



(RESEARCH ARTICLE)



Garlic extract (*Allium sativum*), Lemon (*Citrus limon*), and ground coffee beans (*Coffea arabica*) against mosquitoes (*Culicidae*) as humidifier drops

Nicole Desiree Francisco Abiada, Kyn Rheniel Arteta Guevarra, Edmar Dela Cruz Javier, Kristine Gem Cabigan Nequinto * and Leah Engalla Perez

College of Education, Laguna University, Santa Cruz, Laguna, Philippines.

International Journal of Science and Research Archive, 2024, 11(02), 1018–1029

Publication history: Received on 22 February 2024; revised on 29 March 2024; accepted on 01 April 2024

Article DOI: <https://doi.org/10.30574/ijrsra.2024.11.2.0544>

Abstract

Mosquitoes pose a threat to human health due to their ability to spread diseases. Although effective, Chemical-based repellents have harmful effects. Therefore, it is essential to look for safer, environmentally friendly alternatives. This study investigates the effectivity of natural ingredients: lemon, garlic, and ground coffee beans when used as humidifier drops to repel mosquitoes. The main objectives of the study were to determine the ingredients' right concentration for repelling mosquitoes, measure the effectiveness and duration of their odor, and analyze user preferences for their acceptability and overall satisfaction.

A survey questionnaire was used in the study to collect data from the twenty-one respondents. The results showed that the solution effectively repelled mosquitoes and released a continuous aroma for 3-4 hours. It started working as a repellent within five minutes of the humidifier being opened and continued to work long after the mist disappeared. The respondents strongly agreed that the natural humidifier drops made from lemon, garlic, and coffee grounds were easy to use, fragrant, highly effective, and sustainable. The participants expressed their willingness to continue using these drops and recommended them to others. The study supports the potential of lemon, garlic, and coffee extract-based humidifier drops as a natural and effective approach to repel mosquitoes. They are good alternative for Chemical-based repellents because of their effectiveness, sustainability, and cost-effectiveness.

Overall, this study contributes to the understanding of eco-friendly mosquito repellents. The use of natural ingredients as a safe, effective solution is backed by positive feedback and high satisfaction from participants.

Keywords: Mosquito repellent; Natural ingredient; Humidifier drops; Effectiveness; Acceptability

1. Introduction

Mosquitoes pose a significant nuisance and can transmit various diseases, including dengue, which has been consistently reported in the news. Dengue remains a major concern since there is currently no cure for it. Therefore, preventive measures become crucial, such as maintaining clean surroundings and utilizing chemical-based mosquito repellents. However, many commercial mosquito repellents available in the market can be costly and may contain harmful chemical substances that could have adverse health effects.

This study's significance lies in its potential to provide an eco-friendly solution to repel mosquitoes while avoiding the usage of harmful chemicals that are present commonly in commercial repellents used for mosquitoes. In addition, the popularity of humidifiers in today's generation is also a driving factor in conducting this study. Humidifiers are used due to their ability to improve indoor air quality, alleviate respiratory problems, and promote better sleep because of

* Corresponding author: Kristine Gem Cabigan Nequinto

their aroma. It is a more attractive and convenient option when compared to traditional mosquito repellents we buy in the market. This paper’s findings may also contribute to the development of natural alternatives to commercial mosquito repellents that can be accessible to the public, particularly in developing countries with high rates of mosquito-borne diseases.

This study investigated the effectiveness of combining garlic, lemon, and coffee grounds as natural mosquito repellent solutions in humidifiers. These organic materials are known to have insecticidal properties, making them promising ingredients for this solution. Through several trials, this study determined the right concentration required to achieve maximum effectiveness and evaluated the acceptability of the solution's odor and efficacy as a mosquito repellent. In this paper, the researchers aimed to develop an organic mosquito repellent using not only the typically aromatic lemon but also the foul-smelling garlic extract as water-based humidifier drops, instead of the common essential oils. Additionally, coffee ground extract will be added to the mixture. This presented a challenge for us researchers due to the strong odor of garlic. Data were gathered from 21 teachers of different grade levels from Bagumbayan Elementary School, as this study can be utilized inside the classroom.

1.1. Statement of the Problem

This study focuses on Garlic Extract (*Allium sativum*), Lemon (*Citrus limon*), and Ground Coffee Beans (*Coffea arabica*) against Mosquitoes (*Culicidae*) as Humidifier Drops.

Specifically, it seeks to answer the following questions:

- What are the respondent’s preferences regarding the effectiveness of solutions in humidifiers in terms of:
 - Duration
 - Acceptability
 - Overall satisfaction
- What are the respondents’ preferences regarding the lemon, garlic, and coffee grounds as humidifier drops against mosquitoes?

