



## A Scientometric Analysis of *Cannabis sativa* Research

Mina Hakimi<sup>1</sup>, Jamila Azimi<sup>1</sup>, Farzaneh Razmjou<sup>1</sup>, Mir Abdullatif Yahya<sup>1,2\*</sup>

<sup>1</sup> Women Online University, Faculty of Agriculture, Department of Agronomy, Northwood-England, United Kingdom

<sup>2</sup> Research Committee, Women Online University, Northwood, England, United Kingdom

### HIGHLIGHTS

- Scientometric analysis reveals sharp growth in *C. sativa* research post-2015.
- Medical and pharmacological uses dominate *C. sativa* research themes.
- The National Institutes of Health (NIH) and top universities lead funding and authorship in *C. sativa* studies.
- Keyword trends show rise in emerging topics like genotoxicity and epigenetics.

### Abstract

*Cannabis sativa*, a diploid plant from the Cannabaceae family, was traditionally cultivated for food, medicine, fiber, and industrial purposes. Pharmacologically, this plant is significant due to cannabinoid activity, especially in medicine, nutrition, and industry. Despite its diverse applications, *C. sativa* has faced legal challenges that have severely impeded research in the area and commercial applications. Scientometric analysis, which is the quantitative assessment of scientific literature, is the means employed in a systematic way to gather and understand how each field is moving, who is contributing more, and what subject matter emanates therefrom. This study aimed to analyze the last 24 years of global research trends on *C. sativa* using Scopus and PubMed databases. The methodology employed several advanced bibliometric analyses using VOS-viewer software. Our results show that a sharp growth has been observed in publication output, mainly after 2015 and peaking in 2024. Most studies revolved around medical, pharmacological, and neuroscientific fields. The principal authors were Raphael Mechoulam, and the institutions such as the University of Toronto and Harvard Medical School featuring strongly. The latter was also noted to provide major funds, along with The National Institutes of Health (NIH) and probably the major U.S. agencies. Nevertheless, keyword analysis revealed that dominant themes were medical cannabis, legalization, chronic pain, and cannabinoid pharmacology, while epigenotoxicity and genotoxicity came up as emerging areas. Our study concludes that *C. sativa* research becomes increasingly interdisciplinary and internationally collaborative, due to evolving legal frameworks and growing medical interest. Future research should bridge disciplinary silos, address under-refined areas such as environmental sustainability, and incorporate altimetric and policy data. Scientometric mapping hence yields actionable insight into scholarly and policy priorities in the developing field of *C. sativa* studies.

**Keywords:** Cannabinoids; Hemp; Cannabis legalization; Medical cannabis; Hashish.

**Citation:** Hakimi, M., Azimi, J., Razmjou, F., & Yahya, M. A. (2025). A Scientometric Analysis of Cannabis sativa Research. *Selcuk Journal of Agriculture and Food Sciences*, 39(3), 596-608. <https://doi.org/10.15316/selcukjafsci.1701796>

**Corresponding Author E-mail:** [latif.yahya1@gmail.com](mailto:latif.yahya1@gmail.com)

Received date: 18/05/2025

Accepted date: 23/10/2025

Author(s) publishing with the journal retain(s) the copyright to their work licensed under the CC BY-NC 4.0.

<https://creativecommons.org/licenses/by-nc/4.0/>

## 1. Introduction

*Cannabis sativa*, scientifically known as a diploid plant from the Cannabaceae family that is widely distributed in temperate and tropical regions. This plant is known as a native species of Central Asia and is one of the oldest domesticated plants cultivated worldwide for various purposes including food, medicine, industry, fiber, and fuel (Basses et al., 2020; Gonçalves, 2019; Ren et al., 2019). *C. sativa* is one of the earliest plants to be domesticated and cultivated by humans, with a history spanning thousands of years. Over the years, it has been used in Europe, Asia, Africa, and America as a source of fiber, oil, and drugs (Salami et al., 2020). Over the years, the selection of agricultural methods and the development of varieties have contributed to the creation of different types of hemp. Today, other genotypes selected for high oleoresin production are known as marijuana (Dugan, 2021). The first evidence of the use of *C. sativa* as a medicine date back 5000 years when it was prescribed to treat fatigue, rheumatism, and malaria (Salami et al., 2020). Furthermore, *C. sativa* has been used in European countries as a source of natural fiber. Its narcotic and medicinal properties were only recognized after contact with the cultures of Asia and North Africa. *C. sativa* spread from Asia to Europe and Africa along the Silk Road around 500 to 1000 years BC (Zuardi, 2006).

*C. sativa* is of enormous importance due to its diverse applications in the pharmaceutical, food, and industrial fields. This plant has long been used as a source of fiber, food, oil and medicine, and its flowering tops extract a concentrated oleoresin with pharmacological effects in humans, the most well-known use of *C. sativa* being its psychoactive properties (Rasera et al., 2021). In the food industry, various parts of the plant, including leaves, seeds and oil, are used as raw materials, additives and flavorings in the preparation of foods and beverages. Hemp oil has a 3:1 ratio of omega-6 to omega-3 essential fatty acids and is considered a healthy oil in the diet, with low saturated fat and high in unsaturated fats (Abdollahy et al., 2020). Despite these benefits, *C. sativa* has received less attention due to legal obstacles; therefore, studying the botanical, phytochemical, and therapeutic properties of this plant can pave the way for its scientific and commercial exploitation (Asadi et al., 2019). Depending on its usage and chemical composition *C. sativa*, is referred to as hemp or marijuana. Its resinous extracts contain pharmacologically active compounds with psychoactive effects (Karche, 2019). In addition to its medicinal properties, this plant has numerous applications in the textile industry as well. Its fibers, which are like cotton fibers, are notably soft and strong, and have good environmental compatibility. These features have led to the use of *C. sativa* in the production of fabrics and shoes (Väisänen, et al., 2018). *C. sativa* also serves as a low-cost natural raw material in the construction industry, such as concrete, gypsum, and wall insulation, as well as in the production of water and oil pipes made from its seeds and chemical paints (Sorrentino, 2021). *C. sativa's* oil is also used as a wood polish, and its stem, which is made up of about 85% cellulose and hemicellulose, is an ideal source for synthetic products like furniture (Pejić, et al., 2020).

