquito larvae. The fruit skin of *P. pinnata* was extracted using n-hexane solvent, followed by phytochemical screening. The larvicidal effectiveness of the extract was tested at concentrations of 25 ppm, 50 ppm, 75 ppm, 100 ppm, 200 ppm, 500 ppm, and 1000 ppm. The LC50 value of the n-hexane extract demonstrated significant larvicidal activity. The results indicate that the n-hexane extract of *P. pinnata* fruit skin has the potential to serve as a natural larvicide, providing an eco-friendly solution for mosquito control.

KEYWORDS: Larvicide, Matoa (*Pometia pinnata)*, Mosquito control, Plant-based insecticides

ARTICLE DETAILS

Published On:
19 July 2024

Available on:
https://ijpbms.com/

INTRODUCTION

Indonesia, a country plagued by tropical diseases transmitted by various insect vectors, faces significant health challenges. Among these vectors, the Anopheles mosquito is the primary carrier of malaria, while *Aedes aegypti* spreads dengue fever, chikungunya, and yellow fever. These disease vectors have become increasingly difficult to eradicate due to their adaptability to environmental conditions, enhancing their survival capabilities [1]. Despite intensified mitigation efforts, challenges persist. The increasing resistance of Plasmodium species to anti-malarial drugs and the rising number of insecticide-resistant Anopheles mosquitoes underscore the need for alternative control strategies [2–6]. Consequently, scientific focus has shifted towards larvicidal activities as a means of disease vector control.

Prevention strategies include avoiding mosquito bites, treating infected individuals to eliminate infection sources, and eradicating mosquitoes and their larvae. Traditional methods, such as spraying, are less effective in eradicating adult mosquitoes due to their mobility and ability to hide in inaccessible places. Therefore, targeting mosquitoes at the larval stage, before they mature into adults, proves to be a more effective eradication strategy. One promising approach to controlling mosquito-borne diseases is the use of biological agents, including natural enemies, predators, and pathogens derived from plants [7,8].

The matoa plant (*Pometia pinnata*), an endemic species in Papua, has shown potential as a natural larvicide. Matoa fruits are seasonal, and literature indicates that the plant possesses various biological activities, including antioxidant, antibacterial, antidiabetic, toxic, analgesic, and α-glucosidase inhibitory properties [9–15]. Phytochemical studies have isolated several compounds from *P. pinnata*, including pometia, kaempferol-3-O-rhamnoside, quercetin-3-O-rhamnoside, proanthocyanidin A2, epicatechin, and stigmasterol-3-O-glucoside. Additionally, a glycolipid, a steroid glycoside, and a pentacyclic triterpenoid saponin have been identified. These compounds contribute to the plant's diverse biological activities [16–19].

Observations from Papuan village communities suggest that *P. pinnata* sawdust pulp can lethally affect fish and shrimp in river ecosystems, indicating potential bioactivity. However, its efficacy as a larvicide from hexane extract has not been reported. Therefore, this study aims to investigate the larvicidal potential of *P. pinnata* bark hexane extract against mosquito larvae at various concentrations. By exploring the larvicidal properties of *P. pinnata*, this research seeks to provide an eco-friendly solution for mosquito control, contributing to the broader efforts of managing and preventing tropical diseases in Indonesia.

METHODS

Preparation of Simplicia

The fruit skin of the matoa plant (*Pometia pinnata*) was obtained from Jayapura, Papua Province, Indonesia. The fruit skin was collected, air-dried, and then further dried in an oven at 50°C. Once dried, the fruit skin was blended into a fine powder to obtain simplicia. The extraction of *P. pinnata* skin was performed using the maceration technique with 70% n-hexane as the organic solvent [20].

Larvicide Evaluation

This study employed a post-test only group design. A total of 210 mosquito. The larvae were divided into seven treatment groups [21–24]. One positive control group was treated with 100 ppm of abate, while one negative control group was treated with distilled water. The remaining five groups were treated with different concentrations of *P. pinnata* skin extract: 25 ppm, 50 ppm, 75 ppm, 100 ppm, 200 ppm, 500 ppm, and 1000 ppm. The mortality of the mosquito larvae was observed 24 hours after treatment with abate, distilled water, and the *P. pinnata* skin extract. Each treatment was replicated three times to ensure accuracy and reliability of the results (Figure 1).

