



## Mini Bibliometric Analysis of Citronella Oil based on Scopus Database using VOSviewer

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### Abstract

Mosquitoes can transmit various dangerous diseases such as malaria, dengue fever, and elephantiasis. Solutions are needed to overcome this problem in addition to using conventional methods such as the use of mosquito coils and synthetic mosquito repellents that pose a risk to health. Citronella oil is an alternative to repel insects including mosquitoes. Bibliometric analysis was used to investigate the development of citronella oil using VOSviewer software. Data were extracted from the Scopus database with the keyword "Citronella Oil" and showed there were 386 publications over 96 years (1927-2023). This shows that interest in citronella oil research is still low. This article provides an overview of citronella oil's year-to-year research trends and predicts its opportunities for the relevant future.

*Keywords: Bibliometric Analysis; Citronella Oil; Insect Repellent; VOSviewer*

### 1. Introduction

Mosquitoes are dangerous animals because they can transmit various diseases such as malaria, elephantiasis, and dengue fever. In Indonesia, 95,971 cases and 663 deaths due to dengue fever were reported in December 2020 [1]. Various methods are carried out to prevent mosquitoes, such as using candles and mosquito coils. This method is effective for repelling mosquitoes but can disrupt the respiratory system and risk causing a fire. In addition to this method, the use of N,N-Diethyl-meta-toluamide (DEET), and permethrin as synthetic mosquito repellents has developed. However, this synthetic mosquito repellent has some disadvantages such as skin rashes, respiratory disorders, and eye irritation [2]. In response to this, mosquito repellents from natural materials began to be developed as an alternative way. Previous research has shown that essential oils effectively repel mosquitoes without causing side effects on human health [3].

Citronella (*Cymbopogon nardus*) is a short impellent grass with erect stems [4], characteristic smell [3], and belongs to the family Poaceae [2]. The leaves and stems of citronella plants can be extracted to obtain essential oils. This oil can be applied to repellent insects including mosquitoes [5] because it contains citronellal active compounds [2]. In addition, phenolic compounds and flavonoids in citronella oil have antioxidant and antimicrobial properties [6].

In the expanding field of natural insect repellents, Citronella oil emerges as a notable contender, attributed to its effectiveness against mosquitoes and other pests. A variety of studies have investigated the attributes and applications of Citronella oil, validating its insect-repelling capabilities [7-9]. For example, research has identified citronellal as a

key active compound in Citronella oil, significantly contributing to its insect-repelling properties [8]. Moreover, other studies have highlighted the antioxidant and antimicrobial characteristics of citronella oil, further enhancing its appeal beyond mere insect repellency [10,11]. In addition to Citronella, other essential oils such as eucalyptus [12], lavender [13], and peppermint [14] have also garnered attention for their insect-repelling qualities, often utilized in alternative formulations or combined applications. Comparative evaluations have shared insights on the distinct efficacy and longevity of these oils, providing a comprehensive understanding of their utility in diverse environments. Collectively, these studies not only strengthen Citronella oil's position as a natural insect repellent but also situate it within a broader spectrum of botanical solutions, emphasizing the multifaceted potential of natural compounds in pest management.

Bibliometric analysis has recently received significant attention from researchers in various fields of study. Bibliometric analysis is used to focus on data findings, show literature trends, and predict the future direction [15]. On this occasion, citronella oil was analyzed using bibliometric methods.

The bibliometric analysis of studies on Citronella is a valuable contribution to the scientific community for several reasons. Firstly, despite the growing interest in natural insect repellents, there is a knowledge gap in related to the lack of comprehensive understanding of research trends, influential publications, and collaborative networks specific to Citronella oil. This study aims to elucidate the historical evolution, current trajectories, and future prospects of Citronella research, thereby offering insights into its scientific impact and potential applications through

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conducting a bibliometric analysis. Secondly, given the escalating global health concerns related to mosquito-borne diseases such as malaria, dengue fever, and Zika virus, a nuanced understanding of Citronella oil's role as a natural repellent is crucial for fostering evidence-based research and policy interventions. Thirdly, this analysis facilitates the identification of key research clusters, institutions, and countries spearheading Citronella research, thereby fostering collaboration and resource allocation in advancing this field. In essence, this bibliometric study endeavors to consolidate and streamline the existing knowledge on Citronella, fostering innovation, collaboration, and informed decision-making in the realm of natural insect repellents.