Another application of *C. sativa* is in the paper industry. Karche (2019) indicates that paper made from cannabis fibers lasts longer than paper made from wood and is also recyclable. These characteristics make *C. sativa* a suitable option for reducing the exploitation of limited natural resources and forests. The compounds in *C. sativa* are effective in controlling diseases and disorders, and its oil is used in the production of cosmetics and personal care products such as soap, shampoo, and detergents (Paul et al., 2019). Historical evidence shows that *C. sativa* has a wide genetic diversity and numerous medicinal and industrial properties. However, the legal prohibitions imposed on this plant due to its narcotic properties have posed significant challenges to the expansion of this valuable plant (Salami et al., 2020)

This study conducts a scientometric analysis of *C. sativa* in the period 2000 to 2024 in two reputable scientific databases, PubMed and Scopus, as well as its analysis in the VOS-viewer program. The study attempts to clarify the level of interaction and role-playing of key players in the production of knowledge in this field by analyzing scientific collaborations between authors and organizations. Nevertheless, the goal of the study is to provide an accurate picture of the structure of knowledge and identify potential capacities in the research of *C. sativa* to help guide future research more effectively.

## 2. Materials and Methods

A scientometric analysis was employed to examine global research trends related to *C. sativa* during the period from 2000 to 2024. Scientometric analysis is an analytical method used to examine the structure, dynamics, and impact of scientific research within a specific field. This type of analysis utilizes bibliometric data, such as publication and citation information, to identify publication patterns, collaboration networks, and research trends, serving as an important tool for understanding scientific developments in a particular area (Haghani, 2023). These analyses are usually based on reliable and extensive databases such as Scopus, PubMed, and Web of Science, which have been selected for their wide coverage and scientific credibility in the field of biological and medical sciences. These databases provide the required bibliographic data that is used to draw scientific maps and analyze relationships between authors, articles, and keywords (Van Eck & Waltman, 2010). Moreover, use of rigorous bibliometric methods and authoritative databases such as Scopus and PubMed allow for a more comprehensive understanding of the research landscape, including collaboration between authors, key vocabulary trends, and contributions from academic institutions (Yahya, M. A., 2024). Covering thousands of hundreds of scientific titles and advanced search tools, Scopus is a comprehensive abstract writing and indexing database that covers peer-reviewed literature, including journals, books, and conference papers across all disciplines. PubMed is one of the most prominent scientific databases in the field of medicine and life sciences, provided free of charge and managed by the U.S. National Library of Medicine (NLM) and the National Biotechnology Information Center (NCBI). This bibliographic database contains more than 29 million scientific references and is recognized as a trusted source for researchers, clinicians, and health professionals (Falagas et al., 2008; Sanyal et al., 2019).

In this study, Scopus and PubMed databases were used as the main sources for scientometric analysis. Data was extracted from the period 2000 to 2024 and the search process took place in May 2025. VOS-viewer software version 1.6.20 was used to perform the analysis, which has advanced capabilities for visualizing and interpreting bibliometric data. A specific search strategy (Table 1) was adopted in the search process in the Scopus and PubMed databases.

**Table 1.** Search strings for *C. sativa* in Scopus and PubMed databases

Database	Advanced Search String
Scopus	TITLE-ABS-KEY* (cannabis AND sativa) OR (cannabinoids) OR (cannabisAND legalization) (medical AND cannabis OR hashish) AND PUBYEAR > 1999 AND PUBYEAR < 2026 AND (LIMIT-TO (DOCTYPE, "ar")) OR LIMIT-TO (DOCTYPE, "re") OR LIMIT-TO (DOCTYPE, "cp"))
PubMed	("cannabis"[MeSH Terms] OR "cannabis"[All Fields] OR ("cannabis"[All Fields] AND "sativa"[All Fields]) OR "cannabis sativa"[All Fields] OR ("cannabis"[MeSH Terms] OR "cannabis"[All Fields] OR "hemp"[All Fields]) OR ("cannabis"[MeSH Terms] OR "cannabis"[All Fields] OR "hashish"[All Fields])) AND (2000:2024[pdat])

\*: Title-Abstract-Keywords

Document types were filtered to list only articles review, and conference papers. Keywords such as Cannabinoids, Hemp, Cannabis legalization, medical cannabis, and Hashish were used. The search was conducted using Boolean operators in the title, abstract, and keywords of the articles to obtain more accuracy and coverage. The pertinent files included information such as the author(s) data, document title, year, source title, citation count, source and document type, affiliations, publisher, correspondence address, abstract and author keywords, sponsor, conference information, included references, and indexing keywords. The search results were saved in the form of CSV files and then uploaded to VOS-viewer software. Some statistical charts were created in Microsoft 365. Based on the obtained data from Scopus and PubMed databases the following several types of analyses conducted (Table 2).

