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Citronella Oil: A Review of Its Potential as a Preventive Therapy for Dengue Fever

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ABSTRACT

Dengue fever is a viral infection transmitted by mosquitoes, particularly the Aedes aegypti species, and represents a significant public health concern in tropical regions. The growing interest in alternative and complementary strategies for dengue prevention has brought attention to citronella oil as a potential solution. Citronella oil, an essential oil derived from the Cymbopogon nardus plant, is well-known for its distinctive lemony fragrance and its widespread use in repelling mosquitoes. Historically, this oil has been utilized in traditional medicine for various treatments, including its anti-inflammatory effects and insect-repellent properties. This review article explores the potential of citronella oil as a preventive measure against dengue fever, a mosquito-borne viral illness. Existing research indicates that citronella oil possesses promising characteristics as a preventive therapy for dengue. It not only exhibits significant mosquito-repellent activity but also demonstrates antiviral properties, suggesting it could be an effective component in the fight against dengue fever.

INTRODUCTION:

Citronella oil is an essential oil derived from the leaves and stems of different species of grasses in the Cymbopogon family. Known for its distinctive lemony scent, it has been used for centuries in various cultures for its therapeutic properties, particularly as a natural insect repellent. Over time, citronella oil has found applications in diverse industries, including cosmetics, food, and agriculture, due to its multifaceted properties. The oil's popularity stems not only from its pleasant aroma but also from its environmental sustainability, as it provides a natural alternative to synthetic chemicals in various uses.

SOURCE OF CITRONELLA OIL:

Citronella oil is predominantly extracted from two species within the Cymbopogon genus:

1. Cymbopogon nardus (Ceylon Citronella): This species is native to Sri Lanka and India, and it is the source of what is commonly referred to as Ceylon citronella oil. The plant grows as a perennial, tufted grass with sharp-edged leaves and a fibrous root system. It thrives in tropical climates and can be cultivated in a range of soils, although it prefers well-drained, loamy soils.

2. Cymbopogon winterianus (Java Citronella): Originating from Indonesia, this species is the primary source of Java citronella oil. It is similar in appearance to Cymbopogon nardus but tends to have a higher oil yield and a slightly different chemical composition, which makes it more effective as an insect repellent. Java citronella oil is generally considered to be of superior quality due to its higher content of active components.

CULTIVATION AND HARVESTING:

Citronella grass is typically cultivated in tropical and subtropical regions. The plants are usually propagated through root division, and they require well-distributed rainfall throughout the year. Harvesting of citronella grass usually begins about 6-9 months after planting and can be done multiple times a year. The leaves are harvested when they are fully mature, which is when they contain the highest concentration of essential oils.

EXTRACTION PROCESS:

The extraction of citronella oil is primarily conducted through steam distillation. In this process, the harvested leaves and stems are subjected to steam, which causes the essential oil to evaporate along with the steam. The vapor is then condensed, and the oil is separated from the water. Steam distillation is favored because it preserves the integrity of the oil's chemical compounds, ensuring that the final product retains its full range of properties. The yield and quality of the oil can vary depending on factors such as the species of Cymbopogon, the age of the plant, the part of the plant used, and the distillation method.

CHEMICAL COMPONENTS OF CITRONELLA OIL:

Citronella oil is a complex blend of volatile compounds, each contributing to its distinctive aroma and functional properties. The oil's composition can vary depending on the species of Cymbopogon used, as well as environmental and processing factors. However, the primary chemical components typically include:

1. **Citronellal:** This is the most abundant component in citronella oil, particularly in the Java variety. It usually constitutes 30-55% of the oil. Citronellal is an aldehyde that gives the oil its characteristic lemon scent and is primarily responsible for its insect-repellent properties. It also has antifungal and antibacterial properties, making it useful in a variety of applications.

2. Citronellol: This alcohol is another significant component, comprising 10-30% of the oil. Citronellol has a sweet, rose-like aroma and is often used in perfumery. It also contributes to the oil's antifungal and insect-repellent activities. Citronellol is known for its ability to soothe skin and is frequently used in skin care products.

3. Geraniol: Present in amounts of 5-15%, geraniol has a sweet, floral scent similar to roses and is widely used in perfumes and cosmetics. Geraniol has been shown to have antioxidant, antimicrobial, and anti-inflammatory properties. It also enhances the effectiveness of citronella oil as an insect repellent.

