Determining The Effectiveness Of Neem And Papaya Leaves As Mosquito Repellent Coil

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Abstract. The fatality rate of children from ages one (1) to four (4) years old has increased due to mosquito-borne diseases, specifically dengue. Mosquitoes may transmit deadly diseases such as Yellow Fever, Dengue, Malaria, Filarial and Japanese Encephalitis through their bites, which may affect not only people but also the animals. Due to this, repellents such as mosquito coils must be used to avoid contact with mosquitoes. However, burning one inorganic coil is equivalent to smoking up to 137 cigarettes, which shows that the usage of mosquito coils are bad for the health since it can cause lung cancer, acute chronic health risks and may transmit infectious pathogens. In order to address the urgency and importance of such health issues, an experimental study was conducted using Neem and Papaya Leaves as primary components of a mosquito coil. The researchers aimed to substantiate the effectiveness of a mosquito coil using different botanical materials. This study is designed to protect and contribute to a healthier society by way of controlling if not combatting the growing population of mosquitoes, hence, lower the probability of people, especially children, to get infected with mosquito-borne diseases. The effectiveness of an organic mosquito coil, together with other factors such as cost, longevity, flammability, odor, durability, and effectiveness are evaluated in this study.

1. Introduction
Mosquitoes have always been a threat to human health because it is the root cause of numerous deadly diseases in the world for over decades [1]. Through the bite of a mosquito, vector-borne diseases such as malaria, dengue fever, yellow fever, Japanese encephalitis, Rift valley fever, Zika virus, and Chikungunya can be obtained [2].

Incremental human migration and travel, climate change, urbanization and social changes became factors for the reappearance of dengue cases. Presently, severe cases of dengue in more than 100 countries are endemic wherein the most extremely affected regions are America, Southeast Asia, and Western Pacific. As presented by state members, beyond 1.2 million in 2008 and over 3.2 million in 2015 are reported cases on the regions mentioned previously. Explosive outbreaks are also happening aside from the continuous surge in the number of reported cases [3].

Dengue is described as a tropical and subtropical mosquito-borne viral disease [4]. Therefore, Philippines considered this as a major health concern, in fact an all-year round disease in the country [4]. It was also reported during the year 2008, that the Philippines was one of the countries among the Western Pacific Region with the highest number of dengue cases and deaths [4]. Cases of dengue and...
several outbreaks were reported by all regions which occurred mostly in provinces and municipalities during the year 2010. A total of 135,355 cases were recorded which was 135% greater than that of 2009 with 57,636 cases [5].

A mosquito coil is one of the home insecticides that has a large share of value because it is affordable and efficient to use. It does the job quickly by burning, and as soon as the smoke emits on the atmosphere, no mosquito can enter the room [6].

The purpose of a mosquito coil is to create an odor barrier. The odor barrier creates a zone where it serves as a shield for the host from the insects. This is how the mosquito coil prevents disease transmission to humans/animals [7].

Mosquito Coils were used by consumers in order to protect themselves from mosquitoes, but the smoke emitted by this product contributed to the 50% of lung cancer deaths in Taiwan [8]. A study conducted says that higher frequency of burning mosquito coils increase the risk of lung cancer, making it harmful for the health of humans [8]. Also, long-term exposure to the smoke emitted by the mosquito coil can result to asthma and wheeze in young people [9].

An ideal mosquito repellent should protect humans from being bitten by insects in a long duration without causing health implications or reactions to the user exposed to the material [10]. Inorganic mosquito coils consist of fine and ultrafine particles, PAHs, VOCs, and aldehydes, with high irritation or suspected harmful effects [11]. Exposure to these pose both acute and chronic health risks [8-10].

Neem leaves consist of metabolites with strong and dominant effects on insects. Its plant has been used by some farmers in the ancient times for pest control due to its component called “azadirachtin” [12]. According to a study conducted on testing the effect of Azadirachta indica leaves on mosquitoes, after experimentations, it was concluded that the presence of Neem delayed the molting period of the larvae making it an effective alternative to conventional insecticides. The study has proven that Neem has biologically active components that show insecticidal activity, making it applicable as a mosquito controlling agent [13].

