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Review Article

Biological & Insecticidal Effect of Citronella Oil: A Short Review

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Abstract:

Introduction: The comprehensive research on the chemical composition of citronella grass led to various advantages, including the development of analytical tools for quality evaluation, which is the primary reason the plant is cultivated. Attacks by pests such as stink bugs, brown planthoppers, grasshoppers, ladybugs, and aphids are the most significant threat to crop productivity. Other problems include grasshoppers. This assault slows the development of the rice plants, resulting in a decrease in productivity or possibly preventing harvesting altogether. Applying chemical pesticides may help minimize the number of illnesses and pests. Using chemical pesticides over an extended period, on the other hand, may wreak havoc on the environment.

Objective: This review aims to examine the biological & insecticidal effectiveness of citronella oil, which can help to understand to use of this oil to control insects and mosquitos.

Method: Multiple computerized databases, such as PubMed, Google Scholar, ScienceDirect, etc., were used to write the paper. Result. The medicinal benefits of Citronella oil have been extensively documented, and the oil's components have been well studied. Citronella oil has been used as an antifungal, antiparasitic, effective insect repellent, and antibacterial, thanks to extensive research into its medicinal potential.

Conclusion: Oil of citronella contains citronellol, citronellal, and geraniol. If they enter the environment, some will vaporize. In water, they evaporate slowly. Once vapours are airborne, their half-lives range from 38 minutes to 3.2 hours. Instead, microbes degrade citronellol and geraniol.

Keywords: **Citronella oil, Aedes aegypti, Geraniol, Antifungal, Antiparasitic, etc.**

Introduction

The ancient palm-leaf writings discovered in South Asia were preserved using oil made from lemongrass, which has dual use as a pesticide and a preservative. More than fifty kinds of grasses native to tropical Asia and southern India belong to the genus *Cymbopogon*, sometimes known as lemongrass. The plant imparts a scent and taste similar to lemon to foods and drinks such as soups, curries, teas, and other liquids. In addition to its use in the culinary world, lemongrass oil is also utilized in Ayurvedic medicine, aromatherapy, and the beauty and fragrance sectors. You may also cultivate other species from the same family as lemongrass [19]. The oil of citronella is a naturally occurring insect and animal repellant distilled from two different types of grass. It ranges from yellow to brown and has an odor similar to grass or flowers.

The oil of citronella is a complex concoction made up of a variety of different elements. The precise make-up differs depending on the kind of grass used.

On the other hand, citronellol, citronellal, and geraniol are the primary constituents. In addition, citronella oil is often a flavoring ingredient in various meals and drinks. As a food additive, the Food and Drug Administration has determined that it satisfies the criteria for the GRAS designation, which stands for 'generally recognized as safe [3]. The word "citronella" comes from the French word "Citronelle," which was first used around the year 1858 [13]. Citronella was first extracted for use in the perfume industry. It was first used to ward off mosquitoes by the Indian Army at the turn of the 20th century [10], and it was not until 1948 that it was approved for use in commercial settings in the United States

[7]. At concentrations ranging from 5 to 10%, citronella is one of the natural repellents that is now one of the most popular choices on the market.

Biological Effects

It is possible to extract oil from the plant known as citronella (*Cymbopogon nardus*), which includes the antimicrobial chemical components citronellal, geraniol, and citronellol. Studies have shown that it is beneficial whether used alone or in combination with other substances and has a high antibacterial activity [25]. In this sense, citronella oil may have a phytotherapeutic potential for antibacterial and antifungal activity, which opens up new avenues of inquiry on managing oral biofilm. To this day, the research that has been conducted on the use of citronella oil as a mouthwash has not shown any results. It has been demonstrated that citronella essential oil is a potential active phyto complex that may be used to produce a novel mouthwash [4].

