International Journal of Recent Advances in Multidisciplinary Topics
Volume 5, Issue 5, May 2024
https://www.ijramt.com | ISSN (Online): 2582-7839

AppleTron: Natural Mosquito Incense Stick using Citronella Oil and Sugar Apple Skin

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***Abstract*: The AppleTron is a natural mosquito incense stick designed to combat mosquitoes, which are carriers of diseases like Malaria, Dengue fever, Zika, and West Nile virus. This product utilizes citronella oil and sugar apple skin, both known for their mosquito-repelling properties. The development of AppleTron aligns with growing concerns over the environmental and health impacts of synthetic mosquito repellents. This research focused on the efficacy of citronella oil and sugar apple skin, excluding other plant and fruit materials. Citronella oil, a primary ingredient in AppleTron, has been well-documented for its ability to repel mosquitoes, lessening their ability to prey-finding and spread diseases. Sugar apple skin contains compounds that enhance the repellent effect. By combining these two natural ingredients, AppleTron offers a dual-action approach to mosquito control. Studies have shown that natural alternatives like citronella oil can effectively repel mosquitoes without the drawbacks of synthetic chemicals. Research indicates that essential oils such as palmarosa, lemongrass, and citronella, as well as mylol—a chemical oil—can provide almost protection against some mosquito species (Pollack, R., Kiszewski, A., & Spielman, A. 2002). Similar research has demonstrated the efficacy of natural repellents against mosquito species like Anopheles stephensi and Aedes aegypti, crucial vectors for diseases affecting human health. Testing data showed that AppleTron significantly reduces the number of mosquitoes attracted to honey bait in its presence. Statistical analysis confirmed a significant reduction in mosquito numbers, reinforcing the product's efficacy. AppleTron addresses the need for sustainable solutions to combat mosquito-borne diseases without harming the environment or human health.**

***Keywords*: AppleTron, Citronella oil, Sugar apple skin, Incense stick, Mosquito repellent.**

1. Introduction

Mosquitoes are not only a nuisance but also pose a significant threat to human health as carriers of various diseases such as malaria, dengue fever, the Zika virus, and the West Nile virus. In practically every faith, burning incense sticks is a long-standing custom used during various rites. In the past, it had been utilized solely for divine purposes but as time goes on, it is now utilized for ancillary functions like bug repellent and air fresheners (Yadav, V., et al 2020). The Flaviviridae family of RNA viruses transmitted by Aedes mosquitoes, is the primary cause of dengue (Wadhwa, A., Shah, A., Madhuri, K., Tyagi, B., & Mudgal, M. 2020). Common signs and symptoms include circulatory shock, hemorrhagic episodes, cutaneous rashes, muscle and joint pain, acute-onset high fever, and myalgia. A prompt and precise diagnosis is necessary to lower mortality.

Bahadur, A., Chandrashekar, K. & Pai, V. (2020), developed a safer, cheaper, and simple mosquito repellent using dried powdered herbs and incense. The repellent is scented with essential oil and released into the air when ignited. When it comes to the testing for potency, the incense sticks were found to be effective in controlling mosquitoes, reducing the use of synthetic chemicals and promoting environmental and human health. As reported by Ojewumi, M., Obanla, O., & Atauba, D. (2021), it has become clear that synthetic medications and repellents are hazardous to both people and the environment. Repellents are no longer effective since mosquitoes have become used to these aside from the fact that these are costly, and nonbiodegradable. With these shortcomings, there is an urgent need for a replacement eco-friendly plant-based insecticide. According to a study conducted by Abdullahi, R., Dahiru, S., Rabiu, A. & Mohammed, D. (2020), 144 active patents were found in the patent literature on mosquito repellent innovations using 67 plant essential oils, and 9 glyceridic oils listed in at least 2 patents. In addition, a metagenomic study on Aedes albopictus mosquitoes in Ticino, Switzerland, to identify 13 contagions from seven different contagion families and several unclassified viral taxa was conducted by Kuback, J., Flacio, E., Qi, W., Guidi, V., Tanolla, M., & Fraefel, C. (2020) which aim is to identify new viral agents within Aedes aegypti mosquitoes in the Amazonian region. The study of Bhat, N., and Agrawal, A. (2020) involved testing the trap using four cardboard strips treated with sweet solutions, with the most significant results seen with fermenting solutions. Additionally, the traps attracted male and non-gravid female mosquitoes to a certain extent. They were equipped with UV lamps and a photocatalytic plate to mimic human hosts by emitting carbon dioxide, heat, and moisture.

