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Revealing Therapeutic Potential of Virgin Coconut Oil through Scientific Mapping during 2004–2024 with Bibliometric Analysis Using VOSviewer and Biblioshiny R Package

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Abstract

This study aimed to identify keywords, countries/regions, institutions, publications, authors, and journals associated with the diverse therapeutic properties of VCO.Virgin Coconut Oil (VCO) serves as a safe herbal anti-inflammatory agent derived from natural constituents. The antioxidant properties of VCO can inhibit inflammation by averting cellular damage and obstructing the oxidative processes that generate free radicals.Using extensive bibliometric analysis, data and related information extracted from the Scopus database were subjected to bibliometric analysis using VOSviewer and the Biblioshiny R Package.A total of 323 Scopus articles satisfied the requirements for analysis. The findings indicated that the most substantial growth in the study transpired in 2013. Indonesia emerged as the most prolific nation in this research domain, with Silalahi, J., and Fumarewa, A. C. being the foremost contributors to the publication of research articles. The highest number of journal citations, totaling 227, was garnered by Mariana A.M., Che Man Y.B., and Amin. I.The bibliometric data further demonstrates potential therapeutic effects of VCO, encompassing antioxidant, antibacterial, and anti-inflammatory properties that may inform future study in this domain.

Keywords: Bibliometric Analysis; VOSviewer; Biblioshiny; VCO.

1. Introduction

Traditional herbal therapy has been integral to Indonesian culture for centuries. A multitude of researchers in Indonesia concentrate on the investigation of diverse advantageous flora [1]. The utilization of green coconut for the manufacture of Virgin Coconut Oil (VCO) exemplifies this practice. Oxidative stress has numerous health implications as it manifests in the human body[2] [3].

Oxidative stress is the primary cause of numerous degenerative illnesses. Furthermore, oxidative stress and aging exert a significant causal influence. The lifestyle and consumption of instant or fast food enhance the formation of oxidative stress. These traits are strongly associated with the incidence of obesity. Obesity is a major global risk factor for chronic liver disease, associated with free radicals from air pollution. Consequently, autonomous generation and externally sourced free radicals can both jeopardize human health. Another discovery indicates a high correlation between oxidative stress and elevated levels of inflammatory agents, including cytokines and interleukins [4] [6].

Antioxidant activity of VCO has primarily been investigated in animal models. In an osteoporosis rat study, it was observed that VCO can impede the process of lipid peroxidation and augment the production of antioxidant enzymes, particularly Glutathione peroxidase (GPx) and Superoxide dismutase (SOD), within the rat's physiology. Another benefit of VCO is its effectiveness as an anti-inflammatory, analgesic, and antipyretic agent. Virgin coconut oil (VCO) can be incorporated as an anti-infective agent and to enhance antioxidant synthesis, thereby fortifying the immune system [7][8].

Despite the numerous prospective advantages of VCO, additional proof concerning its efficacy and safety remains necessary. Additional research is required to ascertain the ideal type and quantity for the control of VCO utilization. Comprehensive investigation is required to ascertain the progression of research concerning the medicinal applications of VCO. A bibliometric analysis offers a comprehensive overview and mapping of the possible sustainability of this subject [9] [10].

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Bibliometric analysis frequently use statistical and mathematical techniques to statistically and qualitatively assess various knowledge sources, such as journal articles. This is a crucial and verified approach for identifying contemporary research, potential partners, categorizing dominant themes, delineating emerging patterns, and establishing future boundaries [11] [12]. This method can also assess the influence and efficacy of research about the possible therapeutic effects of VCOs. This method may discern the most notable authors, institutions, countries, journals, as well as the most cited research articles, themes, and global collaborations. This information is essential for assessing the current level of research, pinpointing gaps and possibilities, and guiding future paths. Moreover, bibliometric analysis is employed to monitor temporal patterns, assisting researchers in remaining informed about recent advancements in their discipline [13] [14].

This study aims to contextualize and review information on the potential therapeutic effects of VCO. The studied aspects encompass keywords or co-occurrence, country/region, publication count, institution, author, and journal. Bibliometric and visual studies were performed to create a detailed knowledge map regarding the potential therapeutic properties of VCO, including its antioxidant, antibacterial, and anti-inflammatory activity. The data were utilized to pinpoint prospective areas for more research.

1. Results and Discussion

2.1 Analysis of Global Publication Trends

Figure 1: Trends in research regarding potential activity of VCO as a therapeutic, indicated by the annual publication count

The global proliferation of scientific articles about VCO activity in therapeutics has increased from 2004 to 2022, as illustrated in **Fig. 1**. The annual publication count is on the rise, with the most significant increases noted in 2008-2009 (150.00%), 2013-2014 (142.86%), and 2011-2012 (133.33%). This signifies a growing global interest in VCO research about its potential therapeutic properties, particularly as antioxidants, antibacterials, and anti-inflammatories [15].

