The Potential of Coffee Grounds in Enhancing Lanzones (Lansium Domesticum) Peel as Mosquito Coil Repellent

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ABSTRACT

This research paper explores the potential of used coffee grounds in enhancing the repellent efficacy of lanzones (*Lansium domesticum*) peel in the formulation of eco-friendly mosquito coils. To addresses the increasing demand for sustainable control methods amidst the rising dengue cases, this study utilized an experimental design wherein the mosquito coil was formulated using 75% coffee grounds and 25% lanzones peel, and was subjected to standard phytochemical analysis at the Department of Science and Technology (DOST) to determine the presence of bioactive compounds that are known for mosquito-repelling properties. Results showed positive detection for all seven bioactive compounds: sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides, tannins, confirming that the integration of coffee grounds significantly enhanced the chemical composition of the lanzones-based coil thereby suggesting that spent coffee grounds can enhance the repellent properties of Lanzones peel, making the resulting coil an effective alternative mosquito repellent. The study thus confirms the rejection of the null hypothesis and demonstrates the potential of organic waste materials, like lanzones peel, in developing sustainable mosquito control solutions. To advance the study and foster further innovation, future researchers may focus on the appropriate drying and pulverizing of the lanzones peel and used coffee grounds, investigate the use of other binding agents for better stabilization, optimize the use of appropriate molders, conduct assessments that compare the enhanced coils with commercial products, and perform field trials for practical applicability evaluation.

Keywords: coffee grounds, lanzones peel, mosquito coil, natural repellent, phytochemical analysis.

INTRODUCTION

This chapter provides an overview of the study, including the background of the research, the statement of the problem, the objectives of the study, and its significance. It also outlines the scope and limitations of the research, as well as the definition of key terms used throughout the study. By presenting these components, this chapter sets the foundation for understanding the purpose, direction, and context of the investigation into the potential of coffee grounds in enhancing lanzones peel as a mosquito repellent.

Background of the study

Mosquito bites can transmit various diseases, including malaria, dengue fever, chikungunya, yellow fever, elephantiasis, and others. In fact, according to newsinfo.inquirer.net, as of February 28, 2025, CALABARZON logged the highest number of dengue cases, a total of 10,759. The Provincial Epidemiology and Surveillance Unit (PESU) reported that dengue fever is a significant health concern, ranking as the leading notifiable disease with a rate of 520 per 100,000 population. Since Laguna, which is part of CALABARZON, has one of the highest numbers of cases, it suggests that Santa Cruz is likely experiencing a significant dengue situation.

A community-based approach for dengue prevention and control in Santa Cruz has been activated to address the surge in dengue cases. However, these measures are still not enough to prevent the increasing incidence. Hence, a group of student-researchers, taking up Bachelor of Secondary Education major in Science, came up with experimental research regarding the potential of coffee grounds in enhancing lanzones peel as mosquito repellent coil.

Coffee grounds are used in mosquito coils as a natural mosquito repellent due to their strong, pungent aroma that masks scents that attract mosquitoes. The unpleasant smell of coffee grounds when burned is believed to be a natural deterrent for mosquitoes. Lanzones peels and coffee grounds are organic materials that have been proven to be a source of natural insect-repellent compounds. Lanzones peels have bioactive substances which include tannins, flavonoids, and alkaloids that are shown to exhibit mosquito-repelling properties (Octaviana et al., 2020). Tannins, in particular, are known for their ability to inhibit insect growth and reproduction, while flavonoids and alkaloids exhibit strong repellent effects. Moreover, coffee grounds have caffeine, which has neurotoxic effects on insects; that is why it is recognized for its potential to repel mosquitoes effectively (Spyriounis et al., 2020).

