

UTILIZATION OF PETAI PEEL (*Parkia speciosa* Hassk.) EXTRACT IN SPRAY FORMULATION AS A MOSQUITO REPELLENT AGAINST *Aedes Aegypti*

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ABSTRACT

Mosquitoes act as vectors of disease in humans. One method to break the chain of transmission is to reduce contact between humans and mosquitoes by using repellents. Currently, several repellents on the market contain chemicals that are harmful to users and the environment. Some researchers have conducted studies as an alternative to replace the chemicals contained in repellents by utilising extracts from natural materials. One part of the plant that is thought to have potential as a repellent is petai peel waste (*Parkia speciosa* Hassk.), which contains several bioactive compounds. The purpose of this study was to determine the effectiveness of petai peel waste extract in spray formulation as a repellent for *Aedes aegypti* mosquitoes. Extraction was carried out using the Ultrasonic Assisted Extraction (UAE) method with 96% ethanol solvent. The 25% petai peel extract formulation showed the highest repellent activity, providing over 91% protection during the first and second hours, although its effectiveness gradually declined over time, resulting in an overall average protection of 87.94%. Based on these results, petai peel waste extract has the potential to be developed as an environmentally friendly natural repellent, while also adding value to waste utilization and supporting mosquito control programs.

ABSTRAK

Nyamuk berperan sebagai vektor penular penyakit pada manusia. Salah satu metode untuk memutus rantai penularan yakni mengurangi kontak antara manusia dan nyamuk dengan memakai *repellent*. Saat ini, beredar beberapa *repellent* dipasaran yang mengandung bahan kimia berbahaya bagi pengguna dan lingkungan. Beberapa peneliti telah melakukan penelitian sebagai alternatif untuk mengganti bahan kimia yang terdapat di *repellent* dengan memanfaatkan ekstrak dari bahan alam. Salah satu bagian tumbuhan yang diduga berpotensi sebagai *repellent* adalah kulit petai (*Parkia speciosa* Hassk) yang mengandung beberapa senyawa bioaktif. Tujuan penelitian ini untuk mengetahui efektivitas ekstrak kulit petai dalam sediaan spray sebagai *repellent* nyamuk *Aedes aegypti*. Ekstraksi menggunakan metode *Ultrasonic Assisted Extraction* (UAE) dengan pelarut etanol 96%. Sediaan spray ekstrak kulit petai menunjukkan karakteristik fisik yang baik dan aman digunakan. Formulasi dengan konsentrasi 25% memiliki efektivitas tertinggi sebagai repelan, dengan daya proteksi di atas 91% pada jam pertama dan kedua, meskipun efektivitasnya menurun seiring waktu, sehingga nilai rata-rata daya proteksi keseluruhan mencapai 87,94%. Berdasarkan hasil ini, ekstrak limbah kulit petai berpotensi dikembangkan sebagai repelan alami yang ramah lingkungan, sekaligus memberikan nilai tambah pada pemanfaatan limbah dan mendukung program pengendalian nyamuk.

INTRODUCTION

The incidence of dengue fever globally has increased over the past two decades, posing a public health challenge. From 2000 to 2019, WHO reported a tenfold surge in cases worldwide, from 500,000 to 5.2 million. The year 2019 marked an unprecedented peak, with reported cases spreading across 129 countries (WHO, 2023). Based on available data, it is stated that in Indonesia, diseases caused by mosquito vectors are still fluctuating, such as the cumulative number of confirmed cases of Dengue Hemorrhagic Fever (DHF) from January 2022 reported as many as 87,501 cases (IR 31.38/100,000 population) and 816 deaths (CFR 0.93%) (Kementerian Kesehatan Republik Indonesia, 2024).

One of the efforts to control the spread of DHF is focused on breaking the chain of transmission through vector mosquito control using insecticides. Repellent is a type of insecticide that can protect the body from mosquito bites. Chemical repellents containing the active substance DEET (Diethyltoluamide) can provide protection against *Ae. aegypti* mosquitoes, but the chemical compound can cause irritation, muscle cramps, rashes, and hypersensitivity reactions (Kelik & Zuliatus, 2018). If these chemical insecticides are used for a long time, they can cause environmental pollution and resistance, so there is a need for natural alternative insecticides from natural ingredients that are safer, easily obtained, easily decomposed, and environmentally friendly (Şengül & Canpolat, 2022).

