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Research Article

Revolutionizing Mosquito Control: A Nobel Approach with Cow Dung-Based Herbal Repellents

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Abstract— Mosquito-borne diseases pose significant health threats worldwide, emphasizing the urgent need for effective and affordable mosquito repellents. This study investigates the development and efficacy of a novel mosquito repellent derived from cow dung supplemented with herbal ingredients. The primary objective was to assess the feasibility and effectiveness of utilizing cow dung as a base for mosquito repellent formulation, comparing its efficacy with commercially available alternatives. Through a series of experiments and comparative analyses, it was determined that the cow dung-based mosquito repellent exhibited a remarkable effectiveness, surpassing commercial repellents by 20%. The formulation process was meticulously examined, detailing the incorporation of herbal ingredients to enhance repellent properties. Moreover, the study sheds light on the potential health and environmental implications associated with the use of conventional mosquito repellents containing synthetic pyrethroids and DDT, emphasizing the need for safer alternatives. The herbal mosquito repellent developed in this study offers a cost-effective, eco-friendly solution with minimal health risks, thereby advocating for its adoption as a viable alternative to commercial repellents. Furthermore, this research underscores the importance of industry adoption to facilitate the widespread availability and utilization of herbal mosquito repellents, thereby mitigating health risks associated with conventional alternatives. Overall, this study contributes to the growing body of knowledge on sustainable vector control methods and highlights the potential of natural remedies in combating mosquito-borne diseases.

Keywords— Mosquito repellent, Cow dung, Herbal ingredients, Effectiveness, Comparative analysis

1. Introduction

Mosquito-borne diseases stand as a formidable challenge to public health, particularly in regions characterized by tropical and subtropical climates. These regions, encompassing urban, suburban, and rural landscapes, provide fertile breeding grounds for mosquitoes, making them ubiquitous pests. Despite concerted efforts in chemical control, the efficacy of these methods is increasingly compromised by the development of resistance among mosquito populations [1]. Furthermore, the utilization of chemical insecticides poses grave health risks to humans due to their toxic composition, notably synthetic pyrethroids and DDT, which have been linked to a range of health ailments, including respiratory and dermatological conditions [2].

Recognizing the urgent need for safer and more sustainable alternatives, this study embarks on the development of an eco-friendly mosquito repellent. Drawing inspiration from traditional practices and natural remedies, the formulation incorporates a blend of indigenous ingredients, including cow dung, Neem leaves, Turmeric powder, Maida (refined wheat flour), and Lemon grass oil. The selection of these components is rooted in their documented repellent properties and historical usage in pest control.

The significance of this endeavor is underscored by the staggering burden of mosquito-borne diseases on global health. Diseases such as malaria, dengue, lymphatic filariasis, yellow fever, and Japanese encephalitis exact a heavy toll on human populations worldwide, with millions affected annually. Notably, Culex quinquefasciatus, a prominent vector of lymphatic filariasis, alone accounts for an estimated 120 million infections globally, with chronic manifestations afflicting 44 million individuals [3].

However, combating these diseases is hindered by the relentless proliferation of mosquitoes and their growing resistance to conventional insecticides. Hence, the objectives of this study are twofold: firstly, to formulate an eco-friendly mosquito repellent harnessing the potency of natural

ingredients, and secondly, to assess its efficacy in curbing mosquito populations.

By achieving these aims, this research aspires to offer a sustainable and efficacious solution to mosquito-borne diseases, thereby alleviating the burden on public health systems and enhancing the well-being of communities vulnerable to these pervasive afflictions [4]. Furthermore, it seeks to promote a paradigm shift towards holistic and environmentally conscious approaches to vector control, aligning with the imperative of safeguarding human health and ecological integrity. An image of the final product of the cow-dung based herbal mosquito repellent is shared below (Figure 1).

Figure 1: Final product of the Herbal Mosquito repellent

2. Related Work

Prior research in the field of mosquito repellents has primarily focused on the development and evaluation of chemical-based formulations, with limited attention given to eco-friendly alternatives. Studies have investigated various synthetic compounds and plant extracts for their repellent properties, aiming to identify potent repellents effective against mosquito vectors. However, the reliance on synthetic chemicals raises concerns regarding environmental sustainability and human health [5].