2.2 Fundamental journal examination on the potential activity of VCO for therapeutic applications

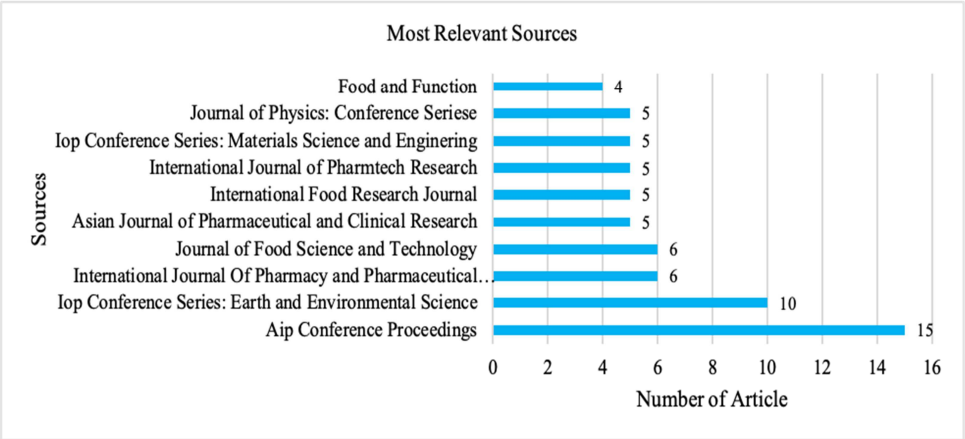

Figure 2: Top ten journals with the most publications on VCO as a therapeutic

Fig. 2 illustrates the ten foremost peer-reviewed publications that have disseminated the greatest quantity of articles in the field of VCO for therapeutic purposes during the past 21 years. The top three journals are IOP Conference Series: AIP Conference Proceedings (H index 83), IOP Conference Series: Earth and Environmental Science (H index 43), and International Journal of Pharmacy and Pharmaceutical Sciences (H index 58). This proves these journals are top scientific journals worldwide [16].

2.3 The most productive authors in the publication on the potential activity of VCO as a medicinal

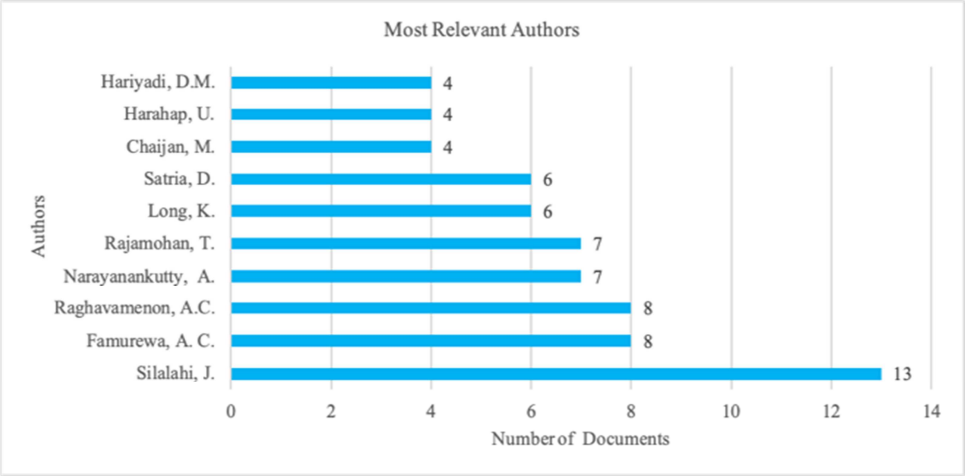

Figure 3: Top ten contributing authors in the field of research on VCO therapeutic potential activity worldwide and the number of their published paper

Fig. 3 shows the top ten Scopus journal contributors to VCO papers on its therapeutic potential. Silalahi, J. has authored articles in thirteen publications, rendering this individual the most prolific on the list. Raghavamenon, A. C., and Famurewa, A. C., each own eight publications, followed by Narayanankutty, A., and Rajamohan, T., with seven publications apiece. Long, K., and Satria, D., have six publications each, while Chaijan, M., Harahap, U., and Hariyadi, D. M., each have four publications. All writers have made substantial contributions to the fields of potential activity of VCO as a therapeutic. The 10 most valuable publications by citation weight are listed in **Table 1** [17].

Table 1: Top ten most valuable publications by citation weight

Rank	Authors	Title	Year	Journal	Cited by	Reference
1	Mariana A.M.; Che Man Y.B.; Amin. I.	Virgin coconut oil: emerging functional food oil	2009	Trends in Food Science & Technology	227	[18]
2	Nevin K.G; Rajamohan. R.	Virgin coconut oil supplemented diet increases the antioxidant status in rats	2006	Food Chemistry	211	[19]
3	Mariana A.M; Che man. Y.B; Nazimah S. A. H; et al.	Antioxidant capacity and phenolic acids of virgin coconut oil	2009	International Journal of Food Sciences and Nutrition	206	[20]
4	Intahphuak S; Khonsung P; Panthong A.	Anti-inflammatory, analgesic, and antipyretic activities of virgin coconut oil	2010	Pharmaceutical Biology	145	[21]
5	Verallo-Rowell V. M; Dillague K. M; Yah- Tjundawan B. S.	Novel antibacterial and emollient effects of coconut and virgin olive oils in adult atopic dermatitis	2008	Derm	136	[22]
6	Khaw, K. T.; Sharp, S. J.; Finikarides L.; et al.	Randomised trial of coconut oil, olive oil or butter on blood lipids and other cardiovascular risk factors in healthy men and women	2018	BMJ Open	133	[23]
7	Shilling M.; Matt	Antimicrobial effects of virgin	2013	Journal of	110	[24]