However, the combined properties of these two elements as mosquito coils have not been thoroughly explored. Consequently, this study aimed to investigate the full potential of coffee grounds in enhancing lanzones peel as a sustainable mosquito coil repellent, focusing on reducing and mitigating the spread of mosquitoes to combat mosquito-borne diseases. By combining the bioactive compounds of these two materials, the research sought to develop a mosquito coil that is safe and effective using organic materials that may facilitate the development of innovative, natural insect-repelling products that enhance public health outcomes while promoting environmental sustainability.

Objectives of the study

This study aimed to determine the potential of coffee grounds in enhancing lanzones peel as mosquito coils repellent.

Specifically, it sought to attain the following objectives:

1. investigate the potential of coffee grounds on the efficacy of lanzones peel as a mosquito repellent through a standard phytochemical analysis
2. evaluate the combined potential of lanzones peel and coffee grounds based from the formulation: 25% Lanzones Peel and 75% Coffee Grounds
3. statistically prove that coffee grounds can enhance the lanzones peel mosquito repellent coil

Null Hypothesis

The coffee grounds have no potential to enhance the lanzones-based mosquito repellent coils.

Significance of the Study

This study will be beneficial to the following area:

In terms of Policy

Findings of the study can serve as a basis for evidence-based decision-making in crafting policies on sustainable product development, thereby contributing to a more effective and just society by addressing a specific issue or problem.

In terms of Practice

Research output can benefit practitioners engaged in the commercial production of mosquito coil. Hence, increasing the level of productivity, giving additional income to them.

In terms of Social Action

This study would help in developing a potential mosquito coil from organic materials that can reduce mosquito populations and the associated health risks in vulnerable communities.

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Scope and Delimitations of the Study

This study aimed to investigate the potential of using coffee grounds as a reinforcing agent in enhancing lanzones (*Lansium domesticum*) peel mosquito coil. The materials used for the study were gathered from Paete, Laguna where both coffee grounds and lanzones peel are available. Local coffee shops are the source of used coffee grounds, and lanzones peels are collected from households in the community. The research testing was conducted by the Department of Science and Technology (DOST) over a span of five weeks. 25% of dried lanzones peel mixed with 75% coffee grounds is utilized for the formulations of making the mosquito coils. After the testing and observation phase, the data gathered were analyzed using appropriate statistical methods that establish the level of significance that may exist.

Since this study is limited to the phytochemical analysis of the lanzones peel with coffee grounds mosquito coil, focusing on identifying the presence of bioactive compounds such as alkaloids, tannins, saponins, and flavonoids that are known to have mosquito-repellent or insecticidal properties, the actual performance of the mosquito coil in repelling or killing mosquitoes o real-life setting was not evaluated through direct testing. Since no field or laboratory tests against mosquitoes were conducted, external factors such as humidity, wind, and mosquito species that may influence the coil's performance were not considered.

Definition of terms

Alkaloids. A phytochemical that acts as mosquito repellent and insecticide through neurotoxicity and growth inhibition. Both present in lanzones peel and coffee grounds.

Coffee grounds. The residual coffee remains after brewing, which will be assessed in this study as the independent variable for its potential in enhancing mosquito repellent properties on mosquito coils made of Lanzones peels.

Fehling's test. A standard phytochemical test done by DOST to detect the presence of glycosides on the mosquito coil sample.

Ferric Chloride test. A standard phytochemical test done by DOST to detect the presence of tannins on the mosquito coil sample.

Flavonoids. A phytochemical that provides mosquito repellency properties. Both found in lanzones peel and coffee grounds

Froth test. A standard phytochemical test done by DOST to detect the presence of saponins on the mosquito coil sample.

Glycosides. A phytochemical detected through Fehling's test after hydrolysis that contributes to mosquito control by interfering with larval physiological processes. Both present in lanzones peel and coffee grounds.

Lanzones (*Lansium domesticum*) Peel. The outer skin of lanzones fruit, which is being studied with its potential as organic content in mosquito coils. This will be sun-dried, powderized, and mixed with other materials to form a mosquito coil.