1.2. Theoretical Paradigm

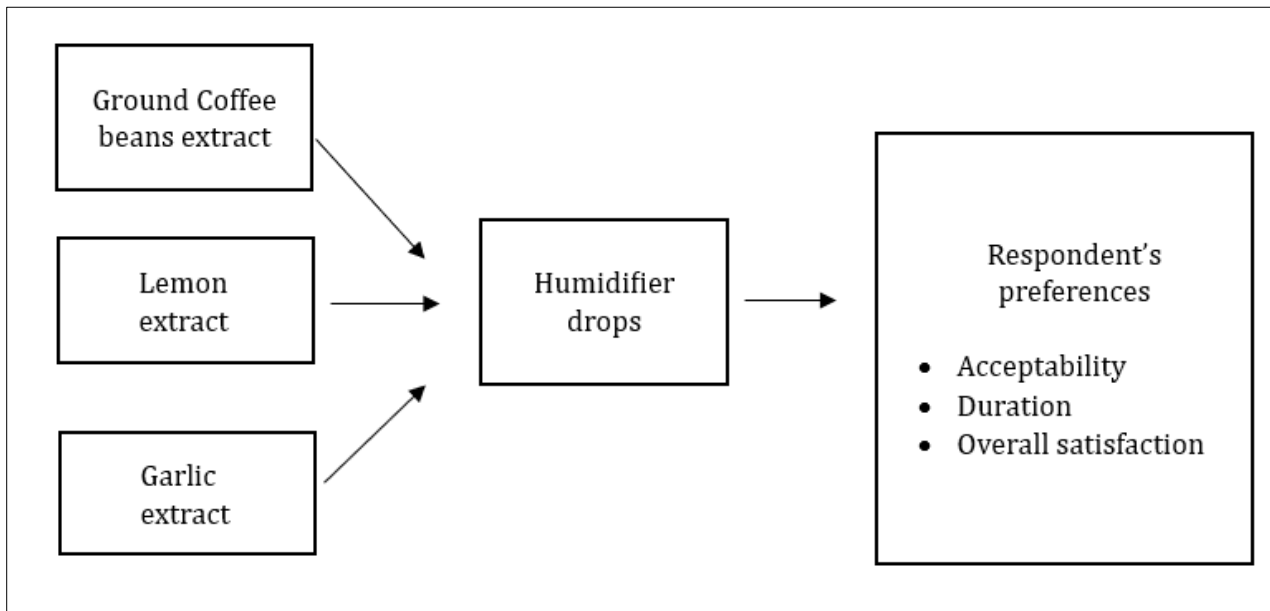


Figure 1 Theoretical paradigm

The theoretical framework contains the theory used as a basis for research development. In this study, the researchers decided to create a new theory based on studies aligned with the topic of the insecticidal activity of lemon extract, coffee grounds extract, and garlic extract against mosquitoes. The lemon, coffee grounds, and garlic were extracted using the distillation process, and their extracts were mixed to create humidifier drops for use as a mosquito repellent. The solutions made from these extracts were hypothesized to possess insecticidal activity in repelling mosquitoes due to the strong aroma they produce.