	L.; Rubin E.; et al.	coconut oil and its medium-chain fatty acids on Clostridium difficile		medicinal food		
8	Nevin K. G.; Rajamohan T.	Effect of topical application of virgin coconut oil on skin components and antioxidant status during dermal wound healing in young rats	2010	Skin pharmacology and physiology	110	[25]
9	Ghani N. A. A.; Channip A. A.; ChokHwee Hwa P.; et al.	Physicochemical properties, antioxidant capacities, and metal contents of virgin coconut oil produced by wet and dry processes	2018	Food science & nutrition	105	[26]
10	Seneviratne K. N.; HapuarachchI C. D.; Ekanayake S.	Comparison of the phenolic-dependent antioxidant properties of coconut oil extracted under cold and hot conditions	2009	Food Chemistry	102	[27]

2.4 Top fifteen author countries by number of publications on potential therapeutic activity of VCO

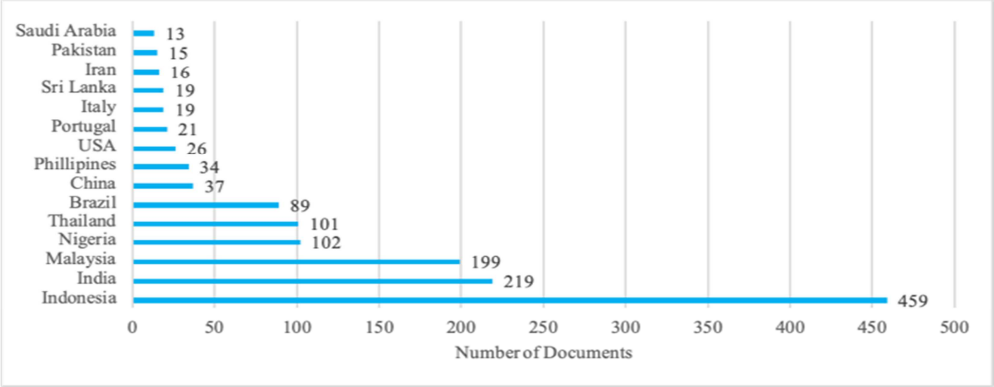

Figure 4: Top fifteen countries in the area of research on potential activity of VCO as a therapeutic

Figure 4: displays the top fifteen countries ranked by the number of publications in the domain of potential activity VCO. Indonesia produced the highest number of articles concerning the therapeutic potential of VCO, totaling 456 publications (31.10%), followed by India with 219 publications (14.84%), Malaysia with 199 publications (13.48%), Nigeria with 102 publications (6.91%), Thailand with 101 publications (6.84%), Brazil with 89 publications (6.03%), and Saudi Arabia in 15th place with 13 publications (0.89%).

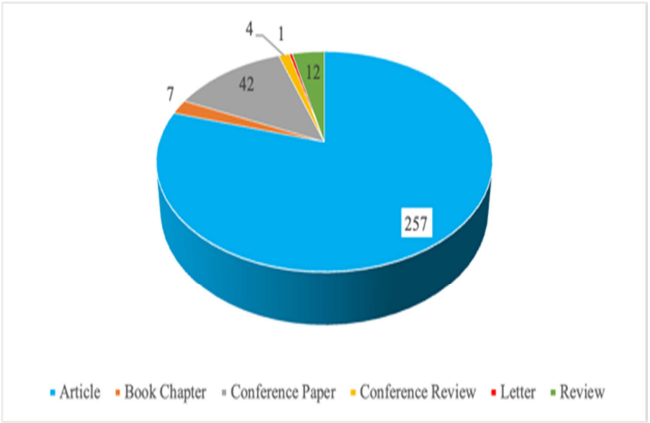

Figure 5: Type of documents that published in potential activity of VCO as a medicinal therapeutic

According to the publication type, the majority are journal articles, totaling 257 documents (79.57%), followed by conference papers (42 documents, 13.00%), reviews (12 documents, 3.72%),book chapters (7 documents, 2.17%), conference reviews (4 documents, 1.24%), and letters (1 document, 0.31%), as illustrated in Fig. 5.

2.5 International collaboration corresponding authors country for research on the therapeutic potential activity of VCO

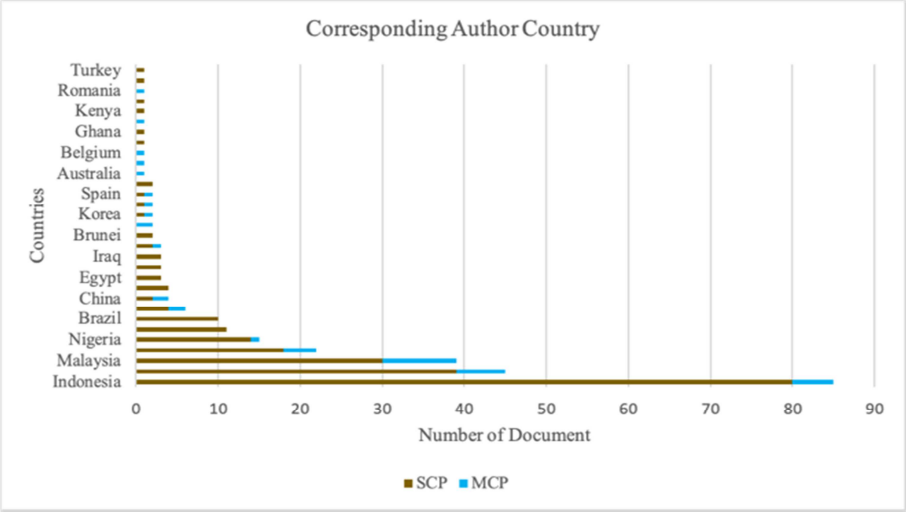

Figure 6: Collaborative research between authors countries with research results for potential publication of VCO activity as a therapeutic

Information:
SCP : Single Country Publication
MCP : Multiple Country Publication

2.6 Network visualization of co-occurrence

VOSviewer visualized keywords related to VCO therapeutic potential. The visualization shows keywords as circles by default, see Fig. 7. The size of each circle reflects the frequency and importance of the keyword. The terms "Virgin coconut oil" (117 occurrences) and "Activity" (97 occurrences) surfaced as the predominant research subjects owing to their elevated frequency. Colors are designated to each circle to enhance clarity according to their corresponding clusters [28].

