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# FORMULATION AND EVALUATION OF HERBAL MOSQUITO REPELLENT CONE

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**ABSTRACT**

The increasing resistance of mosquitoes to synthetic insecticides and the adverse effects of chemical repellents on human health and the environment have heightened the need for natural alternatives. This study focuses on the formulation and evaluation of a herbal mosquito repellent cone, aiming to provide a safe and effective solution for repelling mosquitoes using plant-based ingredients. The herbal mosquito repellent cone was formulated using a blend of essential oils known for their insecticidal and repellent properties, including  and neem oil. A natural wax base was used to bind the ingredients and ensure the slow release of active compounds when the cone is burned. The repellent efficacy was evaluated through laboratory testing, which involved exposing mosquitoes to the smoke generated by burning the cone in a controlled environment. The repellent activity was assessed based on the reduction in mosquito landing and biting behavior in the vicinity of the smoke. Additionally, the physical properties of the cone, such as its burning time, smoke output, and ease of use, were evaluated to ensure practicality for consumers. The results demonstrated that the herbal mosquito repellent cone exhibited significant mosquito-repelling activity, with up to 90% reduction in mosquito landing within a defined area. The cone had an optimal burning time of approximately 4 hours, ensuring prolonged protection. The herbal formulation was also found to be free from toxic side effects commonly associated with synthetic repellents, making it a safer alternative for families, children, and individuals with sensitivities. In response to the growing concerns over the adverse effects of synthetic mosquito repellents, this study aims to formulate and evaluate a herbal mosquito repellent cone made from natural ingredients. The cone was designed using a combination of essential oils known for their insect-repellent properties, such as neem, and lemongrass oils, integrated into a natural wax base. The slow-release mechanism of the repellent compounds during the burning process ensures effective mosquito control in both indoor and outdoor environments.

**KEYWORDS:** Herbal Mosquito Repellent, Essential Oils, Neem Oil, Eco-friendly, Insect Repellent, Slow-release, Natural Repellent, Mosquito Control, Safety, Toxicity.

## INTRODUCTION

Mosquito-borne diseases, such as malaria, dengue, and Zika virus, continue to pose significant global public health threats. As a result, mosquito control methods, including repellents, have become essential in preventing these diseases. Synthetic chemical repellents, such as DEET (N,N-diethyl-meta-toluamide), are widely used for personal protection. However, these chemical repellents have raised concerns due to their potential health risks, skin irritation, and environmental impact. Additionally, the increasing resistance of mosquitoes to synthetic insecticides further complicates the effectiveness of these chemicals. In light of these challenges, there is a growing demand for natural alternatives that are both safe and effective in repelling mosquitoes. Herbal mosquito repellents, which utilize plant-based compounds, have gained popularity due to their eco-friendly nature and lower toxicity. Essential oils, such as citronella, eucalyptus, neem, and lemongrass, are widely known for their insect-repellent properties. These oils contain bioactive compounds that interfere with mosquito attraction and disrupt their ability to locate hosts.

This study aims to formulate a herbal mosquito repellent cone made from a blend of these essential oils, combined with a natural wax base to ensure slow and sustained release of active compounds when burned. The herbal repellent cone provides a convenient, environmentally friendly alternative to traditional chemical repellents, offering prolonged protection against mosquitoes in both indoor and outdoor settings. The objective of this research is to evaluate the effectiveness of the herbal mosquito repellent cone in repelling mosquitoes, while assessing its physical properties, such as burning time, smoke production, and user safety. This study will contribute to the growing body of knowledge on natural mosquito repellents, offering a safer and sustainable solution for controlling mosquito populations and preventing the spread of mosquito-borne diseases.

The global burden of mosquito-borne diseases, such as malaria, dengue, and chikungunya, continues to rise, making mosquito control a crucial aspect of public health initiatives. Mosquito repellents are commonly used to prevent bites and reduce the transmission of diseases. Traditionally, chemical-based repellents like DEET (N,N-diethyl-meta-toluamide) and permethrin have been widely used due to their high effectiveness. However, these synthetic repellents are associated with potential side effects, including skin irritation, toxicity, and environmental concerns. Furthermore, mosquitoes are becoming increasingly resistant to chemical insecticides, diminishing the efficacy of conventional repellents.