Using plant materials as environmentally friendly botanical pesticides has gained increasing interest among scientists in recent years because such pesticides often have fewer adverse effects on beneficial insects, require more infrequent and less expensive chemicals, and slow the emergence of resistance. Over the past few decades, more research has been done on citronella oil than any other botanical pesticide. Citronella oil is effective as a repellent, anti-feedant, and oviposition deterrent against multiple insect species. Citronella oil is effective as an antifungal and antibacterial agent, as well as a mosquito (*Aedes aegypti*) and a fungus (*Spodoptera frugiperda*) repellent, according to a few studies. Compounds such as citronellal, trans-geraniol, carvone, and limonene were effective as anti-microbials; citronellal and linalool were effective as antifungal agents; and menthone, trans-geraniol, and citronellal exhibited a potent inhibitory effect [2].

Table 1: A summary of the findings from the research on the effectiveness of repellent plants.

Plant	Location	Repellent compound(s)	Repellency (%) protection
C. nardus	Brazil, India, Bangladesh, Srilanka, South East Asian Countries.	Citronellal	100% protection for 7-8 hours against *An. stephensi*
C. citratus	USA South Africa Bolivia	Citral α-pinene	74% protection against *An. darlingi* for 2.5h 95% protection against *Mansonia spp.* for 2.5 hours
C. winterianius			100% protection against *Ae. aegypti* for 6.5 hours
C. martini	Tanzania, Kenya	Geraniol	100% protection against An. culicifacies for 12 hours

Therapeutic Effects

The physical qualities of the essential oils, which are natural products, include analgesic, anticonvulsant, and anxiolytic. The fragrance, cosmetic, medicinal, and flavouring industries employ the steam-extracted volatile essential oils from its leaves. The oil has been used in traditional medicine as a vermifuge, diuretic, antispasmodic, and aromatic tea. Although citronella oil has various applications in aromatherapy, it is most well-known for its inherent ability to repel insects. It may be used as massage oil for sore muscles and joints. The oil's ability to ward off insects may be employed efficiently in a humidifying or nebulizing diffuser. Fever, intestinal parasites, digestive issues, and monthly irregularities are among the traditional uses. Citronella may be enlightening and balanced while treating mental disorders. Combining it with Lemon oil might offer even more of a bright influence on the mind.

When it comes to the medicinal benefits of citronella oil, the vast majority of its applications are limited to those of a mosquito repellent, an antiparasitic, a nematicidal, an antifungal, and an antibacterial agent [24]. This study, 38 essential oils were tested for their ability to ward against mosquito bites, including those caused by the *Aedes aegypti* species. Compared to the other essential oils that offered repellency for 2 hours, citronella oil proved the most effective. In a study that looked at five different commercial plant extracts [26], one of which was citronella, researchers discovered that the extract successfully prevented red flour beetles from infesting cartons containing muesli and wheat germ. It has been shown that citronella oil has other benefits, including reducing ticks in cattle. The crude essential oil significantly inhibited the development of several different species of *Aspergillus*, *Penicillium*, and *Eurotium*. Citronellal and linalool were the most active compounds out of the sixteen volatiles he investigated. These compounds were composed of six critical components of the essential oil as well as ten additional related monoterpenes [18].

There are already products on the market derived from plants and include essential oils from at least one of the following plants: citronella, cedar, eucalyptus, geranium, lemon-grass, peppermint, neem, and soybean [5]. Most insect repellents based on essential oils provide protection that is often only effective for less than two hours. It has been shown that doses of citronella oil ranging from 0.05% to 15% (w/v) are effective against 44 different species of mosquitoes, either on their own or in conjunction with other natural or commercial insect repellent solutions [9]. It has been shown that this oil quality is brought about by the presence of citronellal, eugenol, geraniol, and limonene, the four most important components [22].

