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The Effectiveness of Coconut Coir Extract (*Cocos nucifera*) Combined with Frangipani Flowers (*Plumeria* sp.) as an Anti-Mosquito Lotion

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Abstract

Coconut coir is one of the wastes whose processing is not optimal. On the other hand, coconut coir contains of tannins which can be used as an insect repellent, including mosquitoes. Frangipani flowers also contain of essential oils that are insecticidal. Therefore, these two materials have the potential to be developed as an anti-mosquito lotion. The purpose of this study was to determine the effectiveness of coconut coir and frangipani flower extract as an anti-mosquito lotion. This research is an experimental study with anti-mosquito lotion formulation treatment and the level of treatment consists of T0 (negative control), T1 (coconut coir only), T2 (coconut coir: frangipani flowers = 1:1), T3 (coconut coir: frangipani flowers=1:2), T4 (coconut coir:frangipani flowers=2:1), T5 (Frangipani flowers only), and T6 (commercial lotions as positive control). Data of the number of mosquito bites on the hands of participants after treatment were analyzed using one way anova and Duncan. The conclusion of this study was the anti-mosquito lotion using coconut coir extract combination with frangipani flower extract are effective as anti mosquito lotion, with T3 treatment (coconut coir: frangipani flowers=1:2) was the most effective formulation in preventing the bite of the mosquito which has a Protection Power of 90%.

Keywords: anti-nutrients; repellent; mosquito; tannin.

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INTRODUCTION

Coconut (*Cocos nucifera* L.) are quite abundant in tropical regions, such as Indonesia. Indonesia has held the top position with the largest coconut plantations in the world since 1988 (Dwiyana et al., 2021). The demand for coconuts as a food ingredient continues to increase. However, the use of coconut as a food source leaves behind waste, one of which is coconut coir that is considered to pollute the environment and disrupt the scenery.

Coconut coir is for about 35% of the weight of the coconut fruit, with a thickness ranging from 5 to 6 cm (Jannah and Aziz, 2017). About 0.4 kg of coir is produced from one coconut. This makes the presence of coconut coir quite abundant and not yet matched by optimal utilization (Mulyawan et al., 2015). Coconut coir is generally used as a substitute for firewood (Suantara and Oktaviani, 2015). However, the use of coconut coir as an alternative fuel is rarely found, especially in urban areas, leading to its waste (Sarina et al., 2017). Coconut coir is also utilized as a material for making doormats, brooms, and organic fertilizer. Oktaviani et al. (2022) also mention that coconut coir can be utilized in the process of land reclamation of former mining sites and article boards.

Coconut coir contains cellulose (21.07%), hemicellulose (8.50%), pectin (14.25%), lignin (29.23%), and water (26.0%) (Hartini et al., 2013). In addition, pyroligneous acid, gas, charcoal, tar, potassium, and tannin are also contained within it (Indahyani, 2011). The tannin content in young and old coconut coirs is 5.62% and 4.28%, respectively (Lisan and Palupi, 2015). Tannins are substances known to have anti-nutritional effects and act as enzyme inhibitors. Thus, the hydrolyzed starch becomes low, as does the response to blood sugar (Matsushita et al., 2002). In addition, tannins can also trigger water absorption in the organism's body, which can lead to the organism's death due to water deficiency (Siamtuti et al., 2017). The presence of tannins in coconut coir gives it the potential to be developed as a natural insecticide. Matsushita et al. (2002) state that tannins are one of the compounds

that mosquitoes dislike. Mosquitoes are averse to tannins because they can lead to a reduction in starch hydrolysis, which can decrease their response to mosquitoes.

Mosquitoes are one of the insects that need to be controlled due to their role as disease vectors. Some of the diseases transmitted by mosquitoes include Dengue Fever, Chikungunya, Filariasis (Elephantiasis), Malaria, and Encephalitis (Cahyati et al., 2016).