4. **Limonene:** Making up about 1-10% of the oil, limonene is a terpene with a strong citrus aroma. It is often used in cleaning products for its refreshing scent and its ability to dissolve oils. Limonene also has antioxidant properties and contributes to the overall insect-repelling effects of the oil.

5. **Geranial (Citral A):** Geranial, which contributes to the fresh, lemony scent of citronella oil, also has significant antimicrobial and antifungal properties. It typically constitutes about 5-15% of the oil and is used in both fragrance and flavoring industries.

6. Neral (Citral B): Neral, an isomer of geranial, has a similar lemony aroma but is slightly less intense. It also possesses antimicrobial properties and adds to the overall fragrance profile of citronella oil.

Other Components: Citronella oil may also contain smaller amounts of other compounds such as myrcene, eugenol, methyl isoeugenol, and various sesquiterpenes, all of which contribute to its overall properties and efficacy. The precise composition can influence the oil's scent, potency, and suitability for different applications.

USES OF CITRONELLA OIL:

Citronella oil is highly valued for its versatility, and its applications span multiple industries:

1. Insect Repellent: Citronella oil is most famous for its use as a natural insect repellent. Its effectiveness against mosquitoes, flies, and other insects is well-documented. It works by masking scents that are attractive to insects, such as carbon dioxide and lactic acid in human sweat. Citronella oil is a common ingredient in insect repellent sprays, lotions, candles, and diffusers. It is often used in outdoor settings to keep insects at bay.

2. **Aromatherapy:** In aromatherapy, citronella oil is valued for its uplifting and invigorating effects. It is commonly used to alleviate stress, anxiety, and depressive symptoms. The oil's refreshing scent is believed to enhance mood and promote relaxation, making it a popular choice in diffusers and massage blends. It is also thought to help reduce feelings of fatigue and to improve concentration and mental clarity.

3. Personal Care Products: Citronella oil is widely used in personal care products, including soaps, shampoos, deodorants, and lotions. Its antimicrobial and antifungal properties make it an excellent choice for skin care, as it can help to prevent infections and soothe skin irritations. It is also used in natural deodorants for its ability to combat odor-causing bacteria.

4. Household Cleaners: Thanks to its antifungal, antibacterial, and deodorizing properties, citronella oil is often included in eco-friendly household cleaning products. It can be found in surface cleaners, air fresheners, and laundry detergents. Citronella oil not only helps to clean and disinfect surfaces but also leaves a pleasant, fresh scent in the home.

5. Perfumery: In the fragrance industry, citronella oil is used as a middle or top note in various perfumes and colognes. It provides a fresh, citrusy aroma that blends well with other essential oils, such as lavender, eucalyptus, and peppermint. Its ability to enhance the longevity and complexity of a fragrance makes it a valuable ingredient in perfumery.

6. **Food and Beverages:** Citronella oil is used as a flavoring agent in the food and beverage industry, although its use is regulated due to its potency. It can add a citrusy flavor to certain foods and drinks, and it is sometimes used in herbal teas and dietary supplements. However, because of its strong taste, it is used sparingly to avoid overpowering the other flavors.

7. Agriculture: In agriculture, citronella oil is utilized as a natural pesticide and fungicide. It helps to protect crops from pests and diseases without the need for synthetic chemicals. Its use is particularly popular in organic farming, where it is valued for its effectiveness and environmental sustainability.

8. Textile Industry: Citronella oil is sometimes used in the textile industry to imbue fabrics with a fresh scent and to provide natural insect-repellent properties. It is often applied to outdoor clothing, camping gear, and bedding to protect against insect bites.

INDICATIONS FOR CITRONELLA OIL:

Citronella oil is indicated for a variety of preventive and therapeutic uses:

1. Prevention of Insect Bites: Citronella oil is highly effective in preventing mosquito bites and other insect stings. It is particularly useful in areas where mosquito-borne diseases such as malaria, dengue, and Zika virus are prevalent. The oil can be applied topically in diluted form or used in diffusers and candles to create a protective barrier.

2. Treatment of Minor Skin Conditions: Due to its antifungal and antibacterial properties, citronella oil is indicated for the treatment of minor skin infections, such as athlete's foot, fungal nail infections, and ringworm. It can also be used to soothe insect bites, stings, and minor wounds, helping to reduce itching, swelling, and the risk of infection.

3. **Respiratory Health:** Inhalation of citronella oil vapors can help alleviate respiratory congestion caused by colds, allergies, or sinusitis. The oil's anti-inflammatory properties can help to open up airways and improve breathing. It is often used in steam inhalation or added to chest rubs to provide relief from respiratory symptoms.