**Table 2.** List of analyses conducted using Scopus and PubMed data

Analysis Type	Database	
	Scopus	PubMed
Documents by funding sponsor	✓	
Documents by year	✓	
Documents per year by source	✓	
Documents by author	✓	
Documents by affiliation	✓	
Documents by type	✓	
Documents by subject area	✓	
Co-authorship analysis of authors	✓	
Co-authorship analysis of organizations	✓	
Co-occurrence analysis of all author keywords	✓	✓
Citation unit analysis of organizations	✓	

Based on all these analyses, network visualizations, overlay visualizations, and density visualizations were created to complete the analysis procedure. Layout and clustering parameters were tweaked as per the nature of the content and data for better visual representation. Larger nodes imply more connectivity and significance in their areas.

### 2.1. Scientific database selection

There are various other bibliometric data sources like the Web of Science (WoS), Dimensions, and Google Scholar that also promise large-scale coverage; however, this study chose to focus on Scopus and PubMed specifically for some methodological reasons. First, the databases give highly consistent metadata and export formats (including DOI, affiliation, funding, and citation information) that are straight away compatible with VOSviewer and other scientometric software, while WoS and Dimensions need institutional access and operate with non-standard export formats that make data harmonization difficult. Secondly, the field of Scopus and PubMed was particularly fitting for the study of this topic. Scopus guarantees extensive multidisciplinary coverage, and PubMed is still the primary source of medical and life science literature. They, together, give the most powerful and complementary depiction of *C. sativa* research in the main disciplines. Thirdly, the prevention of data duplication was a key consideration since it has been reported in earlier research that there is over 80% overlap in life-science coverage among Scopus, PubMed, and WoS (Falagas et al., 2008) and including WoS or Dimensions would only have increased the amount of data already collected without significantly enlarging the coverage. Finally, Google Scholar was not considered since it includes non-peer-reviewed materials like these, conference abstracts, and web content, which might lead to skewed citation metrics and untrustworthy quantitative analysis. Hence, the combination of Scopus and PubMed gave a great balance in terms of coverage, data quality, and analytical compatibility, which is in line with acknowledged scientometric best practices (Haghani, 2023).

### 2.2. Analytical tools and parameters

The bibliographic data for this study were extracted from the Scopus and PubMed databases covering the time frame from 2000 to 2024. These two databases were chosen for their thorough and trustworthy coverage of the life, agricultural, and medical sciences. The VOSviewer version 1.6.20 was used for data analysis, which is a popular tool for building and displaying bibliometric networks. During present analysis, multiple technical parameters were applied to ensure the transparency and reproducibility of the methodology. The Louvain modularity-based clustering algorithm was used to find community structures and thematic clusters in the networks. To increase the clarity of the results, a minimum co-occurrence threshold of five was enforced for author keywords, while a minimum of ten co-authored documents was established for the author and institutional collaboration networks. The link strength between items was determined using a full counting method, which reflects the total number of shared connections between nodes. For layout normalization, a force-directed (LinLog) method was used to enhance spatial clarity and separation among the clusters. The

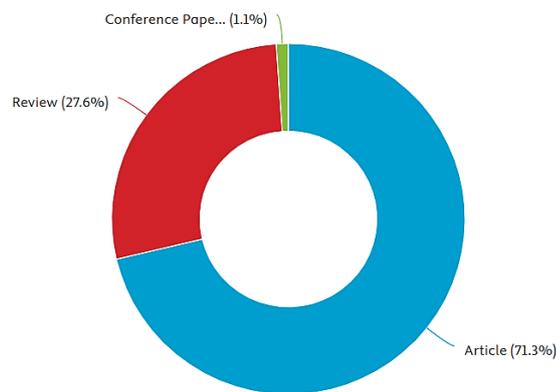
visualizations of the networks, overlays, and density maps were then explained through results and discussion section to help readers grasp the structural and thematic aspects of the maps.

### 3. Results

Scientometric analysis method made it possible to investigate the overall structure of research related to *C. sativa*. These analyses provided useful information about prominent authors, hot research topics, scientific interactions, and future research directions in this field, and helped to gain an overview of the trends of scientific developments in this area.

#### 3.1. Analysis of documents by type (Scopus database)

Utilizing the search string employed in this study (Table 1) yielded a total of 28,897 literature items in the Scopus database. The publication-type analysis revealed that, among all *C. sativa* publications, a greater portion consisted of scientific articles (figure 1).

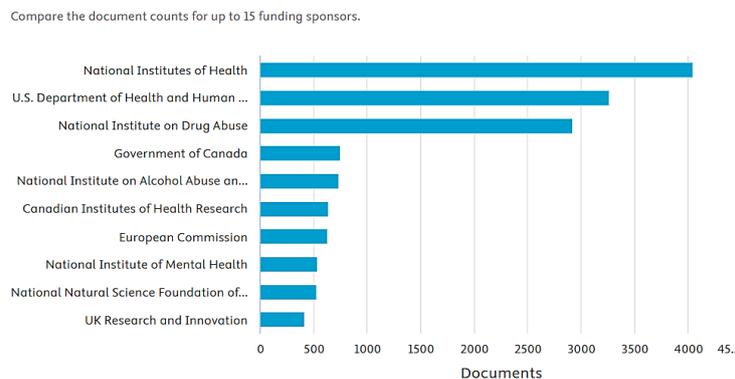


**Figure 1.** Distribution of *C. sativa* research publications by document type (Scopus database)

As shown in figure 1, articles comprised the largest share of publications, accounting for 71.3% (n=20,607). Review papers were the next largest group, bearing 27.6% (n=7966) of the studies. The remaining literature accounted for 1.1% (n=315), consisting of conference papers. These emphasize the prominent inclination of researchers of *C. sativa* to document and disseminate their findings and theories in peer-reviewed journal articles.