In addition to coconut coir, frangipani flowers are also known to contain essential oil compounds such as citronellol, geraniol, eugenol, linalool, and phenethyl alcohol (Nurcahyo andPurgiyanti, 2017). These essential oil compounds can induce relaxation, thereby reducing stress, and repel mosquitoes (Megawati, 2016).

The presence of chemical compounds in coconut coir and frangipani flowers gives both materials a significant potential as mosquito repellents. One of the practical mosquito repellent formulations for application is in the form of lotion. On the other hand, so far research on the utilization of coconut coir has only focused on its use as krengseng coconut oil by leveraging its antioxidant properties (Dwestiwati and Sulistyowati, 2016), as bioethanol (Jannah and Aziz, 2017), as liquid fertilizer (Waryanti et al., 2013), and as a raw material for the production of alternative composite paper (Paskawati andRetnoningtyas, 2017). Meanwhile, previous research has shown that the materials used in the production of anti-mosquito lotion come from turmeric oil (Ameliana and Winarti, 2011), papaya leaf extract (Fadlilah et al., 2017), kenikir leaf extract (Suprianto et al., 2021), and essential oil from rosemary leaves (Farida, 2017). The production of mosquito repellent lotion from coconut coir extract combined with frangipani flowers has been carried out by Sriwulan et al. (2023), but its effectiveness in preventing mosquito bites has not yet been reported. Therefore, a study was conducted to test the effectiveness of lotion made from coconut cior and frangipani flowers as an anti-mosquito agent.

MATERIALS AND METHODS

This research was conducted through an experiment, where the treatment involved a comparison of coconut coir extract and frangipani flower extract in lotion formulations. This research was conducted over a period of 4 months, from May to August 2021. This research was conducted at the Biology Laboratory of Universitas PGRI Ronggolawe. The materials used in this study include coconut coir obtained from the Tuban Grand Market, frangipani flowers sourced from the Sukolilo Cemetery in Tuban Regency, aquades, stearic acid, triethanolamine (TEA), glycerin, nipagin, cetyl alcohol, and nipasol.

Maceration is used as a method for producing coconut coir extract, referring to the research by Sriwulan et al. (2023). Dry the coconut coir in the air until its moisture content reaches 5% and achieves a constant moisture level. The coconut coir is then ground and subsequently macerated with distilled water for 2x24 hours. Meanwhile, the extract of frangipani flowers is made by slicing the frangipani flowers and then drying the slices in an oven. The dried slices of frangipani flowers are ground and filtered using filter paper (120 mesh). The filtrate were then subjected to distillation with 5 repetitions. The lotion is made with a total preparation mass of 30 g following the formula in Table 1. The lotion preparation refers to the research by Sriwulan et al. (2023).

Table 1. Formulation of coconut coir lotion combined with frangipani flower extract.

Materials	T0	T1	T2	T3	T4	T5	T6
Coconut Coir Extract	0%	5%	5%	5%	10%	0%	commercial mosquito repellent lotion
Frangipani Flower Extract	0%	0%	5%	10%	5%	5%	
TEA	4%	4%	4%	4%	4%	4%	
Stearate Acid	15%	15%	15%	15%	15%	15%	
Glyserin	15%	15%	15%	15%	15%	15%	
Cetil alcohol	2%	2%	2%	2%	2%	2%	
Nipagin	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	
Nipasol	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%	
Aquadest	Add 30 ml	Add 30 ml	Add 30 ml	Add 30 ml	Add 30 ml	Add 30 ml	

The effectiveness testing of mosquito repellent lotion made from coconut coir combined with frangipani flower extract was conducted based on the testing guidelines for repellent formulations for human skin from the WHO (World Health Organization, 2009). The test was conducted by applying 10 ml of lotion preparation from each treatment onto the hands of the test subjects. The hands that had been coated with lotion were placed into a mosquito cage containing 25 fasting Aedes aegypti, which

had been starved for 1 day prior, and observations were made every 15 minutes for a duration of 60 minutes. The Protection Power of each treatment is calculated using the following formula:

$$\text{Protection Power} = \frac{C-T}{C} \text{X}100\% \text{ (World Health Organization, 2009)}$$

where:
C= The number of mosquitoes that landed on the hands of participants in the control treatment
T = The number of mosquitoes that landed on the hands of the experimenter with treatment

The data was then processed in the SPSS version 21 for windows program. Data processing with the Kolmogorov-Smirnov test, and continued with the one-way Anova test. Duncan's further test was carried out to determine the most effective treatment.