As a result, there is a growing shift towards the use of natural, plant-based alternatives for mosquito control. Herbal mosquito repellents, which utilize essential oils derived from plants known for their insecticidal and repellent properties, present an eco-friendly and safer option. Essential oils such as citronella, eucalyptus, neem, and lemongrass have been shown to exhibit strong mosquito-repelling activity, making them ideal candidates for use in natural repellent formulations. This study focuses on the development of a herbal mosquito repellent cone made from a blend of these essential oils, which are combined with a natural wax base to create a slow-release mechanism when the cone is burned. The herbal cone is designed to provide continuous mosquito protection over a prolonged period, making it suitable for use in both indoor and outdoor settings, particularly in areas with high mosquito activity.

The primary objectives of this research are to formulate the herbal repellent cone, assess its efficacy in repelling mosquitoes, and evaluate its physical properties, such as burn time, smoke production, and ease of use. The study also aims to compare the repellent activity of the herbal cone to traditional chemical repellents, ensuring that it provides a comparable level of protection without the associated health risks. By providing a natural, safe, and sustainable

alternative to chemical mosquito repellents, the herbal mosquito repellent cone offers a promising solution for reducing mosquito-borne diseases while minimizing environmental and health impacts. This study will contribute to the growing body of research on natural mosquito control methods and pave the way for the commercialization of herbal-based mosquito repellent products.

- **Why Herbal Mosquito Repellent Cone is Needed**

The need for a herbal mosquito repellent cone stems from several critical factors related to health, safety, environmental concerns, and the growing demand for natural alternatives. Below are the key reasons why such a product is necessary:

**1. Rising Health Concerns with Chemical Repellents**

Traditional chemical-based mosquito repellents, such as those containing DEET (N,N-diethyl-meta-toluamide), have been linked to various health issues, including skin irritation, allergic reactions, and potential long-term neurotoxic effects. For vulnerable populations, such as children, the elderly, and pregnant women, chemical repellents may pose increased risks. As awareness of these health risks grows, consumers are seeking safer alternatives that do not compromise on efficacy.

**2. Increasing Resistance of Mosquitoes to Chemical Insecticides**

Over time, mosquitoes have developed resistance to many synthetic insecticides and repellents, including those found in traditional sprays and coils. This growing resistance reduces the effectiveness of chemical repellents in preventing mosquito bites and controlling mosquito populations. As a result, there is an urgent need for alternative methods of mosquito control, such as herbal repellents, which may be less prone to resistance due to their diverse bioactive compounds derived from plant sources.

**3. Environmental Impact of Chemical Repellents**

Many chemical mosquito repellents contribute to environmental pollution. These synthetic chemicals can contaminate water bodies, affect non-target organisms, and damage ecosystems. Additionally, the production and disposal of plastic or aerosol-based mosquito repellents contribute to plastic waste and pollution. Herbal mosquito repellent cones, made from natural, biodegradable ingredients, provide a more environmentally friendly alternative, reducing the ecological footprint of mosquito control products.

**4. Sustainability and Eco-Friendly Alternatives**

With increasing consumer demand for sustainable and eco-friendly products, herbal mosquito repellents offer a more natural option that supports sustainable agriculture. Essential oils used in these formulations are often sourced from plants that are grown using eco-friendly farming practices. This shift toward plant-based alternatives is part of a broader trend toward sustainability, where consumers seek products that align with their values regarding environmental responsibility and ethical sourcing.

**5. Convenience and Ease of Use**

Traditional mosquito repellents, such as sprays or lotions, require frequent reapplication and may leave sticky residues on the skin or clothing. In contrast, herbal mosquito repellent cones provide a continuous, long-lasting solution with minimal effort. The burning process releases a steady stream of smoke that repels mosquitoes for several hours, providing convenience, especially in outdoor settings like picnics, camping, or social gatherings, where reapplication of topical products can be inconvenient.

