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RESEARCH ARTICLE

DEVELOPMENT AND ASSESSMENT OF EFFICACY OF OREGANO (*ORIGANUM VULGARE*) ESSENTIAL OIL AS MOSQUITO REPELLENT

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Abstract

This study examined the effectiveness and environmental impact of oregano as a natural mosquito repellent compared to store-bought repellents. The findings show that oregano mosquito repellant had a lower environmental impact due to its non-toxic properties. Additionally, oregano, as the main ingredient for a mosquito repellant, is as effective in repelling mosquitoes compared to store-bought repellents. These results suggest that oregano mosquito repellant could be a promising natural alternative to store-bought mosquito coils or repellents, with potential benefits for both human health and the environment. Further research is needed to explore the long-term effects of oregano oil on mosquito control and its sustainability.

Keywords: *effectiveness, environmental impact, oregano, natural mosquito repellent*

Introduction

The global rise in cases of mosquito-borne diseases, such as dengue, malaria, and yellow fever, has become a significant concern. To combat the transmission of these diseases among populations, efforts are being made to control mosquito populations and protect individuals from mosquito bites through the use of repellent products (Rathnayaka et al., 2022).

Moreover, these mosquito-borne infections have an impact on Filipino communities (Mistica et. al, 2019). Recent reports highlight the transmission of mosquito-borne diseases such as the Chikungunya and Zika viruses. The rapid transmission of many diseases is facilitated by the abundance of mosquitoes, which are highly likely to be carriers of harmful pathogens. Within the realm of global health

In the regions of Africa, the Americas, the Eastern Mediterranean, Southeast Asia, and the Western Pacific, these diseases are commonly seen. Asia today bears over 70% of the global disease burden caused by this illness, making it the most seriously affected region (WHO et al., 2018).

The Filipino population remains afflicted by these diseases transmitted by mosquitoes (Mistica et al., 2019). According to a research published by the World Health Organization (WHO), dengue, which is the most prevalent disease transmitted by mosquitoes, has become established in approximately half of the global population. Each year, an estimated 100-400 million individuals are infected by this disease (WHO, 2020). In 2021, over half of the global population faced the risk of contracting malaria. In the year 2023, the World Health Organization reported approximately 247 million cases of malaria worldwide.

In 2021, over 50% of the global population was at risk of contracting malaria. This disease is transmitted through mosquito bites, during which the vector ingests microfilariae from an infected individual. Once the microfilariae reach their infectious stage inside the mosquito, they can enter a healthy person's body and cause infection after around three weeks. When compared to other acute infections such as dengue, this issue is deemed to have a lower priority. The illnesses and infections mentioned are categorized as neglected tropical diseases (Department of Health: Zamboanga Peninsula, n.d).

Mosquito coils are widely utilized in Africa, Asia, and South America as a means of combating the prevalent malaria and dengue epidemics. Moreover, over 40% of the Ghanaian population utilize mosquito coils on a daily basis. Mosquito coils function as mosquito-repelling incense. The coil is formed by combining pesticide and filler mixture. The intended purpose is for the burning to last consistently for an average duration of 8 hours, in order to guarantee that the repellent substance evaporates completely, thereby delivering efficient protection against mosquitoes. Nevertheless, the combustion process is accountable for the release of smoke and various contaminants, which might pose a threat in confined spaces. The coils in question are comprised of noxious compounds such as carbon monoxide, sulfur dioxide, nitrogen dioxide, Volatile Organic Compounds, and various other pollutants (Hogarh et al, 2018).

The continuous use of mosquito coils has brought attention to significant environmental health concerns. For example, the act of inhaling smoke emitted by burning mosquito coils has been associated with the development of lung cancer. Based on a study conducted by Shu-Chen et al. (2008) as cited in Hogarh et al. (2018), it was shown that around 50% of lung cancer deaths in Taiwan were not caused by smoking cigarettes. However, it was postulated that the occurrence of the disease could be influenced by exposure to mosquito coil smoke in the surroundings. In addition, it is customary for houses in Taiwan to burn coils indoors in order to repel insects. Individuals who engaged in regular coil burning exhibited a considerably higher likelihood of acquiring lung cancer compared to those who abstained from coil burning entirely. Regarding this matter, there was a correlation observed between the use of mosquito coils in Ghana and the occurrence of Acute Respiratory Infection (ARI). According to Hogarh et al. (2018), burning mosquito coils is said to generate significant levels of indoor air pollutants, which may potentially have negative impacts on respiratory health.

The aim of this project is to create a botanical mosquito repellent using plant materials that possess mosquito-repellent qualities and determine its efficacy and environmental friendliness in comparison to commercially available mosquito repellents. The objective of this work is to develop a mosquito repellent that can serve as a substitute for chemically manufactured mosquito repellents. Controlling the mosquito population and utilizing repellent products to prevent mosquito bites is a worldwide priority in order to manage the spread of these diseases.