#### 3.2. Analysis of documents by funding sponsor (Scopus database)

Our findings show that major U.S. government agencies have been mostly involved in funding the *C. sativa* research. The National Institutes of Health (NIH) was the biggest funding sponsor, appearing in the acknowledgements of over 4,000 documents. It was followed by the U.S. Department of Health and Human Services and the National Institute on Drug Abuse garnering contributions more than 3,000 and 2,800 publications, respectively (Figure 2).

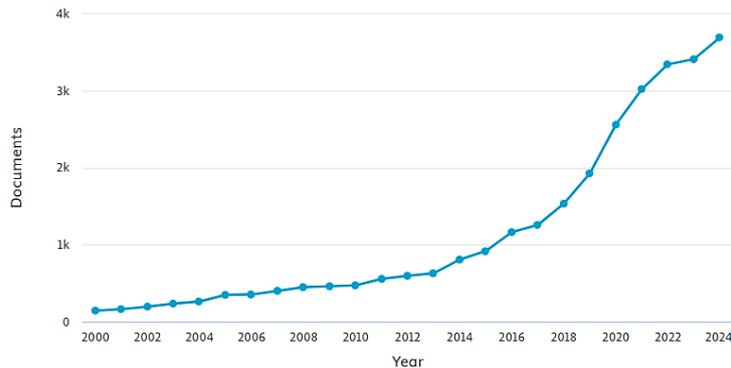


**Figure 2.** Documents by funding sponsor related to *C. sativa* research (Scopus database)

The Government of Canada, the National Institute on Alcohol Abuse and Alcoholism, and the Canadian Institutes for Health Research ranked higher as well, jointly recognizing support for between 500 and 1,000 documents. Other top sponsors from abroad would be the European Commission, National Natural Science Foundation of China, and UK Research and Innovation, albeit with lesser document counts.

3.3. *Analysis of documents by year (Scopus database)*

Analysis of the publication output per year on *C. sativa* clearly depicts upward trends in research activity over the last two decades. The number of documents published slowly and steadily increased between the years 2000 and 2010, showing very slow growth. More significant growth came after 2015, with a sharp rise happening mainly between the years 2018 and 2021.

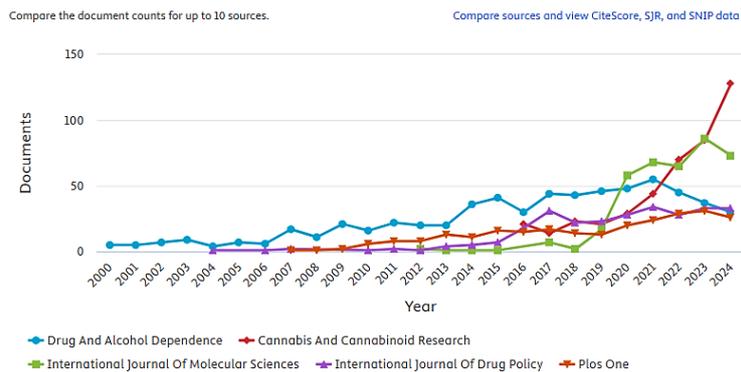


**Figure 3.** Annual scientific publication output on *C. sativa* from 2000 to 2024 (Scopus database)

The publication number increased above 2,000 records in 2020 alone, and it steadily grew, reaching almost 4,000 documents by 2024. This growth has been one of accelerating interest in the research on *C. sativa*, especially in the last five years.

3.4. *Analysis of documents per year by source (Scopus database)*

Analysis of documents distribution by sources over time revealed that several major journals significantly contributed to *C. sativa* research. These include Drug and Alcohol Dependence, which consistently published the highest number of documents each year from 2000 to 2021. However, after the year of 2021, a remarkable change took place: the Journal of Cannabis and Cannabinoid Research experienced a rapid rise in production and occupied the top spot by 2024 with a staggering 150 publications in that very year (Figure 4).

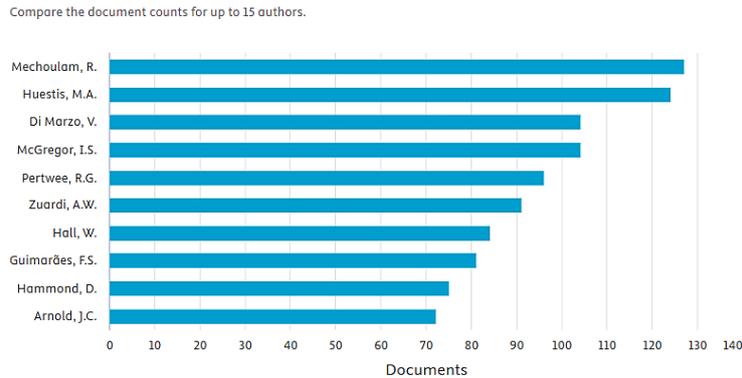


**Figure 4.** Annual number of documents on *C. sativa* by source journal (2000–2024)

The International Journal of Molecular Sciences also witnessed a nice error growth-ultra from 2018 to 2022, peaking in 2022 with a slight descendance in 2024. Other journals such as the International Journal of Drug Policy and PLOS ONE witnessed slow yet moderate increases in publication numbers of the passing years, adding steadily to the knowledge base.