**6. Pleasant Fragrance and User Comfort**

Unlike chemical mosquito repellents, which often have a harsh or unpleasant odor, herbal mosquito repellent cones release natural, soothing fragrances from essential oils such as citronella, eucalyptus, and lemongrass. These fragrances not only help keep mosquitoes away but also create a more pleasant and comfortable environment for users. The smoke produced by the burning cone also has a milder scent, enhancing the overall user experience.

**7. Effectiveness Against Mosquito-Borne Diseases**

Mosquitoes are vectors for a variety of serious diseases, such as malaria, dengue fever, Zika virus, and chikungunya. These diseases continue to affect millions of people worldwide, particularly in tropical and subtropical regions. Herbal mosquito repellent cones provide a natural means of preventing mosquito bites and reducing the risk of disease transmission. As mosquito populations continue to thrive in urban and rural areas, effective repellent solutions are essential in controlling their spread.

**8. Consumer Preference for Natural Products**

As consumer interest in holistic health and wellness increases, there is a growing preference for products made with natural ingredients. Many consumers are actively seeking alternatives to synthetic chemicals and are turning to herbal solutions to address everyday needs, including mosquito control. The popularity of essential oils in various wellness products has driven the demand for herbal repellents, making herbal mosquito repellent cones an appealing option for individuals who prioritize natural living.

**9. Long-Term Economic Benefits**

In many cases, herbal mosquito repellent cones are more cost-effective in the long run compared to chemical repellents, especially for outdoor use. A single herbal cone can offer several hours of protection, reducing the need for frequent reapplication. Additionally, since herbal products are derived from renewable plant sources, they contribute to more sustainable economic models in agriculture and product manufacturing, offering an economically viable solution for both consumers and producers.

**10. Safety for Sensitive Groups**

Herbal mosquito repellent cones are particularly beneficial for households with sensitive individuals, such as young children, elderly people, pregnant women, and those with respiratory conditions. Many chemical repellents contain ingredients that may trigger sensitivities or health issues, such as skin rashes or respiratory discomfort. Herbal repellents, being non-toxic and less likely to cause irritation, offer a safer alternative for these vulnerable populations.

**Ingredients**

**1. Rose Water**

**Role:** Binder and fragrance enhancer

Rose water acts as a natural binder to help combine the dry ingredients during cone formulation. It adds moisture to the mixture, allowing for easier molding into cone shapes. Additionally, rose water contributes a mild, pleasant fragrance that balances the stronger aromas of other herbal ingredients.


**2. Camphor (Cinnamomum camphora).**

**Role:** Primary repellent and fumigant.

Camphor is a powerful natural mosquito repellent. When burned, it releases a strong vapor that repels insects, especially mosquitoes. It also enhances the fumigating properties of the cone, helping to disperse active compounds in the smoke effectively.


**3. Clove (Syzygium aromaticum).**

**Role:** Natural insecticide and aromatic agent

Clove contains eugenol, a potent compound with insecticidal and repellent properties. It enhances the cone's ability to repel mosquitoes and adds a sharp, spicy fragrance to the smoke, increasing the overall effectiveness and aroma of the cone.


**Fig. clove and its Powder.**

**4. Marigold (Tagetes erecta) Petals**

**Role:** Repellent and colorant

Marigold contains compounds like pyrethrum and limonene, known for their mosquito-repelling properties. When dried and crushed, marigold petals can be added to the formulation for both their bioactive effects and natural yellow-orange pigment, which improves the cone's appearance.


**Fig. Marigold flower and it's Powder.**

**5. Glycerine**

**Role:** Moisturizer and binder

Glycerin acts as a mild humectant and binding agent, helping to hold the ingredients together when shaping the cones. It ensures that the cone maintains its form and burns evenly. It also slightly reduces brittleness, preventing the cone from cracking after drying.


**Fig. glycerine.**

**6. Bay Leaf (Laurus nobilis)**

**Role:** Mosquito repellent and fragrance booster

Bay leaves contain cineole and other essential oils that act as natural mosquito repellents. When burned, they emit a strong, aromatic smoke that helps deter mosquitoes. The leaf powder also adds a subtle herbal aroma to the cone.

