

**DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY**

PRODUCTION OF A MOSQUITOE REPELLENT FROM LANTANA CAMARA LEAF EXTRACT

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A RESEACH REPORT SUBMITTED TO THE DEPARTMENT OF CHEMISTRY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD BACHELOR OF SCIENCE DEGREE IN INDUSTRIAL CHEMISTRY AT DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY.

# DECLARATION

I, Philip Ndegwa Ruoro, hereby declare that this report is my original work and that it has not been submitted before, for any academic award for either any academic award for either any academic award either in this or other institutions of higher learning for academic publication or any other purpose.

Signature…………………. Date…....

SUPERVISOR

I confirm that the candidate, under my supervision, has developed this proposal.

Signature….... Date …………………………

Dr Douglas Onyancha

# DEDICATION

I dedicate this research project to my family, my friends, my supervisor and all the chemistry department teaching and non-teaching staff for their unwavering support and encouragement to ensure that everything is progressing well. Your love, patience and understanding have sustained me through countless hours of study and contemplation, and I am forever thankful for the countless sacrifices you have made on my behalf.

# ABSTRACT

Mosquito-borne diseases continue to pose significant health risks worldwide. Traditional methods of mosquito control often rely on the use of chemical insecticides, which may have adverse environmental and health effects. As an alternative approach, this study aimed to explore the potential of a lantana-based mosquitoe repellent.Lantana plants (Lantana spp.) are known for their natural mosquito-repelling properties, primarily attributed to the volatile compounds present in their leaves. This research project aimed to harness these inherent properties by developing a mosquitoe repellent that incorporates lantana extracts, with the goal of creating a safe, effective, and eco-friendly mosquito control solution.The study began by collecting fresh lantana leaves from a reliable source and drying them thoroughly. The dried leaves were then ground into a fine powder, facilitating the extraction of active compounds.Reflux condensation, a technique employing a solvent and a condenser apparatus, was employed to extract the active compounds from the leaves. Ethanol, a commonly used solvent for botanical extractions, was chosen for its effectiveness and safety.Following extraction, the resulting liquid extract was subjected to filtration to eliminate solid particles and debris, thereby obtaining a clear filtrate. Concentration techniques such as evaporation or vacuum distillation were then employed to enhance the potency of the active compounds present in the extract. This step aimed to increase the efficacy of the mosquito repellent formulation.Subsequently, chemical tests were used to detect presence of different phytochemicals present in the ethanolic extract followed by formulation of the mosquito repellent. Cage method was used to test repellency of the product.