3.5. *Analysis of documents by author contributions (Scopus database)*

Analyzing the author’s contributions in *C. sativa* research revealed some prime movers in the field. Raphael Mechoulam led with the highest number of publications, exceeding 130 documents. Thereafter, followed closely by Marilyn A. Huestis, who contributed nearly as many. Vincenzo Di Marzo and Iain S. McGregor also contributed significantly with each authoring more than 100 documents (Figure 5).

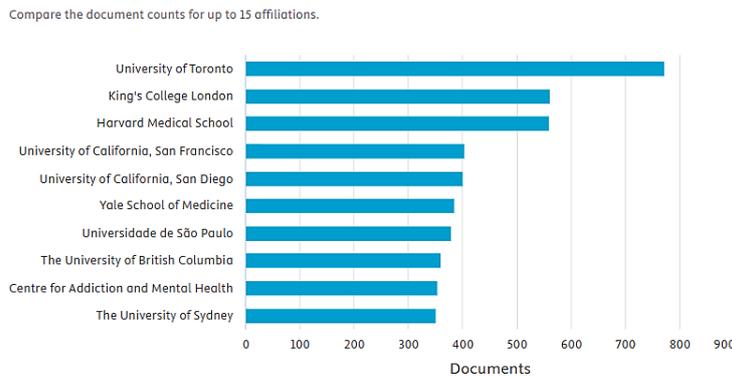


**Figure 5.** Top contributing authors by number of documents on *C. sativa* research (Scopus database)

Among the other notable authors were Roger G. Pertwee, Antonio W. Zuardi, Wayne Hall, and Francisco S. Guimarães, all with publication totals somewhere between 85 and 100. David Hammond and Jonathon C. Arnold made up the balance of the top ten authors, with approximately 75 documents each. These researchers are the key players pushing forward scholarly output on *C. sativa*.

### 3.6. Analysis of documents by affiliation (Scopus database)

The University of Toronto stood as the highest-ranked institution with over 800 publications. King College London and Harvard Medical School followed, each accounting for over 550 documents (Figure 6). The others deemed significant contributors included the University of California, San Francisco, and the University of California, San Diego, each having about 400 publications under their belts. Yale School of Medicine, Universidade de São Paulo, and the University of British Columbia were among the sizeable contributors, publishing roughly between 350 and 400 documents.



**Figure 6.** Number of documents on *C. sativa* research by institutional affiliation (Scopus database)

The Centre for Addiction and Mental Health and the University of Sydney made up the remaining two from the top ten list, with just over 300 publications each. The findings truly suggest a global and multidisciplinary engagement with *C. sativa* across North America, South America, Europe, and Australia.

### 3.7. Analysis of documents by subject area (Scopus database)

The results of this analysis revealed a strong dominance of medical-oriented disciplines (Figure 7). Medicine sits in the first position, with 37.1% (n= 17,982) of all publications as the plant's therapeutic usage and clinical interest. The second most prominent discipline with 15.8% (n= 7,634) of the publications is Pharmacology, Toxicology, and Pharmaceutics, bringing into focus issues of pharmacological mechanism, safety, and drug development. Biochemistry, Genetics, and Molecular Biology account for 9.5% (n= 4,605) of

the research, with Neuroscience coming next at 8.5% (n= 4,118), illustrating interest in the biochemical pathways and neurological effects of cannabis compounds. Psychology (n= 1,999) and Social Sciences (n= 1,969) occur at 4.1% each, indicating attention to issues of mental health and societal impact engendered by cannabis use.

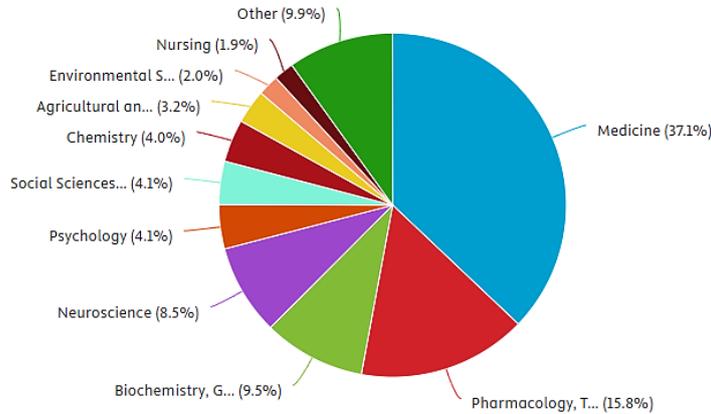


Figure 7. Distribution of *C. sativa* publications by subject area between 2000-2024

There are other inputs from Chemistry (4.0%, n= 1,941), Agricultural and Biological Sciences (3.2%, n= 1,536), Environmental Science (2.0%, n= 961), and Nursing (1.9%, n= 899). Another 9.9%, (n= 4,175) are allocated to “Other” wherein interdisciplinary and emerging research are captured.