In this work, research studies on citronella oil from 1927-2023 were used to determine the development of future directions. Based on the author's literature study, there have been no publications on the bibliometric analysis of citronella oil.

## 2. Database and Methodology

In this study, the scope of the journal is limited by the time of publication, namely from 1927 to 2023. Data were taken from the Scopus database on February 12, 2023. The data is analyzed to be able to represent the existing information. The development of citronella oil topics was analyzed using VOSviewer software to generate co-occurrences of published title terms. The keywords used in Scopus database searches are (TITLE-ABS-KEY("Citronella Oil")) with year intervals ranging from 1927 to 2023. A search showed that there were 386 publications on citronella oil. The selected data is converted to RIS format. The information contained in the RIS format is used for the visualization of similarities (VOS) using VOSviewer software.

## 3. Results and Discussion

### 3.1. Characteristics of Documents and Year of Publication

A total of 386 journals on citronella oil have been published in the last 96 years with 7 different types of documents. From the 386 publications, 291 articles became the most published articles, followed by conference papers (73) and reviews (12). Book chapter (3), conference review (3), book (2), and short survey (2) are only occasionally published. Figure 1 shows the number of citronella oil publications from year to year. From 1927-2007, the number of publications was still relatively small and tended to stagnate at less than 10 publications per year. Then in the following years, the number of publications slowly increased until the most publications in 2020 were 48 publications and in 2022 there were 42 publications. This shows that researcher's interest in citronella oil is increasing but is still relatively small so research opportunities for citronella oil publication are still wide open.

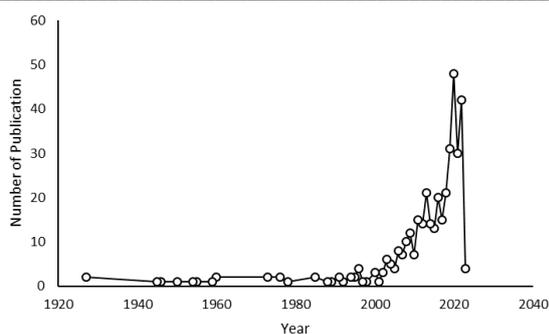


Figure 1. Publication number of citronella oil from 1927-2023

### 3.2. The Most Influential Title Source from the Citronella Oil Publication

The top ten most influential title sources were identified in the last 96 years (1927-2023). This is done to find out an overview of the source of the title that contributes to citronella oil. Table 1 shows that IOP Conference Series Earth and Environmental Science ranked first with a total of 26 publications (28.9%). This means that IOP Conference Series Earth and Environmental Science has been the title of the most influential source of citronella oil publications over the past 96 years. The IOP Conference Series Materials Science and Engineering followed with a total of 17 publications (18.9%). This was followed by AIP Conference Proceedings and Journal of Physics Conference Series which had 9 (10%) and 8 (8.9%) publications respectively.

Table 1. Top 10 most influential source titles in 1927-2023

Rank	Source Title	Number of Publications
1	IOP Conference Series Earth and Environmental Science	26
2	IOP Conference Series Materials Science and Engineering	17
3	AIP Conference Proceedings	9
4	Journal of Physics Conference Series	8
5	Journal of The American Mosquito Control Association	7
6	Journal of Management Science	6
7	Journal of Food and Fragrance Journal	5
8	Journal of Medical Entomology	4
9	Journal of Advanced Materials Research	3
10	Journal of Parasitology Research	2

### 3.3. The Most Productive Institutions and Countries in Citronella Oil Publications

From the 386 publications on citronella oil over the past 96 years, 160 institutions from 49 countries and 1 undefined country contributed. We present the top 30 institutions that contribute to the total publications compiled from the Scopus database. In the last 96 years, IPB University and