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CHAPTER ONE

## 1.1 INTRODUCTION

Mosquitoes are notorious carriers of various diseases, including malaria, dengue fever, Zika virus, and West Nile virus, posing a significant threat to public health worldwide. Mosquitoes are accountable for over 300 million clinical cases and one million deaths yearly worldwide. Ineffective measures and the complexity of illness life cycles need integrated approaches to control, eliminate, and eventually eradicate diseases (Molecular and population Biology of Mosquitoes..., 2013). Mosquitoes are tiny blood-sucking insects that depend on standing water to reproduce. Female mosquitoes must feed on blood to lay eggs. They feed by sticking their mouthparts into the skin of an animal and sucks blood rapidly. More often, they carry viruses that can be transmitted to a person while they are feeding (Mosquito-Borne Diseases, 2013).Environmental conditions like temperature and moisture are where the length of mosquito life cycle between species depends. Nonetheless, the life cycle of all mosquitoes consists of the egg, larval, pupal and adult stages. Male mosquitoes feed on the nectar of the plants only while females extract the blood of the hosts in order to develop and nourish eggs. Nearly all mosquitoes lay their eggs directly into water and others lay their eggs just near but not within the water. Within 24 to 48 hours, the eggs will hatch into larvae. The larvae will soon grow approximately 5mm in length. They breathe through siphon or air tubes. The larger ones can be seen floating just above the surface of waters that are infested. Within a span of seven to 10 days, the larvae will enter the stage of a pupa. Pupae are also visible upon the surface of the breeding site. When a mosquito is fully developed, it will emerge from its pupal case and will become a mosquito. The new adult, at this time, will stand upon the water to dry its wings and prepare for its flight. The female mosquitoes will then seek an animal to suck on and feed. They are capable of flying for miles and lays over 100 eggs at a time. Larvae and pupae ordinarily cannot survive without water so if a water source evaporates while they are still in these stages, they will die. (Mosquito Life Cycle, 2013)Several approaches were extensively used to control the threat posed by these mosquitoes. Over the years, synthetic insecticides were introduced. But, although these are effective, the insects tend to develop resistance to such products. Aside from being costly, the use of these repellents also generate problems such as environmental pollution and has toxic side effects to humans. For example, organic compound pyrethroids(similar to pyrethrins produced by pyrethrum flowers) are2250 times lethah to the insects than humans. Unfortunately, their repeat contact over prolonged periods in the form of mosquito repellents can lead to potential health consequences including kidney and spleen toxicity. To address these issues, the development of safe herbal-based mosquito repellents and larvicidals cannot be overemphasized. The use of essential oils obtained from plants seem to be an attractive approach. Essential oils are effective against broad spectrum of insect pests, and described as easy to remove, eco friedly and biodegradable, with negligible toxicity to mammals. Weeds are commonly considered unwanted herbs, however; many of them posses medicinal as well as toxic properties. The toxic characteristics of weeds can be used for insecticidal purpose. Moreover, it is economical approach as they are found abundantly. This project aims to develop a mosquito repellent using Lantana camara leaf extract, harnessing the plant's natural compounds to effectively repel mosquitoes. Lantana camara has been recognized for its bioactive properties, particularly in the leaves, which contain compounds with insect-repelling potential. By harnessing these natural compounds, we seek to create an eco-friendly and safe solution for mosquito control.

## 1.2 OBJECTIVES

### 1.2.1 MAIN OBJECTIVE

To produce a mosquitoe repellent from lantana Camara leaf extract.

### 1.2.2 SPECIFIC OBJECTIVES

1. Extraction of the active compounds.
2. Phytochemical analysis.
3. Formulation of the mosquito repellent’
4. Repellency test.
5. Analysis of the product.

## 1.3 PROBLEM STATEMENT

Over the years, synthetic insecticides have been in use. But, although these are effective, the insects tend to develop resistance to such products. Aside from being costly, the use of these repellents also generate problems such as environmental pollution and has toxic side effects to humans. Therefore, there is a need to develop a natural and eco-friendly mosquito repellent that effectively protects individuals from mosquito bites while minimizing the risks associated with synthetic repellents.

## 1.4 SIGNIFICANCE

The development of a mosquito repellent from lantana camara leaf extract is justified by its potential to offer a sustainable and eco-friendly solution for mosquito control. Synthetic mosquito repellents often contain synthetic chemicals that can be harmful to human health and the environment. By utilizing lantana camara, a plant with natural mosquito repellent properties, we can create a safer alternative that reduces the reliance on harmful chemicals while effectively protecting individuals from mosquito-borne diseases. Additionally, this project aligns with the growing global demand forenvironmentally friendly products and supports sustainable practices in pest management. The availability of a lantana camara-based repellent would provide a valuable option for individuals and communities seeking efficient mosquito protection without compromising their health or the planet's well-being.

## 1.5 HYPOTHESIS

The formulation from the extract will effectively deter mosquitoes, reduce their biting activity, and provide a natural and safe alternative to synthetic repellents.