1.3. Conceptual Framework

1.3.1. Input process output

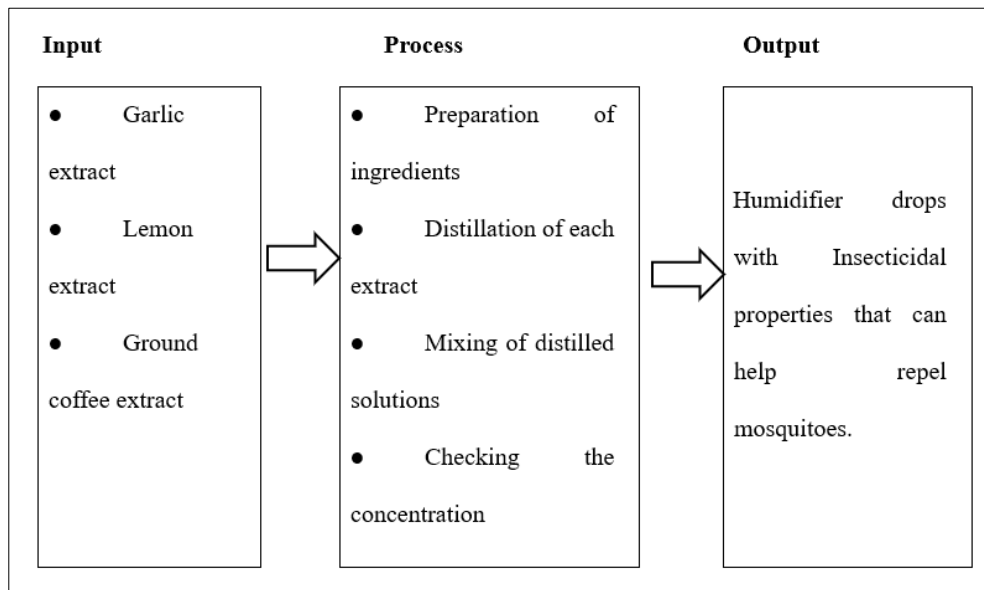


Figure 2 Conceptual framework

The figure above illustrates the IPO (Input, Process, Output) conceptual framework of the study. The input includes the ingredients or materials used to create the product, which are garlic, lemon, and ground coffee beans extract. The process involves various steps, such as preparation, distillation of extracts, mixing of the distilled solutions, and checking the concentration. The output of the study is a humidifier drop with insecticidal properties, capable of repelling mosquitoes.

1.4. Significance of the Study

The researchers of this study about Garlic, Lemon, and Coffee Grounds Extracts against Mosquitoes as Humidifier Drops believe that the results will be beneficial to the;

- **Community.** This study helps to introduce more organic and cheaper mosquito repellents as humidifier drops to the community rather than the use of chemical-based mosquito repellents to minimize the diseases caused by mosquito bites in a more natural way.
- **Health professionals:** The researchers believed that this study would benefit health professionals because it might lower the number of cases and mortality of mosquito-related diseases like dengue in the country.
- **Humidifier drops manufacturers:** This study will help them come up with an innovative idea for a better product for the community and will also help them in product development.
- **Students:** To gain knowledge on how these extracts can repel mosquitoes and how the extracts' aroma can be effective as humidifier drops. Students can also produce their own mosquito repellent as humidifier drops.
- **Future Researchers.** This study will serve as their basis for doing other research on extracts such as mosquito repellents and humidifier drops. Results will be the basis for using the extracts to become another type of mosquito repellent.

1.5. Scope and Limitation of the Study

This study entitled "Garlic, Lemon, and Coffee Grounds against Mosquitoes as Humidifier Drops" mainly focus on finding the right mixture to complement each other and become effective as a mosquito repellent.

The gathered data was limited to the final concentration of the ingredients' extract that complemented each other that is aromatic and effective. In addition, this study attempts to know if the final mixtures can repel mosquitoes. The mortality rate of mosquitoes was not recorded. The data gathered was from 21 teachers of Bagumbayan Elementary School as respondents. Since the researchers provided survey kits that consist of humidifiers, mixture, and questionnaires, it is limited to 21 respondents only.

2. Material and methods

The study is a Mixed Method under the principle of Experimental Research Design, and it is divided into several parts: pre-experimental and experimental. In the pre-experimental phase, this is where the researchers gather materials and make the solution by distilling the ingredients (lemon, garlic, and ground coffee). In the experimental part, phase three (3) focused on conducting the experiment where the researchers tried a different number of drops of the solution to be used in the humidifier. The observation was recorded in the table after. Lastly, phase four (4) was the gathering of necessary information. The respondents observed the final solution and answered the given questionnaire.

This study was divided into two parts, extraction, and data gathering. The extraction procedure was conducted at Patimbao, Santa Cruz, Laguna, to determine the right concentration of the solution to be used as humidifier drops. Due to a lack of equipment in the laboratory for the distillation process, the researchers decided to conduct an improvised distillation process.

The data gathering was done inside Bagumbayan Elementary School. Researchers decided to conduct data gathering in Bagumbayan Elementary School because, based on the interview of a teacher in this school, there appears to be a high number of mosquitoes present in the area.

2.1. Population of the Study

There are twenty-one (21) teachers from different grade levels who served as respondents in this study from Bagumbayan Elementary School. The selection of respondents was based on the factor that the humidifier drops can be utilized inside the classroom for the betterment of the learning and teaching environment of the students and teachers.

2.2. Research Instruments

The researchers used various tools and instruments to study the insecticidal activity of garlic, lemon, and coffee grounds as humidifier drops against mosquitoes. Firstly, they employed a research question in the form of a survey consisting of two parts: respondent's personal information and evaluation. The survey aimed to determine the duration, acceptability, and overall satisfaction of the solution as humidifier drops.

For the extraction process, the following tools were used: measuring cups, weighing scale, clear containers, butane, portable butane stove, cling wrap, rubber band, and knife. The ingredients utilized for extraction were lemon, garlic, and ground coffee. Due to the lack of laboratory equipment, the researchers created an improvised distillation apparatus. This improvised setup involved a pressure cooker, 5/16 braided hose, 5/16 copper tube, hard pipe clamps, water bucket, and a receiving container.