One of the plants that is considered to have repellent potential is petai peel (*Parkia speciosa* Hassk.) because it contains bioactive compounds such as alkaloids, polyphenols, flavonoids, saponins, tannins, and other active compounds (Verawaty & Novel, 2018). Another study reported that these bioactive compounds demonstrated biological potential as mosquito control agents. These compounds interfere with the function of chemical receptors (chemoreceptors) located on the palps and antennae of mosquitoes, thereby inhibiting their ability to detect hosts and causing them to avoid biting and blood-feeding activities (Lestari, 2024). Based on previous studies, petai peel has shown potential as a mosquito control agent due to its bioactive compound content. However, scientific evidence regarding the formulation of petai peel extract into a spray repellent and its effectiveness against *Aedes aegypti* remains limited. Therefore, this study introduces a novel approach by utilizing underutilized petai peel waste as a natural mosquito repellent through spray formulation and evaluating its effectiveness at various concentrations. This research is expected to contribute to the development of eco-friendly and sustainable vector control strategies.

METHOD

Type of Research

This study involves experimental research on several concentrations or dose variations of spray repellent preparations made from petai peel waste extract against *Aedes aegypti* mosquitoes..

Place and Time of Research

This research was conducted from April to September 2024 in the Laboratory of Microbiology and Parasitology, Faculty of Medicine, Universitas Lampung.

Population and Sample

The population in this study was a number of *Aedes aegypti* eggs obtained from the Indonesian Institute for Public Health Laboratories Pangandaran which were then developed into mosquitoes in the Rearing Laboratory at the Laboratory of Microbiology and Parasitology, Faculty of Medicine, Universitas Lampung. Samples in this study were a number of *Aedes aegypti* mosquitoes aged 5–7 days post-emergence that were taken randomly from the population of *Aedes aegypti* mosquitoes in the laboratory. The number of mosquitoes needed for each treatment group was 50 female mosquitoes.

Maintaining consistent mosquito rearing and laboratory testing environments is crucial for producing reliable and repeatable results. Mosquitoes must be raised, kept, and tested—preferably in a designated area—with environmental conditions set at 27 ± 2 °C, relative humidity of $\geq 80 \pm 10\%$, and a 12-hour light and 12-hour dark cycle. Mosquito collections via human landing catches should be conducted during the active biting times of the target mosquito species (WHOPES, 2009).

Data Collection

Data collection for this study started from plant determination, sample preparation, and extraction process, followed by preparation of spray repellents with various dose variations, evaluation of formulation, scatter test and skin irritation test, and testing the effectiveness of spray preparations as repellents. In this study, three replications were performed following World Health Organization Pesticide Evaluation Scheme (WHOPES) recommendations, which state that the testing of mosquito repellents should be conducted with a minimum of three repetitions. The second and third tests were carried out on different days, specifically on the following days at the same testing time (WHOPES, 2009). A negative control (no treatment) was used, and a DEET-based repellent (Soffell spray) served as the positive control for comparative evaluation. The extract was formulated in spray form with concentrations of 5%, 10%, 15%, 20%, and 25%, respectively. The following is the petai peel extract spray formulation presented in Table 1.

Table 1. Petai peel extract spray formulation

Materials	Composition (%)					
	F0	F1	F2	F3	F4	F5
Petai Peel Extract	0	5	10	15	20	25
Propylene glycol	5	5	5	5	5	5
Ethanol 96%	25	25	25	25	25	25
Aquadest	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100	Ad 100

Petai peel extract was added with 96% ethanol and stirred until homogeneous. Then propylene glycol and aquadest were added and stirred until homogeneous.

The repellent effectiveness test was conducted following the procedure recommended by WHOPES and used human subjects; this method was chosen because it matches the actual user conditions (WHOPES, 2009). The anti-mosquito effectiveness test was conducted with 7 volunteers. Volunteers were not allowed to use any fragrances or products for 6 hours prior to the test, as a requirement for hand treatment is that the skin must be completely clean. The efficacy test was determined based on the percent mosquito repellency of the test arm using the anti-mosquito spray product and compared to the control arm that did not use any treatment. Mosquito repellency (protection power) was calculated using the formula (Wardani et al., 2022).

$$\text{Protection Power} = \frac{K - P}{K} \times 100\%$$

Description: K = Number of mosquitoes that landed on the control arm (-)

P = Number of mosquitoes that landed on the test arm (formula)

It is said to be effective, if the protection power reaches 90% until the 6th hour which applies to synthetic repellents (Direktorat Pupuk dan Pestisida, 2012).