Lieberman-Burchard test. A standard phytochemical test done by DOST to detect the presence of sterols and triterpenes on the mosquito coil sample.

Mayer's test. A standard phytochemical test done by DOST to detect the presence of alkaloids on the mosquito coil sample.

Mosquito Coil. A slow-burning mosquito repelling incense which releases active substances to repel mosquitoes. This will be the product of this study which will be made out primarily of lanzones peels enhanced by used coffee grounds.

Organic Waste. The discarded lanzones peel and coffee grounds used as materials to make mosquito coils.

Potential. The possibility of coffee grounds in enhancing lanzones peel as mosquito repellent coils.

Saponins. A phytochemical that has insecticidal and repellent properties that is detected through Froth test when it creates foam. Both present in lanzones peel and coffee grounds.

Shinoda test. A standard phytochemical test done by DOST to detect the presence of flavonoids on the mosquito coil sample.

Sterols. A phytochemical detected through the Liebermann–Burchard test which is also involved in mosquito repellent activity. Both present in lanzones peel and coffee grounds.

Sustainability. Using organic and biodegradable materials such as the usually discarded lanzones peels and used coffee grounds to conserve the environment and contribute to proper waste management.

Tannins. A phytochemical works as a natural repellent with insecticidal and anti-feedant properties. Both present lanzones peel and coffee grounds

Triterpenes. A phytochemical that provides insecticidal and therapeutic properties; detected with sterols. Both present in lanzones peel and coffee grounds

METHODOLOGY

In this chapter, the method and procedure which was used in the entire study was presented. These are research design, research locale, research instrument, research procedures, and treatment of data.

Research Design

The research used an experimental research design which is a method of inquiry that changes one variable to observe the effect on another variable. The independent variable in this case was the insertion of 75% used coffee grounds in the mosquito coil mixture and the dependent variable was the detection of bioactive compounds with insect-repellent properties.

The experiment was performed to verify whether the mixture of coffee grounds and lanzones peel could have a more potent mosquito-repelling effect than either one alone. The researchers prepared a control mixture of 25% powdered lanzones peel and 75% used coffee grounds by phytochemical analyzing it to identify the presence of sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides, and tannins, among other active compounds.

By means of this experiment, the scientists had the chance to observe and measure the effects (presence of bioactive compounds) resulting from their particular formulation, hence determining how effective coffee grounds were in enhancing the properties of lanzones peel as a mosquito repellent.

Research Locale

The study was primarily conducted in Paete, Laguna, where the collection and preparation of materials, as well as the formulation of the mosquito coils, took place. The used coffee grounds were freely collected from Truffle House, a local coffee shop in Paete to ensure uniformity in the type and quality of the grounds utilized in the study. Other ingredients, such as beeswax and cornstarch, were obtained from the local market. The process of creating the mosquito coils such as the drying, mixing, molding, and curing was carried out on one of the researcher's residence in Paete to maintain the consistency and prevent contamination. After the preparation, the mosquito coil samples were submitted to the Science and Technology Division (STD) Building, Department of Science and Technology (DOST) Complex, located at Gen. Santos Avenue, Bicutan, Taguig City, Metro Manila 1631, Philippines for its laboratory testing. This facility provided the necessary equipment, standardized environment, and expertise required for the phytochemical and repellency analyses of the mosquito coils.

Research Instrument

In this research, standardized laboratory tests were used to gather data to evaluate the chemical composition and mosquito-repellent properties of the formulated coils. It is conducted at the Science and Technology Division (STD) Building, Department of Science and Technology (DOST) Complex, located at Gen. Santos Avenue, Bicutan, Taguig City, Metro Manila 1631, Philippines.

The phytochemical properties of used coffee grounds and lanzones (*Lansium domesticum*) peel were analyzed with the guidance and expertise of a science research specialist and a licensed chemist. Phytochemical screening was performed to identify the presence of bioactive compounds such as sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides, and tannins that are known for their insect-repellent and insecticidal properties.