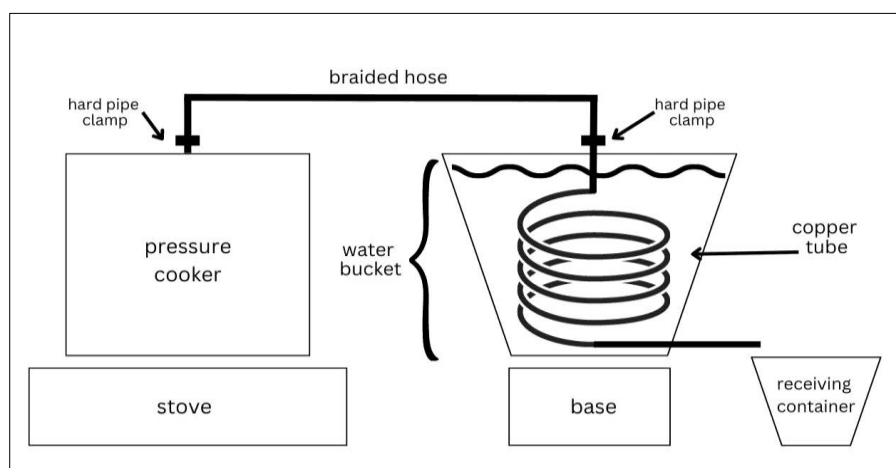


Figure 3 Distillation Process

A Five-Point Likert Scale was employed to measure the respondents' acceptability and preferences regarding the duration of effectiveness of solutions in humidifiers. This scale also gauged how the duration of effectiveness influenced the respondents' overall satisfaction with the product.

Table 1 Five-Point Likert Scale in terms of Duration

Rating scale	Numerical values	Descriptive value
5	4.21-5.00	Strongly Agree
4	3.41-4.20	Agree
3	2.61-3.40	Neutral
2	1.81-2.60	Disagree
1	1.00-1.80	Strongly Disagree

Table 2 Five-Point Likert Scale in terms of Acceptability

Rating scale	Numerical values	Descriptive value
5	4.21-5.00	Highly Acceptable
4	3.41-4.20	Acceptable
3	2.61-3.40	Neutral
2	1.81-2.60	Unacceptable
1	1.00-1.80	Totally Unacceptable

Table 3 Five-Point Likert Scale in terms of Overall Satisfaction

Rating scale	Numerical values	Descriptive value
5	4.21-5.00	Very Satisfied
4	3.41-4.20	Satisfied
3	2.61-3.40	Neutral
2	1.81-2.60	Dissatisfied
1	1.00-1.80	Very Dissatisfied

2.3. Data gathering

The researchers underwent both the pre-experimental and experimental parts of the study to gather necessary information and determine the insecticidal activity of the solution against mosquitoes as humidifier drops.

2.4. Pre- Experimental Phase

2.4.1. Phase 1: Gathering the materials

Lemon, Garlic, and Coffee Ground were collected along with the distilled water to be used for the extraction. The coffee ground was obtained from 7/11 convenience stores, while the other materials were purchased from the market. Measuring cups and other measuring devices were used to ensure the correct concentrations of the extracts.

2.4.2. Phase 2: Making the solution.

Step 1: Distillation

The researchers utilized a distillation process to extract the ingredients. The distillation process involved boiling, evaporation, condensation, and collecting the water droplets from the condenser. Instead of conducting the distillation process in a laboratory, the researchers opted for simple and do-it-yourself distillation equipment. This equipment

consisted of a pressure cooker as the distillation flask, a coiled copper tube placed inside a bucket filled with water as the condenser, and a clean container as the receiving flask.

Three (3) ingredients were used in the distillation process: lemon, coffee ground, and garlic. Five (5) lemons were cut in half, and their juice was extracted. The remaining lemon peels were shredded and mixed with one (1) liter of distilled water. For the coffee extract, 500 grams of coffee grounds were mixed with one (1) liter of distilled water. As for the garlic extract, 50 grams of garlic were mixed with 1 liter of distilled water. Each distilled extract was placed in three (3) different containers for further use.

Step 2: Forming the Solution

The researchers organized various containers and labeled them accordingly, then filled each container with solutions based on the concentrations specified in the table below. To conduct the testing, a humidifier was used for each solution, with different controlled numbers of drops. Observations were recorded, taking into account the odor and insecticidal activity of each solution against mosquitoes.

The researchers established a fixed amount of 50 mL for each solution. This served as the reference for determining the concentration of different ingredients. For each solution, 50 mL was allocated, and the number of garlic drops was subtracted from this amount. The remaining volume was then divided between lemon and coffee, with different concentrations or percentages as indicated in the table.