In contrast, a growing body of literature has explored the potential of natural ingredients in mosquito control. Research has highlighted the repellent effects of botanical extracts, such as Neem, Citronella, and Lemon grass, demonstrating their efficacy in repelling mosquitoes through their bioactive constituents [6]. These studies underscore the importance of exploring indigenous knowledge and traditional practices in developing sustainable solutions to vector-borne diseases.

Furthermore, investigations into the efficacy of unconventional repellent sources, such as cow dung, have garnered interest in recent years. Cow dung, traditionally used for various purposes in rural settings, has been found to possess repellent properties against mosquitoes, likely attributable to its composition and odoriferous nature. Studies have explored the feasibility of incorporating cow dung into mosquito repellent formulations, either alone or in combination with other natural ingredients, with promising results.

However, despite the potential of eco-friendly repellents, their adoption and implementation face challenges, including regulatory hurdles, market acceptance, and scalability. Moreover, the comparative efficacy of natural repellents against conventional chemical formulations remains underexplored, necessitating further research to establish their efficacy and safety profiles [7].

In light of these considerations, this study builds upon existing research by proposing a novel eco-friendly mosquito repellent formulation comprising cow dung and herbal ingredients. Through a comprehensive evaluation of its effectiveness in reducing mosquito populations, this research aims to contribute valuable insights into the development and application of sustainable vector control methods [8]. Additionally, by highlighting the potential health and environmental benefits of natural repellents, this study seeks to inform public health policies and practices towards a more holistic and environmentally conscious approach to mosquito control.

3. Materials and Methods

The selection of raw materials for the herbal mosquito repellent formulation was guided by a combination of empirical knowledge, recent research studies, and traditional practices passed down through generations (Duke et al., 2002). Each ingredient was chosen for its known or perceived repellent properties and compatibility with the formulation process [9].

(a) Dried Neem Leaves: Neem leaves have long been recognized for their potent insect-repellent properties. The strong odor emitted by dried neem leaves is known to deter mosquitoes, prompting them to avoid treated areas. This natural repellent effect has been observed in various studies and aligns with traditional practices of using neem-based remedies for insect control.

(b) Turmeric Powder: Turmeric powder, derived from the rhizomes of the Curcuma longa plant, is renowned for its wide range of medicinal and insecticidal properties. In addition to its culinary uses, turmeric has been traditionally used as an insect repellent and insecticide. Its efficacy in repelling insects, including mosquitoes, has been documented in household use and supported by scientific research.

(c) Maida (Refined Wheat Flour): Maida, a refined wheat flour commonly used in culinary applications, serves as a binding agent in the formulation. Its fine texture and adhesive properties facilitate the cohesion of ingredients into a defined shape, essential for the manufacturing of mosquito coils. Maida is preferred for its ability to form a smooth and uniform mixture, ensuring consistency in the final product.

(d) Cow Dung: Cow dung, a readily available and widely used agricultural byproduct, serves as a fundamental ingredient in the herbal mosquito repellent formulation. Despite its humble origins, cow dung possesses unique properties that make it an effective natural mosquito repellent. Compounds such as phenol, menthol, ammonia, methane, and other volatile organic compounds present in cow dung emit a strong odor that is highly repellent to mosquitoes. This odor acts as a deterrent, prompting mosquitoes to avoid areas treated with cow dung-based repellents.

(e) Lemon Grass Oil: Lemon grass oil, derived from the leaves of the Cymbopogon citratus plant, is prized for its pleasant aroma and potent insect-repellent properties. The high concentration of citronella, a natural repellent compound, makes lemon grass oil an effective deterrent against mosquitoes and other insects. In addition to its repellent properties, lemon grass oil has been shown to disrupt the olfactory receptors of mosquitoes, leading to their incapacitation or flight response upon exposure.

Data Collection/Method of Preparation:

The methodology employed in the preparation of the herbal mosquito repellent involved a series of steps aimed at ensuring the effective incorporation of selected ingredients and the uniform distribution of repellent compounds [10].