Data Analysis and Processing

The data were analyzed using statistical analysis software. In this study, an ANOVA test was used to determine whether there was a difference in the number of mosquitoes that landed between spray preparations of petai peel extract and the positive control.

RESULT

Based on the results of the determination test that has been carried out on this petai plant, it is indeed a species of *Parkia speciosa*. This is evidenced by the characteristics of the plant samples collected such as leaves, flowers, fruits, stems, and roots that have been identified in the Botany

Laboratory, Department of Biology, FMIPA Universitas Lampung. The scientific classification of petai plants according to (Cronquist, 1981) is as follows:

Kingdom: Plantae
 Division: Magnoliophyta
 Class: Magnoliopsida
 Nation: Fabales
 Tribe: Fabaceae
 Genus : *Parkia*
 Species : *Parkia speciosa* Hassk.

Extraction using the Ultrasonic Assisted Extraction (UAE) method with 96% ethanol solvent as much as 1.5 L produced 43.23 grams of petai peel extract with a yield of 28.82%. The extract was formulated in spray form with concentrations of 5%, 10%, 15%, 20%, and 25%, respectively. Evaluation of the petai peel extract spray preparation included organoleptic tests showing a liquid form, a blackish brown colour, a distinctive smell of petai peel, a homogeneous solution, a pH of 4.3, good spreadability, easy sprayability, and irritation test results that met the requirements so that the preparation is safe to use. The organoleptic test results are presented in Table 2.

I. Physical Test of Preparations

a. Organoleptic

Table 2. Organoleptic test of petai peel extract spray preparation

Organoleptic	F0	F1	F2	F3	F4	F5
Shape	Liquid	Liquid	Liquid	Liquid	Liquid	Liquid
Color	Transparent	Brown	Blackish brown	Blackish brown	Blackish brown	Black
Taste	No flavour	Slippery	Slippery	Slippery	Slippery and slightly sticky	Slippery and slightly sticky
Smell	Typical of ethanol	Typical extract	Typical extract	Typical extract	Typical extract	Typical extract

b. Homogeneity

The test was carried out by taking the preparation and then putting it into a test tube and observing the arrangement of coarse particles in the preparation (Aji et al., 2020). Homogeneity testing was conducted by observing the preparation against black and white backgrounds. The white background was used to observe insoluble particles, as well as the black background. The results of the test showed that all formulas were homogeneous.

c. pH

The preparation was placed into a beaker glass as much as 5 mL and then measured using a pH meter. If the resulting pH ranges from 4 to 7, the preparation is considered safe to use (Sari et al., 2021). The pH test results are presented in Table 3.

Table 3. pH test of petai peel extract spray preparation

Formula	Test	pH	pH (Mean±SD)
F0	1	5.4	5.47±0.057
	2	5.5	
	3	5.5	
F1	1	4.3	4.3±0
	2	4.3	
	3	4.3	
F2	1	4.3	4.37±0.057
	2	4.4	
	3	4.4	
F3	1	4.3	4.3±0
	2	4.3	
	3	4.3	
F4	1	4.3	4.23±0.057
	2	4.2	
	3	4.2	
F5	1	4.2	4.2±0
	2	4.2	
	3	4.2	

d. Spreadability

The preparation was sprayed on plastic mica at a distance of 5 cm and the diameter of the spray was measured ([Hayati et al., 2019](#)). The spreadability test results are presented in Table 4.

Table 4. Spreadability test of Petai Peel extract spray preparation

Formula	Test	Spread (cm)	Spread (Mean±SD)
F0	1	10	11.167±1.041
	2	12	
	3	11.5	
F1	1	9.5	9.5±0
	2	9.5	
	3	9.5	
F2	1	8	8.833±0.057
	2	9	
	3	9.5	
F3	1	9	9.667±0.057
	2	10	
	3	10	
F4	1	10.5	8.667±0.057
	2	8	
	3	7.5	
F5	1	10.5	8.667±0.057
	2	7	
	3	8.5	

e. Observation of skin irritation

After the spray formula was sprayed onto the volunteer's skin surface and observed for 24 hours, the results showed no rash, redness, or itching on the skin. This indicates that the spray preparation is safe to use. The test results can be seen in Table 5.