Table 4 Trial 1

Extracts	Garlic	Lemon		Coffee grounds	
		ml	%	ml	%
1	5ml	9	20	36	80
2		22.5	50	22.5	50
3		36	80	9	20

Table 4, titled "Trial 1," presents the first three (3) concentrations of solutions. The researchers chose to start with five (5) mL of garlic extract to determine if this amount would complement the other extracts. The remaining 45 mL of the solution was then divided into different percentages of lemon and coffee extract.

Solution 1 is composed of 5 mL of garlic extract, 20% (9 mL) of the remaining 45 mL is lemon extract, and the remaining 80% (36 mL) is coffee grounds extract. Solution 2 is composed of 5 mL of garlic extract, 50% (22.5 mL) of the remaining 45 mL is lemon extract, and the other 50% (22.5 mL) is coffee grounds extract. Lastly, Solution 3 is composed of 5 mL of garlic extract, 80% (36 mL) of the remaining 45 mL is lemon extract, and the remaining 20% (9 mL) is coffee grounds extract.

Table 5 Trial 2

Extracts	Garlic	Lemon		Coffee grounds	
		ml	%	ml	%
1	3ml	9.4	20	37.6	80
2		23.5	50	23.5	50
3		37.6	80	9.4	20

In Table 5, the concentrations for the 2nd trial are presented. For the 50 mL fixed solution, 3 mL of it was garlic extract, and the remaining 47 mL was divided into different concentrations. Solution 1 consists of 20% (9.4 mL) of lemon extract, and the other 80% (37.6 mL) is coffee grounds extract. In Solution 3, the 80% (37.6 mL) of the remaining 47 mL was lemon extract, and the remaining 20% (9.4 mL) was coffee ground extract. The researchers decreased the amount of garlic extract in the hope of achieving a more complementary and less noticeable scent of lemon and coffee compared to the observations in trial 1.

Table 6 Trial 3

Extracts	Garlic	Lemon		Coffee grounds	
		ml	%	ml	%
1	2.5ml	9.5	20	38	80
2		23.75	50	23.75	50
3		38	80	9.5	20

2.5. Experimental Phase

2.5.1. Phase 3: Conducting the experiment.

The researchers tested the different solutions using a humidifier with 100 mL of water. They recorded their observations in a table based on the number of drops diluted in 100 mL of water to determine the odor and insecticidal activity of each solution against mosquitoes.

Table 7 Observation based on Odor and Repellency of Trial 1

Number of drops to be diluted in 100 ml of water	Observation based on odor and repellency
5	There was no observable aroma or repellency in the solution 1, 2 and 3 diluted in 100 ml of water.
15	There was no observable aroma or repellency in solution 1, 2, and 3 when diluted in 100 ml of water.
25	Each solution diluted in 100 ml of water started to exhibit insecticidal activity but had different aromas. Solution 2 had a foul-smelling aroma that was irritating to the nose. Researchers felt dizzy after inhaling the aroma of it. The smell of lemon in solution 3 faded away when diluted in 100 ml of water inside the humidifier. Solution 1 had a gentle coffee aroma that did not cause any nasal discomfort, and there were no side effects after smelling it, but the aroma of garlic is noticeable.

Table 8 Observation based on Odor and Repellency of Trial 2

Number of drops to be diluted in 100 ml of water	Observation based on odor and repellency
5	There was no observable aroma or repellency of the solution 1, 2, and 3 diluted in 100 ml of water
15	There was no observable aroma or repellency on solutions 1, 2, and 3 diluted in 100 ml of water
25	Same observation as the first trial, each solution started to have an insecticidal activity and aroma. Solution 1 has the smell of coffee, but the garlic extract is still noticeable even if there is a lesser amount of garlic extract mixed with it. Solution 2 has the same result as trial 1. The aroma of lemon in solution 3 also fades when diluted in 100 ml of water inside the humidifier.

Table 9 Observation based on Odor and Repellency of Trial 3

Number of drops to be diluted in 100 ml of water	Observation based on odor and repellency
5	There was no observable aroma or repellency of the solution 1, 2, and 3 diluted in 100 ml of water
15	There was no observable aroma and repellency on solutions 1, 2, and 3 diluted in 100 ml of water
25	The garlic extract is finally unnoticeable, unlike the first two trials. Each solution showed insecticidal activity. Solution 1 has a mild coffee aroma and did not cause any nasal discomfort. In addition, there are no negative side effects such as dizziness after smelling the aroma. The combination of the same amount of lemon and coffee ground extract did not blend well, resulting in an unpleasant smell that caused nasal discomfort and dizziness upon smelling. Solution 3 showed the same result as the first two trials where the aroma of lemon fades after diluting in 100 ml of water.