According to a study conducted by Malathi & Vasugi [14], papaya leaves are used as a remedy against various diseases such as asthma. The findings of the investigation have shown that the leaf, bark, root and seed of the Carica Papaya possess larvicidal and repellent activity against mosquitoes [14]. In an experiment conducted by Sesanti et.al. [15], bitter substances of alkaloid carpain extracted from the Papaya leaf is not favored by mosquitoes.

According to a study and experiment conducted on the anti-mosquito activity of Neem and Papaya leaf extracts, the mixture of Neem and Papaya leaf extracts showed the highest mortality rate than all the other extracts. Secondary metabolites namely: steroids, tannins, coumarins, proteins, alkaloids, and amino acids contribute to the larvicidal activity of mosquitoes [16].

Thus in this work, The authors focused on the comparison of two different kinds of mosquito coil, particularly inorganic coil having DEET as a component and organic coil made from Neem and Papaya Leaves. Hence, other repellents such as lotion, spray and patch were not part of this study. Also, the researchers chose Aedes Aegypti as the main subject of the study. Furthermore, the factors that the researchers included are its effectiveness and health concerns.

2. Methodology

2.1. Research Design
The researchers used a comparative type of design since it attempted to determine the extent of the relationship between inorganic and organic mosquito coils. This study was defined by the domination of an independent variable to measure and interpret its influence on a particular dependent variable. In this study, the dependent variables were the two different coils namely: Organic and Inorganic Coil.

2.2. Subjects and Study Site
The researchers used Aedes Aegypti as the main test subject of this study. This type of mosquito is common in the Philippines and is a carrier of different mosquito-borne diseases, such as Dengue fever,
Zika virus, Yellow Fever, and Japanese Encephalitis. However, the researchers obtained the said mosquitoes as larvae therefore, it is disease-free. The researchers focused the study in determining which among the two repellents, Organic and Inorganic Mosquito Coil, has the best potential to repel mosquitoes. The Inorganic Mosquito Coil, which contains DEET, a major ingredient to repel mosquito, is the cheapest and most commonly used product in the market. This ingredient is capable of causing irritation on the mosquito’s sensors to avoid smelling their prey. On the other hand, the Organic Mosquito Coil, composed of Neem and Papaya Leaves, has the same potential as the DEET since these plants contain metabolites that have a strong effect on insects, in general. For the execution of the experiment, the researchers used 30 grams of blended neem leaves, 15 grams of blended papaya leaves, 30 grams of pulverized dried neem leaves, 45 grams of pulverized candle, 45 grams of ethyl alcohol, and 15 grams of cornstarch.

The researchers decided to execute the experiment in a controlled environment in order to compare the two types of mosquito repellent coil. This was done to lessen the variables that cannot be controlled by the researchers during the experiment, thus, allowing both repellents to have even chances of repelling the mosquitoes during the fifteen (15) trials. The experiment was conducted inside a carton box with a cylindrical wall inside covered in plastic and topped with a net with the box having the dimensions of 10in x 10in x 15in. Both of the repellents were placed inside their designated containers in order to obtain the fastest effect in repelling mosquitoes. Before the release, the mosquitoes were placed inside one (1) at a time and then the researchers observed if the mosquitoes would change their location while inside the container provided that both coils were lighted.

2.3. Data Gathering Procedure

The mosquito larvae was purchased from University of the Philippines — Los Baños (UPLB), Aedes Aegypti, which was the main subject of the study. The authors waited for 3-5 days for the mosquito larvae to hatch upon receiving it. Next once the mosquito has hatched, the following was done. The mosquitoes were divided into two groups. The first fifteen (15) mosquitoes were placed inside a cage together with the organic mosquito coil and the other half with the inorganic mosquito coil. Each mosquito was exposed to two (2) trials in the experiment. The mosquitoes were tested individually inside the cage. By doing that, the researchers trapped one mosquito inside a cylindrical container and transferred it inside the cage with the mosquito coil covered with a net. The researchers observed the time the mosquito changes its location while it was inside the cage where the inorganic/organic coil was lit. As soon as the mosquito is transferred inside the cage, the researchers waited for it to stay on one place before starting the stopwatch. The researchers started the stopwatch when the mosquito left its location inside the cage. This step is repeated once to suffice the two (2) trials needed to be undergone by each mosquito. Each mosquito was killed after the researchers have gathered the lapse time of the two (2) trials. The researchers have conducted a total of thirty (30) trials for the fifteen (15) mosquitoes in each cage with the inorganic coil and another thirty (30) trials for the last fifteen (15) mosquitoes in a different cage with the organic coil.