Table 5. Irritation Test Observation Results

Type of Irritation	Day Observations		
	1	2	3
Itchy Feeling	X	X	X
Redness	X	X	X
Swollen Skin	X	X	X
Stinging	X	X	X

X : no type of irritation found in 7 Volunteers

II. Repellent effectiveness of petai peel extract spray preparation against *Ae. aegypti* mosquitoes.

This test aims to determine the repellent activity by calculating the protective power of all concentrations of petai peel extract spray preparation. The repellent effectiveness test was conducted following the procedure recommended by WHOPES. The repellent test results are presented in Table 6.

Table 6. Average percentage of protective power results of petai peel extract spray preparation

Treatment	Hour Observations (%)						Average overall protection power (%)	P Value
	1	2	3	4	5	6		
Control (-)	0	0	0	0	0	0	0	0.000
F1 (5%)	55.26	52.94	51.43	52.78	51.52	45.45	51.56	
F2 (10%)	68.42	67.65	65.71	61.11	60.61	54.55	63.01	
F3 (15%)	78.95	76.47	74.29	69.44	63.64	60.61	70.57	
F4 (20%)	89.47	85.29	80.00	83.33	78.79	66.67	80.59	
F5 (25%)	92.11	91.18	88.57	86.11	84.85	84.85	87.94	
Control (+)	100.00	100.0	100.00	97.22	96.97	96.97	98.53	

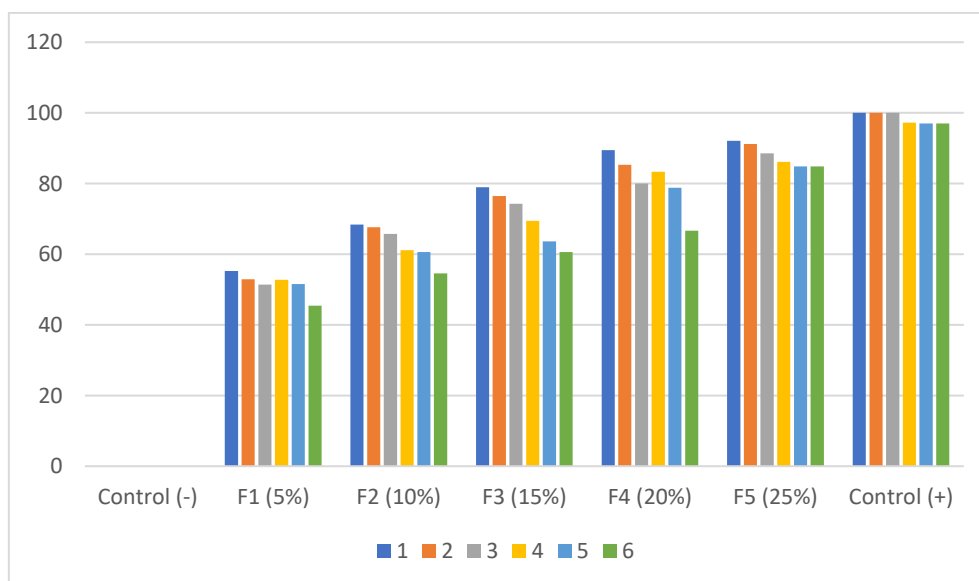


Figure 1. Graph of the average protective power of petai peel extract spray preparation

The protection rate did not reach 90% for 6 hours due to several factors, namely the properties of the formulation and the volatility of the active compounds, the formulation type and application method, environmental factors, and the conditions of mosquito testing.

DISCUSSION

Testing spray preparations aims to obtain preparations that are safe and effective for use. Based on the tests that have been carried out, the anti-mosquito spray preparation from petai peel extract has the appearance of a homogeneous solution that is clear and easy to spray, and has a liquid form, blackish brown color, slippery and slightly sticky texture, and a distinctive smell of petai peel. The difference in color density at each concentration is due to the amount of active substance added to each formulation. The higher the concentration of active substances, the more intense the color of the spray preparation produced in the formula. The spray preparation has the odor of petai peel extract; this is because the preparation is not fragranced (Handayani et al., 2023). The homogeneity test is one of the requirements for cosmetic preparations when applied to the skin. The homogeneity requirement is that the preparation must not contain rough materials that can be felt when applied. The homogeneity test was carried out visually by observing the absence of particles that separated in the preparation. This homogeneity test is carried out to determine the mixing of the base with the formulated extract. Based on the results, it is known that the preparation shows homogeneous results characterized by the absence of coarse grains or lumps in the preparation. The results of this observation have met the homogeneity requirements, which are free from particles that are still clumped together.