# CHAPTER TWO

## 2.1 LITERATURE REVIEW

### 2.1.1 Background

Lantana is a gregarious, upright or half-climbing, more of a hairy strongsmelling shrub. When upright, it is usually one to two meters high. Leaves are egg-shaped, five to nine centimeters long, three inches long, sharp at the tip and curved at the bottom and saw-like in the borders. Flowers are pink, orange, yellow, white, lilac and other shades, according to the diversity and bear in stalked heads which are two to 3.5 centimeters in diameter. Fruit is drupaceous, sweet tasting, purple or black, fleshy ovoid and about five millimeters long. The phytochemical analysis of the plant detected common secondary metabolites–alkaloids, phenolics, terpenoids and other minor compounds such as phytosterols, saponins, tannins, phycobatannin and steroids. It has mosquito larvicidal activity. Phytochemical screening of leaves yielded saponin, terpenoids, flavonoids and cardiac glycosides. Phytol, a diterpene, is present in higher concentration in the methanol leaf extract of Lantana camara. The larvicidal activity noted was attributed to the phytochemicals and results suggest the shrub may have a potential in the control of vector borne diseases.Lantana camara has therapeutic value because of the presence of natural agents. Greater part of their activity is due to “bioactive compounds like flavones, isoflavones, flavonoids, anthocyanins, coumarins, lignans, catechins, isocatechins, alkaloids, tannin, saponins and triterpenoids” (Ganjewala, 2009). Terpenoids or terpenes occur in almost every plant and represent the biggest class of secondary metabolites. They contribute to the taste, smell and colors of plants. The main active components of essential oils like terpenoids are highly volatile compounds called monoterpenoids and sesquiterpenoids that contribute to their distinctive scents. Sterols are complex terpenoids which are precursors to essential hormones in plants. Terpenoids are insect growth regulators . The chemicals disrupt larval development and increase insect mortality. Saponins are soap-like substances that are able to disrupt the cell membranes of insects which make it toxic to them at specific concentrations. D-limonene, a saponin, can destroy the wax coating of the respiratory systems of insects, causing suffocation.Phenolics are another large class of secondary metabolites produced by the plants. They are aromatic compounds that give the plants their distinctive smells and encompass a wide variety of defense-related compounds that include flavonoids, anthocyanins, phytoalexins, tannins, lignin and furanocoumarins. These toxic molecules disrupt the pathogen metabolism or cellular structure of insects but are often pathogen to the specific to their toxicity. The wide varieties of plants produce the toxins that are activated by ultraviolet light. These are some of the phenolics that can kill the pests: Eugenol, Salicylate, Quartering and Methoxyphenol. Alkaloids are plant components used as insecticides because it interferes with insect’s nerve impulses. The methanolic extracts of Lantana camara were found to have an advanced larvicidal rate against Aedes aegypti, common household mosquitoe, the concentration of extracts have to be improved for better larvicidal effect. The high rate of mortality may be due to a component in the essential oil known as terpenoids in the methanol extracts of the leaves of Lantana camara.

### 2.1.2 Phytochemical analysis

Lantana camara is known to contain various bioactive compounds that contribute to its potential repellent properties. These compounds include terpenoids, flavonoids, and alkaloids, among others.

Terpenoids: Lantana camara leaves contain several terpenoids, such as lantadene A, lantadene B, and lantadene C. These compounds are triterpenoids and are believed to contribute to the plant's insecticidal and repellent properties. Studies have shown that terpenoids have mosquito larvicidal and repellent effects by disrupting the nervous system of mosquitoes.

Flavonoids: Lantana camara leaves are rich in flavonoids, including luteolin, apigenin, quercetin, and kaempferol derivatives. Flavonoids are known for their various biological activities, including insecticidal and repellent properties. They act as natural insecticides by interferingwith the feeding, growth, and development of mosquitoes. Some flavonoids also possess repellent activity by deterring mosquitoes from landing on treated surfaces or individuals.

Alkaloids: Lantana camara contains alkaloids like lantanine and lantanine alkaloids. These alkaloids have been studied for their potential insecticidal properties against mosquitoes. Alkaloids often exhibit neurotoxic effects on insects and disrupt their physiological processes, making them potential candidates for mosquito control.

Phenolic compounds: Lantana camara leaves are also a source of phenolic compounds, such as caffeic acid, chlorogenic acid, and ellagic acid derivatives. These compounds possess antioxidant and antimicrobial properties and may contribute to the plant's repellent effects against mosquitoes.

Essential oils: Lantana camara leaves and flowers contain essential oils that have been studied for their mosquito repellent properties. These oils are rich in volatile compounds like monoterpenes (e.g., linalool, camphor) and sesquiterpenes (e.g., β-caryophyllene). Essential oils can act as effective repellents by interfering with mosquito olfactory receptors and disrupting their host-seeking behavior.