3.8. Co-authorship analysis of authors (Scopus database)

The co-authorship structure of authors in Scopus data shows some distinct clusters of authors and important actors in the *C. sativa* research community. The network visualizations, generated through VOS-viewer, convey the frequency and strength of the collaboration ties that exist (Figure 8). Some prominent clusters of authors emerge from the network show that authors such as Austin, Kong, Hammond, Halford, Longo, McGregor, Sakkab, Thai, Tran, and Zajicek are in a reasonably dense central cluster, indicating rather close collaborative ties in the area. On the other hand, it is found that authors like Raphael Mechoulam and Vincenzo Di Marzo are the major players in cannabinoid research as they work often in their clusters and bridge different groups. Other important clusters exist under Tom P. Freeman, Yan Wang, and Carla J. Berg, who collaborate within institutional or disciplinary boundaries. Peripheries with authors like Janet Hardy and Abbas Haghparast present isolated journals or somewhat smaller groups, preferring perhaps less conspicuous or niche contributions to literature.

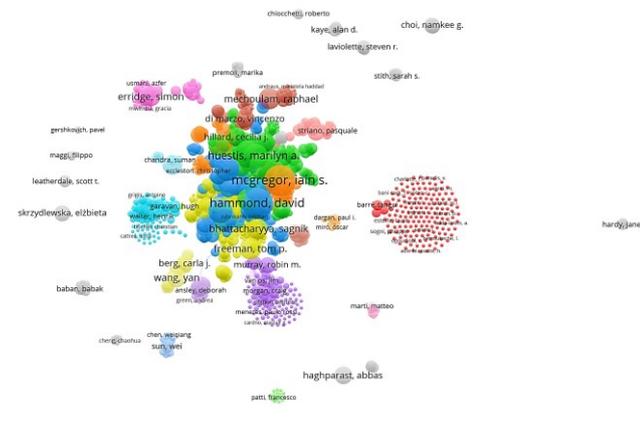
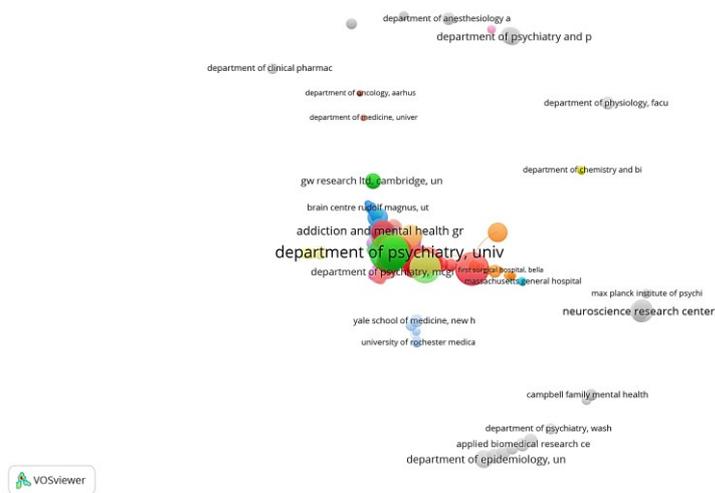


Figure 8. Co-authorship network of authors in *C. sativa* research (Scopus database, visualized via VOS-viewer)

The ultimate picture comprises an extraordinarily interlinked scientific network in which some authors bridge among clusters while others remain within localized ones.

### 3.9. Co-authorship analysis of organizations (Scopus database)

This analysis shows the collaborative relationships among various academic institutions and research groups, with the "Department of Psychiatry, Univ" being the most central and prominent node (Figure 9). Its large size and central position signify its critical function as one of the major hubs in collaborative research involving psychiatry and mental health. The network has been color-coded in clusters, with each cluster representing a community of institutions that work together in co-authoring publications. For example, some members of the green cluster are "Addiction and Mental Health Gr" and "GW Research Ltd, Cambridge, UN" while those of the red cluster include "Massachusetts General Hospital" and "Department of Psychiatry, McGill." The relative size of each node corresponds to an institution's strength in collaborative output, whereas the lines indicate co-authorship relationships.

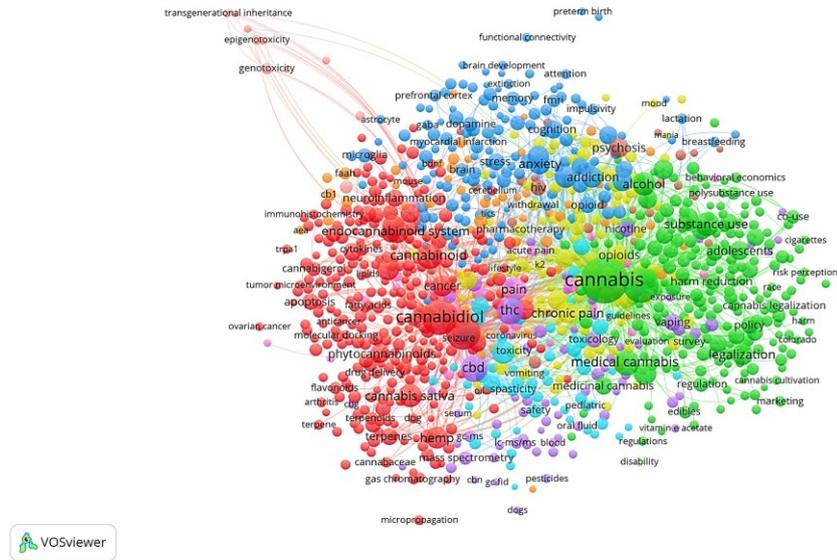


**Figure 9.** Co-authorship Network of organizations in *C. sativa* research (Scopus database, visualized via VOS-viewer)

In contrast, peripheral nodes such as "Department of Clinical Pharmac" and "Department of Anesthesiology A" are smaller and more isolated, implying that they have weaker ties in collaboration or accept research that is very niche. This network map synthesizes the collaborative landscape of this research domain, locating key contributors and potential bridging points or openings for novel partnerships.