In conclusion, all the concentrations have insecticidal activity against mosquitoes, but each concentration of solutions has different results in terms of its aroma. The solutions with a higher concentration of coffee grounds extract showed the best result among other concentrations of solutions. It is aromatic, and there are no side effects after smelling the aroma of it. The same amount of lemon and coffee ground extract is not complementary to each other. It is irritating to the nose and causes dizziness. While the solutions with a higher concentration of lemon extract showed that the lemon aroma fades after diluting it in 100 ml of water.

2.5.2. Phase 4: Gathering Necessary Information

From the trials, one (1) solution was used and observed by the respondents to determine its duration, acceptability, and overall satisfaction. The final solution has 2.5 ml of diluted garlic, 20% or 9.5 ml of diluted lemon extract, and 80% or 38 ml of diluted coffee ground extract. This solution has the right aroma and is effective in repelling mosquitoes based on the researchers' observation.

2.6. Treatment of Data

Responses to the survey questionnaire were statistically analyzed using the Mean and weighted mean to determine the acceptability of the solution based on the five-point Likert scale. The Likert-scale is a common method used in surveys and research studies to measure the attitudes or opinions of respondents on a range of options. The researchers asked the respondents to rate the solution based on its duration, acceptability, and their overall satisfaction. By computing the mean of these scores, the researchers will be able to answer the second statement of the problem of this study based on the interpretation of each table of the survey questionnaire.

Table 10 Statistical Treatment

Statement of the problem	Statistical treatment
What is the level of concentration of garlic extract, lemon, ground coffee beans, and sweet basil in terms of: Trial 1 Trial 2 Trial 3	bservation
What are the respondent's preferences regarding the effectiveness of solutions in humidifiers in terms of: Duration Acceptability Overall satisfaction	Mean and Weighted Mean
Is there an insecticidal activity from the garlic, lemon, and ground coffee beans as humidifier drops against mosquitoes?	Observation

3. Results

Table 11 Effectiveness of solutions in humidifiers in terms of Duration

Indicators	Mean	Verbal Interpretation	Rank
I found out that the mosquito repellent solution is effective in repelling mosquitoes during the entire period that the humidifier was working.	4.52	<i>Strongly Agree</i>	4
I observed that the humidifier lasts for about 3 - 4 hours.	4.67	<i>Strongly Agree</i>	2
I can smell the aroma of the solution as long as the humidifier is still on.	4.90	<i>Strongly Agree</i>	1
I noticed that the mosquitoes started to disappear within five minutes after opening the humidifier.	4.57	<i>Strongly Agree</i>	3
I noticed that five minutes after the smoke disappeared from the humidifier, the mosquitoes still did not come back.	4.10	<i>Agree</i>	5
General Weighted Mean	4.55	<i>Strongly Agree</i>	

Legend:

Score	Range	Verbal Interpretation
5	4.21 - 5.00	<i>Strongly Agree</i>
4	3.41 - 4.20	<i>Agree</i>
3	2.61 - 3.40	<i>Slightly Agree</i>
2	1.81 - 2.60	<i>Disagree</i>
1	1.00 - 1.80	<i>Strongly Disagree</i>

The results from Table 11 provide further insights into the respondents' evaluation of the effectiveness and duration of the humidifier drops made from lemon, garlic, and coffee grounds. The first statement refers to the effectiveness of the solution in repelling mosquitoes when the humidifier was working, with a mean score of 4.52, which falls under the descriptive value of "strong agreement." Similarly, the second statement about the humidifier lasting 3–4 hours received a mean score of 4.67, indicating "strong agreement." The third statement, which refers to the aroma of the solution as long as the humidifier is on, has a mean score of 4.90, also indicating "strong agreement." The fourth statement received a mean score of 4.57, indicating "strong agreement" that the mosquitoes disappear within 5 minutes after the opening of the humidifier. The fifth statement received a mean score of 4.10, falling under the descriptive value of "agreeing" that mosquitoes did not come back after the smoke disappeared after 5 minutes. The evaluation of the respondents regarding the duration of the humidifier drops received a weighted mean score of 4.55, reflecting "strong agreement."