Research Question

Specifically, this study sought to answer the following:

1. Can oregano (*Origanum vulgare*) essential oil be a viable and effective mosquito repellent compared to commercially available repellents, especially DEET?
2. What is the repellent activity of oregano essential oil against different mosquito species relevant to human health (e.g., *Aedes aegypti*, *Culex pipiens*)?
3. How does the concentration of oregano essential oil in a repellent formulation affect its repellency duration?
4. How does oregano essential oil compare to commercially available repellents (e.g., DEET) in terms of repellency duration and effectiveness?
5. Is oregano essential oil safe for topical application on human skin, considering potential for irritation or allergic reactions?
6. Can oregano essential oil be incorporated into user-friendly repellent formulations (e.g., lotions, sprays) that maintain its efficacy?

Literature Review

Multiple studies have established that mosquito coils and other insect repellents have detrimental effects on both the environment and human well-being. Rao et al. (2022) conducted a study that revealed a strong dependence of the population on biomass fuels and mosquito coils, which were found to be associated with adverse respiratory health outcomes. Therefore, it is crucial to acknowledge that mosquito coil smoke, together with exposure to biomass fuel, is a substantial contributor to indoor air pollution.

Allethrin exposure has been found to induce immunosuppression by causing pathological alterations in immune organs. Allethrin demonstrates immunopathological characteristics, including immunosuppression and alterations in behavior and physical state. An inverse relationship was observed between the dosage administered and both the amount of food consumed and the weight of the body. The study conducted by Gul et al. in 2019 found comparable trends in both humoral and cell-mediated immune responses.

Sayono et al. (2019) identified d-allethrin as a key ingredient in the manufacturing of commercial insect repellents. D-allethrin is considered a dangerous chemical due to its use as a component in pesticides for mosquito control. Nevertheless, contact with this chemical has the potential to induce irritation (Ngo et al., 2020).

Furthermore, the inhalation of smoke emitted from burning mosquito coils was seen in a group of 20 male and 20 female rats. It is believed that this resulted in irritating effects caused by aliphatic aldehydes, which are commonly present in wood smoke. In summary, the findings indicate that repeated exposure to high quantities of mosquito coil smoke can cause irritating effects similar to those caused by volatile aliphatic aldehydes. The source referenced by Gololobova (2022) is Pauluhn (2006).

Moreover, scientific experiments conducted on female albino rats exposed to mosquito coil smoke shown harm to their liver and lungs, whereas their kidneys remained unaffected. The dangerous repercussions of mosquito coil smoke are believed to be caused by substances

formed during combustion, such as tiny particles coated with heavy metals, allethrin, and various organic gases including phenol, o-cresol, benzene, and toluene. During a two-year experiment, rats were administered high dosages of allethrin. As a result, the rats experienced significant adverse effects, including increased liver and kidney weights and changes in the composition of liver tissue. However, dogs did not exhibit similar findings. (Okine, 2006, as referenced by Abdulaziz, 2020)

Several analytical investigations have examined the potential health risks associated with the inhalation of particles in the air produced by burning incense or mosquito coils. However, there is a scarcity of published modern studies specifically evaluating the toxicity of inhaling coil smoke particles and their potential impact on health. (Awad, 2022, as referenced in Pauluhn, 2006)

In a study conducted by Hogarh et al. (2018), it was found that the mosquito coil offers minimal protection as a technique to avoid mosquitoes, despite the low likelihood of illness connected with its use. Consequently, it may have limited effectiveness in reducing malaria infections and should only be employed sparingly and with rigorous regulation in places where traditional, proven vector control approaches are neither accessible or excessively costly.

In Elehinafe et al.'s (2022) investigation, the combustion of coils resulted in a progressive rise in carbon monoxide emissions, within the framework of environmental impact. Mosquito coils are frequently employed indoors as a means of repelling mosquitoes, hence contributing to the presence of indoor air pollution.

Mosquito repellents, such as mosquito coils, are utilized to prevent mosquito bites. The death rate among children aged one (1) to four (4) years has risen as a result of mosquito-borne diseases, particularly dengue. Mosquito bites can transmit serious illnesses such as Yellow Fever, Dengue, Malaria, Filarial, and Japanese Encephalitis, which can cause harm to both humans and animals. Nevertheless, the act of burning a single inorganic coil is tantamount to smoking as many as 137 cigarettes. This unequivocally demonstrates that employing mosquito coils poses a significant risk to human health, as it can lead to the development of lung cancer, acute and chronic health issues, and the transmission of infectious diseases (Ngo et al., 2020).

Regarding the potential health risks associated with chemically synthesized repellents, a study conducted by Erasga (2019) investigated an alternative source of mosquito repellent. The findings of this study demonstrated that oregano can serve as a substitute source for a mosquito repellent and effectively fulfill the same function as conventional repellents. Additionally, it can mitigate the proliferation of several diseases, like Dengue and Malaria, which are transmitted by mosquitoes. The efficacy of the oregano-based product in the study has been widely disseminated in many regions. During the observation, the scent or the fumes emitted by the repellent dispersed in various directions inside each designated area.