### 2.1.3 mosquitoe repellent

Lantana camara leaf extract can also be utilized to create a mosquito repellent that offers a natural and safe alternative to traditional repellents. The extract contains compounds such as lantadene A and B, which possess mosquito repellent properties. By formulating lantana camara leaf extract into a repellent, it effectively deters mosquitoes and reduces the risk of mosquito-borne diseases. The extract's repellent action works by interfering with the mosquito's ability to detect and locate potential hosts, thereby reducing their biting and feeding activity. This natural repellent derived from lantana camara leaf extract provides a sustainable and eco-friendly solution for individuals seeking protection against mosquitoes without the use of synthetic chemicals.

### 2.1.4 Synthetic repellents

Synthetic repellents, such as DEET (N,N-Diethyl-meta-toluamide), have been widely used and studied. DEET is known for its robust efficacy against a variety of mosquito species. Despite its effectiveness, concerns have been raised regarding its potential adverse effects on human health, such as skin irritation and rare instances of neurotoxicity. Additionally, the distinctive odor and feel of DEET may deter some users.

Picaridin is another synthetic alternative gaining popularity. It exhibits efficacy comparable to DEET but with a milder scent and lower risk of irritation. However, its longevity is sometimes reported to be shorter than DEET.

### 2.1.5 Natural repellents

Natural repellents have garnered attention as eco-friendly alternatives with fewer reported adverse effects. Essential oils, derived from plants, are prominent in this category. Citronella, extracted from lemongrass, has been widely used and recognized for its mosquito-repelling properties. Other essential oils like eucalyptus, lavender, and peppermint are also explored for their potential in repelling mosquitoes.

Lantana camara leaf extract, a natural source rich in terpenoids and flavonoids, has shown promise as a mosquito repellent. Studies suggest that these compounds may interfere with mosquito olfactory receptors, disrupting their feeding behavior.

### 4.1.6 Advantages of Natural Repellents Over Synthetic Counterparts

1. Environmentally Friendly: Natural repellents, sourced from plants, are biodegradable and have a lower environmental impact compared to synthetic chemicals.
2. Lower Toxicity: Natural repellents often exhibit lower toxicity and fewer adverse effects on human health. This is particularly significant for individuals with sensitivities or allergies.
3. Sustainability: The renewable nature of plant-based sources contributes to the sustainability of natural repellents, aligning with growing global concerns about sustainability and eco-friendliness.
4. Diverse Compounds: Natural repellents often contain a diverse array of phytochemicals, potentially providing a broader spectrum of protection against different mosquito species.

While synthetic repellents like DEET and Picaridin continue to be widely used, the literature suggests that natural alternatives, particularly those derived from essential oils and plant extracts like Lantana camara, offer promising avenues for the development of effective and environmentally conscious mosquito repellents.

# CHAPTER THREE

## 3.1 MATERIAL AND METHODOLOGY

### 3.1.1 REAGENTS AND OTHER CONSUMABLES

Lantana Camara leaves,methanol, distilled water,sodium benzoate,glycerin,polysorbate 20, ethanol.

### 3.1.2 EQUIPMENTS AND APPARATUS

Round -bottomed flask, reflux condenser, heating mantal, 250ml beaker, weighing apparatus, mortal and pestle,test tubes,conical flask,measuring cylinder,stirer and filter paper.

### 3.1.3 PROCEDURES

#### i. Material collection and preparation

The leaves of Lantana camara were collected locally in and around Nyeri at Dedan kimathi area.The leaves were washed thoroughly using water. Afterwards, the washed leaves were dried in shade at room temperature and powdered with the help of mortar and pestle which were aseptically cleaned using 70% alcohol. The powdered leaves were sieved to get fine powder from which the extracts will be prepared.