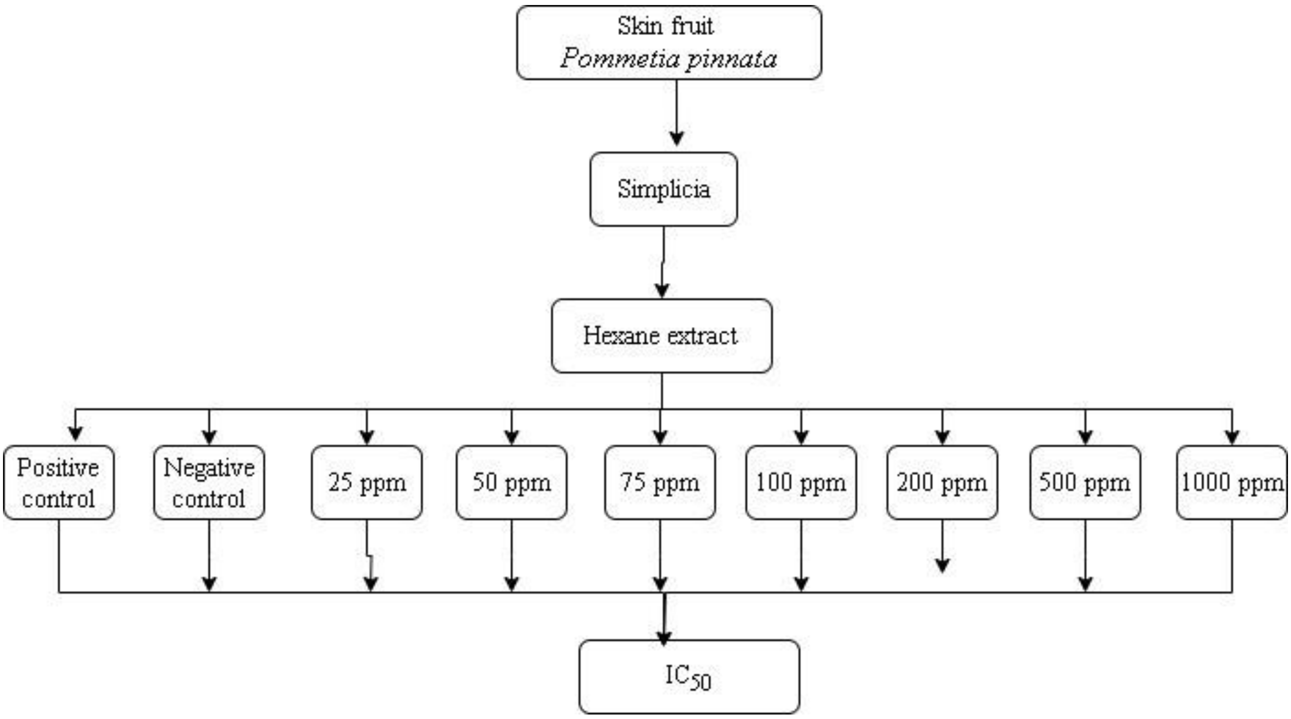

Figure 1. Research Procedure Schem

RESULTS AND DISCUSSION

Preparation of Sample

The extraction process yielded 0.28 grams of hexane extract from the skin of *P. pinnata*, resulting in a soft-textured solid. The hexane solvent facilitated the breakdown and expansion of the *P. pinnata* skin cells, allowing for the extraction of compounds through internal osmosis and withdrawal from the cell membrane. According to literature, the Pometia genus contains secondary metabolites from the terpenoid triterpene group [10,15]. A phytochemical screening of the n-hexane extract from *P. pinnata* skin was conducted, focusing specifically on detecting terpenoids and unsaturated steroids [13,25]. The results of this screening, as illustrated in Figure 2, indicated the presence of these metabolites. The screening test for terpenoids should show a color change in the sample before and after the addition of the n-hexane extract. Typically, a yellow color changes to reddish, suggesting the presence of terpenoids. This color change is attributed to the reaction between the Liebermann-Burchard reagent and the active groups within the extract, resulting in the observed color transformation.