Citronella oil is known for its strong and distinctive aroma and has been traditionally used in candles, lotions, and sprays as a mosquito repellent. It contains compounds such as citronellal, geraniol, and citronellol, which are believed to repel mosquitoes by masking the attracted scents. Additionally,

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citronella oil has low toxicity for humans and is considered safe for topical use (Wilson, D., 2019). Baynes, R. (2014) mentioned that citronella oil has been noted as a highly effective mosquito repellent. Although, it's moderate irritancy and quick volatility prevent its topical use. Based on another case study from Sajo, M., Song, S., Bajgai, J., Kim, Y., Ahn, D., Khanal, N., & Lee, K. (2015) in the Tikapur Municipality of the Kailali district, Nepal, a repellence activity test was performed by using 100 citronella oil (Cymbopogon winteratus). The outgrowth measures were the protective effects of citronella oil against mosquitoes, the number of mosquito bites, the repellency percentage, the smell satisfaction, and the irritation level.

Using natural mosquito repellents like as citronella oil can give sufficient protection against mosquitoes. Moreover, it could repel Anopheles stephensi and Anopheles dirus for 8 and 6 hours, respectively, without causing effects on human health (Asadollahi, A., Khoobel, M., Ramazani, A., Mosawi, S., & Azarmi, S. 2019). Furthermore, Halim, R., Lesmana, O., & Sitepu, F. (2021) mentioned that citronella oil has an active component in repellent products which can give a protection of 85.2% for over to 6 hours against Aedes aegypti bites which are dangerous for human health.

Citronella is a source of essential oil obtained via steam distillation. Moreover, citronella oil has a significant yield and may be used in a variety of fields. Additionally, it can be used as a substance in lotions to ward off mosquitoes (Handayani, P., Hartanto, D., Eden, W., Anyelir, D., & Salsabila, G., 2022). The overall objective of this work was to encapsulate citronella oil (CO) in a nanostructure lipid carrier (NLC) in order to produce a topical repellent with an effective safety profile that concentrates on preventing skin penetration and longlasting skin efficacy. Geraniol, citronellal, and citronellol were found to be the main chemical components in the investigated CO and were subsequently utilized as labels for the in vitro skin permeation testing (IVPT) (Higuchi, C., et al 2023).

On the other hand, according to the study conducted by Padmanabhan, P., & Paliyath, G. (2016) which aims to utilize the potential of sugar apple skin as an abundant and readily available source of natural mosquito incense stick compounds, sugar apple skin contains various bioactive compounds, including acetogenins, alkaloids, and flavonoids, which have been studied for insecticidal properties. While it is consumed for its nutritional value, the skin is often discarded.

As stated of Novasari, P. & Sasongkojati, S. (2018), the concentration of 50 detergent in sugar apple skin had the greatest impact on reducing as many as 36 Aedes aegypti mosquitoes died after exposure. Therefore, the aim of this study is to produce a natural mosquito incense stick using citronella oil and sugar apple skin to reduce the carriers of various diseases such as malaria and dengue fever.

A. A. Statement of the Problem

Specifically, the researchers sought to answer the following questions:

1. How may the natural mosquito incense stick be described in terms of:
   1.1 Dimension; and 1.2 Diameter?
2. How long does the AppleTron last?
3. How many mosquitoes will take the honey bait without AppleTron?
4. How many mosquitoes will take the honey bait with AppleTron?
5. Is there a significant difference in the number of mosquitoes who will take the honey bait with or without AppleTron?

Hypothesis:

Null: There is no significant difference in the number of the mosquitoes who took the honey bait with or without AppleTron.

B. Significance of the Study

The study will be beneficial for the following:

People in the Community: This study will be beneficial for the community owing to the fact that it will provide sufficient information to repel the areas where mosquitoes rest. In addition, it can assist the community in limiting the transmission of illnesses and preserving individuals from infections like malaria.