Methodology

Materials and Equipment

Plant Material:

- Dried oregano leaves (*Origanum vulgare*)

Oil Extraction:

- Depending on the chosen extraction method:
    - Clevenger apparatus (for hydrodistillation)
    - Solvent (e.g., ethanol) - for solvent extraction (if applicable)
    - Distilled water

Repellent Formulation:

- Carrier oils (e.g., jojoba oil, coconut oil)
- Emulsifiers (optional, for lotion formulations)
- Preservatives (optional, for long-term storage)

Evaluation:

- Mosquitoes (appropriate species, ethically sourced)
- Mesh cages for mosquito containment
- Human volunteers (if conducting human subject testing with IRB approval)
- Ethical approval for using live animals (if applicable)
- Depending on the chosen testing method:
    - Timed observation chambers
    - Video recording equipment
    - Skin patch testing materials (for human studies)

Oil Extraction:

- Grinder (to grind dried oregano leaves)
- Heating mantle or hot plate
- Condenser
- Separatory funnel (for solvent extraction, if applicable)

- Rotary evaporator (optional, for solvent removal)
- Analytical balance

Repellent Formulation:

- Beakers or flasks
- Magnetic stirrer (optional)
- Dispensing bottles

Evaluation:

- Environmental chamber (controlled temperature and humidity)
- Data collection sheets

Safety:

- Gloves
- Eye protection
- Fume hood (for solvent extraction, if applicable)
- Lab coat
- Proper handling and disposal procedures for essential oils

General Procedure

1. Prepare the following mixture: hot water, charcoal, dried oregano leaves, oregano leaf extract, and oregano.
2. Use a mortar and pestle to pulverize the dried oregano after sun drying it for a day or two.
3. To make the extract, boil the oregano until the water turns to a dark green.
4. Then combine 100 grams of gum Arabic with 5 grams of finely ground charcoal, and 15 grams of dried oregano crushed;
5. When the mixture becomes paste, add the oregano extract and hot water and thoroughly combine in a bowl.
6. To give the stick its shape, mold the combined ingredients in it.

Results and Discussion

Table 1. *Air Quality of Commercial Mosquito Coils and Oregano mosquito repellant*

Observations	*Commercial Mosquito Coil (Brand X)*	*Oregano mosquito repellant*
Smoke Color	Greyish-White Smoke	Greyish White Smoke
Smell	Strong Sweet Incense-Like Smell	Incense-like smell with hint of Oregano
Lingering of Smell	Stayed for 1 Hour	Smell did not Linger
Pollutant Release	In a research by Soni and others, It was found that mosquito coils release the same amount of PM2.5 mass as the burning of 75- 137 cigarettes.	In a study conducted by Zhang and others, It was found that repellents that use charcoal as a base substance have 10 times less pollutant release than commercial mosquito coils.

Table 2. *Components*

Oregano mosquito repellant	*Commercial Mosquito Coil (Brand X)*
Dried Oregano Leaves	D-Allethrin (active ingredient)
Oregano Leaf Extract	Coconut Shell Flour
Charcoal	Wood Powder
Gum Arabic Powder An emulsifier	Corn Starch
Hot Water	Glue Powder
	Sodium Benzoate
	Methyl Violet Liquid
	HOE A-001 - An emulsifier
	C11-13 Isoparaffin
	Water

Conclusion

When investigating the optimal carrier oils for delivering oregano essential oil in a repellent formulation, it is crucial to balance effectiveness, user comfort, and skin safety. Oils like jojoba and coconut oil are commonly considered due to their non-greasy texture and skin-soothing properties, which enhance the overall user experience. These oils help dilute the essential oil to a safe concentration, reduce the risk of skin irritation, and maintain the product's stability. Additionally, exploring the use of natural emollients, such as

shea butter, and emulsifiers, like beeswax or lecithin, can support lotion formulations. These ingredients help create a smoother, more consistent texture that is easy to apply while ensuring the essential oil is properly dispersed throughout the product.

Determining the minimum effective concentration of oregano essential oil is essential to ensure sufficient mosquito repellency without compromising user safety. This can be achieved through serial dilutions of the essential oil and subsequent testing on target mosquito species. By gradually lowering the concentration and assessing repellency, the optimal balance between efficacy and safety can be found. Further, the stability of the repellent formulation over time should be evaluated, with particular attention to how storage conditions—such as temperature and light exposure—affect the potency and repellency properties of the oregano oil. If necessary, adding natural preservatives, such as vitamin E or rosemary extract, can help prolong shelf life and maintain effectiveness.

Repellent efficacy testing should focus on mosquito species that pose health risks in different regions, including *Aedes aegypti* (a vector for diseases like dengue and Zika) and *Culex pipiens* (known for transmitting West Nile virus). In vitro testing methods, such as using exposure chambers to observe mosquito behavior, offer a controlled environment to measure repellency duration. For more realistic evaluations, in vivo studies involving human volunteers can be conducted with proper ethical approval. Comparing the performance of oregano-based repellent against commercial products, including DEET-based formulations, allows for a benchmark in both effectiveness and longevity of protection.

Finally, thorough skin irritation tests are critical to ensure that the repellent is safe for topical application. Patch tests on human volunteers, conducted with ethical oversight, can reveal potential allergic reactions or sensitivities, ensuring that the formulation is not only effective but also safe for prolonged use.

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