#### ii. Extraction of the phytochemicals

In the conducted phytochemical extraction using the Soxhlet apparatus, dried plant material was initially ground into a coarse powder to facilitate efficient solvent penetration. The ground plant material was then loaded into the extraction thimble of the Soxhlet apparatus. A suitable solvent, such as ethanol, was used in the extraction process.The extraction apparatus was assembled, and the Soxhlet extraction was performed by continuously cycling the solvent through the plant material. This cyclical process allowed for efficient extraction of phytochemicals over an extended period, ensuring a thorough extraction of compounds from the plant material. The solvent, enriched with phytochemicals, was collected in a flask attached to the Soxhlet apparatus.

After completion of the extraction cycles, the collected solvent was evaporated to obtain the crude extract rich in phytochemicals. The residue obtained was further processed and analyzed to assess the yield and composition of the extracted phytochemicals.

#### iii. Phytochemical analysis

Terpenoids:Salkowski test was used to detect terpenoids. Extract (5 ml) was mixed with chloroform (2 ml), and concentrated sulphuric acid (3 ml) was carefully added to form a layer. A reddish-brown coloration of the inter face was formed to show positive results for the presence of terpenoids.

Flavonoids: Two to three drops of sodium hydroxide were added to 2 mL of extract. Initially, a deep yellow colour appeared but it gradually became colourless by adding few drops of dilute HCL, indicating that flavonoids were present.

Alkaloids: Mayer's test. Few drops of Mayer's reagent were added to 1 mL of extract. A yellowish or white precipitate was formed, indicating the presence of alkaloids.

Phenolic compounds: Litmus test Phenol turns blue litmus paper red. Ferric chloride test Violet or blue colouration shows presence of phenol.

Tannins:Sample was first hydrated with water. Water excess was removed with filter paper. Then, three drops of ferric reagent were added to the sample. A grey or black colour formation indicates the presence of tannins.

#### iv.Formulation of the repellent

Prepared the necessary ingredients for the formulation, including carrier agents, stabilizers, and fragrances.Determined the appropriate proportions of the Lantana camara leaf extract and other additives based on preliminary studies or established guidelines.Mixed the Lantana camara leaf extract with the carrier agent (ethanol) to ensure even distribution of the active compounds.Added a stabilizer (glycerol) to increase the shelf life and prevent degradation of the formulation.Incorporated a fragrances (coconut oils) to enhance the repellent's scent and potential mosquito-repelling properties.Thoroughly mixed the ingredients to achieve homogeneity and ensured that all components were well-dispersed.

**v. Repellence test**

The cage test was used to assess the viability of repelling substance against mosquitoes for lotions, cream and spray included impregnated material done fast and effective approach. It was designed to observe the mosquito landing on the untreated and treated fabric in the cage. The advantages of this method was that it provided the real situation of the probing and biting of the mosquito to the human, besides it directly provided the observation of the mosquitoes behaviour towards the treated materials. The drawbacks of cage test involved the human participation, it took a lot of preparation either in term of paper works such as needed to apply ethical approval, the human and mosquito preparation. In term of human participation, the consent form and incentives must be prepared as an appreciation to the volunteer. The mosquitoes used in the test need to be free from pathogen as the human subject involved in the test must have the assurance that the test will not harm them. The cage measurement was according to WHO guideline for efficacy testing of mosquito repellents for human skin (WHO 1996) the range of 35–40 cm per side. Some studies reported in modification of the cage dimension; Bano et al. used a cage 18 × 18 × 18 cm dimension(Bano 2014), Phasomkusolsil et al. used cage 30 × 30 × 30 cm dimension (Phasomkusolsil and Soonwera 2011), Anitha et al. used 34 × 32 × 32 cm cage dimension (Anitha et al. 2011) and Chang et al. used the 35 × 35 × 35 cm cage dimension (Chang et al. 2006). Two other studies reported the used of bigger cage dimension, measuring 40 × 30 × 30 cm by Fei and Xin (2007) and 45 × 45 × 45 cm by (Vigneshkumar and Vijaykumar Vediappan 2012).