Health Agencies: This study will benefit health agencies by assessing the health risks of the population. Additionally, this will aid these agencies in gaining more knowledge about how to reduce the spread of disease brought by mosquitoes as well as to promote health.

Future Researchers: This study will aid future researchers in looking for a guide and reference about citronella oil and sugar apple skin as a natural mosquito incense stick. Additionally, this study has a timely and current review of related literature to support its analysis.

C. Scope and Delimitation

The study focused on developing the citronella oil and sugar apple skin as the main materials in making the AppleTron, a natural mosquito incense stick. This evaluates the range of possibilities and evaluation through testing and observation of the number of the mosquitoes who took the honey bait with or without AppleTron.

The researchers excluded the other types of plant and fruit materials other the citronella oil and the sugar apple skin as the researchers consider the limited number of financial resources and time framework.

2. Methodology

A. Research Design

This study used a quantitative method. This method involves the design that was chosen, observed and analyzed mosquito behaviors, and innovative development of AppleTron for groundbreaking mosquito control solutions. The quantitative research is a method in which diverse numerical data are collected through various methods and then statistically analyzed to aggregate and compare the data, or show relationships among data (Sreekumar, D. 2023). According to Bhandari, P. (2020), it can be used to find patterns and averages, make predictions, test causal relationships, and generalize

results to wider populations. The purpose of quantitative research is to validate or test a theory or hypothesis and that of qualitative research is to understand a subject or event or identify reasons for observed patterns (Sreekumar, D. 2023).

The research design chosen is developmental research. Developmental research, as opposed to simple instructional development, has been defined as the systematic study of designing, developing and evaluating instructional programs, processes and products that must meet the criteria of internal consistency and effectiveness. In addition, it employs a variety of research methodologies, applying any tool which meets certain requirements. Process studies may adopt descriptive survey methods (Richey, R. 2023).

The researchers employed a systematic approach to observe, document, and analyze the characteristics, and behaviors of a subject or group without manipulating variables (Siedlecki, S. 2020). According to Mugenda, O. and Mugenda, A. (2003), and Siedlecki, S. (2020), a descriptive research design is essentially an approach to study which attempts to collect data in a systematic manner to describe a phenomena, situation, or population that is being studied. Common methodologies include surveys, which use questionnaires to collect data on attitudes and behaviors; case studies, involving in-depth examinations of specific instances; content analysis, for interpreting media or textual content; and observational methods, enabling direct observation of subjects in their natural environment (Siedlecki, S. 2020).

B. Locale of the Study

The testing and development of the study was conducted within the community of Poblacion, Arayat, Pampanga to ensure the researchers' availability of the materials needed and safe place for testing as well as the effectiveness of the research within its intended community context. The implementation phase was carried out in Arayat, Pampanga, aiming to repel mosquitoes.

C. Research Instrument

A *caliper* was used to measure the exact diameter of the incense stick, as for the length of the incense stick, the researchers used a *tape measure.* The *weighing scale* was used to measure the exact weight of the ingredients. The *testing box* used in observing and to be able to count how many mosquitoes took the honey bait with or without

AppleTron. In addition, in able to determine on how long does the AppleTron last, a *timer* was used to measure the time elapsed or the external events that occur for a specific time interval and how many mosquitoes who took the honey bait with or without AppleTron, an *observation sheet* was used.

D. Research Materials

In the prototype, the researchers used the following materials to develop the AppleTron

- Citronella oil is the main ingredient for the mosquito incense stick.
- Makko powder was used to bind all the ingredients together. Sugar apple skin is the main ingredient for the mosquito incense stick
- Incense sticks were used as the foundation of the Appletron.
- Dehydrator is used to dry and pull out the moisture in the sugar apple skin.
- Mosquito Catcher is used to contain the mosquitoes for testing.

E. Research Procedure

1) Making of the AppleTron

a) Pulverizing

To create the incense sticks, the researchers' first essential step was the pulverization of 1 whole sugar apple skin using the blender. This finely ground material played a pivotal role in enhancing the aromatic quality and composition of the final incense product.

b) Mixing

To ensure precise quantities of the citronella oil, powdered sugar apple skin, and makko powder, the researchers used a table spoon in measuring. Then, the researchers combined the powdered sugar apple skin and makko powder. Thorough mixing the dry ingredients ensured even distribution. Then, researchers gradually added the citronella oil and water to the dry mixture, and continuously stirred to create a consistent blend.

c) Molding

Molded the mixture of powdered sugar apple skin, citronella oil, and makko powder into thin sticks using only bare hands. Ensured precise sizing by using caliper and weighing scale before allowing the ingredients to dry, which creates mosquito incense with natural repellent properties.