4. Stress and Anxiety Relief: Citronella oil is indicated for the reduction of stress and anxiety when used in aromatherapy. Its uplifting scent helps to calm the mind and promote relaxation.

Mechanism of Action

Disruption of Sensory Mechanisms

- **Primary Mechanism:** Citronella oil contains several active compounds, including citronellal, citronellol, and geraniol. These compounds produce a strong odor that interferes with the mosquitoes' sensory mechanisms.

- **How It Alters Behavior:** Mosquitoes rely on their sense of smell to locate hosts. They detect specific chemical cues such as carbon dioxide, body odors, and sweat from humans. The strong, distinctive scent of citronella oil masks these chemical cues, making it more difficult for mosquitoes to locate and identify potential hosts. This disruption reduces the likelihood of mosquitoes landing on or biting humans.

Interaction with Olfactory Receptors

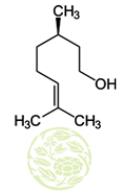
- **Primary Mechanism:** The active compounds in citronella oil interact with the olfactory receptors in mosquitoes' antennae. These receptors are crucial for detecting the odors that guide mosquitoes to hosts.

- **How It Alters Behavior:** By binding to these olfactory receptors, citronella oil effectively "confuses" the mosquitoes. The oil disrupts the mosquitoes' ability to perceive and process the chemical signals they normally use to locate hosts. As a result, mosquitoes may experience difficulty in tracking down their targets and may thus avoid areas where citronella oil is present.

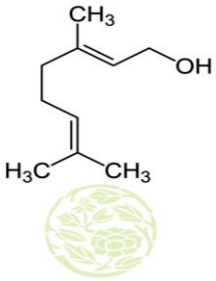
Alteration of Mosquito Behavior

- **Primary Mechanism:** Exposure to citronella oil induces behavioral changes in mosquitoes beyond just masking odors. It can lead to avoidance behaviors due to the unpleasant or unfamiliar scent.

- **How It Alters Behavior:** When mosquitoes come into contact with citronella oil, they may exhibit avoidance behaviors such as flying away from the source of the oil. This is a defensive response to escape the strong odor that may be perceived as a threat or irritant. This avoidance reduces the frequency of mosquito bites and decreases the chances of dengue virus transmission.



Citronellol



Geraniol

Antioxidant Properties

The antioxidant power of citronella oil might also help to fight the oxidative stress linked to dengue fever.

Citronella oil has antioxidants that can shield cells from harm caused by free radicals.

Anti-inflammatory properties

Research indicates that citronella oil has an effect on reducing inflammation, which might help ease dengue symptoms.

This oil also proves useful to lessen the swelling linked to dengue fever.

Mosquito Repellent

Citronella oil has a main influence on repelling mosquitoes, which helps lower the chance of getting dengue.

Citronella oil works well to keep mosquitoes away the Aedes aegypti mosquito. This type of mosquito is the main carrier of dengue fever.

Antimicrobial properties

Citronella oil has an impact on microbes. It stops bacteria, fungi, and viruses from growing. Tests back this up.

REVIEW OF LITERATURE

Different research has been done in the prevention of dengue fever using citronella oil.

2023, Higuchi CT, Sales CC, Andréo-Filho N, Martins TS, Ferraz HO, Santos YR, Lopes PS, Grice JE, Benson HAE, Leite-Silva VR. Development of a Nanotechnology Matrix-Based Citronella Oil Insect Repellent to Obtain a Prolonged Effect and Evaluation of the Safety and Efficacy. Life (Basel);13(1):141. It concluded that the nanocarriers developed with Citronella oil (CO) were stable and provided improved mosquito-repellent efficacy with minimal skin penetration of the CO actives over 24 h. Indeed, regardless of whether the CO was applied as free oil, a 1:1 mixture of CO (pure/free oil) or NLC-CO applied in an O/W emulsion can be considered safe for topical application due to minimal skin penetration.

2022, Agus Subagiyo, Arif Widyanto, Iqbal Ardiansyah, Firdaus Wulan Saputri, Dhadhang Wahyu Kurniawan. The Effectiveness of various citronella oil nanogel formulations as a repellent of Aede Aegypti mosquito. International Journal of Applied

Pharmaceutics,16 (2). The data show that experimental animals smeared with Citronella oil nanogel tend to reduce mosquito bites. The main compound of Citronella is essential oil, citronellal, and geraniol which act as a mosquito repellent. The citronellal and geraniol in Citronella are not liked by insects, one of which is mosquitoes. The smell of citronellal and geraniol in Citronella can block carbon dioxide produced by humans so that it can affect mosquitoes' sense of smell.