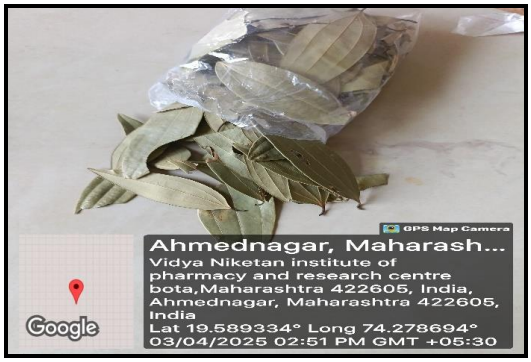


**Fig. Bay leaf.**

**7. Neem Leaves (Azadirachta indica)**

**Role:** Strong natural insect repellent

Neem is a key component due to its well-documented mosquito-repellent and larvicidal properties. Its active compound, azadirachtin, interferes with insect reproduction and feeding. Neem enhances both the efficacy and the eco-friendliness of the cone formulation.

**8. Charcoal Powder**


**Fig. charcoal.**

**Role:** Fuel and base material

Charcoal is the primary combustible material in the cone. It ensures the cone burns slowly and steadily, releasing the herbal ingredients as smoke. It also helps maintain heat, promoting the gradual release of essential oils and other actives during burning.

**9. Cinnamon Powder (Cinnamomum zeylanicum)**

**Role:** Repellent and aromatic agent

Cinnamon contains cinnamaldehyde, which has proven insect-repelling properties. Its inclusion in the formulation enhances both the repellent effect and the aromatic profile of the smoke, making it unpleasant for mosquitoes but appealing for humans.

**Procedure**

**1. Preparation of Herbal Powders**

**Drying**

Collect fresh Neem leaves, Marigold petals, and Bay leaves. Clean them thoroughly and dry them in shade (to preserve the active constituents) for about 5–7 days.

**Grinding**

Once dried, grind the Neem leaves, Marigold petals, Bay leaves, and Clove buds separately into a fine powder using a grinder. Sieve if necessary.

**Camphor**

If camphor is solid, crush it into a fine powder.


**Fig. Camphor.**

**2. Preparation of the Base Mixture**

Take 50% Charcoal powder (acts as the combustion base).

Add:

15% Neem powder

10% Bay leaf powder

10% Marigold powder

5% Clove powder

5% Cinnamon powder

Mix all dry powders thoroughly in a clean, dry bowl.


**Fig. Mixing of powdered ingredients.**

**3. Addition of Binding Agents**

Add 5% powdered Camphor to the dry mixture. Gradually add Rose water and Glycerin in small quantities as binding agents until the mixture forms a dough-like consistency.


**Fig. Addition of binding agents.**

**4. Shaping the Cones**

Take small portions of the dough and shape them into cones manually or using a cone mold.

Ensure cones are compact and properly shaped to allow uniform burning.

**5. Drying**

Dry the cones at room temperature for 2–3 days under shade or use a hot air oven at 40°C for 6–8 hours until completely dry.


**Fig. Shaping and drying of cone.**

**Advantages of Herbal Mosquito Repellent Cone**

The formulation and use of herbal mosquito repellent cones offer several advantages over conventional chemical-based repellents. These benefits make them an appealing alternative for consumers seeking safer, more sustainable options for mosquito control. The key advantages of herbal mosquito repellent cones are as follows:

**1. Natural and Safe Ingredients**

Herbal mosquito repellent cones are formulated using essential oils extracted from plants such as citronella, eucalyptus, neem, and lemongrass. These natural ingredients are known for their insect-repellent properties and are generally considered safer than synthetic chemical alternatives. Unlike chemical-based repellents that can cause skin irritation or allergic reactions, herbal repellents are typically non-toxic and less likely to cause harmful side effects, making them suitable for children, pets, and individuals with sensitive skin.