2) Testing

After creating the AppleTron, the researchers tested the incense stick on how long does the AppleTron will last, if it is efficient in repelling mosquitoes and how many mosquitoes will take the honey bait.

F. Ethical Considerations

Administrative Order No. 281, S. 1996:

Launch of the "National Tepok Lamok and Dengue Sapok" program. The state shall protect and promote the right to health of the people and instill health consciousness. There is a need to prevent and control mosquitoes to address the increase in dengue fever from entering living spaces. This requires local government agencies and private sectors that provides guidance and support for health issues, including control program against diseases like dengue.

FDA Advisory No. 2021-0957:

Pursuant to Book II, Article I, Section 1 (a) of the Rules and Regulations Implementing Republic Act No. 9711, known as the

"Food and Drug Administration Act of 2009". The use of violative product may pose health risks to human health. Potential hazard may come from harmful toxic ingredients that may pose danger to human and animal health. The use of pesticides to control mosquitoes might inadvertently harm beneficial insects, disrupt food chains, or contaminate water sources. Ethical decision making in this context requires

weighing the benefits of mosquito control, such as disease prevention, against the potential ecological harm. It also involves exploring alternative methods, like environmentally friendly repellents, to minimize adverse effects on nontarget organisms and maintain a balanced ecosystem.

The researchers took considerations on such laws and institutional and governmental policies, prioritized environmental sustainability, ensuring minimal impact on ecosystems, thoroughly assess materials for safety and health, in able to confirm that AppleTron is safe. A comprehensive safety and health assessments of its materials has been conducted in able to affirm AppleTron's safety as a natural incense stick. To be able to consider the needs and ensure benefits, researchers engaged with local communities. Educate users for informed choices and minimize waste. Adhere to regulatory compliance and continuously monitor for any issues, taking prompt corrective actions. Integrating these ethical principles ensured that AppleTron aligned with responsible and sustainable practices, positively impacting public health and the environment. Legal considerations are crucial to ensure ethical practices and compliance with regulation to ensure the human treatment of living organisms and to maintain integrity. Human treatment, insects should be treated with respect and subjected to the least amount of harm necessary for the research.

3. Results

This section describes further details about the results and discussion of the study. The researchers explained all the data and the table of results gathered with regards AppleTron.

Table 1
Dimensions of the AppleTron

Dimensions	Measurements
Length	250 mm
Diameter	3 mm
Weight	1.60 grams

Table 1 represents the physicality of the AppleTron in terms of: length, diameter, and weight. The researchers used different equipment, such as a caliper, tape measure and a weighing scale, to gather the necessary data. The measurement conducted by the researchers showed the average of the dimensions that the length is 250 mm, the diameter is 3 mm and the weight of the AppleTron is 1.60 grams.

Table 2
AppleTron in terms of Length

AppleTron	Measurements
Test 1	250 mm
Test 2	250 mm
Test 3	250 mm
Test 4	250 mm
Test 5	250 mm
Test 6	250 mm
Test 7	250 mm
Test 8	250 mm
Test 9	250 mm
Test 10	250 mm
$\bar{x}$	250 mm

Table 2 represents the length of the AppleTron. The measurement conducted by the researchers showed the average of the length of the AppleTron is 250 mm.

Table 3
AppleTron in terms of Diameter

AppleTron	Measurements
Test 1	3 mm
Test 2	3 mm
Test 3	3 mm
Test 4	3 mm
Test 5	3 mm
Test 6	3 mm
Test 7	3 mm
Test 8	3 mm
Test 9	3 mm
Test 10	3 mm
$\bar{x}$	3 mm

Table 3 represents the diameter of the AppleTron. The measurement conducted by the researchers showed the average of the diameter of the AppleTron is 3 mm.