Table 2: Chemical composition of the analyzed citronella essential oil [8]

Compound	Concentration (%)	Chemical groups
Citronellal	46.95	monoterpenoid
Citronellol	9.49	acyclic monoterpenoid
Linalool	9.46	monoterpene alcohol
β-caryophyllene	8.39	bicyclic sesquiterpene
Geranyl acetate	3.32	monoterpene
P-cymene	2.57	
Limonene	2.54	cyclic monoterpene
α-pinene	1.71	monoterpene
Myrcene	0.70	

Insecticidal Effects

There have only been a few research done to assess whether or not the essential oils from citronella are effective as arthropod repellents. Although the mosquito repellent formulation is highly significant [24], the protection offered by repellents containing citronella only lasts for approximately two hours against mosquitoes looking for hosts to feed on [11]. Initially, citronella, which includes citronellal, citronellol, geraniol, citral, pinene, and limonene, is an as effective dose as DEET [6]. Still, the oils rapidly evaporate, causing a loss of efficacy and leaving the user unprotected. Citronella contains citronellal, citronellol, geraniol, citral, and limonene. However, by combining the essential oil of *Cymbopogon winterianus* with a big molecule such as vanillin at a concentration of five per cent, the duration of protection may be significantly increased while simultaneously lowering the rate at which the volatile oil is released [23]. Recently, nanotechnology has made it possible to obtain slower release rates of oils, which has resulted in a prolonged period of protection. To produce an encapsulated citronella oil nanoemulsion, high-pressure homogenization of 2.5% surfactant and 100% glycerol is used. This results in the formation of stable droplets, which improve the oil's capacity to be retained and reduce its release rate. There is a strong correlation between the protection time and the release rate; hence, if the release rate is lowered, the mosquito protection period will be increased [21]. Microencapsulation using gelatin-arabic gum microcapsules is another method for extending the effectiveness of natural repellents. This method maintained the repellency of citronella for up to 30 days on a treated cloth held at ambient temperature (22°C) [14]. It is possible that using these technologies to improve the effectiveness of natural repellents will trigger a revolution in the market for repellents and make the use of plant oils a more realistic choice for producing long-lasting repellents. However, for the time being, citronella-based repellents should not be suggested to travellers going to locations where illness is prevalent [11]. In contrast, using citronella to prevent mosquito bites may protect significantly from disease vectors in communities where more effective alternatives are unavailable or prohibitively expensive [15]. Citronella has been shown to have anti-inflammatory and antimicrobial properties.

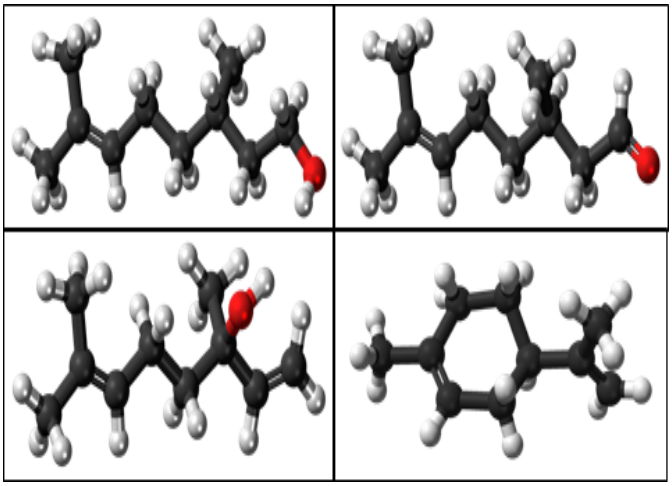

Figure 1: Three Dimention picture of Citronellal, Citronellol, Linalool & Limonene.

Mosquito repellent assay

Oils containing citronella are effective in repelling *Aedes aegypti* mosquitoes. The extracted oil was microencapsulated using a sophisticated coacervation technique (1.5% gelatin and 1.5% Arabic gum). We used a pad dry technique to apply gelatin and gum acacia microcapsules to cotton textiles infused with citronella oil. Cage and field tests with human arms coated in treated and untreated materials (at 26.2°C and 80% RH) examined the efficacy of the repellents on cotton fabrics at 15%, 30%, and 50% [16]. Microencapsulated citronella oil-treated fabric (MCF) and untreated fabric were subjected to the identical procedure, with the MCF being washed once and the untreated fabric being washed twice (CF). In this research, citronella leaf cakes sprayed with varying amounts of Citronella oil were tested for their capacity to repel mosquitoes and how long they stayed alight after igniting. Based on the data, Neem powder cake soaked with 10% Citronella oil seems to be the most efficient insect repellent [20].