The data were gathered through tallying the number of seconds the mosquitoes leave the perimeter of the organic and inorganic mosquito coil inside the cage. The unusual activity of the mosquito, leaving the vicinity of the coil means that the mosquito is affected by it. The experiment and data were raw and legitimate as they were gathered directly from the effect of the mosquito coil products used on the test subjects thus, making it genuine and reliable in the comparison of the organic and inorganic mosquito coil.

2.4. Mode of Data analysis

The data acquired from the experiment were compiled and analyzed using different data analyses available in Microsoft Office - Excel. Assuring that the results placed in the data analysis software are credible. F-test is used when the sample size is less than 30. It tests if two population variances are equal or not by comparing the ratio of two variances and identify the type of t-test to use. The researchers did fifteen (15) trials using two types of mosquito coil repellents to the subject, and
acquired significant data, which is the number of seconds the mosquito changes its location due to the smoke, emitted by the two different coils that made their sensory sensitive and irritated. These fifteen trials resulted to fifteen different data which were then evaluated and analyzed using the t-test analysis too.

3. Result and Discussion
The research’s primary objectives were to determine the effectivity of Neem and Papaya leaves to create an organic mosquito coil and then examine whether it repels more mosquitoes as compared to the existing inorganic coil. The researchers thought of measuring the number of seconds the mosquitoes would change its location signifying its reaction when exposed to the coil to further support the above-mentioned goals. In addition to that, the researchers constructed the hypothesis to be further discussed below.

The experimental subjects were divided into two groups, one half was examined with the use of the organic coil while the other half with the inorganic coil. A total of 30 mosquitoes were tested in the same controlled environment and procedure, except that one was organic and the other was inorganic. There were two trials per mosquito and the data measurement was based from the number of seconds the mosquito leaves from its present location using the different coils.

The F-Test and T-Test analysis was the most appropriate statistical tool when it comes to the data gathered through the above-mentioned experimentation since it involved less than 30 samples exposed in two different scenarios namely: The Inorganic and Organic Coil. Table 1 shows the F-test result and Table 2 shows the analysis of the result. An F-test was used in Microsoft Excel to determine if the raw data gathered has equal or unequal variances in order to know which among the types of t-tests would be used and proceed with the computations. The summary table above shows that the P-Value computed was greater than the significance level (α) signifying that the variances are equal. In addition to that, the F test statistic was less than the critical region therefore, accepting the null hypothesis that the variances are equal.

| Variable  | INORGANIC | ORGANIC |
|-----------|-----------|---------|
| Mean      | 12.50166667 | 4.223666667 |
| Variance  | 19.7586881  | 9.088119524 |
| Observation | 15        | 15      |
| df        | 14        | 14      |
| F         | 2.174122825 |         |
| P(F ≤ f) one-tail | 0.079239068 |         |
| F Critical one-tail | 2.483725411 |         |

Table 2. F-test Analysis of the Results

| H₀     | the population variance for the organic mosquito coil is equal to that of the inorganic one |
|--------|-----------------------------------------------------------------------------------------|
| H₁     | the population variance for the organic mosquito coil is not equal to that of the inorganic one |
| α      | 0.05                                                                                   |
| P-value| 0.079                                                                                  |
| Conclusion | Accept H₀ since p-value > α therefore, the variances are EQUAL                        |
After learning that the variances were equal through the F-Test, the T-Test Two-Sample Assuming Equal Variances was selected in order to determine whether the hypothesis of the researchers were correct or not. As seen in the summary table 3 and Table 4, the P-value was less than the significance level (α) thus rejecting the Null Hypothesis (Ho) and accepting the alternative hypothesis stating that the mean number of seconds the mosquito leaves from its present location using organic coil is less than that of the inorganic one. The researchers may also conclude that the data was highly credible due to its low p-value. In addition to that, the test statistic t is greater than the critical region making the inequality invalid also, rejecting the null hypothesis. With all these being said, the organic coil repels the mosquito more than the inorganic coil since the mosquitoes change position faster and away from the coil.