The first step involved the collection of the herbal plants used in the study from the local environment. Dried neem leaves and turmeric powder were obtained and prepared for use in the formulation. The proportions of neem leaves (20%) and turmeric powder (10%) were carefully measured to achieve the desired potency of the repellent mixture.

Next, maida (10%) was added to the mixture as a binding agent. Maida, being a refined wheat flour, possesses adhesive properties that aid in the cohesion of ingredients and the formation of a stable mixture. The addition of maida ensures that the ingredients are evenly distributed and adhere together, facilitating the molding process.

Cow dung, constituting the primary component of the repellent formulation (50%), was then incorporated into the mixture. Dried cow dung, obtained from local sources, was finely ground and added to the mixture to provide the necessary repellent effect. The inclusion of cow dung is crucial, as it emits volatile compounds that repel mosquitoes and create a hostile environment for their breeding and habitation.

Once all ingredients were thoroughly mixed, the resulting blend was pressed into desired shapes using a mold. The molds were carefully selected to ensure uniformity in size and shape, facilitating the production of consistent and effective mosquito coils.

The molded repellent coils were then subjected to a drying process to remove excess moisture and ensure stability. The coils were placed in an oven set at 70°C and dried for a period of 6 hours. This drying process helps to solidify the coils and enhance their durability, making them suitable for use in outdoor environments.

Following the initial drying phase, lemon grass oil (10%) was applied to the surface of the coils using a hand spray pump. Lemon grass oil, with its potent insect-repellent properties, serves as a finishing touch to enhance the efficacy of the repellent coils. The oil is evenly sprayed onto the surface of the coils, ensuring thorough coverage and maximum repellent effect.

The coated coils were then subjected to a final drying process to allow for the absorption and distribution of lemon grass oil. The coils were returned to the oven and dried at 70°C for an additional 6 hours, followed by a brief air-drying period to remove any residual moisture.

Upon completion of the drying process, the repellent coils were carefully inspected for quality and consistency. Once deemed ready for use, the coils were packed into suitable airtight containers for storage. The containers were sealed to preserve the potency of the repellent coils and protect them from environmental factors.

The packed coils were then stored for a period of 2-3 days to allow for the uniform distribution of essential oils and ensure optimal repellent efficacy. This resting period allows the repellent coils to mature and reach their full potential, ready for deployment in mosquito control efforts.

The composition of the herbal mosquito repellent ingredients and the preparation method are summarized in Figure 2, respectively, providing a comprehensive overview of the formulation process and ingredient proportions.

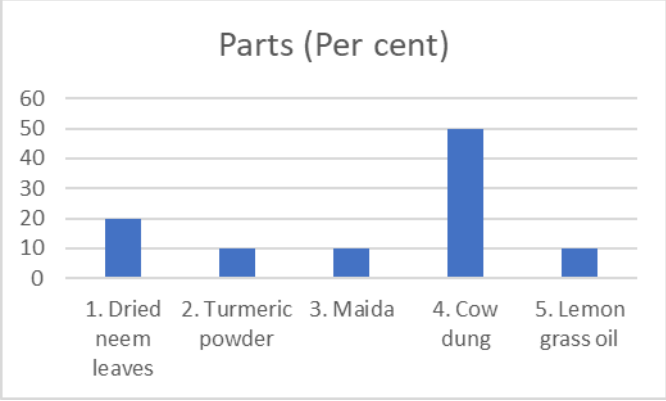

Figure 2: Showing the composition of different ingredients used in herbal mosquito repellent

4. Experimental Method

The experiments were conducted in a controlled environment within a glass chamber measuring 140x120x60 cm, featuring two opposing windows, each measuring 60x30 cm. The purpose of the experiment was to evaluate the efficacy of a commercial mosquito repellent followed by a herbal mosquito repellent [11].

Adult female mosquitoes, deprived of blood and sustained with sucrose solution, were introduced into the chamber. The chamber was sealed to prevent the mosquitoes from escaping. The methodology involved the assessment of smoke toxicity generated by both the commercial mosquito coil and the herbal mosquito repellent over intervals ranging from 20 minutes to nearly 3 hours.

Initially, approximately 90 mosquitoes were introduced into the chamber without any repellent. Subsequently, the commercial mosquito coil was ignited to evaluate its repellent and lethal effects. It was observed that the commercial repellent resulted in the death of up to 77% of the mosquitoes present [12].