Table 12 Effectiveness of solutions in humidifiers in terms of Acceptability

Indicators	Mean	Verbal Interpretation	Rank
I observed that the humidifier drop is fragrant.	4.86	<i>Highly Acceptable</i>	1.5
I believe that using humidifier drops made from natural ingredients is a sustainable option.	4.86	<i>Highly Acceptable</i>	1.5
I found out that the humidifier is easy to set up and use.	4.81	<i>Highly Acceptable</i>	3
I will continue to use this humidifier drops solution for repelling mosquitoes	4.67	<i>Highly Acceptable</i>	4.5
I will recommend this humidifier drops to others because I found it effective in repelling mosquitoes.	4.67	<i>Highly Acceptable</i>	4.5
General Weighted Mean	4.77	<i>Highly Acceptable</i>	

Legend:

Score	Range	Verbal Interpretation
5	4.21 - 5.00	<i>Highly Acceptable</i>
4	3.41 - 4.20	<i>Acceptable</i>
3	2.61 - 3.40	<i>Neutral</i>

2	1.81 – 2.60	Unacceptable
1	1.00 – 1.80	Totally Unacceptable

Table 12 presents the respondents' evaluation of the acceptability of the humidifier drops made from lemon, garlic, and coffee grounds. The survey form included several indicators, and the results indicate that the drops were highly acceptable in each of these indicators. The first statement, regarding the fragrance of the humidifier drops, and the second statement, about humidifier drops made from natural ingredients being a sustainable option, both received a mean score of 4.86, which falls under the descriptive value of "highly acceptable." The third statement received a mean score of 4.81, also indicating "highly acceptable" that the humidifier is easy to set up and use. The fourth and fifth statements both received a mean score of 4.67, falling under the range of 4.21–5.00, which has a descriptive value of "highly acceptable." In general, based on the survey and gathered data, the respondents' preference in terms of acceptability of the humidifier drops made from lemon, garlic, and coffee grounds received a weighted mean of 4.77. This weighted mean falls within the range of "highly acceptable," suggesting that the respondents generally found the drops to be highly acceptable in terms of the evaluated indicators.

Table 13 Effectiveness of solutions in humidifiers in terms of Overall Satisfaction

Indicators	Mean	Verbal Interpretation	Rank
I am satisfied with the overall effectiveness of the mosquito repellent solution.	4.67	<i>Highly Satisfied</i>	4
I like the design of the bottle in packaging and instructions of the product. It was visually appealing and easy to follow.	4.90	<i>Highly Satisfied</i>	1.5
I can easily move this humidifier from room to room without any difficulties.	4.90	<i>Highly Satisfied</i>	1.5
I observed that the area where the humidifier is located is mosquito-free.	4.62	<i>Highly Satisfied</i>	5
After trying it out, I discovered that the humidifier is surprisingly user-friendly.	4.86	<i>Highly Satisfied</i>	3
General Weighted Mean	4.79	<i>Highly Satisfied</i>	

Legend:

Score	Range	Verbal Interpretation
5	4.21 – 5.00	Highly Satisfied
4	3.41 – 4.20	Satisfied
3	2.61 – 3.40	Neutral
2	1.81 – 2.60	Dissatisfied
1	1.00 – 1.80	Very Dissatisfied

The first statement refers to the overall effectiveness of the mosquito repellent solution. The mean score is 4.67, indicating that most users were highly satisfied with the product's effectiveness in keeping mosquitoes away and its fragrance. The second statement pertains to the design of the bottle, packaging, and product instructions, with a mean score of 4.90. This indicates that users were highly satisfied with the product's visual appeal and ease of use. The third statement evaluates the portability of the humidifier, with a mean score of 4.90. This indicates that users were highly satisfied with the ease of moving the device from room to room. The fourth statement assesses the effectiveness of the humidifier in keeping mosquitoes away, with a mean score of 4.62. This suggests that users are highly satisfied with the absence of mosquitoes in the area where the humidifier was located. The fifth statement measures the user-friendliness of the humidifier, with a mean score of 4.86. This means that users found the humidifier easy to use and operate. In conclusion, these statements provide a comprehensive assessment of the overall satisfaction of users with the mosquito repellent solution in the humidifier, and it received a weighted mean of 4.79, signifying that users are highly satisfied with the product.

4. Discussion

The study of Lee (2018) proved that the development of effective and safe repellents against arthropods is very important. The widespread use of synthetic repellents against mosquitoes has raised some issues on safety and health risks to humans and the environment. There is an ongoing need to develop natural product-based repellents with more effective and long-lasting protection, which is the researchers' goal in this study.

The gathered data from the survey questionnaire showed that the humidifier drops made from lemon, garlic, and coffee grounds received positive feedback from the respondents. The drops were found to be highly effective in repelling mosquitoes, lasting for a significant duration, and were considered acceptable in terms of fragrance, sustainability, and ease of use. These findings support the thesis statement that the combination of garlic extract, lemon, and ground coffee beans as humidifier drops exhibits insecticidal activity against mosquitoes. The positive feedback and high satisfaction expressed by the respondents support the potential of these natural ingredients as a promising avenue for mosquito control. The survey results underscore the effectiveness, duration, and acceptability of the humidifier drops made from lemon, garlic, and coffee grounds.

