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Research paper

Scientometric assessment of scientific documents published in 2020 on herbal medicines used for COVID-19

Rasha Atlasi^{a,b,1}, Aboozar Ramezani^{c,1,2}, Ozra Tabatabaei-Malazy^{d,*}, Sudabeh Alatab^e,
Vahideh Oveissi^{f,g}, Bagher Larijani^a

^a Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

^b Evidence Based Medicine Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

^c Tehran University of Medical Sciences, Tehran, Iran

^d Non-Communicable Diseases Research Center, Endocrinology and Metabolism Population Sciences Institute, Tehran University of Medical Sciences, Tehran, Iran

^e Digestive Disease Research Center, Digestive Disease Research Institute, Tehran University of Medical Sciences, Tehran, Iran

^f Department of Pharmacy, Tehran University of Medical Sciences, Tehran, Iran

^g PhytoPharmacology Interest Group (PPIG), Universal Scientific Education and Research Network (USERN), Tehran, Iran



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ABSTRACT

Objective: Many studies have suggested herbal medicines as alternatives or adjuvants to modern drugs for COVID-19. Their scientometric analyses can provide a scientific overview of this topic.

Materials and methods: Web of Science (WOS) and Scopus were searched for articles on the use of herbal medicines in COVID-19 published until 26 October 2020. Collected data were analyzed for document type, subject area, top journal, citation number, and authors' collaboration network using VOSviewer 1.6.15, ScientoPy 2.0.3, Gephi 0.9.2, and SPSS 15 statistical tools.

Results: After screening the 3185 retrieved records, 378 and 849 records, respectively from WOS and Scopus, remained for quantity analysis. Original and review articles were the two main types of papers in both databases. Top subject areas were drug and medicine, respectively in the WOS and Scopus databases. The top three productive countries in the field were China, the US, and India. The most cited article was a practice guideline in both databases. "Journal of Biomolecular Structure Dynamics" in WOS and "Chinese Traditional and Herbal Drugs" in Scopus were the top journals. Top keywords included "COVID-19" and "Traditional Chinese Medicine". US authors had the highest collaboration with other authors.

Conclusions: The current study provides a snapshot of the quantity and characteristics of published scholarly documents in recent months in the intersection of herbal medicines and COVID-19. Our findings help scientists to find the existing gaps, identify the active authors and scientific institutes to collaborate with and use their experience to produce new knowledge in the future.

1. Introduction

The outbreak of the novel coronavirus disease 2019 (COVID-19), a potentially fatal disease, caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), is one of the most serious health concerns.

Currently, there is no specific drug to cure COVID-19 disease, and the real efficacy and safety of the recommended therapeutic approaches is under debate (Zhang and Liu, 2020a; Silveira et al., 2020). This has provoked researchers to discover new measures for prevention and better treatment of the disease (Rothan and Byrareddy, 2020; Sanders

Abbreviations: SARS-CoV-2, Severe acute respiratory syndrome coronavirus-2; 2019-nCoV, 2019 novel coronavirus; 3CLpro, 3-chymotrypsin-like cysteine protease; NF-κB, Nuclear factor kappa-light-chain-enhancer of activated B cells; WOS, Web Of Science; MeSH, Medical Subject Headings; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; VOSviewer, Visualizing Scientific Landscapes; IF, Impact factor; SJR, SCImago Journal Rank.

* Correspondence to: Endocrinology and Metabolism Research Institute, No.10 Next to Dr. Shariati Hospital, Jalal Al, Ahmad Hwy., North Kargar Ave., Tehran 1411713119, Iran.

E-mail address: tabatabaeiml@sina.tums.ac.ir (O. Tabatabaei-Malazy).

¹ Equally contributed as First authors

² ORCID: <https://orcid.org/0000-0002-3888-1363>

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et al., 2020).

The tendency for using traditional medicine approaches and research for the discovery and development of herbal medicine formulations has increased significantly (Luo et al., 2020). Medicinal plants and their phytochemicals have been used to treat a wide range of diseases since prehistoric times and in modern pharmacotherapy it is recommended to use herbal medicines as an alternative option for the treatment of disease (Eddouks et al., 2012; Sofowora et al., 2013; Tabatabaei-Malazy et al., 2021). Moreover, botanical drugs are regarded as having relatively fewer side effects compared to modern medicines, while being more cost-effective (Cherkin, 1998; Posadzki et al., 2013). Generally, plants synthesize chemical compounds as secondary metabolites to protect themselves against insects, fungi, and other pathogens. These compounds have biological properties that make them profitable choices to formulate as pharmaceutical products (Ahn, 2017).