### Table 3. T-test: Two-Sample Assuming Equal Variances

| T-Test: Two-Sample Assuming Equal Variances |
|--------------------------------------------|
| Variable | ORGANIC | INORGANIC |
| Mean     | 4.223666667 | 12.50166667 |
| Variance | 9.088119524 | 19.7586881 |
| Observations | 15 | 15 |
| Pooled Variance | 14.42340381 | |
| Hypothesized Mean Difference | 0 | |
| df | 28 |
| t Stat | -5.969283048 |
| P(T<=t) one-tail | 0.0000009939 |
| t Critical one-tail | 1.7011309343 |
| P(T<=t) two-tail | 0.0000019878 |
| t Critical two-tail | 2.048407142 |

### Table 4. T-test: Analysis of Results

| T-Test: Two-Sample Assuming Equal Variances |
|--------------------------------------------|
| H₀ | μ\text{organic} ≥ μ\text{inorganic} |
| H₁ | μ\text{organic} < μ\text{inorganic} |
| α | 0.05 |
| C.R. t < | -1.7011 |
| Test Stat t | -5.9628 |
| P-value | 0.0000009939 |
| Conclusion | Reject Ho since P-Value < α therefore, the mean number of seconds the mosquitoes change its designated place with the presence of the organic coil is less than that of the inorganic one |

In addition to that, the researchers’ also considered the cost per box of both organic and inorganic mosquito coils. Showing in the Table 5 is the average cost of one (1) box containing 10 coils.

### Table 5. Cost per Box of Mosquito Coil

| Organic Mosquito Coil | Inorganic Mosquito C |
|-----------------------|----------------------|
| Php 30                | Php 25               |
In order to measure the flammability of the mosquito coils, with the use of a stopwatch, the researchers recorded the number of seconds it takes the coil to light up. Based on Table 6, it is seen that the organic mosquito coil takes four (4) to six (6) seconds while the inorganic mosquito coil takes six (6) to eight (8) seconds. With that being said, the organic mosquito coil lights up faster than that of the inorganic one.

Table 6. Flammability of Mosquito Coil

| Organic Mosquito Coil | Inorganic Mosquito Coil |
|-----------------------|-------------------------|
| 4-6 seconds           | 6-8 seconds             |

4. Conclusion
The authors focused evaluating the performance of two different kinds of mosquito coil, particularly inorganic coil having DEET as a component and organic coil made from Neem and Papaya Leaves, which is more eco-friendly and less harmful to human. The researchers first performed the F-test analysis to identify what type of T-test analysis, assuming equal variances or assuming unequal variances, was appropriate to use in this experiment. Since, the F-test results showed that the p-value is 0.079 and the significance level (α) is 0.05, p-value is greater than the significance level (α), therefore, the researchers concluded that the variances were equal. Hence, assuming equal variances analysis for T-test tool was the appropriate analysis to use. After performing the T-test analysis with the use of the data from the experiment conducted, the researchers obtained a p-value of 0.0000009939 and used a significance level (α) of 0.05. Thus, p-value is less than the significance level (α), therefore, the researchers’ conclude that the organic coil is more effective in repelling mosquitoes compared to the inorganic coil. With all the positive and credited results obtained from the experiment, the researchers accomplished all primary objectives stated at the beginning of this study, which were to determine the effectiveness of Neem & Papaya Leaves as mosquito coil that can drive or eliminate mosquitoes and/or its larvae and statistically examine and verify which between the organic and synthetic product repels more mosquitoes.

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