The results were produced from keyword frequencies using VOSviewer-analyzed bibliographic data [29]. Minimum keyword occurrence was five. The search produced 8,129 terms, although only 214 satisfied the inclusion criterion. Upon assessing the results, four groupings, distinguished by various colors, were established as research trends concerning Virgin coconut oil and its activity. The keyword "Virgin coconut oil and activity" dominates cluster 1 and the network.

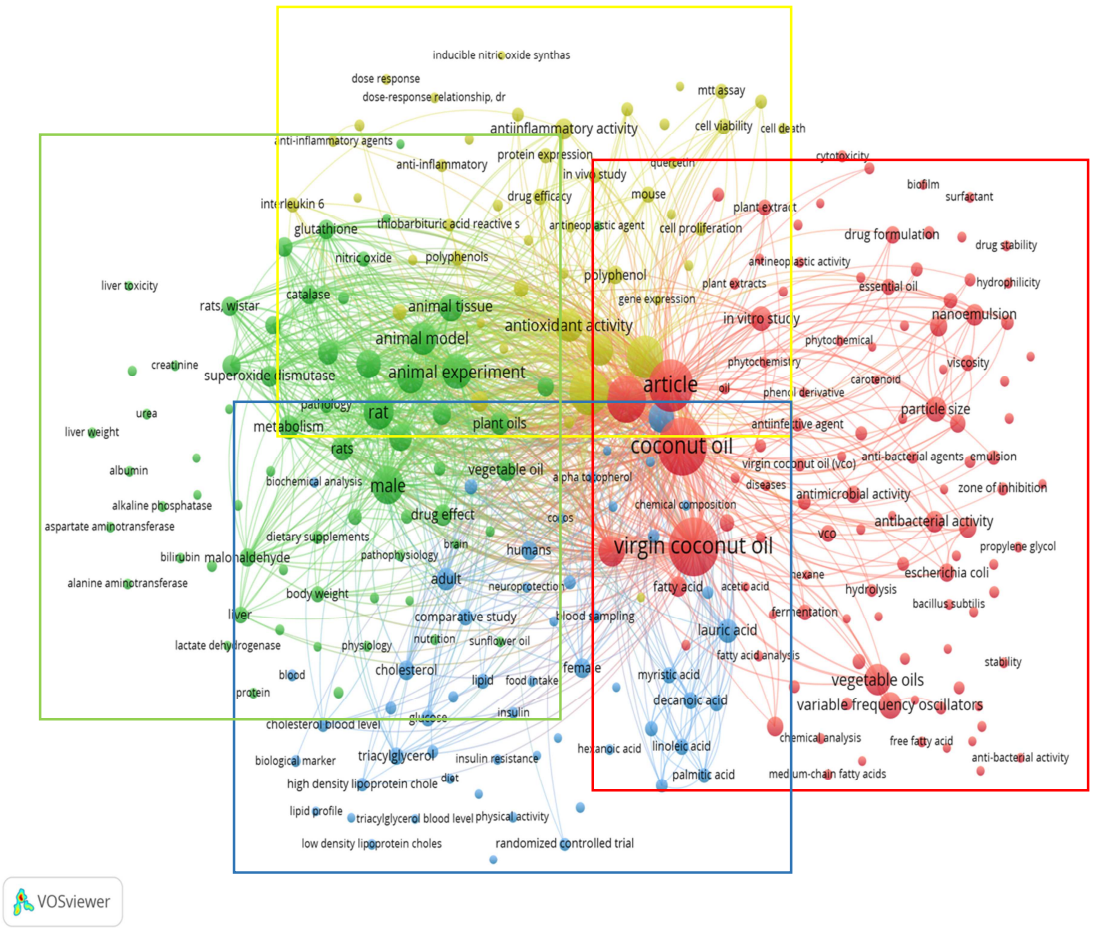

Figure 7: Network visualization of virgin coconut oil for activity therapeutic publication co-occurrence map using VOSviewer

Fig. 7. illustrates the network representation of the four clusters and their interrelationships among the examined regions [30]. Each cluster comprises numerous terms exhibiting significant concordance within the map structure. Numerous high-frequency keywords signify research subjects previously explored within each cluster. Four clusters exhibiting the highest frequency of recurrence in the corresponding terms were determined. The initial cluster comprises the subsequent terms: The first cluster included virgin coconut oil (184), coconut oil (173), and an article (145), whereas the second cluster comprised man (75), animal experiment (68), and rat (66). The third cluster comprises Human (47), lauric acid (31), and αadult (28). The fourth cluster comprises Controlled study (112), unclassified drug (95), and antioxidant activity (58). Comprehensive information pertaining to the cluster analysis outcomes is recorded in **Table 2.**