### 3.10. Co-occurrence analysis of all author keywords (Scopus database)

The network visualization of this analysis revealed several distinct clusters of keywords that co-occur very frequently with each other (Figure 10). The biggest cluster, with the term "cannabis" at the core, is closely linked with keywords such as "medical cannabis," "chronic pain," "substance use," "legalization," and "adolescents," thereby revealing an intense concentration of studies on medical applications, policy, and public health. Another large cluster is around the words "cannabidiol" and "cannabinoid," with related words like "endocannabinoid system," "pain," "apoptosis," and "phytocannabinoids," and thus accounts for key areas of activity in pharmacology, therapeutic mechanisms, and molecular biology. Still other clusters represent the words "anxiety," "stress," "memory," and "addiction," thus suggesting a large body of literature on neuropsychological and behavioral effects.

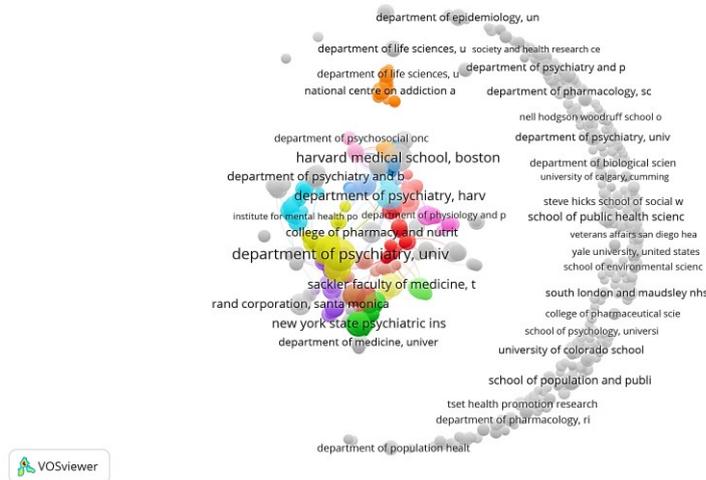


**Figure 10.** Network visualization of author keyword co-occurrence in *C. sativa* research

Terms such as "epigenotoxicity," "transgenerational inheritance," and "genotoxicity," which appear on the periphery, revealing emerging or niche research areas. This map shows how these topics are interconnected with frequent co-occurrences of medical, biological, and social science keywords, thus providing a bird's eye view of the thematic landscape of *C. sativa* research.

3.11. Citation unit analysis of organizations (Scopus database)

Results of this analysis demonstrate a network of institutional affiliations that contribute to *C. sativa* research. Large and tight clusters appear as central nodes in the network (Figure 11), corresponding with internationally prestigious institutions such as Harvard Medical School, Boston, and various departments of Psychiatry and Medicine of major universities.



**Figure 11.** Citation network visualization of organizations in *C. sativa* research (Scopus database)

Because these organizations have a high number of citation linkages, they occupy a very prominent position in the domain. Other prominent institutions that are also in the center exhibiting strong inter-institutional citation link relations include New York State Psychiatric Institute, Sackler Faculty of Medicine, and Rand Corporation, Santa Monica. Peripheral nodes are other contributing organizations with lesser citation connections, implying a broadly scattered and less interconnected involvement in *C. sativa* research.



London, and Harvard Medical School, seem thus to have appeared as the principal actors setting the research agenda of *C. sativa*, indicating an impressively transatlantic academic presence. Small groups of authors such as Raphael Mechoulam and Marilyn A. Huestis are central in steering the scholarly conversation, since co-authorship networks display disciplinary silos but also cross-field interactions emerging notably between psychiatry, pharmacology, and molecular biology.

Being a major medical field, recurring themes of cannabis concern chronic pain, addiction, epilepsy, and anxiety, while the peripheral interest in neuroscience, genetics, and social science signals an enlarged horizon of conception. The alternative trend in publication sources, as in the case of the rising Journal of Cannabis and Cannabinoid Research, thus points to the increasing fragmentation and academic endorsement of cannabis research. Keyword co-occurrence analyses present the landscape as layered with core biomedical interests and emergent ones like epigenotoxicity and transgenerational effects, which hint at the long-term implications in health and ecology.

Despite well-embodied collaboration networks in some domains, opportunities remain for more interdisciplinary and international integration into cluster-node schemes. The limitations of coverage and semantic nuances arise in our study due to the keyword-based approach that involved databases such as Scopus and PubMed. Future research could integrate altimetric indicators, policy documents, and patent data and venture into less studied areas like agricultural sustainability and the environmental impact of cannabis cultivation.

---

**Author Contributions:** All authors contributed equally to all stages of the preparation of this manuscript. Similarly, all authors approved the final version of the manuscripts.