Table 4
AppleTron in terms of Weight

AppleTron	Measurements
Test 1	1.60 grams
Test 2	1.60 grams
Test 3	1.60 grams
Test 4	1.60 grams
Test 5	1.60 grams
Test 6	1.60 grams
Test 7	1.60 grams
Test 8	1.60 grams
Test 9	1.60 grams
Test 10	1.60 grams
$\bar{x}$	1.60 grams

Table 4 represents the weight of the AppleTron. The measurement conducted by the researchers showed the average of the weight of the AppleTron is 1.60 grams.

Table 5
Time duration of the AppleTron

AppleTron	Time Duration
Test 1	69 minutes
Test 2	69 minutes
Test 3	71 minutes
Test 4	72 minutes
Test 5	72 minutes
Test 6	73 minutes
Test 7	78 minutes
Test 8	82 minutes
Test 9	82 minutes
Test 10	83 minutes
$\bar{x}$	75.10 minutes

Table 5 represents the time duration of the AppleTron. The researchers used timer and calculator to gather the necessary data. The time duration conducted by the researchers showed that the highest time duration utilized by the researchers is 83 minutes and the lowest is 69 minutes. On the average, the time duration is 75.10 minutes.

Table 6
Number of mosquitoes who took the Honey bait without AppleTron

AppleTron	Number of Mosquitoes in Box A	Number of mosquitoes who took the Honey bait
Test 1	15 mosquitoes	5 mosquitoes
Test 2	17 mosquitoes	5 mosquitoes
Test 3	15 mosquitoes	8 mosquitoes
Test 4	16 mosquitoes	9 mosquitoes
Test 5	15 mosquitoes	10 mosquitoes
Test 6	15 mosquitoes	9 mosquitoes
Test 7	17 mosquitoes	14 mosquitoes
Test 8	16 mosquitoes	12 mosquitoes
Test 9	16 mosquitoes	9 mosquitoes
Test 10	17 mosquitoes	7 mosquitoes
$\bar{x}$	15 mosquitoes	8.80 mosquitoes

Table 6 represents the number of mosquitoes who took the honey bait without AppleTron. The researchers used timer and calculator to gather the necessary data. Based on the results, researchers showed the highest number of mosquitoes utilized was 17 mosquitoes and the lowest was 15 mosquitoes and having the average of 15.90 mosquitoes. On the other hand the highest number of mosquitoes who took the honey bait was 14 mosquitoes and the lowest was 5 mosquitoes. With the average of number is 8.80 mosquitoes.

Table 7
Number of mosquitoes who took the Honey bait with AppleTron

AppleTron	Number of Mosquitoes in Box A	Number of mosquitoes who took the Honey bait
Test 1	15 mosquitoes	0 mosquito
Test 2	16 mosquitoes	1 mosquito
Test 3	16 mosquitoes	0 mosquito
Test 4	15 mosquitoes	0 mosquito
Test 5	15 mosquitoes	3 mosquitoes
Test 6	15 mosquitoes	4 mosquitoes
Test 7	16 mosquitoes	6 mosquitoes
Test 8	16 mosquitoes	6 mosquitoes
Test 9	18 mosquitoes	5 mosquitoes
Test 10	17 mosquitoes	4 mosquitoes
$\bar{x}$	15.90 mosquitoes	2.90 mosquitoes

Table 7 represents the number of mosquitoes took the honey bait with AppleTron. The researchers used timer and calculator to gather the necessary data. Based on the results, researchers showed the highest number of mosquitoes utilized was 18 mosquitoes and the lowest was 15 mosquitoes and having the average of 15.90 mosquitoes. On the other hand the highest number of mosquitoes who took the honey bait was 6 mosquitoes and the lowest was 0 mosquito. With the average of number 2.90 mosquitoes.

Table 8 shown and presented above that the computed value of the significance 2-tailed is r = 0.000 which is less than the alpha level a = 0.05, which indicates that there is strong evidence to reject the null hypothesis because there is a significant difference between the two variables is 0 (zero).

This means that, there is a significant difference in the number of the mosquitoes who took the honey bait with or without AppleTron.

4. Discussion

The summary of findings states all the summarized results from the experiment and observation made and conducted by the researchers. The study aimed to produce or to introduce a product that can be of great help and advantage in repelling mosquitoes especially through the use of sustainable products and materials, and utilizing materials that can be used by most of the people.