Recent investigations have shown natural products to have the potential to be used as therapeutic agents against the virus responsible for COVID-19. For instance, curcumin and *Glycyrrhizin* have shown significant inhibitory effects on the virus' structural glycoproteins and virus-induced cytokine storm (Liu and Ying, 2020; Sinha et al., 2020). Inhibition of virus replication and 3-chymotrypsin-like cysteine protease (3CLpro) activity, blocking the Nuclear factor kappa-light-chain-enhancer of activated B cells (NF- κ B) signaling, and prevention from the production of inflammatory markers might mediate the antiviral protection effects of curcumin against SARS-CoV-2 infection (Tabatabaei-Malazy et al., 2020).

There are many scientific publications about prevention or treatment of COVID-19 disease using herbal medicines (Bibi et al., 2021; Jalali et al., 2020; Zhang et al., 2020b). While the demand for using herbal medicine to treat COVID-19 and the number of published documents in this topic are increasing, one approach to better understand the trend is to assess the quality of these documents by analysing the characteristics of the published studies. The analysis of these documents can improve our perception, present an overview of the research conducted in this field and identify existing gaps. The scientometrics analysis of the published studies on herbal medicines for COVID-19 is one of the best approaches to help achieve this goal.

The Scientometric analysis is a reliable method for the quantitative analysis of scientific characteristics of publications, including their quantity and type, most used keywords, highly active authors, and network visualization of co-authorship and co-occurrence of data in a particular field (Ellegaard and Wallin, 2015; Tabatabaei-Malazy et al., 2016). A few scientometric studies have also analysed the global research trend in the intersection of traditional, integrative, complementary, and alternative medicines (TICAMs) or Traditional Chinese Medicine (TCM) and COVID-19 (Ng, 2020; Yang et al., 2020). Ng (2020), in their study, found a total of 327 TICAMs in 296 eligible published articles until 5 July 2020; the most common treatments were TCMs (n = 94), followed by vitamin D (n = 67), melatonin (n = 16), phytochemicals (n = 12), and general herbal medicine (n = 11). Yang et al., 2020, in their bibliometric study, analyzed 309 documents published until 11 March 2020 in the Chinese journals. In addition, they evaluated the collaboration between the Chinese authors and institutions to explore the research trend and efficiency of research output in the field of TCM and COVID-19 in China.

Based on the increase in demand for using herbal medicines to treat COVID-19, it is essential to not only carry out a comprehensive global search but also to update research on the topic to better understand the situation and determine the knowledge gaps in order to manage future research and budget needed in the field. So, the purpose of this study was to conduct a scientometrics analysis of all publications related to herbal medicines and COVID-19 and compare their characteristics, between Web Of Science (WOS) and Scopus databases, for more details.

2. Material and methods

For the retrieval of all documents produced on the topic of herbal medicines and COVID-19 disease, the authors searched using keywords based on the Medical Subject Headings (MeSH) and Emtree terms as well as their synonyms in the WOS and Scopus databases from 1 January 2020–26 October 2020. Some of these keywords were “herbal”, “plant”, “traditional medicine”, “COVID-19”, “coronavirus”, and “SARS-CoV-2”. No other limitations for language or document types were applied.

In total, 3185 records from these databases were retrieved; 903 from WOS and 2282 from Scopus. These records were imported into the Endnote software program and two groups were created for each database. After excluding the duplicates, the title and abstract of the papers were assessed using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart (Moher et al., 2009). The full texts of the remaining papers and the reference list of the potentially eligible studies were independently assessed by two investigators. All the collected records were screened for their relevance in the use of herbal medicines for treatment or prevention of COVID-19 disease and the unrelated documents were excluded. For scientometric analysis, we used (Visualizing Scientific Landscapes) VOSviewer version 1.6.15, Gephi 0.9.2, and ScientoPy version 2.0.3. In addition, SPSS version 15 was used to assess the correlation between the number of publications and the publication month. The density and average betweenness centrality of the graph was calculated in the Gephi software. The short description of the main measures/metrics used in this study (Bensman, 2001; Borgatti and Everett, 2018; Cernile et al., 2021; Eck et al., 2021; Nicolaisen and Hjørland, 2007; Ruiz-Rosero et al., 2019; Tran and Aytac, 2021) is shown in Table 1. This study was approved by The Tehran University of Medical Sciences' Ethics Committee, numbered IR.TUMS.

