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A Mini Bibliometric Analysis of Research on Vetiver Oil from 1961 to 2022

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Abstract

Essential oils are volatile liquids derived from aromatic plant extracts. One of the essential oils that are an export commodity in Indonesia is vetiver oil. Over the past 61 years, the development of vetiver oil has not occurred significantly. This article presents vetiver oil research around the world using bibliometric analysis published from 1961 to 2022. The Scopus database found 175 publications related to vetiver oil. For 61 years, the country with the most publications was India, and the institution that contributed the most publications was Punjab Agricultural University. The author's co-authorship mapping and network keyword co-occurrence were analyzed using VOSviewer software. The most common vetiver oil research topics include vetiver oil, essential oil, vegetable oil, unclassified drugs, vetiveria, and *Vetiveria zizanioides*. This article describes the overall current global vetiver oil research that can help steer equally relevant studies forward.

Keywords: Vetiveria zizanioides (L.) Nash; bibliometric analysis; scientific mapping; VOSviewer

1. Introduction

Essential oils are volatile liquids derived from the extraction of aromatic plants such as flowers, bark, roots, leaves, and so on. Aromatic plants contain 1-2% essential oils [1]. In recent years, there has been a growing trend in the research of essential oils due to their multifunctional properties in addition to being a secondary substance. It has been confirmed that essential oils can be used as an anti-inflationary, antibacterial, antifungal, and antioxidant. This is because of its composition of terpenes/terpenoids, aromatic and aliphatic compounds [1].

Currently, Indonesia is one of the essential oils-producing countries and there are 45 types of essential oil-producing plants currently in existence. About 15 types have become export commodities, one of which is vetiver oil [2]. The market price of Indonesian vetiver oil is 58 - 60 US $ per kg which is much lower than Haiti (US $ 93 per kg) and Brazil (US $ 85 per kg) [2]. The low price of vetiver oil in Indonesia is due to the low yield of oil produced during the conventional extraction process.

Vetiver oil (*Vetiveria zizanioides* (L.) Nash) has become the most important raw material in fragrance ingredients [3]. This oil is used in aromatherapy because of its sedative properties. There are more than 150 sesquiterpenoid constituents with 3 main components, namely sesquiterpene alpha-vetivone, beta-vetivone, and khusimol [4]. However, different methods of growing vetiver can significantly affect its composition [4].

Therefore, to review various studies on vetiver oil, bibliometric analysis is used. Blioblimetric analysis is a quantitative technique that reviews in terms of adding data, statistics, and mathematics to display trends in certain research areas [5]. This technique is popular and applied to various studies. This includes the use of bibliometric data in sustainable oil and gas production research [6] and rapeseed research (*Brassica napus* L.) [7]. This method could make for an interesting path to develop further research.

Therefore, in vetiver oil research studies, articles available from 1961 to 2022 were used to investigate progress toward where trends will develop in the future. To the authors' knowledge, there is still no bibliometric analysis that has been reported recently on vetiver oil studies.

2. Database and Methodology

The data used in this research review were obtained from co-occurrence analysis (Figure 1). Co-occurrence analysis is a bibliometric analysis method to examine the co-occurrence of keywords in documents. The Scopus database was used with keywords (TITLE-ABS-KEY("Vetiver Oil")) in the interval 1961 to 2022. By maintaining several types of documents, namely articles, short surveys, reviews, book chapters, conferences, letters, and notes, 175 documents were obtained. The profile of the document was analyzed using Microsoft Office Excel 2016. Network co-outsourcing and keyword analysis were visualized using VOSviewer (Version 1.6.18).

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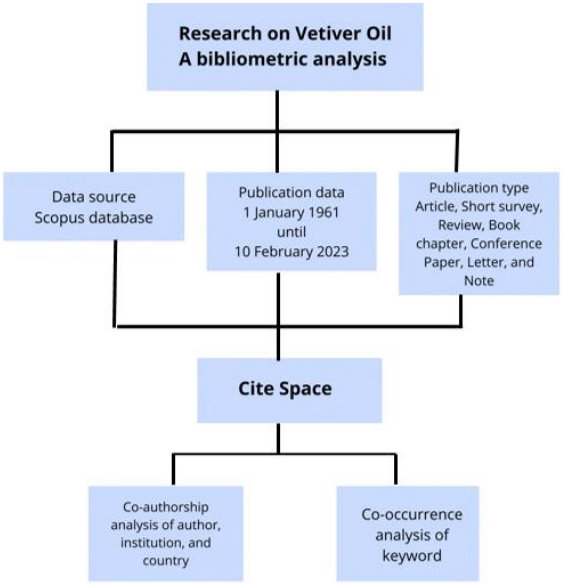