The cage concealed with transparent mosquito nets for easy observation and also to keep mosquito remain inside the cage. It had holes which also covered with nets for arm accessing purpose. According to WHO (WHO 1996) conventional standards, the cage needs to be filled with 200 mosquitoes that have been starved overnight and only were supplied with sucrose solution. Updated standards the use of lesser number of mosquitoes in the cage (as low as 30 mosquitoes), as lower density provided more accuracy which better reflected the typical biting environment encountered during most indoor and outdoor activities and also to give a comfortable condition to volunteer. Volunteers should be preferable not to be tobacco users and should avoid using fragrance or repellent products for 12 h ad during testing. This factor may alter the person attractiveness to the mosquitoes and would affect to the outcome repellency assay. In preparation of the volunteer, their hand must be washed with unscented soap and rinsed with water and placed separated from each other by ≥20 m away. The arm covered with gloves or treated materials of the volunteers will be inserted into the cages. The left arm served as control while the right arm use as treated samples. Both forearms with untreated and treated materials will be exposed to the population of mosquitoes simultaneously for a period of 3 min. At least two mosquitoes landed or bite within the 3 min, the test will continue. If there is no mosquito landed within 3 min, the hand will withdraw from the cage. The number of mosquito landing will be counted independently using the digital camera for an accurate result. The exposition is done every 30 min up to 8 h or until the repellency fails. Each test samples done in triplicates at 28 ± 2 °C and 80 ± 5 % RH with 5 min waiting period between replicates. The time between applications of the treated materials recorded as the protection time. The percentage of repellency or protection time was calculated using the formula. % mosquito protection:(U-T)/U×100

where U corresponded to the number of mosquitoes on untreated samples or control samples and T represented the number of mosquitoes on treated samples. This was the regularly utilized formulas as stated by Lupi et al. (2013) although the percentage of repellency was sometimes calculated with other formulas, but it would not be discussed further in this review. The results would be collected and performed in ANOVA software for further analysis. Six studies (Chang et al. 2006; Fei and Xin 2007; Fradin and Day 2002; Masetti and Maini 2006; Vigneshkumar and Vijaykumar Vediappan 2012; Yang and Ma 2005) demonstrated the use of cage tests in their study for mosquito repellent.

**vi.Compatibility testing**

Conduct stability testing by monitoring the physical and chemical stability of the detergent formulation over time, including factors such as pH, viscosity, color, and odor.

# 

# CHAPTER FOUR

## 4.1 DISCUSSION AND RESULTS

### 4.1.1 EXTRACTION RESULTS

Soxhlet extraction of Lantana camara leaves involved finely grinding the plant material and placing it in a thimble within the Soxhlet extractor. A suitable solvent, ethanol ,was heated in a round-bottom flask, causing it to vaporize and travel through a condenser. The vaporized solvent driped onto the sample in the Soxhlet extractor, dissolving compounds as it cycles through the system. The lighter solution is siphoned back into the round-bottom flask, facilitating continuous extraction. This process was repeated until a sufficient concentration of target compounds, essential oils, was achieved. The collected extract was then concentrated, and the solvent was recovered through distillation for reuse.

Table : Results for three trials

|  |  |  |
| --- | --- | --- |
| Trial | Mass of leaves in (g) | Volume of extract in (ml) |
| 1 | 30 | 4 |
| 2 | 30 | 3.5 |
| 3 | 30 | 3.8 |

The percentage yield was calculated as; total weight of extract/total weight of leaves x 100

11.3/90x100=12.56%

The extraction results revealed a percentage yield of 12.5% for the phytochemical-rich crude extract obtained using the Soxhlet apparatus. This yield was obtained after multiple extraction cycles, indicating a successful extraction process. Comparing this result with available literature, it's noteworthy that reported yields can vary based on factors such as plant species, solvent used, and extraction conditions.

The obtained 12.5% yield falls within the range reported for similar phytochemical extractions using Soxhlet extraction methods in the literature. Variability in yields can be attributed to differences in plant material composition, geographic origin, and variations in extraction parameters. This suggests that the chosen methodology effectively extracted a substantial portion of phytochemicals present in the plant material.

Additionally, comparing the yield with literature underscores the importance of optimization for specific plant species and target compounds. The 12.5% yieldobtained provides a baseline for future experiments and highlights the need for further studies to fine-tune extraction conditions.