Anti-parasitic assay

In this work, the anti-proliferative effects of lemongrass essential oil and its primary component, citral, on the three different types of *Trypanosoma cruzi* that have evolved through time are analyzed. Cell counting in a Neubauer chamber was used to calculate the IC50/24 h (concentration that decreased the parasite population by 50%) of the oil and of citral upon *T. cruzi*, while scanning and transmission electron microscopy were used to detect morphological changes [1].

Anti- fungal assay

As shown by a vapour-agar contact experiment for antifungal activity, the crude essential oil significantly inhibited the airborne proliferation of several species of *Aspergillus*, *Penicillium*, and *Eurotium.* At 112 mg/L, the combined effects of citronellal and linalool effectively suppressed the development of all fungal strains examined. Minimal inhibitory concentrations varied between 14 and 56 mg/L. To suppress the growth of some fungus, the - and - pinenes were found, but the other 8 volatile chemicals were ineffective [17].

Anti-bacterial assay

The broth dilution technique was used to study the inhibitory activity of citronella oil against key species of spoilage bacteria, such as *Staphylococcus aureus*, *Klebsiella* spp., and *Pseudomonas* spp., which were identified on the surface of *Decapterus maruadsi* (semi-dried round scad). To determine the minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC) for the bacteria, citronella oil and its primary components, d-limonene and linalool [12], were added to a nutrient broth at volume concentrations (v/v) ranging from 0.5% to 10%. This was done in order to determine the minimum inhibitory concentration (MIC) and the minimum bactericidal concentration (MBC).

Discussion

The most significant risk to agricultural production is pests

such as stink bugs, brown planthoppers, grasshoppers, ladybugs, and aphids. Grasshoppers are another kind of nuisance insect. This attack impedes the rice plants' growth, leading to a drop in output and possibly even wholly making harvesting impossible. The use of chemical pesticides could be able to assist in lowering the overall incidence of diseases and vermin. On the other side, using chemical pesticides over a long period might potentially wreak havoc on an ecosystem. Instead of killing bugs, the oil of citronella drives them away with its pungent odor. This method is effective because it covers the scents that insects find appealing. As a result, it is difficult for insects to locate their prey on which to eat. The oil of citronella may operate by covering up smells that animals find appealing.

On the other hand, no studies were able to be found. Chemicals may enter a person's body by ingestion, inhalation, or direct contact with the skin, eyes, or mucous membranes. The most usual ways for people to come into contact with the oil of citronella are by inhaling its fumes or applying it topically to their skin in the form of a spray. Inhalation of the spray mist or failure to wash one's hands before eating or smoking, are both potential routes of exposure for individuals. On the other hand, oil of citronella may sometimes cause slight irritation to the eyes and skin. Some individuals develop skin allergies when exposed to them for an extended period or regularly. Should it be consumed, it may cause individuals to cough or have throat discomfort.

However, research on oil of citronella's carcinogenic potential is lacking. But research has proven that citronella oil does not harm or change genes. The oil of citronella contains a compound called geraniol, which has been shown in several studies to inhibit the development of various malignancies. Large amounts of a few of the oil of citronella's minor components were given to rats five times weekly for two years in a separate investigation. There was no proof that cancer rates had risen. Little in citronella oil, methyl eugenol is "reasonably predicted to be a human carcinogen," according to the “United States Department of Health and Human Services.” It has been linked to tumor growth in mice.

Citronella oil is almost completely safe for birds to be around. Some fish and other aquatic species can handle it, although it is still somewhat poisonous. Oil of citronella does not kill insects but keeps them away. Consequently, pollinators like bees shouldn't be threatened. The low toxicity and infrequent use of oil citronella mean that it poses little threat to birds, fish, and other species. Essential oils like citronella and geraniol are found in the oil of citronella. If released into the atmosphere, some of them would likely become gases. They evaporate off the water's surface at a steady pace. Vapors have short half-lives, from 38 minutes to 3.2 hours, after entering the atmosphere. Microorganisms may quickly degrade both citronellol and geraniol.

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Conflict of Interest

There is no conflict of interest.

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