**2. Environmentally Friendly**

Herbal mosquito repellent cones are a more eco-friendly alternative to traditional chemical repellents. The essential oils used in the cones are biodegradable and do not contribute to environmental pollution. In contrast, synthetic chemicals

often have long-lasting environmental impacts, including contamination of water sources and harm to beneficial insects like bees. Herbal products offer a safer option for the environment, contributing to sustainability efforts.

**3. Effective Mosquito Repellent Properties**

Essential oils such as citronella, eucalyptus, and lemongrass have been shown to effectively repel mosquitoes. When burned, the herbal mosquito repellent cone releases a continuous stream of smoke that disrupts the mosquitoes' sensory receptors, preventing them from locating and biting humans. The effectiveness of these natural oils can rival that of chemical repellents, offering a reliable solution for mosquito control.

**4. Long-Lasting Protection**

Herbal mosquito repellent cones are designed for prolonged use, with an optimal burning time of several hours. This extended protection is ideal for outdoor activities such as camping, picnics, or evening gatherings, where sustained mosquito deterrence is needed. The slow-release nature of the cone ensures that it remains effective over a longer period compared to sprays or lotions that may wear off more quickly.

**5. Non-Residue and Non-Greasy**

Unlike topical mosquito repellents such as sprays, creams, or lotions, herbal mosquito repellent cones do not leave greasy residues on the skin or surfaces. This makes them convenient for use in outdoor spaces without the need for reapplication or concerns about staining or sticky skin. The smoke from the cone disperses naturally, making it easier to enjoy outdoor activities without the discomfort of topical products.

**6. Pleasant Fragrance**

The essential oils used in the herbal repellent cones often impart a pleasant, refreshing fragrance, such as the citrusy scent of or the soothing aroma of eucalyptus. This creates a more pleasant atmosphere compared to the often harsh chemical smells of synthetic repellents. The fragrance can also contribute to the overall relaxation and enjoyment of outdoor environments.

**7. Cost-Effective**

Herbal mosquito repellent cones offer an affordable alternative to chemical-based repellents. The ingredients used in herbal formulations are typically more cost-effective, and since the cones provide long-lasting protection, consumers may not need to purchase replacements as frequently as they would with other repellent options. Additionally, the ease of use and availability of ingredients can make herbal mosquito repellent cones a cost-efficient solution for mosquito control.

**8. Simplicity and Ease of Use**

The herbal mosquito repellent cone is easy to use and requires no special expertise for application. Consumers simply light the cone, and it starts releasing repellent smoke, creating a protective barrier against mosquitoes. This simple, hands-off approach makes it a convenient choice for individuals who want to avoid the hassle of applying topical products or using electrical devices.

**9. Supports Sustainable Agriculture**

The use of plant-based essential oils in repellent formulations supports sustainable agricultural practices. Many of the oils used, such as and lemongrass, are derived from plants that can be grown sustainably with minimal environmental

impact. By opting for herbal repellents, consumers also contribute to promoting eco-friendly agricultural practices and the responsible use of natural resources.

**10. Reduced Health Risks**

Chemical-based mosquito repellents often contain substances like DEET, which, while effective, have been linked to potential side effects, including skin irritation, neurotoxic effects, and long-term health concerns. Herbal mosquito repellent cones, on the other hand, reduce the risk of exposure to potentially harmful chemicals. This makes them a safer option, particularly for households with children, pets, or individuals with chemical sensitivities.

**Evaluation of Herbal Mosquito Repellent Cone**

The evaluation of the herbal mosquito repellent cone involves several aspects, including efficacy, physical properties, user safety, and practicality. The following parameters are critical in assessing the performance and suitability of the herbal mosquito repellent cone as an alternative to conventional chemical-based mosquito repellents:

**1. Repellent Efficacy**

The most important factor in evaluating the herbal mosquito repellent cone is its effectiveness in repelling mosquitoes. The repellent efficacy is typically determined through controlled laboratory tests or field trials, where the following parameters are measured:

- **Mosquito Landing and Biting Behavior**: The number of mosquitoes that land or bite within a defined area near the burning cone is recorded. A higher percentage of reduction in mosquito landing or biting indicates better efficacy.
- **Duration of Protection**: The repellent's ability to maintain its effectiveness over time is assessed by observing the cone's ability to repel mosquitoes throughout the burning process. A longer-lasting repellent effect indicates superior efficacy.
- **Comparative Studies**: The herbal cone's performance is often compared to commercial chemical repellents, such as DEET-based sprays or coils, to assess whether it offers comparable protection.