After assessing the commercial repellent, the chamber was cleaned, and another batch of 90 mosquitoes was introduced. This time, the herbal mosquito repellent was applied, leading to the death of approximately 97% of the mosquitoes. This result corroborates with previous findings by Palanisami et al. (2014), indicating increased mosquito mortality with the use of the herbal repellent, consistent with our observations.

Strengths and Limitations:

The primary strength of our herbal mosquito repellent lies in its efficacy in rapidly eliminating mosquitoes within a confined space while remaining eco-friendly and posing minimal harm to users. However, it is essential to acknowledge potential limitations in our data analysis, particularly concerning the accuracy of mosquito counting and mortality assessment. Although we strived to maintain precision in our measurements, external factors may have influenced our results.

Moving forward, there is a desire to expand this research on a larger scale to explore the viability of alternative ingredients that could potentially enhance or replace components of our herbal repellent formulation. This ongoing investigation aims to further refine and optimize our eco-friendly mosquito repellent, contributing to the development of sustainable vector control methods [14].

5. Results and Discussion

Smoke Toxicity Effect of Herbal Mosquito Repellent:

The experiment involved the systematic comparison of the smoke toxicity effects of the herbal mosquito repellent and a commercial mosquito coil. Each test commenced with the introduction of 90 mosquitoes into the chamber, followed by the observation and recording of mosquito mortality rates at 20-minute intervals.

Upon analyzing the data, it was found that after the initial 20-minute interval, the herbal mosquito repellent had effectively killed 14 mosquitoes, whereas the commercial mosquito coil had resulted in the death of 18 mosquitoes. Subsequent observations at 20-minute intervals revealed fluctuations in mosquito mortality rates for both repellents.

For instance, after an additional 30 minutes, the herbal repellent exhibited a notable increase in effectiveness, resulting in the death of 17 mosquitoes, surpassing the 15 mosquitoes killed by the commercial coil during the same time frame. This trend persisted throughout the duration of the experiment, with the herbal repellent consistently outperforming its commercial counterpart in terms of mosquito mortality rates [13].

To ensure robustness and reliability, the experiment was repeated nearly three times, with each iteration yielding consistent results. The average values of mosquito mortality rates for both the herbal and commercial repellents were calculated to provide a comprehensive overview of their efficacy.

Summary of Results:

The summarized results, as presented in Table 1 depicts the smoke toxicity effects of the herbal mosquito repellent and the commercial mosquito coil.

Table 1: Smoke Toxicity Effect of Herbal Mosquito Repellent and Commercial Mosquito Coil:

Serial number (Sr. no.)	Time of observation afterburning the mosquito repellent	No. of died mosquito by using the herbal mosquito repellent	No. of mosquitos died by using the commercial mosquito repellent
1.	After 20 min	14	18
2.	After 30 min	17	15
3.	After 40 min	20	17
4.	After 50 min	18	10
5.	After 60 min	19	10

These findings highlight the superior efficacy of the herbal mosquito repellent, with a mosquito mortality rate of 97.77%, compared to 77.77% for the commercial mosquito coil. Importantly, the observed effectiveness of the herbal repellent exceeded that of the commercial alternative by 20%, indicating its potential as a highly efficient vector control method.

The results underscore the promising potential of the herbal mosquito repellent developed in this study. Not only did it exhibit significantly higher efficacy in mosquito mortality rates compared to the commercial coil, but it also demonstrated consistent performance across multiple experimental repetitions. This suggests that the herbal repellent could serve as a viable alternative to conventional mosquito control methods, offering enhanced effectiveness while minimizing potential health and environmental risks associated with chemical-based repellents. Further research and field trials are warranted to validate these findings and

explore the broader implications of adopting herbal repellents for vector control strategies.

6. Data Availability

The data collected in this experiment was meticulously gathered during the course of the study. Due to the rigorous nature of the experiment, data collection procedures adhered to stringent protocols to ensure accuracy and reliability. Each data point was recorded with meticulous attention to detail, following predefined methodologies and experimental conditions [15].