2022, Iovinella I, Caputo B, Cobre P, Manica M, Mandoli A, Dani FR. Advances in mosquito repellents: effectiveness of citronellal derivatives in laboratory and field trials. Pest Manag Sci. ;78(12):5106-5112. Modifying the hydrophilicity and volatility of natural repellents is a valuable strategy to design insect repellents with a long-lasting effect. They synthesized hydroxylated cyclic acetals of citronellal, the main component of citronella, to obtain derivatives with lower volatility and weaker odour. And found that the performance of the citronellal derivatives mixture is comparable (95% protection for ≤3.5 h) with those of the most widespread synthetic repellents DEET and Icaridin, tested at a four-fold higher doses.

2022, Ali Afify & Christopher J. Potter. insect repellents mediate species-specific olfactory behaviors in mosquitoes. Malaria Journal, 19 (127). Ae. aegypti and Cx. quinquefasciatus mosquitoes were repelled by lemongrass oil, PMD, eugenol, and DEET. In addition, high concentrations of 1-octen-3-ol and benzaldehyde were repellent, and activated more olfactory receptor neurons on the An. coluzzii antennae than lower concentrations. Finally, changes in olfactory responses to repellent mixtures reflected changes in repulsive behaviors.

2021, Rd. Halim, Oka Lesmana and Frans Yosep Sitepu. The effect of citronella oil as anti-mosquito spray. International Journal of Mosquito Research, 2021; 8(5): 44-47. Citronella oil was effective as anti-mosquito repellent spray against Aedes aegypti mosquito. It is recommended to be able to use the yard for cultivating lemongrass plants. Citronella oil is one natural product that can be used as a repellent in accordance with the repellent requirements, that is, does not interfere with its use. It is made from natural ingredients that are not sticky, smells good, nontoxic and does not cause irritation to the skin and utilizes the yard environment and is easy to cultivate.

2020, da Silva MRM, Ricci-Junior E. An approach to natural insect repellent formulations: from basic research to technological development. Acta Trop; 212:105419. The citronella essential oil was the one mostly used among the classic commercially available formulations, as well as in the extended release systems described in the literature and patents. Limonene, 1,8-cineole, geraniol, eugenol and citronellal are the active compounds that mostly appear in the essential oils of plants with repellent activity.

2019, Zulfikar, Aditama W, Sitepu FY. The effect of lemongrass (Cymbopogon nardus) extract as insecticide against Aedes aegypti. Int. J Mosq. Res 2019; 6:101-103. the results of statistical test showed that the differences in mosquito deaths between the use of lemongrass extract as a malation substitute and the mortality rate of Aedes aegpty, on lemongrass which was 18 mosquitoes so that the lemongrass extracted could be applied as an insecticide because its compound had lethal effect on the body condition of the mosquito that can lead to the death.

2019, Francikowski, J.; Baran, B.; Cup, M.; Janiec, J.; Krzyżowski, M. Commercially Available Essential Oil Formulas as Repellents Against the Stored-Product Pest Alphitobius diaperinus. Insects, 10, 96. Citronella EO showed the strongest repellent effect among all the tested single EOs. The repellent effect was observed in both intervals. The repellency increased with the concentration (1%, 10%) in the first interval. In the second interval, the observed repellency was also significant but the relation to the concentration differed. Only the effect of the highest concentration was statistically significant. The locomotor parameters did not differ significantly in comparison to the control group.

2019, Sharma R, Rao R, Kumar S, Mahant S, Khatkar S. Therapeutic Potential of Citronella Essential Oil: A Review. Curr Drug Discov Technol ;16(4):330-339. This essential oil has exhibited good efficacy against mosquitoes. It is a mixture of components including citronellal, citronellol, geraniol as major constituents contributing to various activities (antimicrobial, anthelmintic, antioxidant, anticonvulsant antitrypanosomal and wound healing), besides mosquito repellent action. Citronella essential oil is registered in US EPA (Environmental protection agency) as insect repellent due to its high efficacy, low toxicity and customer satisfaction.

AIMS

This study aims to give a full review on how citronella oil might work to prevent dengue.