Figure 1. Major steps of the research

3. Results and Discussion

3.1. Publication Trends

In this study, the scope of the journal was limited by the publication time from 1961 to 2022 which is based on the Scopus database. A total of 175 vetiver oil journals have been published over the past 61 years. Figure 2 shows the number of vetiver oil publications from year to year. It can be seen that for 61 years, very few journals were published and in some years, it seems that there was only 1 journal publication related to vetiver oil. In 2006, the highest number of journals, (10) were published relating to vetiver oil. The publication trend shows that there was little interest in vetiver oil research. This could have caused a setback in research on vetiver oil in the future.

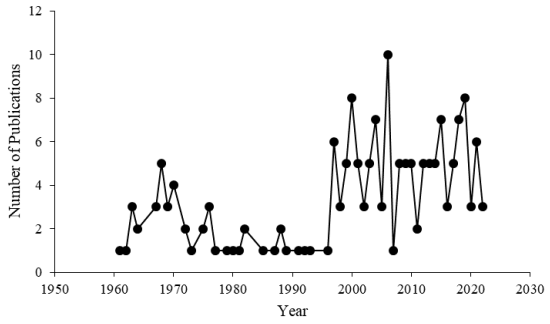

Figure 2. Annual publication of vetiver oil research

3.2. Subject area of vetiver oil publications

Nineteen (19) subject areas characterize the publication of vetiver oil in the year range 1961-2022. Table 1 shows that Chemistry ranked first with a total of 81 publications (46.29%). In second place, Agricultural and Biological Sciences accounted for a total of 68 publications (38.86%). In third place, Biochemistry, Genetics, and Molecular Biology accounted for a total publication of 57 (32.57%). For some other subject areas, there were only a few publications. Thus Chemistry has a close relationship with vetiver oil.

Table 1. The subject area that is most often found in documents with keywords (TITLE-ABS-KEY("Vetiver Oil")) in the interval 19961 to 2022

Rank	Subject Area	Number of Documents	Percentage (%)
1	Chemistry	81	46.29
2	Agricultural and Biological Sciences	68	38.86
3	Biochemistry, Genetics and Molecular Biology	57	32.57
4	Pharmacology, Toxicology and Pharmaceutics	45	25.71
5	Chemical Engineering	24	13.71
6	Medicine	21	12.00
7	Environmental Science	12	6.86
8	Engineering	11	6.29
9	Materials Science	6	3.43
10	Immunology and Microbiology	5	2.86
11	Earth and Planetary Sciences	3	1.71
12	Neuroscience	3	1.71
13	Veterinary	2	1.14
14	Dentistry	1	0.57
15	Economics, Econometrics and Finance	1	0.57
16	Mathematics	1	0.57
17	Physics and Astronomy	1	0.57
18	Social Sciences	1	0.57
19	Undefined	1	0.57

3.3. Country productivity on the publication of vetiver oil

In the last 61 years, there have been 175 publications with the keyword "Vetiver Oil". Thus, there are only a few countries around the world that contribute to the publications in this area. Based on the Scopus database, the author has presented the top 15 countries in publication contributions as seen in Figure 3. In Figure 3, it can be seen that India is the most productive country in this area with 35 publications. This was followed by several countries such as the United States with 31 publications, France with 13 publications, and so on. India is the most published country due to being the largest in the vetiver cultivation sector in the world [8]. In addition, vetiver plants in India can increase household income in Bihar's Madhepura District [9].

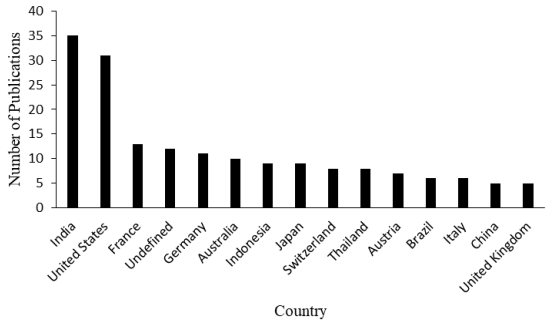

Figure 3. Countries/regions with the most published documents with keywords (TITLE-ABS-KEY("Vetiver Oil")) in the interval 19961 to 2022

3.4. Most publications of vetiver oil

Table 2 shows the 20 research institutes (institutions) that published the most documents related to vetiver oil. The institution with the most publications is Punjab Agricultural University from India with 12 publications. This was followed by Technische Universität Berlin from Germany and LSU Agricultural Center from the United States with 9 publications, Louisiana State University, United States, and National Chemical Laboratory, India with 8 publications.