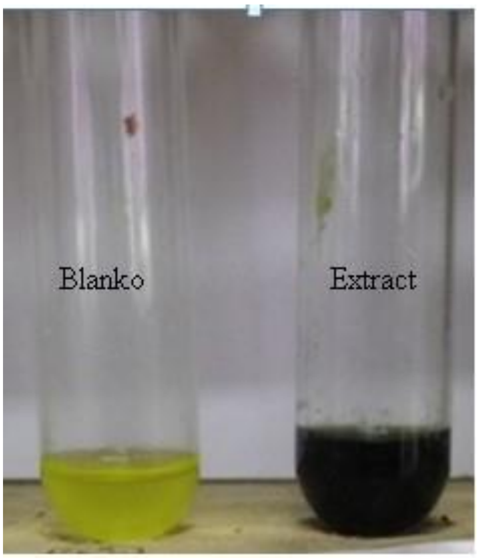

Figure 2. Results of Steroid Screening on n-Hexane Extract of *P. pinnata* Skin

Biolarvicide Test Results

The hexane extract of *Pometia pinnata* skin contains terpenoid compounds, which are known for their toxic properties. This toxicity has been reported in various studies on plants and is particularly harmful to fish and other cold-blooded animals such as frogs (Sirait, 2007). The biolarvicide test results for the hexane extract of *P. pinnata* skin, at concentrations ranging from 25 to 1000 µg/mL, are shown in Table 1. The extract exhibited a significant mortality rate, with an estimated 50% mortality at 200 µg/mL.

Table 1. Biolarvicide Test Results for Hexane Extract of *P. pinnata* Skin

Concentration Solution Test (µg/mL)	Average number of dead larvae	Average Larval Mortality (%)
Control	0	0
25	0.33	3
50	1.00	10
75	2.67	26
100	1.1	36
200	5.33	53
500	9.33	93
1000	10	100

The relationship between the concentration of the extract solution and larval mortality is depicted in Figure 3.

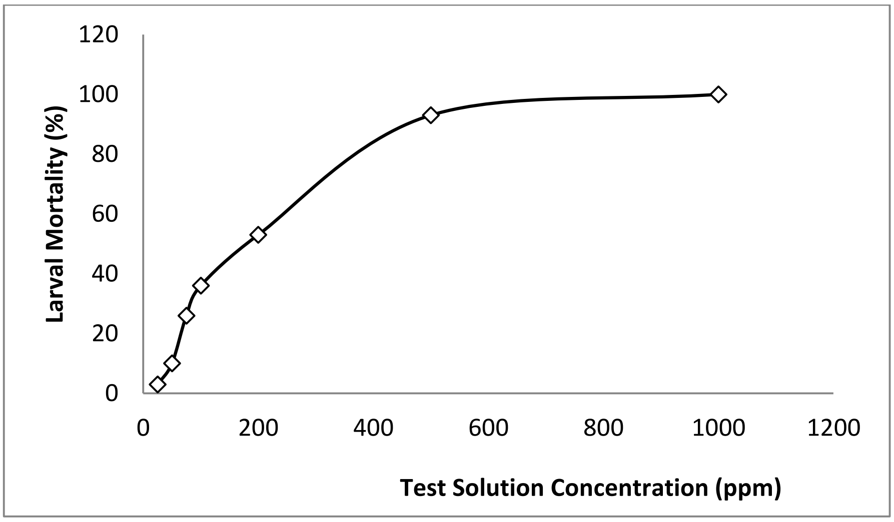

Figure 3. Relationship Between Extract Concentration and Larval Mortality

The data presented in Figure 3 demonstrate that even at low concentrations, the hexane extract of *Pometia pinnata* skin exhibits significant toxicity to mosquito larvae. As the concentration of the extract increases, there is a notable rise in larval mortality. At a concentration of 500 µg/mL, the extract achieved an 80% mortality rate, underscoring its potential as a potent biolarvicide capable of disrupting the mosquito life cycle. To determine the LC50 value, the relationship between the log concentration of the extract solution and the percentage of larval mortality was analyzed. This data is presented in Table 2 and illustrated in Figure 4.

Table 2. Log Data of Extract Solution Concentration and Percent Larval Mortality for Hexane Extract of *P. pinnata* Skin

Concentration	Concentration Log i	% Death
0	0	0
25	1,40	3
50	1,70	10
75	1,88	26
100	2,00	36
200	2,301	53
500	2,699	93
1000	3,000	100

Based on the data, a graph was constructed to depict the relationship between the log concentration of the extract solution and the percentage of larval mortality (Figure 4).