Furthermore, as regards the summary of the statistical treatment, the null hypothesis of the study, which assumed no effect on the insecticidal activity of mosquitoes from the scent of garlic, lemon, and coffee as humidifier drops, was rejected. This implies that there is indeed an effect on the insecticidal activity of mosquitoes from these natural scents as humidifier drops. As supported by Elliot (2022), Lemons and other citrus fruits seem to be effective natural insect repellents. Although the exact reason is unknown, it is possible that lemons' ability to fool a mosquito's sense of smell is due to their distinctive aroma. Coffee grounds have a strong smell; they work well as a mosquito repellent. Most insects have keen senses of smell. Coffee grounds have a strong flavor and become even stronger when burned. Pests will be repelled by the potent aroma (Ayers, 2023). Additionally, Onasanya, S.S. et al. (2021) also proved that the scent of garlic oil is particularly strong and pungent, and it has insecticidal qualities against flying insects like mosquitoes.

5. Conclusion

Based on the study's findings, the researchers conclude that there is an effect on the insecticidal activity of mosquitoes from the scent of garlic, lemon, and ground coffee beans as humidifier drops, which rejects the null hypothesis of this study. The concentration levels of these ingredients were evaluated in three different trials, and all concentrations exhibited insecticidal activity against mosquitoes. However, each concentration also yielded different results in terms of aroma. Notably, trial 3 showed that solutions with higher concentrations of coffee grounds extract had the best results among the different concentrations tested. Additionally, when 25 drops of the solution were diluted in 100 ml of water and used in a humidifier, it demonstrated both repellency and a pleasant odor. The respondents' preferences regarding the effectiveness of solutions in humidifiers from the survey questionnaire revealed positive feedback in terms of duration, acceptability, and their overall satisfaction. The feedback from the respondents indicated positive responses in terms of duration, acceptability, and overall satisfaction. The respondents strongly agreed with the effectiveness of the solution in terms of its duration, and they expressed high satisfaction and acceptance of the product.

In conjunction with the observations, supporting literature and studies, and the result of the survey questionnaire, it is indeed proved that there is an insecticidal activity from the garlic, lemon, and ground coffee beans as humidifier drops against mosquitoes. The combination of these findings supports the overall effectiveness of the solution in repelling mosquitoes and provides evidence for its practical use as an alternative mosquito repellent.

Recommendations

Based on the findings and conclusions drawn from the research, several recommendations can be made. A future researcher is suggested to explore the use of other organic materials or different species of citric plants and coffee in the production and creation of humidifier drops. This could potentially offer a wider range of options and benefits in terms of aroma. Future researchers should focus on improving and extending the shelf life of humidifier drops. This could involve developing methods to increase the longevity of the products, thereby enhancing their usability and effectiveness over a prolonged period. Lastly, suggest that researchers focus on the creation and development of oil-based humidifier drops using organic materials. It is possible to make drops that offer additional advantages by utilizing the benefits of oils made from natural sources, such as plant extracts or essential oils. The researchers also recommended to use scientific trials in providing additional information about the insecticidal activity of lemon, garlic, and coffee grounds against mosquitoes as humidifier drops.

Compliance with ethical standards

Acknowledgment

The researchers would like to emphasize the importance of the help, cooperation, and advice of different people in the betterment and completion of this study.

To Laguna University for developing our skills as researchers.

The researchers would like to express their heartfelt gratitude to these people;

To Prof. Rose Nannette J. San Juan, the research coordinator, for guiding researchers and providing them with this opportunity to conduct this study.

To Prof. Leah E. Perez, LPT, MAEd, their research adviser, for imparting knowledge to the researchers' minds, providing ideas, and offering advice in developing the study, which made the researchers more curious in seeking answers to the questions that arose during the completion of this study. Her meaningful comments and suggestions have improved and made this research possible.

To our panelists, Mr. Jhonie Castro, Mr. John John Zotomayor, Ms. Jovelle Reyes and Engr. King Leonard Nograda for giving advice, guidance, and putting in efforts to help the researchers improve this research. Their advice was significantly valuable throughout the research and writing of this thesis.

To the researcher's classmates for being a support system, sharing ideas, and cheering them on during the process of developing this research study.

To the 21 respondents of this study. Without them, it would not be possible to have data and continue the process of this research. Their effort in participation is much appreciated.

Finally, the researchers extend their gratitude to our savior and creator, Jesus Christ, for providing wisdom, knowledge, faith, and strength, mentally, emotionally, and physically. He continuously guided us to conquer and overcome the different challenges and hardships we encountered during the duration of this study.

Disclosure of conflict of interest

The authors declare no conflicts of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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