Table 2. The institution that publishes the most documents with keywords (TITLE-ABS-KEY("Vetiver Oil")) in the interval 19961 to 2022

No	Institution	Number of Documents	Country
1	Punjab Agricultural University	12	India
2	Technische Universität Berlin	9	Germany
3	LSU Agricultural Center	9	United States
4	Louisiana State University	8	United States
5	National Chemical Laboratory India	8	India
6	Universität Wien	7	Austria
7	Central Institute of Medicinal and Aromatic Plants India	6	India
8	Tohoku University	5	Japan
9	Givaudan Schweiz AG, Dübendorf	5	Swiss
10	Université Côte d'Azur	5	France
11	Institut de Chimie de Nice	5	France
12	Universidade Estadual de Campinas	4	Brazil
13	Veticon Consulting and International Vetiver Network	3	Australia
14	USDA ARS Beltsville Agricultural Research Center	3	United States
15	USDA Agricultural Research Service	3	United States
16	CNRS Centre National de la Recherche Scientifique	3	France
17	École Nationale Supérieure de Chimie de Paris	3	France
18	Mahidol University	3	Thailand
19	Consiglio Nazionale delle Ricerche	3	Italy
20	Kasetsart University	3	Thailand

3.5. Analysis of the terms' occurrences

The research trends of co-occurrence analysis was demonstrated using a network map of co-occurrences of at least 15 more occurrences. In total, there were 1680 keywords relating to vetiver oil. The keyword network map was generated with the help of the VOSviewer application. The map is shown in Figure 4. The size of the circle or vertices of a term is proportional to the number of terms in the article. Five (5) clusters with 92 items, 2077 links, and a total link strength of 5849 represented identifiable research themes in the network. Keywords such as vetiver oil, essential oil, vegetable oil, unclassified drug, vetiveria, and *vetiveria zizanioides* were the most used keywords. These keywords are very closely related to vetiver oil.

Cluster 1 in the network map is indicated by a red circle. There are 83 links, a total link strength of 417, and 41 occurrences with vetiveria items. It can be seen from the branching of red color related to chemical composition and chemical structure. Chemical composition and chemical structure are some areas that can be researched to increase the benefits of vetiver oil. Furthermore, in the red circle, it is known that vetiver plants can be extracted to obtain oil using the distillation process [10]. Fragrant root crops can be distilled for 12 hours to extract 96.9% of the total oil. Dried fragrant root crops can produce a yield of (0.15-0.29%) essential oils [10]. One of the applications of vetiver oil seen in the red circles is as a perfume. The export commodity of vetiver oil perfume in some regions is very large to be able to alleviate poverty.

Cluster 2 in the network map is shown with a green circle. There are 75 links, a total link strength of 311, and 24 occurrences with vegetable oil items. From the green circle, it can be seen that some branching refers to the word 'animals'. Vetiver oil has major constituents of 8 oils such as eucalyptol, citronellal, citral, citronellol, citronellol, cinnamaldehyde, eugenol, thujopsene, and α- and β-vetivone [11]. These constituents can be used in formulating insecticides. Vetiver oil is very promising for use in reducing termite populations in the soil [12–14]. Furthermore, five constituents (terpinen-4-ol, α-terpineol, valencene, vetiverol, and vetivone) were characterized as capable of being used as protection against *Aedes aegypti*, *Aedes*

albopictus and *Culex quinquefasciatus* mosquitoes [15,16]. If used, vetiver oil does not cause toxicity [15].

Cluster 3 in the network map is shown with a blue circle. There are 90 links, a total link strength of 651, and 67 occurrences with essential oil items. From the blue circle, it can be seen that vetiver oil is included in the essential oil category. Some lines refer to the keyword 'human'. Vetiver oil has a close relationship with human activities as an antimicrobial [17,18], mosquito repellent [15,16], and prevention of fly attacks [19].

Cluster 4 in the network map is indicated by a yellow circle. There are 72 links, a total link strength of 259, and 20 occurrences with oils, and volatile items. From the yellow circle, it can be seen that vetiver oil is associated with oils and volatiles. Based on research conducted by Pripdeevech et al. [20], vetiver oil contains a complex of more than 200 components. The content was evaluated using GC-MS analysis. The volatile constituents in each vetiver oil sample were determined using the peak volume normalization method. There were 64 volatile constituents that could be identified [20].