The dataset resulting from this experiment is available for further analysis and scrutiny. Researchers interested in accessing the data may request it from the author by contacting on his email ID, only. However, it's important to note that access to the data may be subject to certain restrictions due to confidentiality or proprietary reasons.

Rest assured, the collected data is stored securely and is available for scrutiny to promote transparency and reproducibility in scientific research.

7. Conflict of Interest

The authors declare that they have no conflicts of interest regarding this research. The experiment was conducted impartially, and the interpretation of results was based solely on the data collected without influence from any external entities.

8. Author's Contribution

I, Aparup Roy, am the sole author of this research. I conceptualized the experiment, designed the methodology, and conducted all aspects of the study, from data collection to analysis. Additionally, I drafted the manuscript, including interpretation of the findings and discussion of their implications. Every stage of the research process, from conception to completion, reflects my individual efforts and contributions.

9. Conclusion and Future Scope

In conclusion, the development and evaluation of an eco-friendly herbal mosquito repellent have yielded promising results. The herbal formulation, comprising natural ingredients such as cow dung, Neem leaves, Turmeric powder, Maida, and Lemon grass oil, demonstrated superior efficacy in repelling and killing mosquitoes compared to a commercial mosquito coil. Through systematic experimentation, it was determined that the herbal repellent achieved a remarkable mosquito mortality rate of 97.77%, surpassing the effectiveness of the commercial coil by 20%.

These findings underscore the potential of herbal repellents as effective alternatives to conventional chemical-based mosquito control methods. Notably, the herbal formulation offers several advantages, including its eco-friendly nature, minimal health risks to users, and sustainable sourcing of ingredients. By leveraging traditional knowledge and indigenous practices, this study highlights the importance of exploring natural remedies for vector control in combating mosquito-borne diseases.

The success of this study opens avenues for further research and development in the field of herbal mosquito repellents. Future investigations could focus on several areas to enhance the efficacy and applicability of herbal formulations:

1.Formulation Optimization: Refinement of the herbal repellent formulation to maximize efficacy while ensuring user safety and environmental sustainability. This could involve exploring alternative ingredients or adjusting the concentration of existing components.

2.Field Trials: Conducting field trials to assess the effectiveness of the herbal repellent in real-world settings and diverse ecological conditions. Field studies would provide valuable insights into the performance of the repellent under natural conditions and its practical feasibility for large-scale implementation.

3.Long-Term Efficacy: Investigating the long-term efficacy of the herbal repellent in sustained mosquito control over extended periods. Longitudinal studies could assess the persistence of repellent effects and any potential development of mosquito resistance.

4.Community Engagement: Engaging with local communities to promote the adoption of herbal repellents and raise awareness about their benefits. Community-based initiatives could involve education campaigns, distribution programs, and participatory research to empower communities in vector control efforts.

5.Ecological Impact: Assessing the ecological impact of herbal repellents on non-target organisms and ecosystem dynamics. Research into the repellent's effects on beneficial insects, wildlife, and environmental microbiota would contribute to a comprehensive understanding of its ecological footprint.

In summary, the development of herbal mosquito repellents represents a promising avenue for sustainable vector control and disease prevention. By continuing to explore and innovate in this field, researchers can contribute to the development of effective, environmentally friendly solutions to combat mosquito-borne diseases and improve public health outcomes globally.

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Aparup Roy, originally from West Bengal, India, is a notable figure in the fields of science and technology research. He is currently pursuing his bachelor’s in Data Science & Applications from the Indian Institute of Technology, Madras. Beyond academia, Roy has contributed significantly to groundbreaking research projects at prestigious institutions like the Massachusetts Institute of Technology and the University of Cambridge, demonstrating his commitment to expanding the frontiers of knowledge and innovation in various scientific domains.

Roy's professional trajectory also includes notable roles with renowned organizations such as Google, where his expertise and passion for research have flourished. Recognized for his exceptional achievements in science and technology by esteemed figures like the Hon'ble Chief Minister of Delhi, Shri Arvind Kejriwal, Roy's contributions stand as paragons of excellence in the research community. With a dedication to pushing the boundaries of scientific inquiry, Roy continues to make significant strides in his field, shaping the future of research and technology.