Based on the pH measurements that have been carried out, the spray preparation has a pH value of 4.2–5.47 and meets the pH testing requirements that are in accordance with the skin, namely 4.5–6.5 (Salsabila et al., 2024). Preparations that are too alkaline will cause dry and sensitive skin, while preparations that are too acidic will cause inflamed skin, acne, and irritation (Banne et al., 2022). Assessment of sensitivity showed no symptoms of erythema or symptoms of skin irritation such as itching, heat, and redness that occur in anti-mosquito spray preparations containing petai peel extract, making them safe to use.

Research on the effectiveness of ethanol extract of petai peel against *Ae. aegypti* mosquitoes showed that it has potential as a repellent. In this study, several different treatments were used, namely the provision of negative control, positive control, and ethanol extract of petai peel with different concentrations. The test was carried out by spraying the lower arm with spray preparation as a negative control without extract, a positive control using anti-mosquito spray (Soffell) containing N,N-diethyl-

m-toluamide (DEET) 13%, and ethanol extract of petai peel with different concentrations. This observation was carried out until the 6th hour.

The mosquito repellency test showed that the F1 spray preparation had the lowest effectiveness, namely an average of 51.56% at the observation time of 6 hours, while F2–F4 had fairly good mosquito repellency at the observation time of 6 hours with averages of 63.01%–80.59%. Furthermore, F5 showed effectiveness as a good repellent in the 1st and 2nd hour observations, namely 92.11% and 91.18%, but experienced a decrease in effectiveness from the 3rd hour to the 6th hour so that the average overall protection power at that concentration became 87.94%. Thus, the repelling power achieved has not met the standards set by the Pesticide Commission, namely that a repellent can be said to be effective if its repelling power can reach at least 90% for 6 hours (Direktorat Pupuk dan Pestisida, 2012). This can occur due to several factors. The effectiveness of repellents is strongly influenced by the volatility and stability of active compounds on the skin; the faster the compounds evaporate, the quicker the protection diminishes. This represents a major limitation of natural repellents compared to synthetic repellents, which are designed for longer-lasting protection (Mapossa et al., 2021). Most plant-based repellents in the study showed limited effectiveness, as mosquitoes began landing again less than 2 hours after application. However, it is difficult to directly compare results across studies due to various factors that can influence repellent effectiveness. These factors include differences in chemical formulations, environmental conditions, application methods, and experimental designs (Amalia et al., 2025).

According to (Adnani, 2020), this indicates that the higher the concentration used, the fewer mosquitoes that land on the treatment arm. This condition indicates that the potential of the substance as a repellent becomes stronger because the higher the concentration used, the greater the number of mosquitoes that are repelled. The effectiveness and duration of repellency depend on the active ingredients of the repellent formulation, application method, temperature, humidity, and the attractiveness of mosquitoes to individuals (Suwasono, 2009). This effectiveness can also be reduced due to evaporation, abrasion, absorption by the skin and sweat, as well as volunteer characteristics such as age, gender, and the biochemical attractiveness of mosquitoes to repellent test volunteers (Hidayah et al., 2018).

Based on research conducted by (Wardani et al., 2022), it was concluded that the preparation of anti-mosquito spray from tembelean flower extract with a concentration of 17% has a protection power of 85.67%, making it the most effective as a repellent. The results of the effectiveness test show that the most effective formula is formula F5 containing 25% petai peel extract concentration which has a protection power of 92% in the early observation period and has the best physical properties with strong protection power. Male palm flower extract lotion (*Elaeis guineensis* Jacq.) also has activity as an anti-mosquito agent (Arsita et al., 2022). The results of research by (Mangalik et al., 2023) showed that the ethanol extract of bandotan leaves (*Ageratum conyzoides* L.) was not significantly different in the organoleptic test, homogeneity test, viscosity test, and pH test. The greatest mosquito repellent power was at a concentration of 20%, which was 66.33%, while concentrations of 10% and 15% had an average anti-mosquito activity of 22.83% and 57.83%, respectively, compared to the positive control with the Autan brand of 99.30%.

Research by (Inayah et al., 2024) showed that the 96% ethanol extract of teki grass bulbs at a concentration of 6% provided the highest protection from mosquito bites with a protection power of 73.84%. According to (Zen & Asih, 2017) repellents are considered to have good protective power if the number of mosquitoes that land on them is small and the protection percentage is high. Mosquitoes can detect the presence of warm-blooded living beings from sweat containing excretory products, lactic acid, and carbon dioxide. Olfactory organs, namely antennae and maxillary palpi, play a role in capturing these stimuli. Repellents work by blocking lactic acid receptors in the mosquito's antennae which results in the mosquito losing contact with humans (Fauziah, 2017).