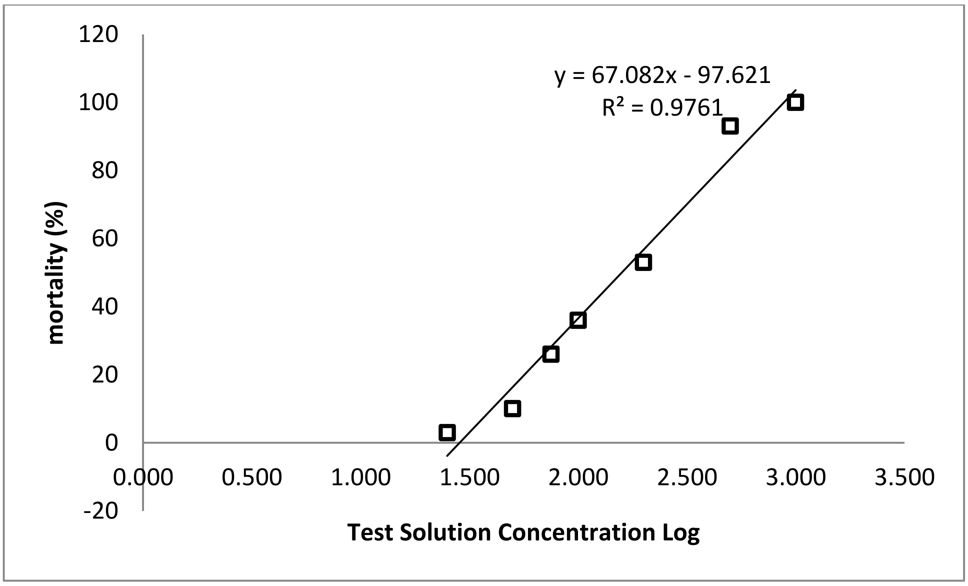

Figure 4. Relationship Between Log Concentration of Extract Solution and Percent Larval Mortality for Hexane Extract of *P. pinnata* Skin

As shown in Figure 4, there is a linear relationship between the log concentration of the extract solution and larval mortality. The linear regression equation $y = 67.082x - 97.621$, with an R^2 value of 0.9761, indicates a strong correlation between the concentration of the extract and the observed mortality rate. This linear relationship suggests that the hexane extract of *P. pinnata* skin has significant larvicidal activity, with a calculated LC_{50} value of 158.7103 ppm. Biolarvicides are generally biodegradable, making them an environmentally safe option for controlling mosquito populations. Although the specific species of mosquito larvae used in this study were not identified, the method of colonization using clear water in an open area suggests they are likely Aedes aegypti. This species is known to thrive in clean, open water sources such as bathtubs and flower pots and is a primary vector for dengue fever. From other research, it was found that leave ethanol extract of Pometia pinnata possesses larvicidal properties against Aedes aegyptilarvae, as evidenced by an LC_{50} value of 0.101%. The results offer insights into the possible utilisation of Pometia pinnata leaf extract as a viable source of active compounds for developing biolarvicides to control dengue vectors [26].

Based on these findings, the hexane extract of *P. pinnata* skin shows considerable promise as an effective biolarvicide. Similar to ABATE, it can be used in locations where mosquitoes lay their eggs, such as bathtubs and flower beds, to control mosquito populations and reduce the incidence of mosquito-borne diseases. Understanding the concentration-response relationship is crucial for evaluating the interaction between a toxic substance and its effects. This relationship, often expressed as LD_{50} or LC_{50} values, helps determine the dose required to achieve 50% mortality. Although probit analysis is commonly used to handle toxicity data, deviations from the log concentration model can occur [8]. Nonetheless, the findings of this study suggest that the hexane extract of *P. pinnata* skin is a promising natural solution for mosquito control.

CONCLUSION

The hexane extract of *Pometia pinnata* skin has demonstrated significant potential as a biolarvicide, exhibiting high toxicity against mosquito larvae. The phytochemical screening confirmed the presence of secondary metabolites, particularly terpenoids and unsaturated steroids, which contribute to its larvicidal properties. The extract showed a strong larvicidal effect, with an LC50 value of approximately 158.71 ppm. This highlights its potential as a natural and eco-friendly alternative to chemical insecticides. The findings suggest that the hexane extract of *P. pinnata* skin can be effectively used to control mosquito populations, particularly Aedes aegypti, which is known to transmit dengue fever. The extract's biodegradability further supports its use in various environments without posing significant environmental risks. Future research should focus on field trials to evaluate the practical applications of this extract in different environmental settings. Additionally, investigating the long-term effects and potential resistance development in mosquito populations would be valuable.

REFERENCES

I. Ernawan, B., Sasmita, H.I., Sadar, M., and Sugoro, I., “Current status and recent achievements of the sterile insect technique program against dengue vector, Aedes aegypti, in Indonesia,” Atom Indones. 45(2):115–121, 2019, doi:10.17146/aij.2019.908.