The laboratory results were interpreted and validated by the chemists and research analysts at the DOST facility, ensuring scientific rigor and precision in data collection and analysis.

Data Gathering Procedure

The data gathering techniques for this study were designed to assess the potential effectiveness of coffee grounds in enhancing lanzones peel-based mosquito repellent coils. This process involved several phases, from the collection of materials to the formulation of mosquito coil and the sending the mosquito coil prototype to DOST - STD for standard phytochemical content analysis.

Phase 1: Gathering the Materials

The materials were carefully selected to ensure their quality for the study. Lanzones peels were collected after the fruit was consumed, then sun-dried and ground to a powdered texture. The coffee grounds used as the main variable were sourced from a local coffee shop in Paete, Laguna called Truffle House, ensuring they were of the same type for consistency of quality. Other ingredients, such as beeswax and corn-starch, were purchased from the market. Standardized measuring equipment such as measuring cups, spoons, and a weighing scale, were used to ensure accurate concentrations and ratios of the ingredients in doing the formulation.

Phase 2: Prototype Formulation

The mosquito coil formulation was prepared by mixing 25% of powdered lanzones peel and 75% of spent coffee grounds, based on the goal of enhancing the repellent properties of lanzones peel by incorporating the bioactive compounds present in spent coffee grounds. The dry powder mixture was moistened with water, beeswax and corn-starch as binding agents, then shaped into coil molds and placed into the oven to dry until fully set.

Table 1 Mosquito coil formulation

Lanzones peel powder (g)	**Coffee Grounds (g)**	**Corn-starch (g)**	**Beeswax (g)**	**Water (ml)**
21.7	65.2	24	21.4	120

Table 1 provides a detailed breakdown of the ingredients used to develop the mosquito coil sample, with the primary focus on the variable concentrations of coffee grounds. It contains 21.7 grams of lanzones peel powder (25%), 65.175 grams of spent coffee grounds (75%), 24 grams of corn-starch, 21.4 grams of beeswax, and 120 ml of water.

Phase 3: DOST testing

A total of 86.9 grams of the formulated sample, in the form of mosquito coil bits, was carefully measured and packaged. This sample was then formally submitted to the DOST-STD for standard phytochemical testing. At DOST-ITDI, the phytochemical testing was conducted following institutional laboratory protocols. The tests aimed to detect the presence or absence of key bioactive compounds: alkaloids, tannins, flavonoids, and saponins. These compounds were selected due to their known insect-repelling effects as supported by related literature (Abdallah et al, 2022; Spyriounis et al, 2022; Zengin et al, 2020). To test each parameter and determine the presence of the key bioactive compounds, several tests were conducted by the laboratory: Liebermann–Burchard test for sterols and triterpenes, Shinoda test for flavonoids, Mayer's test for alkaloids, Froth test for saponins, Fehling's test for glycosides, and Ferric chloride test for tannins. Once the analysis was completed, the laboratory released an official test result that served as the primary data source for the research analysis and interpretation.

Treatment of Data

The data obtained from the phytochemical analysis conducted by the DOST-ITDI were qualitative in nature, focusing on the detection of specific bioactive compounds such as alkaloids, tannins, flavonoids, and saponins. These were recorded using standard notation, with a plus sign (+) indicating the presence of a compound and a minus sign (–) indicating its absence. The results were systematically organized into a summary table to provide a clear overview of the phytochemical content of the formulated mosquito coil. Because the test results were not numerical and did not involve multiple comparison groups, the data were analyzed using descriptive statistics only. The focus of the analysis was to interpret whether the identified compounds support the hypothesis that coffee grounds enhance the phytochemical content of lanzones peel. The results were then used to draw conclusions about the formulation's potential as a natural mosquito repellent.