Table 2: Result of cluster analysis

Cluster	Most frequent keyword	Keywords
Red (107)	Virgin coconut oil (184), Coconut oil (173), Article (145)	Nonhuman (110), antioxidants (53), vegetable oils (52), variable frequency oscillators (38), in vitro study (33), particle size (32), nanoemulsion (26), antibacterial activity (25), staphylococcus aureus (23), fatty acid (22), Zeta potential (22), fatty acids (20), ph (18), eschericia coli (18), antimicrobial activity (17),

Cluster	Most frequent keyword	Keywords
		vco (17), drug information (16), olive oil (16), plant extract (15), viscocity (14), essential oil (14), dispersity (14), fermentation (14), polysorbate 80 (13), emulsion (12), extraction (12), palm oil (12), antiinfective agent (11), drug delivery system (10), antibacterial (10).
Green (66)	Male ((75), animal experiment (68), rat (66)	Animal model (55), animals (52), animal (45), animal tissue (42), oxidative stress (37), rats (32), metabolism (31), lipid peroxidation (30), plant oil (26), priority journal (26), vegetable oil (26), superoxide dismutase (25), drug effect (24), wistar rat (24), glutathione (21), hispathology (21), catalase (20), chemistry (20), rats, wistar (19), glutathione peroxidase (18), liver (16), diet supplementation (15), body weight (14), nitric oxide (13), pathology (13), dietary supplement (11), dietary supplements (10).
Blue (54)	Human (47), lauric acid (31), adult (28)	Female (21), cholesterol (20), humans (20), comparative study (16), decanoic acid (16), triacylglycerol (16), linoleic acid (15), glucose (14), myristic acid (14), octanoic acid (14), palmitic acid (13), coconut (12), lipid (12), oleic acid (12), lipid composition (11), blood sampling (10), cholesterol blood level (10).
Yellow (49)	Coltrolled study (112), unclassifield drug (95), antioxidant activity (58)	Antioxidant (52), anti-inflammatory activity (24), enzyme activity (22), polyphenol (19), animal cell (16), maouse (15), cell viability (14), drug efficacy (14), inflammation (14), in vivo study (13), interleukin 6 (12), mtt assay (12), polyphenols (12), protein expression (12), cell proliferation (11), human cell (11), tumor necrosis factor (11), mice (10).

Virgin coconut oil (VCO) has attracted considerable scientific research interest over the past twenty years due to its antioxidant, antibacterial, anti-inflammatory, and hypolipidemic qualities. Preclinical and clinical studies indicate that polyphenol-rich VCO formulations can elevate the functional levels of high-density lipoprotein (HDL) in both healthy individuals and those with cardiovascular conditions [31-34].

Virgin coconut oil contains several medium-chain triglycerides. Long-chain triglycerides are harder to digest and absorb than coconut oil, which is rich in medium-chain triglycerides [35-37]. Weight loss and metabolic syndrome reduction are possible because medium-chain triglycerides easily pass the mitochondrial membrane and accelerate liver metabolism. Coconut oil's lauric acid and polyphenols have antioxidant and anti-inflammatory properties that slow atherosclerosis progression and suppress platelet aggregation, preventing cardiovascular diseases[38-40].

In rats, VCO inhibits fat peroxidation and increases antioxidant enzyme production, particularly GPx and SOD. VCO also has anti-inflammatory, analgesic, and antipyretic properties. Antibacterial and antioxidant-boosting virgin coconut oil (VCO) boosts immunity [41-43].

VCO comprises lauric acid and its esters, which are generated during digestion and exhibit antibacterial and antiviral properties. Coconut oil exhibits antimicrobial properties in vitro and shows increased antibacterial effectiveness following absorption and metabolism in the body, leading to the production of monoglycerides and free fatty acids. The most potent compounds found were lauric acid and monolaurin, with their minimal bactericidal concentrations against Staphylococcus aureus recorded [44-46].

The principal limitation of this bibliometric study was the dependence on a single database. As a result, certain relevant studies on the potential therapeutic efficacy of VCO may have been excluded. Scopus was chosen over other medical databases for its extensive content coverage and advanced search analytics. Searching various medical databases simultaneously may improve literature results. Despite these limitations, the results provide light on VCO possible therapeutic effects and pave the way for further research.

3. Experimental

3.1 Data Resource Strategy

Bibliometric data was obtained from the Scopus database on September 12, 2024. Scopus is a highly comprehensive database for validated abstracts and citations, serving as a bibliometric data source. Perform a search for certain subjects with the title, abstract, or keywords: “Activity” AND ‘Virgin coconut oil. We retrieve 323 papers from 2004 to 2024 were acquired and

incorporated into the final data analysis. The VOSviewer software and Biblioshiny R Package were employed to map and illustrate the outcomes. A network visualization map depicting the most prevalent terms was generated. Ethical approval was unnecessary as this study did not involve human subjects or animal models [47, 48].

3.2 Data Analysis

Comprehensive publication records were exported to VOSviewer version 1.6.20 and Biblioshiny for sophisticated bibliometric visualization analysis. This study employed the VOSviewer, Biblioshiny R Package to graphically assess co-occurrence patterns, with circles representing the distribution of country and author keywords. The distance between two circles signifies the extent of connection between concepts, with increased distance denoting a weaker association. The graph employs various colors to denote unique clusters of phrases, with circle sizes positively correlating to term frequency.The thickness of the line indicates the strength of the relationship between the phrases. An increase in circle diameter correlates with a rise in phrase frequency.The data obtained from the Scopus database via the results menu was evaluated to clarify research growth trends, identify the most prolific authors, determine the nations with the highest volume and types of publications, and assess the most cited journals. Patterns of research were displayed and evaluated using downloaded article data in CSV format using VOSviewer and in RIS format through the Biblioshiny R Package, enabling the generation of keyword maps based on common networks [49, 50].