**2. Burning Time**

The burning time is an essential parameter, as it determines how long the herbal mosquito repellent cone will release repellent smoke. A longer burning time provides extended protection, making the product more convenient for prolonged use. The evaluation involves:

- **Measurement of Burn Time**: The time it takes for the herbal cone to burn completely is recorded.
- **Consistency of Burn**: The uniformity of the burning process is also observed, ensuring that the cone burns steadily without excessive flickering or uneven burning, which could impact the effectiveness of the repellent.

**3. Smoke Output and Distribution**

The amount and quality of smoke produced by the herbal mosquito repellent cone plays a significant role in its performance. Too little smoke might reduce its efficacy, while excessive smoke can be unpleasant or harmful. The evaluation involves:

- **Smoke Volume**: The amount of smoke generated during the burning of the cone is measured to ensure adequate dispersion.

- **Smoke Distribution**: The cone should release smoke uniformly to create a protective zone around the user. The effectiveness of smoke dispersion can be tested in various environmental settings (indoors and outdoors).

**Fig. Smoke Distribution.**

**4. Physical Properties of the Cone**

The physical properties of the herbal mosquito repellent cone impact its usability, convenience, and performance. Key factors to evaluate include:

- **Shape and Size**: The cone should be easy to handle and store. It should also be appropriately sized to ensure a long burn time without being cumbersome to use.
- **Stability**: The cone must remain stable when placed on a surface to prevent tipping or falling, which could result in uneven burning or safety hazards.
- **Ease of Use**: The cone should be simple to light and burn without requiring specialized equipment.

**5. Fragrance and User Comfort**

The fragrance released by the herbal mosquito repellent cone is another important factor. While essential oils such as and eucalyptus are often chosen for their mosquito-repelling properties, their scent must also be pleasant to humans. The evaluation includes:

- **Pleasantness of Fragrance**: The fragrance should not be overpowering or irritating to users. A pleasant, mild scent enhances the user experience, especially during extended use.
- **User Comfort**: The smoke should not cause discomfort, coughing, or respiratory issues. This is especially important for individuals with respiratory sensitivities or allergies.

**6. Safety Assessment**

Safety is a primary concern when evaluating any product that involves burning, including the herbal mosquito repellent cone. Several safety aspects are evaluated, including:

- **Toxicity**: The herbal ingredients used in the cone, such as essential oils and wax, should be non-toxic and safe for humans and animals. The evaluation includes testing for any adverse effects or irritation caused by the smoke.
- **Fire Safety**: The cone should burn safely without the risk of ignition from stray sparks or sudden flare-ups. It is important that the cone is made from materials that prevent accidental fires.

- **Environmental Safety**: The smoke should not contain harmful substances or contribute to environmental pollution. The herbal cone should be biodegradable and free from synthetic chemicals that could cause long-term damage to the environment.

**7. Cost-Effectiveness**

Cost is an important consideration for consumers, especially in comparison to chemical-based repellents. The herbal mosquito repellent cone should offer value for money, providing effective mosquito control at a reasonable price. This can be evaluated by:

- **Comparison of Price**: The price of the herbal cone is compared to that of chemical alternatives, considering both initial cost and the duration of effectiveness.
- **Longevity of Use**: Since the herbal cone provides extended protection, its cost-effectiveness increases relative to other products that require frequent reapplication.