Institut Teknologi Sepuluh Nopember from Indonesia have been ranked first and second most productive institutions with the most number of publications, namely 8 publications. Followed by Semarang State University from Indonesia and Universidade Estadual Paulista Júlio de Mesquita Filho from Brazil with a total of 7 and 6 publications respectively. Indonesia leads the country with the most total citronella oil publications, namely 82 publications. Followed by India as the second rank with a total of 72 publications and Brazil as the third rank with a total of 44 publications.

Table 2. Top 30 institutions and countries with the most citronella oil publications from 1927 to 2023

Institutions	Number of Publication	Country
Universitas Indonesia	82	Indonesia
Institut Teknologi Sepuluh Nopember	8	Indonesia
Universitas Negeri Semarang	7	Indonesia
Universidade Estadual Paulista Júlio de Mesquita Filho	6	Brazil
Universiti Teknologi MARA	44	Malaysia
Universitat Politècnica de Catalunya	4	Spain
Brew University of Jerusalem	1	Israel
Pesquisa Brasileira de Agropecuária - Embrapa	4	Brazil
Universidade Tecnológica Federal do Paraná	4	Brazil
Institut Teknologi Bandung	4	Indonesia
Indonesian Journal of Science and Technology	4	Indonesia
Universitas Syiah Kuala	4	Indonesia
Research Institute of Higher Education and Research	4	India
Indonesian Spices and Medicinal Crops Research Institute	4	Indonesia
University of Songklanakharajit	4	Thailand
Central Institute of Medicinal and	4	India

Institutions	Number of Publication	Country
Aromatic Plants India	72	India
Universidade Federal de Vicosa	7	Brazil
University of Florida	6	United States
ICAR - Indian Agricultural Research Institute, New Delhi	4	India
United States Department of Agriculture	4	United States
Universidade Federal de Santa Maria	4	Brazil
Widyadarmas Wijaya University	4	Indonesia
Universitas Andalas	4	Indonesia
Politeknik Negeri Lhokseumawe	4	Indonesia
Ju Jambheshwar University of Science and Technology	4	India
Universidade Federal de Sergipe	4	Brazil
Instituto Nacional de Investigaciones Científicas y Técnicas	4	Argentina
Universidade Federal de Alagoas	4	Brazil
Indonesian Institute of Technology	4	Indonesia
Institute of Chemical Technology	4	India

3.4. Analysis Co-occurrence of Terms

Analysis of the emergence of terms is used to provide an overview of research trends in the last 96 years (1927-2023) analyzed using VOSviewer software. The list of keywords in the publication is used to show research trends specifically. Figure 2 shows the network of occurrences of the term. The node size of a term describes the number of occurrences of that term in the publication. The results show that there are 151 items with 5 clusters, 5416 links, and a total link strength of 18222. Terms such as citronella, essential oil, citronella oils, citronellal, insect repellent, and articles are the most frequent terms and indicate that there is interest in developing citronella oil as an insect repellent solution. This is the contribution of citronella oil in the health and agriculture sectors.