4. Conclusion

A bibliometric study of 323 Scopus papers examined VCO research trends on its therapeutic potential. This analysis aims to identify the most prolific nations, journals, authors, research collaborations among countries, and potential future topics in this research arena. According to the statistics, 2013 had the most substantial rise, with Indonesia identified as the most productive nation. Furthermore, Silalahi, J. and Famurewa, A. C. produced the most research, while Mariana A.M., Che Man, Y.B., and Amin. I. garnered the highest number of journal citations, totaling 227. The mechanism via which VCO influences antioxidant, antimicrobial, and anti-inflammatory properties necessitates additional exploration in the future. These bibliometric results provide a foundation for future research, primarily concentrating on essential domains of VCO possible therapeutic effects, including antioxidant, antibacterial, and anti-inflammatory properties. This will facilitate the advancement of VCO and promote their extensive application.

5. Conflicts of interest

The author has disclosed no conflicts of interest. The manuscript's contents have been reviewed by all co-authors, who concur with its contents and have no financial interests to disclose. We attest that the submission is our original work and isn't being considered for publication in others publisher.

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8. References

[1]. T. S. Leyane, S.W. Jere, N. N, Houreld, “Oxidative stress in ageing and chronic degenerative pathologies: molecular mechanisms involved in counteracting oxidative stress and chronic inflammation,” International journal of molecular sciences., *23*(13), 7273, 2022, doi: 10.3390/ijms23137273.

[2]. A. Zhu, F. Zheng, W. Zhang., *et al*, “Oxidation and antioxidation of natural products in the model organism Caenorhabditis elegans,” Antioxidants., *11*(4), 705, 2022, doi: 10.3390/antiox11040705.

[3]. A. Menzel, H. Samouda, F. Dohet, *et al.,* “Common and novel markers for measuring inflammation and oxidative stress ex vivo in research and clinical practice—which to use regarding disease outcomes?,” Antioxidants., 10(3), 414, 2021, doi; 10.3390/antiox10060865.

[4]. M. C. Zicker, C.C Montalvany-Antonucci, D. R. Lacerda, *et al*., “Protective effect of virgin coconut oil on osteopenia induced by high refined carbohydrate-containing diet in mice,” Foods., 11(18), 2800, 2022, doi: 10.3390/foods11182800.

[5]. Y. Q. Zeng, J. T. He, B. Hu, *et al*., “Virgin coconut oil: A comprehensive review of antioxidant activity and mechanisms contributed by phenolic compounds,” Critical Reviews in Food Science and Nutrition., *64*(4), 1052-1075, 2024, doi: 10.1080/10408398.2022.2113361.

[6]. F. O. Nitbani, P. J. P. Tjitda, F. Nitti, *et al*., “Antimicrobial properties of lauric acid and monolaurin in virgin coconut oil: a review.” ChemBioEng Reviews., *9*(5), 442-461, 2022, doi: 10.1002/cben.202100050.

[7]. Y. Zhao, J. Li, C. Tao, *et al*., “Research hotspots and trends of cardiopulmonary exercise test: Visualization analysis based on citespace,” Medicine in Novel Technology and Devices., 16, 100191, 2022, doi: 10.1016/j.medntd.2022.100191.

[8]. L. D. Lubis, A. T. Prananda, N. A. Juwita, *et al*., “Unveiling antioxidant capacity of standardized chitosan-tripolyphosphate microcapsules containing polyphenol-rich extract of Portulaca oleraceae,” Heliyon., 10(8), 2024, doi: 10.1016/j.heliyon.2024.e29541.