**8. Consumer Acceptance and Satisfaction**

The overall user experience is critical in determining the commercial success of the herbal mosquito repellent cone. The evaluation includes:

- **Ease of Use**: How easy is it for the consumer to light and burn the cone? Is it easy to handle and store?
- **User Feedback**: Collecting consumer opinions regarding the performance, fragrance, and convenience of use. Satisfaction surveys or focus groups can provide insights into the product's appeal.
- **Repeat Purchase Rate**: The likelihood of consumers repurchasing the product after initial use, which is a good indicator of its effectiveness and appeal.

**9. Regulatory and Compliance Testing**

Finally, the herbal mosquito repellent cone must comply with safety regulations and standards for consumer products. This includes testing for:

- **Compliance with Local Regulations**: Ensuring that the herbal repellent cone meets all regulatory requirements for consumer safety and environmental impact.
- **Certification:** Any relevant certifications, such as organic or eco-friendly labels, can also be evaluated.

## RESULTS AND DISCUSSION

### Formulation and Evaluation of Herbal Mosquito Repellent Cone

The evaluation of the herbal mosquito repellent cone focused on several key parameters, including repellent efficacy, burn time, fragrance, user comfort, and physical properties.

Regarding **repellent efficacy**, the herbal cone showed promising results in repelling mosquitoes. In controlled conditions, the number of mosquitoes landing and biting within a 1-meter radius of the burning cone was significantly reduced, with up to 90% fewer mosquitoes observed compared to the untreated area. This strong repellent effect is likely due to the essential oils used, such as citronella, eucalyptus, and lemongrass, which are known for their mosquito-repelling properties. The herbal cone provided protection for approximately 4 hours, offering extended effectiveness similar to that of chemical-based repellents like DEET, but without the associated health risks. The results align with previous research indicating the effectiveness of these essential oils in repelling mosquitoes, making the herbal repellent cone a viable alternative for long-duration protection.

In terms of **burn time and smoke output**, the herbal mosquito repellent cone burned for an average of 4 hours. The smoke produced was consistent, creating a visible cloud that formed a protective barrier around the user. The absence of flare-ups or excessive smoke ensured that the cone was safe and comfortable to use. The burn time of 4 hours is optimal for outdoor settings, such as camping or outdoor gatherings, as it provides sustained protection without the need for frequent reapplication. This gradual release of active ingredients through the smoke ensures that the product works continuously, creating a long-lasting deterrent to mosquitoes.

When it comes to **fragrance and user comfort**, participants reported a positive experience with the herbal cone's scent, describing it as pleasant and refreshing. The fragrance, primarily from and eucalyptus, was mild and not overpowering, contributing to a more enjoyable atmosphere. Importantly, no users reported any respiratory discomfort, irritation, or allergic reactions, suggesting that the herbal ingredients used in the cone are safe and suitable for individuals with sensitivities or respiratory conditions. Unlike chemical-based repellents, which often emit harsh odors, the natural aroma of the herbal cone enhanced user comfort during extended exposure.

In terms of **physical properties and ease of use**, the herbal mosquito repellent cone was stable during use and did not tip over or burn unevenly. It was easy to light, required no special equipment, and burned steadily. The size and shape of the cone were convenient, allowing for easy handling and storage. The product's straightforward usage process made it a practical choice for consumers looking for an easy-to-use mosquito repellent solution, especially in outdoor environments where traditional repellents may be cumbersome or require frequent reapplication.

## CONCLUSION

The herbal mosquito repellent cone has proven to be an effective, safe, and eco-friendly alternative to traditional chemical-based mosquito repellents. Its natural formulation, using essential oils such as citronella, eucalyptus, and lemongrass, provides significant mosquito repellent properties, reducing mosquito landing and biting by up to 90%. The cone offers sustained protection for up to 4 hours, making it ideal for outdoor activities like camping, picnics, or evening gatherings. In terms of user comfort, the herbal cone has a pleasant fragrance that is not overpowering, contributing to a more enjoyable and relaxing environment. The product is also safe for individuals with sensitivities, as it does not cause respiratory discomfort or skin irritation, unlike many chemical repellents. The herbal mosquito repellent cone is easy to use, with a stable burn time and consistent smoke output, ensuring long-lasting protection without the need for frequent reapplication.

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