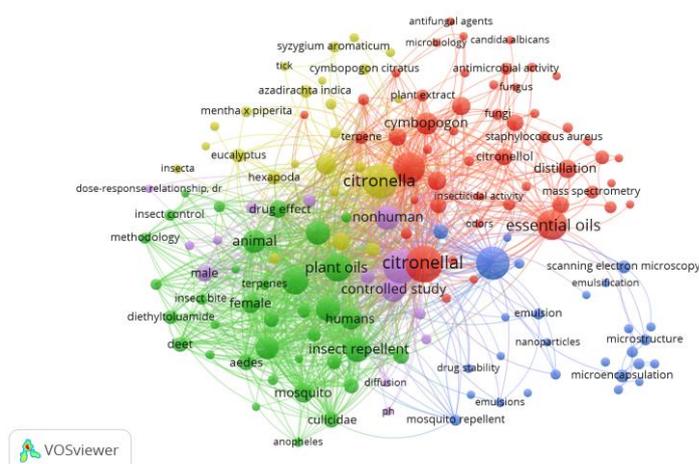


Figure 2. Network of co-occurrences citronella oil

Cluster 1 is indicated in red. The largest red circle with citronella terms has 147 links, 1539 total links strength, and 109 occurrences. This term is in close contact with the terms citronella and distillation which indicates that the three have a close relationship. Hamzah et al. (2014) conducted research on citronella oil extracted using 3 methods, namely ohmic-heated hydro-distillation, hydro-distillation, and steam distillation. Based on these three methods, ohmic-heated hydro-distillation is the most effective method for extracting citronella oil because it produces higher yields. In addition, SEM testing on citronella extracted with ohmic-heat hydro-distillation showed that ohmic heating caused pores to form in the citronella cell membrane even though the walls were still rigid so ohmic heating was considered feasible for the citronella extraction method [16].

Cluster 2 is indicated in green. The largest green circle with the term animals has 136 links, 1077 total links strength, and 62 occurrences. Insect repellent is the most frequently occurring keyword in this cluster. In the study of Gharsan et al. (2022) the toxicity of citronella oil in killing salaried toothed grain beetles (*O. surinamensis*) was investigated. The results showed that citronella was effective in killing salaried toothed grain beetles (*O. surinamensis*) due to its high citronella content. The effectiveness of citronella oil in its role as an insect repellent doubles when converted into nanoemulsions. This is because nanoparticles have a very small size, which ranges from 20-200 nm, and can increase the solubility of some active substances and reduce the rate of decomposition [17].

Cluster 3 is shown in blue. The largest blue circle with the term citronella oil has 139 links, 659 total links strength, and 89 occurrences. Microencapsulation is the most frequently occurring term in this cluster. Ribeiro et al. (2016) conducted research on citronella oil packaged in polyurethane microcapsules. Water and microcapsules containing citronella oil were compared to see where mosquitoes would lay their eggs. The results showed that polyurethane microcapsules were proven to prevent mosquitoes from laying eggs. In fact, microcapsules containing citronella oil will inhibit mosquito egg production by up to 30% because mosquitoes prefer to lay

eggs in water and avoid suspensions of microcapsules containing citronella [18].

Cluster 4 is shown in yellow. The largest yellow circle with the term citronella has 146 links, 1005 total link strengths, and 99 occurrences. Essential oils, citronella oil, and citronella are the most common terms in this cluster. Giménez-Martínez et al. [19] evaluated and compared citronella bioactivity against *V. destructor* mites. The results showed that citronella oil from Argentina is a compound that has been identified to control *V. destructor* mites because of its high toxicity.

Cluster 5 is shown in purple. The largest purple circle with the term article has 147 links, 1428 total link strengths, and 95 occurrences. Articles are the most frequently occurring term in this cluster. This shows that publications about citronella oil are mostly in the form of articles.

#### 4. Conclusion

Based on a bibliometric analysis of citronella oil for 96 years (1927-2023), publications on citronella oil show progress. IOP Conference Series Earth and Environmental Science is the most source title out of the top 10 source titles. Indonesia is the most productive country in publishing citronella oil publications. IPB University and Institut Teknologi Sepuluh Nopember have been the most productive institutions in the last 96 years. VOSviewer analysis reveals that there is a close relationship between one network and another. This shows that essential oils, citronella oil, citronella, and insect repellent are interesting topics and still have many opportunities to be published.

#### 5. Future Direction

The high number of cases of dengue fever resulting in death makes citronella oil important to the topic of the publication. Citronella oil is proven to be a mosquito repellent and an insect repellent because of the main content of citronella. Because citronella oil has a wide range of benefits, citronella oil research must continue to be developed for more innovative publications and effectively involved in health promotion.

#### 6. Conflicts of Interest

The authors declare that there is no conflict of interest.

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