[9]. T. Omotayo, A. Moghayedi, B. Awuzie, *et al*., "Infrastructure elements for smart campuses: A bibliometric analysis," Sustainability., *13*(14), 7960, 2021, doi: 10.3390/su13147960.
[10]. T. T Türkistanli, "Advanced learning methods in maritime education and training: A bibliometric analysis on the digitalization of education and modern trends," Computer Applications in Engineering Education., *32*(1), e22690, 2024, doi: 10.1002/cae.22690.
[11]. X. Huang, X. Liu, Y. Shang, *et al*., "Current trends in research on bone regeneration: a bibliometric analysis," BioMed Research International., (1), 8787394, 2020, doi: 10.1155/2020/8787394.
[12]. D. K. Sari, D. H. Wardhani, & S. Sumardiono, "Bibliometric mapping of cellulose nanoparticle research (2013–2023) using VOSviewer," Egyptian Journal of Chemistry., 67(10), 87-96, 2024, doi: 10.21608/ejchem.2024.258587.9095.
[13]. D. Mukherjee, W. M. Lim, S. Kumar, & N. Donthu, "Guidelines for advancing theory and practice through bibliometric research," Journal of business research., 148, 101-115, 2022, doi: 10.1016/j.jbusres.2022.04.042.
[14]. O. M. Adisa, M. Masinde, J. O. Botai, & C. M. Botai, "Bibliometric analysis of methods and tools for drought monitoring and prediction in Africa," Sustainability., 12(16), 6516, 2020, doi: 10.3390/su12166516.
[15]. E. A. Allam, M. H. Darwish, N. S. Abou Khalil, S. H. A. El-Baset, M. A. El-Aal, A. Elrawy, & M. S. Sabra, "Evaluation of the therapeutic potential of novel nanoparticle formulations of glutathione and virgin coconut oil in an experimental model of carbon tetrachloride-induced liver failure," *BMC Pharmacology and Toxicology.*, *25*(1), 74, 2024, doi: 10.1186/s40360-024-00795-x.
[16]. Y. Q. Zeng, J. T. He, B. Y. Hu, W. Li, J. Deng, Q. L. Lin, & Y. Fang, "Virgin coconut oil: A comprehensive review of antioxidant activity and mechanisms contributed by phenolic compounds," *Critical Reviews in Food Science and Nutrition.*, *64*(4), 1052-1075, 2024, doi: 10.1080/10408398.2022.2113361.
[17]. A. Deen, R. Visvanathan, D. Wickramarachchi, N. Marikkar, S. Nammi, B. C. Jayawardana, & R. Liyanage, "Chemical composition and health benefits of coconut oil: an overview," *Journal of the Science of Food and Agriculture.*, *101*(6), 2182-2193, 2021, doi: 10.1002/jsfa.10870.
[18]. A. M. Marina, Y. C Man, I. Amin, "Virgin coconut oil: emerging functional food oil," *Trends in Food Science &*Technology., 20(10), 481-487, 2009, doi: 10.1016/j.tifs.2009.06.003.
[19]. K. G. Nevin, T. Rajamohan, "Virgin coconut oil supplemented diet increases the antioxidant status in rats," Food chemistry., 99(2), 260-266, 2006, doi: 10.1016/j.foodchem.2005.06.056.
[20]. A. M. Marina, Y. B. Che Man, S. A. H. Nazimah, & I. Amin, "Antioxidant capacity and phenolic acids of virgin coconut oil," International journal of food sciences and nutrition., 60(sup2), 114-123, 2009, doi: 10.1080/09637480802549127.
[21]. S. Intahphuak, P. Khonsung, A. Panthong, "Anti-inflammatory, analgesic, and antipyretic activities of virgin coconut oil," Pharmaceutical biology., 48(2), 151-157, 2010, doi: 10.3109/13880200903062614.
[22]. V. M. Verallo-Rowell, K. M. Dillague, Syah-B. S. Tjundawan, "Novel antibacterial and emollient effects of coconut and virgin olive oils in adult atopic dermatitis," DERM., 19(6), 308-315, 2008, doi: 10.2310/6620.2008.08052.
[23]. K. T. Khaw, S. J. Sharp, L. Finikarides, *et al*., "Randomised trial of coconut oil, olive oil or butter on blood lipids and other cardiovascular risk factors in healthy men and women," BMJ open., 8(3), e020167, 2018, doi: 10.1136/bmjopen-2017-020167.
[24]. M. Shilling, L. Matt, E. Rubin, *et al*., "Antimicrobial effects of virgin coconut oil and its medium-chain fatty acids on Clostridium difficile," Journal of medicinal food., 16(12), 1079-1085, 2013, doi: 10.1089/jmf.2012.0303.
[25]. K. G. Nevi, T. Rajamohan, "Effect of topical application of virgin coconut oil on skin components and antioxidant status during dermal wound healing in young rats," Skin pharmacology and physiology., 23(6), 290-297, 2010, doi: 10.1159/000313516.
[26]. N. A. A. Ghani, A. A. Channip, P. ChokHwee Hwa, *et al*., "Physicochemical properties, antioxidant capacities, and metal contents of virgin coconut oil produced by wet and dry processes," Food science & nutrition., 6(5), 1298-1306, 2018, doi: 10.1002/fsn3.671.
[27]. K. N. Seneviratne, C. D. HapuarachchI, S. Ekanayake, "Comparison of the phenolic-dependent antioxidant properties of coconut oil extracted under cold and hot conditions," Food Chemistry., 114(4), 1444-1449, 2009, doi: 10.1016/j.foodchem.2008.11.038.
[28]. S. K. Sood, N. Kumar, & M. Saini, "Scientometric analysis of literature on distributed vehicular networks: VOSViewer visualization techniques," *Artificial Intelligence Review.*, 1-33. 2021, doi: 10.1007/s10462-021-09980-4
[29]. Z. Cao, Y. Zhang, J. H. Luo, W. Q. Liao, X. Cheng, & J. H. Zhan, "A bibliometric analysis of publications on burn sepsis using VOSviewer," *Frontiers in Medicine.*, *9*, 971393, 2022, doi: 10.3389/fmed.2022.971393.
[30]. O. T. Oladinrin, M. Arif, M. Q. Rana, & L. Gyoh, L, "Interrelations between construction ethics and innovation: A bibliometric analysis using VOSviewer," *Construction Innovation.*, *23*(3), 505-523, 2023, doi: 10.1108/ci-07-2021-0130.
[31]. P. S. Beegum, S. V. Ramesh, R. Pandiselvam, M. Neema, M. R. Manikantan, & K. B. Hebbar, "Perspectives on the cardioprotective, neuroprotective and anti-obesity functions of coconut (Cocos nucifera L.)," *Food Bioscience.*, 103756, 2024, doi: 10.1016/j.fbio.2024.103756.
[32]. M. A. Shabbir, F. Mehak, M. R. Khan, W. Ahmed, M. F. Nawaz, A. Hassoun, & R. M. Aadil, "Unraveling the role of natural functional oils in modulating osteoarthritis related complications," *Critical Reviews in Food Science and Nutrition.*, *64*(20), 6881-6901, 2024, doi: 10.1080/10408398.2023.2176815.