II. Chaniad, P., Phuwajaroanpong, A., Techarang, T., Viriyavejakul, P., Chukaew, A., and Punsawad, C., “Antiplasmodial activity and cytotoxicity of plant extracts from the Asteraceae and Rubiaceae families,” Heliyon 8(1):e08848, 2022, doi:10.1016/j.heliyon.2022.e08848.

III. Sriwilaijareon, N., Petmitr, S., Mutirangura, A., Ponglikitmongkol, M., and Wilairat, P., “Stage specificity of Plasmodium falciparum telomerase and its inhibition by berberine,” Parasitol. Int. 51(1):99–103, 2002, doi:10.1016/S1383-5769(01)00092-7.

IV. Lempang, M.E.P., Dewayanti, F.K., Syahrani, L., Permana, D.H., Malaka, R., Asih, P.B.S., and Syafruddin, D., “Primate malaria: An emerging challenge of zoonotic malaria in Indonesia,” One Heal. 14(January):100389, 2022, doi:10.1016/j.onehlt.2022.100389.

V. Lusiyana, N. and Ahdika, A., “Evaluating recurrent episodes of malaria incidence in Timika, Indonesia, through a Markovian multiple-state model,” Infect. Dis. Model. 7(3):261–276, 2022, doi:10.1016/j.idm.2022.05.008.

VI. Fadilah, I., Djaafara, B.A., Lestari, K.D., Fajariyani, S.B., Sunandar, E., Makamur, B.G., Wopari, B., Mabui, S., Ekawati, L.L., Sagara, R., Lina, R.N., Argana, G., Ginting, D.E., Sumiwi, M.E., Laihad, F.J., Mueller, I., McVernon, J., Baird, J.K., Surendra, H., and Elyazar, I.R.F., “Quantifying spatial heterogeneity of malaria in the endemic Papua region of Indonesia: Analysis of epidemiological surveillance data,” Lancet Reg. Heal. - Southeast Asia 5:100051, 2022, doi:10.1016/j.lansea.2022.100051.

VII. Chandrachood, M., Mehta, S., Godse, A., and Nimavat, N., “Preventing Mosquito Bite : Perceptions & Practices among Medical Students Original Research Article Preventing Mosquito Bite : Perceptions & Practices among Medical Students,” (November 2023), 2024, doi:10.5281/zenodo.10036556.

VIII. Takken, W., Van, H., and Berg, “Manual on prevention of establishment and control of mosquitoes of public health importance in the WHO European Region (with special reference to invasive mosquitoes),” ISBN 9788578110796, 2019.

IX. Rahmawati, R., Tahir, M., and Amir, A.H.W., “KANDUNGAN SENYAWA KIMIA DAN AKTIVITAS FARMAKOLOGI TANAMAN MATOA (Pometia Pinnata J.R. Forster & J.G. Forster),” As-Syifaa J. Farm. 13(2):108–115, 2021, doi:10.56711/jifa.v13i2.778.

X. Islami, D., Anggraini, L., and Wardaniati, I., “Aktivitas Antioksidan dan Skrining Fitokimia dari Ekstrak Daun Matoa Pometia pinnata,” J. Farm. Higea 13(1):30, 2021, doi:10.52689/higea.v13i1.328.

XI. Sidoretno, W.M., Fauzana, D.A., Farmasi, P.A., Makanan, D., Kedokteran, F., and Kesehatan, I., “Aktivitas Antioksidan Daun Matoa (Pometia

Pinnata) Dengan Variasi Suhu Pengeringan," Indones. Nat. Res. Pharm. J. 3(1):2502–8421, 2018.

XII. Sidoretno, W.M., "Potential of the Ethanolic Extract of Matoa Leaves (Pometia pinnata J.R. & G.Forst) against Staphylococcus aureus bacteria," JPK J. Prot. Kesehat. 10(2):107–112, 2022, doi:10.36929/jpk.v10i2.402.

XIII. Wulandari, L., Nugraha, A.S., and Himmah, U.A., "Penentuan Aktivitas Antioksidan dan Antidiabetes Ekstrak Daun Matoa (Pometia pinnata J.R. Forst. & G. Forst.) secara In Vitro," J. Kefarmasian Indones. 11(2):132–141, 2021, doi:10.22435/jki.v11i2.3196.