Cluster 5 in the network map is shown with a purple circle. There are 89 links, a total link strength of 649, and 58 occurrences with article items. From the purple circle, it is known that most vetiver oil publications are in the form of articles. One of the networks refers to the keyword antioxidant. The research by David et al. [21], evaluated the antioxidant activity of vetiver oil. The evaluation was conducted with the DPPH free radical scavenging assay. Antioxidant activity in crude vetiver oil was identified by the presence of β-vetivenene, β-vetivone, and α-vetivone. In addition, there were several potential natural antioxidants [22,23].

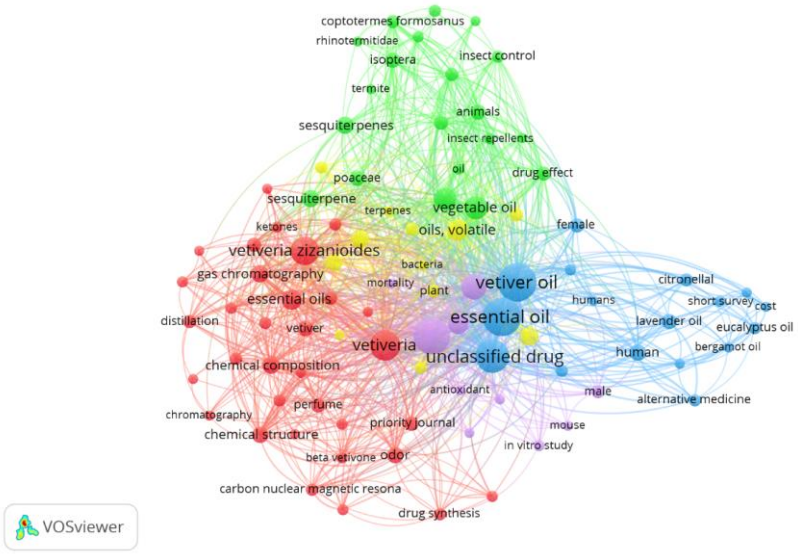

Figure 4. Visualization of keyword networks using VOSviewer

3.6. Analysis of the terms' occurrences

There were 473 authors identified from the 175 documents published from 1961 to 2022. Some authors were removed by fractional calculations. The authors who are in a cluster usually work in teams. In vetiver oil research, three author clusters can be identified (Figure 5). For example, in the blue group, Chauhan, K.R. is one of the authors of the article entitled "Activity of vetiver extracts and essential oils against Meloidogyne incognita" with the help of several other researchers [24,25]. However, there are occasions where some clusters do not have chains that are interconnected or far apart from each other. It tends to be less cooperative and less related [7].

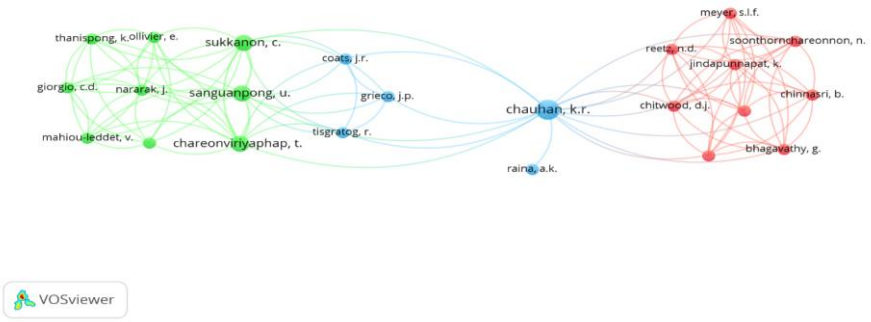

Figure 5. Visualization of author collaboration networks using VOSviewer

4. Conclusions

This study presents a bibliometric review of vetiver oil academic research over the period 1961 to 2022. The data used for the analysis was obtained from the Scopus database, which has been widely recognized by researchers for providing standardized and high-quality information. A total of 175 documents from 32 countries/regions around the world were collected and analyzed. The results show that there has been very little interest in vetiver oil publications over the past 61 years. Based on the number of publications, India is the largest contributor to publications, followed by the United States. In addition, the institution with the most contributors to publications is in India, namely Punjab Agricultural University. This work is useful for understanding research trends on vetiver oil and provides support for further research. However, some limitations were found in this study. Publications indexed in other databases may not be considered. Furthermore, some publications on vetiver oil are excluded using the specified search query.

5. Conflicts of Interest

The authors declare that there is no conflict of interest.

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