### 4.1.2 PHYTOCHEMICAL CONSTITUENTS

Table : Phytochemical composition of the extract

|  |  |  |
| --- | --- | --- |
| Phytochemical | Test | Leaf extract |
| Alkaloids | Mayer's test | + |
| Flavonoids | Ethyl acetate test | + |
| Terpenoids | Salkowski test | + |
| Tannins | Ferric chloride test | + |

Salkowski test was used to detect terpenoids. Extract (5 ml) was mixed with chloroform (2 ml), and concentrated sulphuric acid (3 ml) was carefully added to form a layer. A reddish-brown coloration of the inter face was formed to show positive results for the presence of terpenoids. Alkaline reagent test was used to detect flavonoids. Two to three drops of sodium hydroxide were added to 2 mL of extract. Initially, a deep yellow color appeared but it gradually became colorless by adding few drops of dilute HCL, indicating that flavonoids were present. Mayer's test was used to detect alkaloids. Few drops of Mayer's reagent were added to 1 mL of extract. A yellowish or white precipitate was formed, indicating the presence of alkaloids. For tannins, the sample was first hydrated with water. Excess water was removed with filter paper. Then, three drops of ferric reagent were added to the sample. A grey or black colour formation indicates the presence of tannins.

The identified phytochemicals—terpenoids, alkaloids, tannins, and flavonoids—play a crucial role in the repellent's potential efficacy. Terpenoids, known for their insect-repelling properties, could contribute to the overall effectiveness of the repellent against mosquitoes. Alkaloids, tannins, and flavonoids may further enhance the repellent's bioactivity, potentially providing a broader spectrum of protection.

Literature on natural mosquito repellents often highlights the significance of terpenoids and flavonoids in deterring mosquitoes. These compounds have been recognized for their ability to interfere with mosquito olfactory receptors and disrupt their feeding behavior. The presence of alkaloids, known for their diverse biological activities, adds another layer of complexity to the repellent's potential mechanisms of action.

However, it's essential to note that the efficacy of the mosquito repellent is not solely determined by the presence of these phytochemicals but also by their concentrations and interactions within the formulation.

Table : pH values of the three trials

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Trials | Trial 1 | Trial 2 | Trial 3 | Average |
| pH Values | 5.4 | 5.5 | 5.5 | 5.47 |

Table 2 shows the pH values of the mosquito repellent and the average mean. The significance of the average pH (5.47) value lies in its alignment with the optimal pH range for mosquito repellent, typically around 5.0-6.0(Mohiuddin, 2019). This finding indicates that the m0squito repellent has been formulated to be gentle and compatible with various skin types. Products that closely match the skin's natural pH are less likely to cause irritation and are more likely to support the skin's protective barrier. The consistency observed in pH values across the three trials (5.4, 5.5, 5.5) underscores the stability and reliability of the formulation. It is important to note that the slightly acidic nature of the mosquito repellent, with a pH value below 7, is particularly advantageous for skin care. Such acidity is conducive to maintaining the skin's natural acid mantle, which serves as a protective barrier against moisture loss and bacterial proliferation, ultimately promoting overall skin health.

### 4.1.3 FORMULATION OF THE MOSQUITO REPELLENT

10 ml of Lantana camara leaf extract obtained through Soxhlet extraction was measured and transferred in to a 100ml beaker. To enhance solubility and improve consistency, 30 ml of ethanol (95%) was added to the leaf extract. 5 ml of glycerol was added as a humectant to provide skin-friendly properties and promote moisture retention.5ml of coconut oil was incorporated for added fragrance and potential enhancement of repellent properties.

# CHAPTER FIVE

## 5.1 CONCLUSION AND RECOMMENDATIONS

### 5.1.1CONCLUSION

Soxhlet extraction was successfully used to extract the phytochemicals from the leaves.In summary, the research successfully created a Lantana camara leaf extract mosquito repellent spray.This project contributed to natural solutions in mosquito control, prioritizing responsible herbal formulations.

### 5.1.2RECOMMENDATION

I recommend further refining the Lantana camara leaf extract mosquito repellent spray by conducting additional trials with varying concentrations. Collaboration with entomologists and herbal experts would enhance the formulation's effectiveness and safety.

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