**Funding:** This research received no external funding.

**Conflicts of Interest:** The authors declare no conflict of interest.

---

## References

- Abdollahi, M., Sefidkon, F., Calagari, M., Mousavi, A., & Fawzi Mahomoodally, M. (2020). A comparative study of seed yield and oil composition of four cultivars of Hemp (*Cannabis sativa* L.) grown from three regions in northern Iran. *Industrial Crops and Products*, 152, 112397. <https://doi.org/10.1016/j.indcrop.2020.112397>
- Asadi, S., Moghadam, H., Naghdi Badi, H., Naghdi Badi, H., Naghavi, M., & Salami, S. (2019). A review on agronomic, phytochemical and pharmacological aspects of cannabis (*cannabis sativa* L.). *Journal of Medicinal Plants*, 2(70), 1–20. <http://dx.doi.org/10.29252/jmp.2.70.1>
- Basas-Jaumandreu, J., & de Las Heras, F. X. C. (2020). GC-MS Metabolite Profile and Identification of Unusual Homologous Cannabinoids in High Potency *Cannabis sativa*. *Planta medica*, 86(5), 338–347. <https://doi.org/10.1055/a-1110-1045>
- Duggan, P. J. (2021). The chemistry of cannabis and cannabinoids. *Australian Journal of Chemistry*, 74(6), 369–387. <https://doi.org/10.1071/CH21006>
- Falagas, M. E., Pitsouni, E. I., Malietzis, G. A., & Pappas, G. (2008). Comparison of PubMed, Scopus, web of science, and Google scholar: strengths and weaknesses. *The FASEB journal*, 22(2), 338-342. <https://doi.org/10.1096/fj.07-9492LSF>
- Gonçalves, J., Rosado, T., Soares, S., Simão, A. Y., Caramelo, D., Luís, Â., Fernández, N., Barroso, M., Gallardo, E., & Duarte, A. P. (2019). *Cannabis* and Its Secondary Metabolites: Their Use as Therapeutic Drugs, Toxicological Aspects, and Analytical Determination. *Medicines (Basel, Switzerland)*, 6(1), 31. <https://doi.org/10.3390/medicines6010031>
- Haghani, M. (2023). What makes an informative and publication-worthy scientometric analysis of literature: A guide for authors, reviewers and editors. *Transportation Research Interdisciplinary Perspectives*, 22, 100956. <https://doi.org/10.1016/j.trip.2023.100956>
- Karche, T. (2019). The application of hemp (*Cannabis sativa* L.) for a green economy: a review. *Turkish Journal of Botany*, 43 (6): 710-723. <https://doi.org/10.3906/bot-1907-15>

- Paul, R., Williams, R., Hodson, V. and Peake, C. (2019). Detection of cannabinoids in hair after cosmetic application of hemp oil. *Scientific Reports*, 9 (1): 1-6. <https://doi.org/10.1038/s41598-019-39609-0>
- Pejić, B. M., Kramar, A. D., Obradović, B. M., Kuraica, M. M., Žekić, A. A. and Kostić, M. M. (2020). Effect of plasma treatment on chemical composition, structure and sorption properties of lignocellulosic hemp fibers (*Cannabis sativa* L.). *Carbohydrate Polymers*, 236: 116000. <https://doi.org/10.1016/j.carbpol.2020.116000>
- Rasera, G. B., Ohara, A., & de Castro, R. J. (2021). Innovative and emerging applications of cannabis in food and beverage products: From an illicit drug to a potential ingredient for health promotion. *Trends in Food Science & Technology*, 115, 31–41. <https://doi.org/10.1016/j.tifs.2021.06.035>
- Ren, M., Tang, Z., Wu, X., Spengler, R., Jiang, H., Yang, Y., & Boivin, N. (2019). The origins of *Cannabis* smoking: Chemical residue evidence from the first millennium BCE in the Pamirs. *Science advances*, 5(6), eaaw1391. <https://doi.org/10.1126/sciadv.aaw1391>
- Salami, S. A., Martinelli, F., Giovino, A., Bachari, A., Arad, N., & Mantri, N. (2020). It Is Our Turn to Get Cannabis High: Put Cannabinoids in Food and Health Baskets. *Molecules (Basel, Switzerland)*, 25(18), 4036. <https://doi.org/10.3390/molecules25184036>
- Sanyal, D. K., Bhowmick, P. K., & Das, P. P. (2019). A review of author name Disambiguation Techniques for the PubMed Bibliographic Database. *Journal of Information Science*, 47(2), 227–254. <https://doi.org/10.1177/0165551519888605>
- Sorrentino G. (2021). Introduction to emerging industrial applications of cannabis (*Cannabis sativa* L.). *Rendiconti Lincei. Scienze fisiche e naturali*, 32(2), 233–243. <https://doi.org/10.1007/s12210-021-00979-1>
- Väisänen, T., Batello, P., Lappalainen, R. and Tomppo, L. (2018). Modification of hemp fibers (*Cannabis sativa* L.) for composite applications. *Industrial Crops and Products*, 111: 422-429. <https://doi.org/10.1016/j.indcrop.2017.10.049>
- Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for Bibliometric mapping. *Scientometrics*, 84(2), 523–538. <https://doi.org/10.1007/s11192-009-0146-3>
- Yahya, M. A. (2024). Trends and insights in *Lavandula angustifolia* research: A critical literature review (CLR) and bibliometric analysis of scopus and pubmed databases. *International Journal of Life Sciences and Biotechnology*. <https://doi.org/10.38001/ijlsb.1514950>
- Zuardi, A. W. (2006). History of *cannabis* as a medicine: a review. *Brazilian Journal of Psychiatry*, 28: 153-157. <https://doi.org/10.1590/S1516-44462006000200015>.