Based on the results of previous research on phytochemical screening of petai peel, it was found that methanol extract of petai peel (*Parkia speciosa* Hassk.) contained saponins, terpenoids, tannins, alkaloids, flavonoids, and phenolic compounds. Flavonoid compounds have effectiveness as anti-mosquito agents that work as respiratory toxins. Flavonoids act as respiratory poisons or inhibitors; when mosquitoes breathe, flavonoids enter with air (O₂) through their respiratory organs and then inhibit the respiratory system in the mosquito's body (Suari et al., 2021). The estragole compound has a distinctive pungent aroma, so it can be utilized as a botanical insecticide that is used to kill and repel

insects (repellent) and can be used as a mosquito repellent (Widanty et al., 2014); (Yanti et al., 2020). While alkaloid compounds function as anticholinesterase which causes a decrease in muscle coordination and leads to death in insects (Pradhan et al., 2013). Steroids work as neurotoxins by affecting neurotransmission and inhibiting ion transport. Because the mosquito's nervous system is disturbed by the entry of steroid compounds into the mosquito's body, it causes interference with the nervous system so that the mosquito becomes weak (Hidana, 2015).

Based on the description above and the results of the research that has been done, petai peel extract has the potential as a repellent for *Aedes aegypti* mosquitoes. This research can be further developed to re-examine the appropriate dose and to achieve protection for up to 8 hours like the positive control, as well as to produce practical repellent products. The community can utilize petai peel waste as an alternative natural and environmentally friendly repellent.

CONCLUSION AND SUGGESTION

The conclusions of this research are as follows: Petai peel extract (*Parkia speciosa* Hassk.) has the potential as a mosquito repellent for *Ae. aegypti*, with the highest percentage of mosquito repellency at a 25% concentration and an overall average protection power of 87.94% for 6 hours. The greater the concentration of petai peel extract in the spray preparation, the higher the protective power and the longer the repellent activity against *Ae. aegypti* mosquitoes. Based on these results, we recommend conducting field trials and studies involving larger and more diverse populations, using different concentrations, to validate the effectiveness of petai peel extract as a mosquito repellent under real-world conditions.

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REFERENCES

- Adnani, B. (2020). Uji Potensi Ekstrak Etanol Daun Bawang Merah (*Allium cepa* L) Sebagai Repellent Terhadap Nyamuk *Aedes aegypti*. In *Skripsi*. Universitas Islam Negeri Maulana Malik Ibrahim.
- Aji, N., Anwari, M. T., Azzahrah, N. R., & Azizah, Z. N. (2020). Pemanfaatan Limbah Kulit Buah Rambutan Sebagai Gel Tabir Surya dan Anti Bakteri Terhadap *Staphylococcus aureus*. *Journal of Pharmacopolium*, 3(2).
- Amalia, Riska., Ahmad, Intan., Y. S. (2025). Effectiveness and Public Perception of Synthetic and Natural-Based Mosquito Repellents Against *Aedes aegypti* in Indonesia. *3BIO: Journal of Biological Science, Technology and Management*, 7(1), 289–299. <https://doi.org/10.5614/3bio.2025.7.1.1>
- Arsita, M. A. M., Lestari, U., Elisma, E., & Efendi, M. E. M. (2022). Physical Properties and Anti-Mosquito Activities of Lotion Male from Palm Flower Extract (*Elaeis guineensis* Jacq .). *Indonesian Journal of Pharmaceutical Science and Technology*, 1(1), 50–59. <https://doi.org/10.24198/ijpst.v1i1.42857>
- Banne, Y., Maramis, R., Awitari, I., Dumanauw, J., Rindengan, E., Rumagit, B., & Sapiun, Z. (2022). Pembuatan Sediaan Spray Repelen Dari Minyak Atsiri Bunga Kamboja Putih (*Plumeria alba*). In *Prosiding Seminar Nasional Kefarmasian Program Studi Farmasi FMIPA Universitas Sam Ratulangi*, 12–16. <https://ejournal.unsrat.ac.id/v3/index.php/semnasfarmasi22/article/view/44419/41558>
- Cronquist, A. (1981). *An Integrated System of Classification of Flowering Plants*. Columbia University Press, New York. <https://www.abebooks.com/first-edition/Integrated-System-Classification-Flowering-Plants-Cronquist/31973390061/bd>
- Direktorat Pupuk dan Pestisida. (2012). *Metode Standar Pengujian Efikasi Pestisida Rumah Tangga dan Pengendalian Vektor T.A. 2012*. <https://repository.pertanian.go.id/handle/123456789/18692>
- Fauziah, R. R. (2017). Perbedaan Berbagai Konsentrasi Ekstrak Biji Sirsak (*Annona muricata*) sebagai Repellent terhadap Daya Tolak Nyamuk *Aedes aegypti*. *Jurnal Riset Kesehatan*, 9(2), 34–40.
- Handayani, R., Qamariah, N., & Maretania, J. (2023). Formulasi sediaan serum ekstrak etanol umbi hati tanah. *Jurnal Farmasetis*, 12(2), 227–236. <https://doi.org/10.32583/far.v12i2.1219>