[33]. H. Tao, R. Nan, X. Wang, "Exercise training for heart failure patients with cognitive impairment: A bibliometric analysis," Journal of Novel Physiotherapy and Physical Rehabilitation., 10(2), 029-039, 2023, doi: 10.17352/2455-5487.000102.
[34]. S. Sekhar, S. M. Ravinarayan, A. K. D. Yu, F. Kilic, R. Dhawan, R. Sidhu, & L. Mohammed, "Are we nuts over coconuts? Studying the effects of coconut oil on low-density lipoprotein and cardiovascular diseases: A systematic review," *Cureus.*, *14*(4), 2022, doi: 10.7759/cureus.24212.
[35]. L. Kindernay, K. Ferenczyová, V. Farkašová, *et al*., "Beneficial Effects of Polyphenol-Rich Food Oils in Cardiovascular Health and Disease," Reviews in Cardiovascular Medicine., 24(7), 190, 2023, doi: 10.31083/j.rcm2407190.
[36]. S. Nimbkar, M. M. Leena, J. A. Moses, *et al*., "Medium chain triglycerides (MCT): State-of-the-art on chemistry, synthesis, health benefits and applications in food industry," Comprehensive reviews in food science and food safety., 21(2), 843-867, 2022, doi: 10.1111/1541-4337.12926.
[37]. M. Tian, Y. Bai, H. Tian, et al., "The chemical composition and health-promoting benefits of vegetable oils—A review," Molecules., 28(17), 6393, 2023, doi: 10.3390/molecules28176393.
[38]. M. A. Nasution, J. Silalahi, U. Harahap, *et al*., "The anti-inflammatory activity of hydrolyzed virgin coconut oil towards RAW 264.7 cell," Journal of Research in Pharmacy., 27(2), 2023, doi: 10.29228/jrp.353.
[39]. A. C. Famurewa, C. S. Ugwu-Ejezie, E. E. Iyare, *et al*., "Hepatoprotective effect of polyphenols isolated from virgin coconut oil against sub-chronic cadmium hepatotoxicity in rats is associated with improvement in antioxidant defense system," Drug and chemical toxicology., 44(4), 418-426, 2021, doi: 10.1080/01480545.2019.1598428.
[40]. A. Rohman, Irnawati, Y. Erwanto, *et al*., "Virgin coconut oil: extraction, physicochemical properties, biological activities and its authentication analysis," Food Reviews International., 37(1), 46-66, 2021, doi: 10.1080/87559129.2019.1687515.
[41]. F. O. Nitbani, P. J. P. Tjitda, F. Nitti, *et al*., "Antimicrobial properties of lauric acid and monolaurin in virgin coconut oil: a review," ChemBioEng Reviews., 9(5), 442-461, 2022, doi: 10.1002/cben.202100050.
[42]. S. Joshi, V. Kaushik, V. Gode, *et al*., "Coconut oil and immunity: what do we really know about it so far," J. Assoc. Physicians India., 68(7), 67-72, 2020, doi: 10.1093/fqsafe/fyz004.
[43]. K. M. Hosny, N. A. Alhakamy, A. M. Sindi, *et al*., "Coconut oil nanoemulsion loaded with a statin hypolipidemic drug for management of burns: formulation and in vivo evaluation," Pharmaceutics., 12(11), 1061, 2020, doi: 10.3390/pharmaceutics12111061.
[44]. X. Luo, W. Liu, M. Zhao, *et al*., "Glycerol monolaurate beyond an emulsifier: Synthesis, in vivo fate, food quality benefits and health efficacies," Trends in Food Science & Technology., 127, 291-302, 2022, doi: 10.1016/j.tifs.2022.05.017.
[45]. S. T. Akula, A. Nagaraja, M. Ravikanth, *et al*., "Antifungal efficacy of lauric acid and caprylic acid–Derivatives of virgin coconut oil against Candida albicans," Biomedical and Biotechnology Research Journal (BBRJ)., 5(2), 229-234, 2021, doi: 10.4103/bbrj.bbrj_65_21.
[46]. E. Subroto, R. Indiarto, "Bioactive monolaurin as an antimicrobial and its potential to improve the immune system and against COVID-19: A review," Food Research., 4(6), 2355-2365, 2020, doi: 10.26656/fr.2017.4(6).324.
[47]. X. Huang, X. Liu, Y. Shang, *et al*., "Current trends in research on bone regeneration: a bibliometric analysis," BioMed Research International., (1), 8787394, 2020, doi: 10.1155/2020/8787394.
[48]. D. K. Sari, D. H. Wardhani, & S. Sumardiono, "Bibliometric mapping of cellulose nanoparticle research (2013–2023) using VOSviewer," Egyptian Journal of Chemistry., 67(10), 87-96, 2024, doi: 10.21608/ejchem.2024.258587.9095.
[49]. D. Mukherjee, W. M. Lim, S. Kumar, & N. Donthu, "Guidelines for advancing theory and practice through bibliometric research," Journal of business research., 148, 101-115, 2022, doi: 10.1016/j.jbusres.2022.04.042.
[50]. O. M. Adisa, M. Masinde, J. O. Botai, & C. M. Botai, "Bibliometric analysis of methods and tools for drought monitoring and prediction in Africa," Sustainability., 12(16), 6516, 2020, doi: 10.3390/su12166516.