RESULTS

The results of the effectiveness test of anti-mosquito lotion in this study were shown by the percentage of the number of Aedes aegypti bites on the hands of the subjects (Table 1). The data were tested for homogeneity of variance and normality, where the results showed that the data were homogeneous and normally distributed sig. 0.2 (sig≥0.05). The data were then tested using a one-way ANOVA test and the results showed that there was a significant effect of the treatment in the form of a combination of coconut coir extract and frangipani flower lotion on mosquito bites on the hands of the subjects (Table 2), so it was continued with Duncan's further test.

Treatment group T3 showed the highest percentage in providing protection from Aedes aegypti bites compared to other treatments, namely 90.48%. However, these results were not significantly different from commercial Lotion (T6) as a comparison (92%) (Table 2).

Table 2. Protective power of coconut coir and frangipani flower extract lotion formula against *Aedes aegypti* bites.

Treatment	Number of mosquitoes	Protection Power (%) in minutes					Average (%)
		0	15	30	45	60	
T1	25	60	57.14	0	0	0	23.42[a]
T 2	25	80	57.14	33.33	33.33	0	40.76[ab]
T 3	25	100	100	100	85.71	66.67	90.48[c]
T 4	25	100	100	71.43	66.67	50	77.62[d]
T 5	25	100	100	85.71	66.67	66,67	83.81[de]
T 6	25	100	100	100	100	60	92[cf]

Note: Different notations indicate significant differences based on Duncan's test analysis (a=0.05).

The results of the one-way Anova test obtained a sig value of 0.000 <α, so that the difference in treatment had a significant effect on the protective power of the lotion developed in this study against *Aedes aegypti* that landed on the hands of the subjects. The results of the Duncan test showed that the T3 (1:2) treatment was the most effective formulation as an anti-mosquito lotion based on the parameter of protective power against the number of *Aedes aegypti* that landed on the hands of the subjects with a value of 90.48%.

DISCUSSION

The results of this study indicate that the combination lotion of coconut coir extract with frangipani flowers has the ability as an anti-mosquito. The results of statistical analysis using one-way ANOVA and Duncan's further test showed that the treatment in the form of different lotion formulations had a significant effect and was significantly different from the negative control in preventing *Aedes aegypti* bites. This shows that the use of coconut coir extract and frangipani flowers in formulations T1 to T5 has a repellent effect on *Aedes aegypti*.

Based on the data in Table 2, it is known that the highest percentage of lotion protection power is T6 which is the positive control in this study (92%). The high mosquito bite prevention power in the T6 group is because the commercial lotion product used as a positive control in this study has been widely known for its mosquito repellent power. The commercial lotion contains an active ingredient in the form of DEET (Diethyltoluamide) at a concentration of 130g/L (Wirastuti, 2016). The presence of DEET in the commercial lotion used as a positive control in this study causes disruption of neurons and receptors in the mosquito's antennae and mouthparts, where these receptors play a role in detecting chemical signals (Lee et al., 2010). However, DEET is a corrosive substance that is toxic and can harm

non-target organisms, including humans (Arrizqiyani et al., 2020). Long-term use of DEET can also trigger side effects such as erythema, skin irritation, pruritus, respiratory depression, seizures, and coma (Putri et al., 2022). Chang et al. (2013) stated that topical dermatological preparations must provide a guarantee of safety for their users, where the use of chemicals in them is not allowed in large quantities, because it is feared that it will potentially cause irritation. Therefore, exploration of natural ingredients as a substitute for DEET is important.