- Hayati, R., Sari, A., & Chairunnisa, C. (2019). Formulasi Spray Gel Ekstrak Etil Asetat Bunga Melati (*Jasminum sambac* (L.) Ait.) Sebagai Antijerawat. *Indonesian Journal of Pharmacy and Natural Product*, 2(2), 59–64. <https://doi.org/10.35473/ijpnp.v2i2.256>
- Hidana, R. (2015). Efektivitas Ekstrak Daun Sereh (*Cymbopogon nardus*) Sebagai Anti-Oviposisi Terhadap nyamuk *Aedes aegypti*. *Jurnal Kesehatan Bakti Tunas Husada: Jurnal Ilmu-Ilmu Keperawatan, Analisis Kesehatan Dan Farmasi*, 13(1).
- Hidayah, N., Mustafa, H., & Tolistiawaty, I. (2018). Efektivitas Repelan Losion Minyak Atsiri Kulit Jeruk Bali (*Citrus maxima* (Burm.) Merr.) terhadap *Aedes aegypti*. *Balaba J Litbang Pengendali Penyakit Bersumber Binatang Banjarnegara*, 14(2), 159–168. <https://doi.org/10.22435/blb.v14i2.403> Efektivitas
- Inayah, S., Eta, S., Billa, Z., Churrohmah, S., Azizah, R. N., & Kiromah, N. Z. (2024). Uji Aktivitas Ekstrak Etanol dan Akuades Umbi Rumpun Teki (*Cyperus rotundus* L.) Sebagai Repellent Terhadap Nyamuk *Aedes aegypti*. *Lambung Farmasi: Jurnal Ilmu Kefarmasian*, 5(2), 135–141. <https://doi.org/10.31764/lf.v5i2.19174>
- Kelik, M., & Zuliatus, E. (2018). Uji Efektivitas Ekstrak Buah Lerak (*Sapindus rarak*, D.C) sebagai Repelan Anti Nyamuk *Aedes aegypti*. *Proceeding of Biology Education*, 2, 42–49. <https://doi.org/10.21009/pbe.2-1.6>
- Kementerian Kesehatan Republik Indonesia. (2024). *Rencana Aksi Kegiatan (RAK) Tahun 2022 - 2024*. [https://repository.badankebijakan.kemkes.go.id/id/eprint/5399/1/Rencana Aksi kegiatan KGTK 2022 - 2024.pdf](https://repository.badankebijakan.kemkes.go.id/id/eprint/5399/1/Rencana_Aksi_kegiatan_KGTK_2022_-_2024.pdf)
- Lestari, S. W. B. (2024). Identifikasi Tumbuhan Sebagai Repellent Terhadap Nyamuk : Review. *Biocaster : Jurnal Kajian Biologi*, 4(1), 44–51. <https://doi.org/10.36312/biocaster.v4i1.245>
- Mangalik, A. R., Helmidanora, R., & Sa'adah, H. (2023). Formulasi Sediaan Spray Gel Ekstrak Daun Bandotan (*Ageratum Conyzoides*. L) Sebagai Antinyamuk. *Jurnal Riset Kefarmasian Indonesia*, 5(2), 245–257. <https://doi.org/10.33759/jrki.v5i2.364>
- Mapossa, A. B., Focke, W. W., Tewo, R. K., Androsch, R., & Kruger, T. (2021). Mosquito-repellent controlled-release formulations for fighting infectious diseases. *Malaria Journal*, 20(1), 165. <https://doi.org/10.1186/s12936-021-03681-7>
- Pradhan, D., Suri, K. A., Pradhan, D. K., & Biswasroy, P. (2013). Golden Heart of the Nature : Piper betle L. *Journal of Pharmacognosy and Phytochemistry*, 1(6), 147–167.
- Salsabila, E., Wulandari, F., & Rohana, E. (2024). Formulation and SPF Value Evaluation of Sunscreen Spray Gel Containing Lime Peel Extract (*Citrus aurantifolia*). *Jurnal Farmasi Dan Ilmu Kefarmasian Indonesia*, 11(1), 42–52. <https://doi.org/10.20473/jfiki.v11i12024.42-52>
- Sari, D. Y., Ariansyah, S., Shinta, S., & Beniardi, W. (2021). Face Tonic Formulation From Ethanol Extract of *Maranta arundinacea* L. With Variety of Cosolvent and Surfactant : Propylene Glycol and Polysorbate 80. *Proceeding of 27th International Conference ADRI*, 34–39. <https://doi.org/10.26737/adri27>
- Şengül Demirak, M. Ş., & Canpolat, E. (2022). Plant-based bioinsecticides for mosquito control: Impact on insecticide resistance and disease transmission. *Insects*, 13(2), 162. <https://doi.org/10.3390/insects13020162>
- Suari, L. G., Haq, A. D., & Rahayu, L. A. (2021). Potensi Ekstrak Bunga Kamboja (*Plumeria* Sp.) Dan Bunga Kluwih (*Artocarpus Camansi*) Sebagai Biolarvasida Nyamuk *Anopheles* Sp. Dalam Upaya Pencegahan Penyakit Malaria. *JIMKI: Jurnal Ilmiah Mahasiswa Kedokteran Indonesia*, 8(3), 137–145. <https://doi.org/10.53366/jimki.v8i3.267>
- Suwasono, H. (2009). Uji Efikasi Repelen “X” Terhadap Nyamuk *Aedes aegypti*, *Culex quinquefasciatus* Dan *Anopheles aconitus* di Laboratorium. *Vektora: Jurnal Vektor Dan Reservoir Penyakit*, 1(2), 101–108.
- Verawaty, V., & Novel, D. C. (2018). Efek Ekstrak Etanol Kulit Petai (*Parkia speciosa* Hassk) Terhadap Penurunan Kadar Glukosa Darah Mencit Jantan. *Jurnal Katalisator*, 3(1), 1–6. <https://doi.org/10.22216/jk.v3i1.2178>
- Wardani, I. G. A. A. K., Rahayu, N. P. S., & Udayani, N. N. W. (2022). Efektivitas Sediaan Spray Ekstrak Bunga Tembelekan (*Lantana camara* L.) sebagai Repellent Nyamuk *Aedes Aegypti*. *Jurnal Ilmiah Medicamento*, 8(1), 8–13. <https://doi.org/10.36733/medicamento.v8i1.2405>
- WHO. (2023). *Dengue-Global Situation*. World Health Organization.