Table 1

A short description of the main measures/metrics used in the study.

	Main Measures/ Metrics	Software Of Computation	Interpretation
1	Scientometrics performance	ScientoPy	By using data from WOS and Scopus databases, a comprehensive science mapping analysis for the publication date, articles' language, country, institution affiliations, and authors. (Ruiz-Rosero et al., 2019)
2	Visualization	VOSviewer	Bibliometric networks are illustrated based on network data of researchers, countries, institutional affiliations, and keywords (Eck et al., 2021).
3	Lotka law	Bibliometrix (Biblioshiny)	Used to test the scientific dissemination efficiency and to describe the frequency of publication by authors in any particular field (Tran and Aytac, 2021).
4	Bradford's law	Bibliometrix (Biblioshiny)	Used to scatter sources of information on specific topics. In many disciplines, this pattern is called the Pareto distribution (Bensman SJ, 2001; Nicolaisen and Hjørland, 2007).
5	Betweenness Centrality	Gephi	Betweenness indicates the number of times the node is in the shortest path between the two nodes in the network. The countries, organizations, authors, and keywords are nodes of this study (Borgatti and Everett, 2018; Cernile et al., 2021).
6	Density	Gephi	The density measures the degree of coherence between nodes in the network (Borgatti and Everett, 2018).

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3. Results

As shown in the PRISMA flowchart (Fig. 1), the final search consisted of 378 records from WOS and 849 records from Scopus databases. The highest and lowest proportion of the productions were in May with 159 documents and in January with 14 documents. Overall, the correlation coefficient between the number of publications and publication month was non-significant ($r = 0.292$, R-squared value: 0.092, p-value: 0.413).

The most frequent type of papers indexed in WOS were original articles (178 documents, 47.09%) followed by review papers (136 records, 35.98%). Other types of publication, in a respective manner, included letters and editorials, news, and meeting abstracts. The first ranked type of paper in Scopus, similarly, was original (509 papers, 59.95%) followed by review (219 papers, 25.80%) papers. Other types were letters, editorials, notes, book chapters, short surveys, and conference papers, correspondingly. This showed that main studies aiming to solve this pandemic were published as original papers.

The English language, followed by Chinese and German, were the main languages used in these publications. This showed that the majority of articles were published in an international language, English, so that the majority of people could benefit from.

The top ten publication areas are shown in Table 2. As indicated, the first ranked subject area was “Pharmacology Pharmacy” with 98 documents (25%) in WOS and “Medicine” with 483 documents (36%) in Scopus.

Geographical distribution and also characteristics of institutes with the highest number of scientific productions in the studied field are shown in Table 3 and Table 4, respectively. Based on the WOS and Scopus database search, 66 and 97 countries collaborated to produce the majority of the scientific documents in the studied field, respectively. China, the US, and India were the three countries with the highest

Table 2

The subject area of publications based on WOS and Scopus databases.

WOS			Scopus	
No.	Research Area	Frequency n (%)	Research Area	Frequency n (%)
1	Pharmacology Pharmacy	98 (25.92)	Medicine	483 (36.00)
2	Integrative Complementary Medicine	61 (16.13)	Pharmacology, Toxicology and Pharmaceutics	332 (24.00)
3	Biochemistry Molecular Biology	56 (14.81)	Biochemistry, Genetics and Molecular Biology	184 (13.00)
4	General Internal Medicine	44 (11.64)	Immunology and Microbiology	69 (0.05)
5	Biophysics	35 (9.25)	Agricultural and Biological Sciences	56 (0.04)
6	Research Experimental Medicine	23 (6.08)	Chemistry	40 (0.03)
7	Chemistry	22 (5.82)	Environmental Science	22 (0.01)
8	Biotechnology Applied Microbiology	12 (3.17)	Chemical Engineering	18 (0.01)
9	Food Science Technology	12 (3.17)	Nursing	18 (0.01)
10	Immunology	12 (3.17)	Social Sciences	14 (0.01)

Legend: WOS: Web Of Science

number of publications in both databases (Table 3). This showed that the Asian states are more eager to conduct these types of studies, maybe because many of the used plants are indigenous to these states, and the fact that herbal medicine is practiced more often in these countries. The organization with the highest number of produced documents in WOS was “Chengdu University of Traditional Chinese Medicine” (13