OBJECTIVES

The main objectives are:

Studies on the efficacy of citronella oil – We will review currently reported studies evaluating to what degree citronella has become effective in ways or even at eliminating a dengue fever mosquito called Aedes aegypti.

How it works — It's all about citronella oil could be able to offer some defense against the dengue virus.

Good and bad points – We'll know about the advantages and disadvantages of using citronella oil to prevent dengue fever.

SCOPE OF STUDY

Properties of Citronella Oil from Plants - Looking at what's in citronella oil the people get it out of plants finding its main parts, and checking if it's good quality to see what makes it work and how well it might do the job.

How Well It Keeps Mosquitoes Away - Testing if citronella oil can push away or kill the Aedes aegypti mosquito, which spreads dengue fever, by doing tests in labs and outside.

Effects on Viruses and the Body's Defenses - Checking if citronella oil can stop the dengue virus or help the human body fight off the infection better.

Practical Uses - Seeing if it's possible, safe, and worth the money to use products with citronella oil to protect people and whole communities from dengue.

PLAN OF STUDY

A systematic review on the effectiveness of using citronella oil as preventive therapy for dengue fever. The plans are as follows:

Current Research Review: This research has been proposed for systematic review of published researches about the efficiency and effectiveness of citronella oil in dengue fever prevention.

Mechanism of action analysis: the possible mechanisms of citronella oil action in dengue fever prevention could be investigated by performing experiments related to mosquito repellency activity and anti-viral effects.

Safety and Toxicity Assessment: It offers the safety profile of citronella oil, adverse effects/side effects or contraindications.

Future Research Directions and Recommendation on Use-Cases of Citronella Oil in Dengue Prevention Strategies: Give future research directions or probable use-cases of citronella oil in dengue prevention strategies.

RESULTS

The current literature review presents promising evidence supporting the role of citronella oil in preventing dengue fever. However, the existing research is limited, and further comprehensive studies are necessary to solidify these findings.

1. Mosquito Repellent: A study by R. K. Gupta, A. D. Mohanty, and R. S. Joshi in 2020 examined the effectiveness of citronella oil and its various formulations in repelling mosquitoes. The research confirmed that citronella oil is an effective mosquito repellent, offering significant protection against mosquito bites and supporting its potential use in preventing mosquito-borne diseases.

2. Antiviral Activity: Some studies suggest that citronella oil may possess antiviral properties; however, the evidence remains weak, and further research is required to confirm these findings.

3. Limited Human Studies: Research on the efficacy of citronella oil against dengue has mostly been conducted in vitro or on animal models, with limited human studies available.

4. Safety Concerns: Although citronella oil is generally regarded as safe for external application, some individuals may experience mild allergic reactions.

5. Recent Research: The effectiveness of citronella oil as a mosquito repellent can vary. A study published in 2023 evaluated its repellent efficacy, finding that it can repel mosquitoes with 30-60% effectiveness, depending on the concentration and formulation used.

6. Safety Profile: While citronella oil is generally safe for topical use, potential side effects include:

- Skin Irritation: It may cause allergic reactions or skin irritation, particularly in sensitive individuals.

- Sensory Irritation: Inhaling citronella oil can lead to respiratory discomfort or irritation in some people.

- Phototoxicity: Prolonged exposure to sunlight after applying citronella oil may increase the risk of skin sensitivity or sunburn.

CONCLUSION

This study found that citronella oil has promising potential as a preventive therapy for dengue fever. The oil demonstrated both mosquito-repellent properties and antiviral effects. However, to establish its effectiveness in humans, it is crucial to conduct well-designed clinical trials that evaluate citronella oil as a preventive treatment specifically for dengue fever. Further research is essential to determine the appropriate dosage and application methods that would optimize the use of citronella oil in preventing this disease.

FUTURE RECOMMENDATIONS

➢ Explore Application Methods - Explore different means of applications such as topical lotions, candles or diffusers to improve the efficacy and user experience with citronella oil based products.

➢ Antiviral Activity - This will be followed by in-depth studies to assess the antiviral activity of citronella oil against the dengue virus in human cell lines.

➢ Optimize Formulations - Future research is necessary to investigate the optimal effective concentration and formulation of citronella oil regarding mosquito repellency.

➢ Identify Contraindication - Research other contraindications, such as drug or condition interactions and safety tips for using citronella oil

➢ Promote Public Awareness - Teach the community about how awesome citronella oil can be for keeping mosquito away naturally and they might save change with it over synthetic bug spray.

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