- <https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON498>
- WHOPES. (2009). *Guidelines for Efficacy Testing of Mosquito Repellents for Human*. World Health Organization. <https://www.who.int/publications/i/item/WHO-HTM-NTD-WHOPES-2009.4>
- Widanty, N. I., Herawati, L., & Windarso, S. E. (2014). Penggunaan Mat Serbuk Daun Kemangi (*Ocimum Sanctum*) dan Mat Serbuk Daun Pandan Wangi (*Pandanus Amaryllifolius*) Sebagai Repellent Nyamuk *Aedes Sp.* *Sanitasi: Jurnal Kesehatan Lingkungan*, 6(1), 1–10.
- Yanti, N. L. M., Arpiwi, N. L., & Yulihastuti, D. A. (2020). Minyak Atsiri Daun Kemangi (*Ocimum × africanum* Lour.) dan Efektivitasnya Sebagai Lotion Antinyamuk terhadap *Aedes aegypti* (Linnaeus, 1762). *Metamorfosa: Journal of Biological Sciences*, 7(2), 248–258. <https://doi.org/10.24843/metamorfosa.2020.v07.i02.p14>
- Zen, S., & Asih, T. (2017). Potensi Ekstrak Bunga Tahi Kotok (*Tagetes erecta*) Sebagai Repellent Terhadap Nyamuk *Aedes Aegypti* Yang Aman Dan Ramah Lingkungan. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, 8(2), 142–149.