The study is developmental and testing was done to check the validity and reliability of the product. Moreover, the study is focused on checking the effectiveness of the product, as well as how impactful the product. As for the dimension of AppleTron, the length is 25 mm, 3 mm in diameter, and 1.60 grams in weight. Furthermore, the testing time (in minutes), Testing 1 lasted for 69 minutes, Testing 2 lasted for 69 minutes, Testing 3 lasted for 71 minutes, both Testing 4 and 5 lasted for 72 minutes, Testing 6 lasted for 73 minutes, Testing 7 lasted for 78 minutes, both Testing 8 and Testing 9 lasted for 82 minutes, and Testing 10 lasted for 83 minutes. In average, the testing time lasted for 75.10 minutes. As for the testing without AppleTron, the average number of mosquitoes for the ten (10) testing conducted by the researchers is 15.90 mosquitoes and 8.80 mosquitoes is the average number of mosquitoes which were repelled. Meanwhile, for the testing with AppleTron, the average number of mosquitoes used for testing is 15.90 mosquitoes and 2.90 mosquitoes is the average number of mosquitoes which were repelled during the testing.

For the AppleTron time average duration is 75.10 minutes that ensures continuous release of mosquito-repelling compounds, offering protection over extended periods. This sustained release mechanism makes AppleTron a practical and reliable solution for reducing mosquito bites and minimizing the risk of mosquito-borne diseases such as malaria and dengue fever. As for the testing using SPSS, the computed value of the significance 2-tailed is r = 0.000 which is less than the alpha level a = 0.05, which indicates that there is strong evidence to reject the null hypothesis because there is a significant difference between the two variables is 0 (zero). This means that, there is a significant difference in the number of the mosquitoes who took the honey bait with or without AppleTron.

5. Conclusion

The researchers concluded that AppleTron is an ecologically friendly mosquito repelling product for safeguarding individuals against mosquito bites. The research aimed to create a solution that is not only eco-friendly but also accessible and practical for widespread use. Through a series of developmental stages and rigorous testing, the validity and reliability of AppleTron were thoroughly examined.

The findings demonstrate that AppleTron significantly

Table 8
Number of mosquitoes who took the Honey bait with AppleTron

	Levene's Test for Equality of Variances		T-Test for Equality of Means		
	F	Sig	T	df	Sig. (2tailed)
Equal variances assumed	.014	.906	4.977	18	.000
Equal variances not assumed			4.977	17.692	.000

enhances the repellent efficiency compared to scenarios without its use. The consistent and extended release of mosquito-repelling compounds over an average duration of 75.10 minutes ensures sustained protection, making it a viable option for individuals seeking long-lasting mosquito defense. This attribute is particularly beneficial in regions where mosquito-borne diseases such as malaria and dengue fever pose a significant health risk.

The statistical analysis using SPSS further reinforces the product's effectiveness. The results showed a substantial difference in the number of mosquitoes repelled when AppleTron was used, providing strong evidence to reject the null hypothesis. This statistical significance underscores the product's capability to reduce mosquito bites, thereby lowering the risk of disease transmission.

Generally, the researchers concluded that the AppleTron is an effective, reliable, and eco-friendly mosquito repellent. Its development marks a significant step forward in the fight against mosquito-borne illnesses, offering a practical solution that can be adopted by a broad audience. The research outcomes validate the product's potential to make a meaningful impact on public health and environmental sustainability

6. Recommendation

After a thorough examination and conducting studies with the AppleTron project, the following are the recommendations suggested to provide better understanding in repelling mosquitoes. For the future researchers, it is recommended (1) to use the same study for testing to have a better results, (2) to analyze its components for the better understanding of the product, and the researchers would recommend to (3) have an equal number of mosquitoes during testing to assess and have a more valid and credible testing and understanding of the results of the study. Moreover, the researchers would recommend to (4) use a molder to have a consistent weight and (5) form the AppleTron thicker to make the incense stick last longer and (6) add more citronella oil to the AppleTron for strong fragrance. Furthermore, it is recommended by the researchers (7) to also utilize observation type of study to assess the effectivity of the product.

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