RESULTS AND DISCUSSION

This chapter presents the findings of the phytochemical analysis conducted by the DOST-ITDI on the mosquito coil formulated with 25% Lanzones peel and 75% coffee grounds using standard qualitative screening methods. The results are analyzed and interpreted to determine whether coffee grounds significantly enhance the bioactive composition of Lanzones peel-based mosquito coils.

Table 2 Phytochemical Analysis Result on Mosquito Coil

Test Parameter	**Result**	**Test Method**
Sterols	+	Liebermann-Burchard Test
Triterpenes	+	Liebermann-Burchard Test
Flavonoids	+	Shinoda Test
Alkaloids	+	Mayer's Test
Saponins	+	Froth Test
Glycosides	+	Fehling's Test
Tannins	+	Ferric Chloride Test

The phytochemical analysis of the formulated mosquito coil with the combined ingredients of lanzones peel (*lansium domesticum*) and coffee grounds, presented the presence of bioactive compounds such as sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides, and tannins. It was indicated by the positive results shown in the table. The detection of these compounds proved that the combination of these two ingredients may enhance overall mosquito repelling effectiveness.

In line with this findings, the table shows a positive result (+) for sterols in the mosquito coil sample, which was detected through the Liebermann–Burchard Test, a classical qualitative colorimetric assay used in phytochemical screening. In this method, the presence of sterols is confirmed by a characteristic color change after the extract reacts with acetic anhydride and concentrated sulfuric acid (Guediri et al., 2023). According to Chemistry LibreTexts (2023), sterols are a subclass of steroids. Steroids have been tested to have significant mosquito-repellent properties, which make them valuable in mosquito control products. Lanzones peel is a known source of sterols (Ramos et al., 2022) and also the spent coffee grounds (Nurman et al., 2020; Fadri et al., 2022) so both of these organic ingredients are main source of the detected amounts of sterols in the formulation. The inclusion of 75% coffee grounds in the coil formulation boosted the amount of steroids (sterols) that enhances the mosquito-repellency of the mosquito coil. This contributes to the enhanced bioactivity of the coil and reinforces its potential as an effective natural mosquito repellent.

Triterpenes were also positively identified in the mosquito coil sample using the Liebermann-Burchard Test which is a qualitative method that detects the presence of triterpenes by producing a color change when the compound reacts with acetic anhydride and concentrated sulfuric acid. According to Liu et al., (2023), triterpenes are a class of terpenoids. The study of Rahmawati et al. (2023) showed that triterpenes may disrupt mosquito nervous systems or act as irritants. Terpenoids are bioactive phytochemicals known for their mosquito-repellent properties, contributing to the effectiveness of natural mosquito repellents (Ali et al., 2022; R, D. 2022; Hadidy et al., 2022; Zengin et al., 2020). Triterpenes are present in lanzones peel (Mayanti et al., 2022; Wulandari et al., 2024) and on the spent coffee grounds (Ali et al., 2022) which served as the significant source of these compounds on the tested mosquito coil. The integration of 75% spent coffee grounds in the mosquito coil formulation enhances its phytochemical profile, particularly through the inclusion of triterpenes (and terpenoids), thereby improving its mosquito-repelling efficiency.

The mosquito coil sample, as indicated on the table, also shows a positive result (+) for flavonoids through the Shinoda Test, a qualitative method used to detect flavonoid compounds. This test involves the reduction of flavonoids using magnesium and concentrated hydrochloric acid, resulting in a pink to red coloration which indicates their presence (Maheshwaran et al., 2024). Flavonoids are a group of bioactive phytochemicals that are widely recognized for their mosquito-repellent and larvicidal properties. According to Hadidy et al. (2022), flavonoids such as poncirin, rhoifolin, naringin, and marmesin extracted from Poncirus trifoliata exhibited strong larvicidal effects against *Aedes aegypti*, with 100% repellency and prolonged protection without skin irritation. Similarly, plant extracts containing flavonoids,such as those from *Ocimum basilicum* and *Albizia amara* have demonstrated high repellency against *Culex quinquefasciatus* due to the synergistic effects of flavonoids with alkaloids and terpenoids. In addition, *Lansium domesticum* (lanzones) peel is a rich source of flavonoids which have radical scavenging and antibacterial properties that can enhance the mosquito-repelling properties of the coil through their antioxidant and bioactive mechanisms (Mayanti et al., 2022).