XIV. Siregar, H.N., Rahayu, Y.P., Nasution, H.M., and Nasution, M.P., "UJI AKTIVITAS ANTIBAKTERI NANOPARTIKEL EKSTRAK ETANOL DAUN MATOA (Pometia pinnata J.R. Forst & G. Forst) TERHADAP BAKTERI Escherichia coli," J. Ris. Kefarmasian Indones. 5(1):24–41, 2023, doi:10.33759/jrki.v5i1.329.

XV. Tandi, J., Afriani S, Nadira, Handayani KR, Wirawan W, Afrizal, and Tien Wahyu Handayani, "POTENSI ANTIDIABETIK EKSTRAK ETANOL DAUN MATOA(Pometia pinnata) PADA TIKUS PUTIH JANTAN," J. Ilm. Manuntung 8(1):145–155, 2022, doi:10.51352/jim.v8i1.521.

XVI. Utari, F., Itam, A., Syafrizayanti, S., Putri, W.H., Ninomiya, M., Koketsu, M., Tanaka, K., and Efdi, M., "Isolation of flavonol rhamnosides from Pometia pinnata leaves and investigation of α-glucosidase inhibitory activity of flavonol derivatives," J. Appl. Pharm. Sci. 9(8):53–65, 2019, doi:10.7324/JAPS.2019.90808.

XVII. Suedee, A., Tewtrakul, S., and Panichayupakaranant, P., "Anti-HIV-1 integrase compound from Pometia pinnata leaves," Pharm. Biol. 51(10):1256–1261, 2013, doi:10.3109/13880209.2013.786098.

XVIII. Mohammad, F.V., Ahmad, V.U., Noorwala, M., and Lajis, N.H.J., "A new triterpenoid saponin from the stem bark of Pometia pinnata," Nat. Prod. Commun. 5(2):191–195, 2010, doi:10.1177/1934578x1000500204.

XIX. Trimedona, N., Nurdin, H., Darwis, D., and Efdi, M., "Isolation of triterpenoid from stem bark of Pometia pinnata, forst & forst," J. Chem. Pharm. Res. 7(11), 2015.

XX. Harborne;, J.B., "Metode Fitokimia : Penuntun Cara Modern Menganalisis Tumbuhan," 1987.

XXI. Runge, M., Mapua, S., Nambunga, I., Smith, T.A., Chitnis, N., Okumu, F., and Pothin, E., "Evaluation of different deployment strategies for larviciding to control malaria: a simulation study," Malar. J. 20(1):1–15, 2021, doi:10.1186/s12936-021-03854-4

XXII. Waldetensai, A., "Guideline for efficacy testing of mosquito larvicides," Res. Gate - Public Heal. Entomol. Res. Team (October 2019), 2019.

XXIII. Sayono, S., Anwar, R., and Sumanto, D., "Larvicidal activity evaluation of the chemical compounds isolated from n-hexane extract of Derris elliptica root against the Temephos-susceptible strain of Aedes aegypti larvae," Biodiversitas 23(2):757–764, 2022, doi:10.13057/biodiv/d230221.

XXIV. Almeida, C.S. de, Miccoli, L.S., Andhini, N.F., Aranha, S., Oliveira, L.C. de, Artigo, C.E., Em, A.A.R., Em, A.A.R., Bachman, L., Chick, K., Curtis, D., Peirce, B.N., Askey, D., Rubin, J., Egnatoff, D.W.J., Uhl Chamot, A., El-Dinary, P.B., Scott, J.; Marshall, G., Prensky, M., Rosen, L.D., Palfrey, J. G., & Gasser, U., Oblinger, D., Oblinger, J. L., & Lippincott, J.K., Griffiths, C., Barcelos, A.M.F., Basso, E.A., Becker, H.S., Benevides, A.S., Bertoldo, E.S., Bértoli, P.P., et al., Rev. Bras. Linguística Apl. 5(1):1689–1699, 2016.

XXV. Ngajow, M., Abidjulu, J., and Kamu, V.S., "Pengaruh Antibakteri Ekstrak Kulit Batang Matoa (Pometia pinnata) terhadap Bakteri Staphylococcus aureus secara In vitro," J. MIPA 2(2):128, 2013, doi:10.35799/jm.2.2.2013.3121.

XXVI. Sari, A.R., Ramadhanty, P.K., Anggraeni, N., and Firmansyah, Y., "Medicor : Journal of Health Informatics and Health Policy," Medicor J. OfHealth Informatics Heal. Policy 1(1):25–30, 2023.