In group T3, the ability to prevent mosquito bites was also high and not significantly different from T6 (Positive control). This shows that the active ingredients from coconut coir extract and frangipani flowers with a ratio of 1:2 are able to prevent mosquito bites as well as T6. The active ingredients in coconut coir extract include tannins, saponins, steroids, polyphenols, flavonoids (Anina, 2021; Israel et al., 2011; Mazaya et al., 2020) which are ingredients known to have repellent effects against mosquitoes. Meanwhile, the use of frangipani flower extract as a combination of coconut coir in this study is based on the results of previous studies, which found the presence of active ingredients in the form of steroids, alkaloids, flavonoids, terpenoids, glycosides, and tannins (Fahmi, 2022; Muchtar, 2022; Suari et al., 2021b). The results of distillation of frangipani flowers obtained essential oils from the nerolidol, linalool, geranyl acetate, 2-hydroxy-phenylmet, geraniol, and benzoic acid groups (Firdaus & Saputro, 2012; Sari et al., 2014). Several studies related to the use of frangipani flowers as repellent ingredients have also been conducted, including Sari et al. (2014) who found that frangipani flower essential oil has repellent activity against *Aedes aegypti*; Enggarwati (2019) who obtained the results that a concentration of 15% ethanol extract of red frangipani flowers has the same potential as DEET as a repellent against *Culex* sp.; Banne et al. (2022) who have developed a repellent from white frangipani flower essential oil in the form of a spray preparation; Indriana and Suharti (2019) used a combination of frangipani leaves and flowers as a repellent for *Culex* sp.

The compound content in coconut coir extract and frangipani flowers has repellent activity. According to Matsushita et al. (2002) and Lutfiah et al. (2024), where tannin is said to be one of the compounds that mosquitoes do not like, because tannin can reduce starch hydrolysis so that it can reduce the response in mosquitoes. Djilali et al. (2021) also added that tannin is responsible for astringent properties and has insecticidal effects. As an astringent, tannin reduces tactile stimulus so that it acts as an antifeedant. Astringency in the insect's mouth is caused by protein precipitation in saliva and mucosal surfaces. According to Acheuk et al. (2017), tannin has larvicidal and repellent properties.

In addition to tannins, the presence of saponin compounds, both in coconut coir and frangipani flowers extract, causes inhibition of insect feeding stimuli, in this case the *Aedes aegypti*. Meanwhile, polyphenol compounds are respiratory inhibitors, so they will interfere with the oxygen supply to insect cells (Suari et al., 2021). Essential oils in frangipani flowers are also known to be able to repel mosquitoes, in addition to providing a distinctive fragrance to the lotion.

The aroma of essential oils in frangipani flowers can work by affecting chemoreceptors in the cilia between mosquito antennae, which then bind to Odoran binding receptors (OBPs) and are carried to the olfactory receptor neurons (ORNs). The aromatic molecules will then bind to G protein couple receptors which cause conformational changes in the G-protein. This mechanism is responsible for nerve depolarization, so that electrical impulse transmission will occur to the mosquito antenna lobe. The response resulting from a series of reactions is a rejection response. This causes a repellent effect from materials containing these compounds.

Previous research using other materials with the same secondary metabolite content was also conducted by Putri et al. (2022), which found that there was a repellent effect of lime peel extract on adult *Aedes aegypti*. Lime peel extract itself is known to contain flavonoids, tannins, saponins, essential oils, steroids, and alkaloids. Likewise, the research of Zen and Asih (2017) found that 10% tahi kotok flower extract can provide protection against *Aedes aegypti* bites up to 88.86%.

CONCLUSION

This study concluded that lotion with a combination of coconut coir and frangipani flowers extract has activity as a repellent against *Aedes aegypti*. The lotion formulation treatment showed a significant difference in preventing *Aedes aegypti* bites, where the T3 treatment (coconut coir extract: frangipani flower extract = 1: 2) was the most effective treatment in preventing *Aedes aegypti* bites with a percentage of protection power of 90.48%.

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CONFLICT OF INTEREST

There is no conflict of interest

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