Similarly, a positive result (+) for alkaloids in the mosquito coil sample was detected through the Mayer's Test. A qualitative method that is used for finding the presence of alkaloids. According to Sharma & Ria (2021), alkaloids, a diverse group of naturally occurring compounds found in various plants, have garnered attention for their potential as mosquito repellents and insecticides. Their bioactive properties, including neurotoxicity, feeding deterrence, and growth inhibition, make them promising candidates for eco-friendly mosquito control strategies.

As indicated in the table, saponins were also found to be present in the mosquito coil sample which was detected through the Froth Test, a qualitative phytochemical method where an aqueous extract is shaken and the formation of persistent froth indicates the presence of saponins due to their surface-active properties (Morillo et al., 2022). Saponins are known for their mosquito-repellent properties, making them vital components in natural mosquito control strategies. Their ability to deter mosquitoes enhances the coil's overall effectiveness (Singh et al., 2025). While lanzones peel may contain minor amounts of saponins (Octaviana, D et al., 2020; Wulandari et al., 2024), the primary source in this study is the spent coffee grounds, which are also rich in these bioactive compounds (Nurman et al., 2020; Fadri et al., 2022). The inclusion of 75% spent coffee grounds improves the functional bioactivity of the coil by introducing phytochemicals like saponins. This enhances the mosquito-repelling potential of the mosquito coil (Singh et al., 2025).

Likewise, the presence of glycosides in the mosquito coil sample was detected through Fehling's Test. This test, commonly used to identify reducing sugars, was applied after hydrolysis of the extract to break the glycosidic bonds. Since glycosides are non-reducing in their intact form, hydrolysis is necessary to release the sugar moiety, allowing detection by the Fehling's reagent. The appearance of a red precipitate after this process confirms the presence of glycosides (Sudha et al., 2020b). Their detection is significant, as glycosides are known to exhibit various biological functions and may contribute to the coil's bioactivity, potentially enhancing its mosquito-repellent effectiveness.

In addition, tannins shows a positive result (+) in the mosquito coil sample, which was detected through the Ferric Chloride Test. This test operates on the principle of forming a colored complex between ferric ions (Fe^{3+}) and phenolic hydroxyl groups present in plant extracts (Maheshwaran et al., 2024). The presence of significant bioactivities, including insecticidal and antifeedant effects of this compound, confirmed by the Ferric Chloride

Test, suggests a potential contribution to the product's efficacy as a repellent. Incorporating tannin-based agents into mosquito control strategies offers a sustainable alternative to synthetic insecticides, supporting eco-friendly public health interventions as highlighted by Singh and Sheikh (2021).

Overall, the positive results in all seven tested parameters: sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides, tannins, confirm the effectiveness of the 25% Lanzones peel and 75% coffee grounds formulation in enhancing the bioactive compounds that have been proven to repel or kill mosquitoes. This supports the core hypothesis of the study that spent coffee grounds can enhance the repellent properties of Lanzones peel, making the resulting coil an effective alternative mosquito repellent.

CONCLUSIONS

Based on the findings of the study, the combination of lanzones peel and coffee grounds exhibited the presence of key bioactive compounds such as sterols, triterpenes, flavonoids, alkaloids, saponins, glycosides, and tannins. These compounds are known to have insecticidal and repellent properties that contribute to the effectiveness of mosquito coils. The result indicates that coffee grounds have potential in enhancing lanzones-based mosquito coils.

Therefore, the null hypothesis of the study is rejected. The result of the phytochemical test provides strong evidence which supports the idea that coffee grounds can be a beneficial additive in developing a more effective mosquito repellent.

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