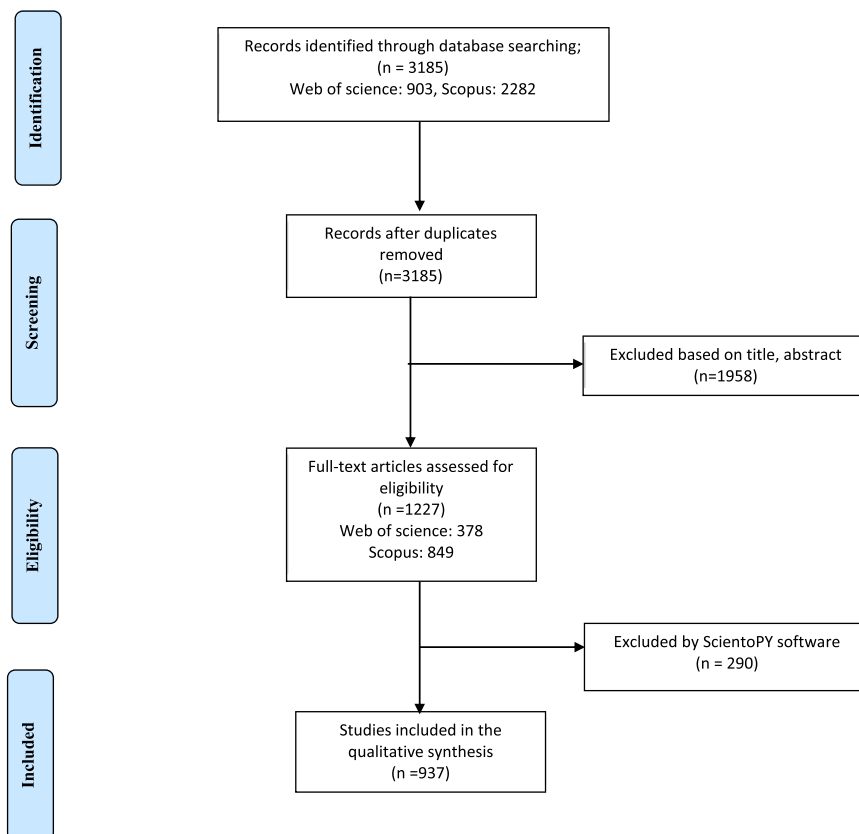


Fig. 1. PRISMA Flowchart for the process of searching and analysis.

Table 3

Top ten countries in document production based on WOS and Scopus databases.

WOS		Scopus		
No.	Countries	Frequency n (%)	Countries	Frequency n (%)
1	China	145 (38.36)	China	358 (30.00)
2	USA	57 (15.07)	India	142 (0.11)
3	India	55 (14.55)	USA	101 (0.08)
4	Italy	18 (4.76)	Italy	45 (0.03)
5	England	17 (4.49)	United Kingdom	40 (0.03)
6	Pakistan	16 (4.23)	Germany	33 (0.02)
7	South Korea	15 (3.96)	Saudi Arabia	24 (0.02)
8	Spain	14 (3.70)	Spain	23 (0.01)
9	Iran	13 (3.43)	Iran	21 (0.01)
10	Saudi Arabia	13 (3.43)	Australia	20 (0.01)

Legend: WOS: Web Of Science

Table 4

Top ten organizations in document production based on WOS and Scopus databases.

WOS		Scopus		
No.	Organizations	Frequency n (%)	Organizations	Frequency n (%)
1	Chengdu University Of Traditional Chinese Medicine	13 (3.43)	Beijing University of Chinese Medicine	30 (0.03)
2	Beijing University Of Chinese Medicine	12 (3.17)	China Academy of Chinese Medical Sciences	30 (0.03)
3	China Academy Of Chinese Medical Sciences	11 (2.91)	Chengdu University of Traditional Chinese Medicine	25 (0.02)
4	Chinese Academy Of Sciences	10 (2.64)	Shanghai University of Traditional Chinese Medicine	22 (0.02)
5	Tianjin University Of Traditional Chinese Medicine	10 (2.64)	Tianjin University of Traditional Chinese Medicine	22 (0.02)
6	University Of Texas System	9 (2.38)	Ministry of Education China	19 (0.02)
7	Guangzhou University Of Chinese Medicine	8 (2.11)	Tongji Medical College	14 (0.01)
8	Korea Institute Of Oriental Medicine	8 (2.11)	Shandong University of Traditional Chinese Medicine	14 (0.01)
9	Shanghai University Of Traditional Chinese Medicine	8 (2.11)	Huazhong University of Science and Technology	14 (0.01)
10	Chinese University Of Hong Kong	7 (1.85)	Mahatma Gandhi Ayurved College Hospital and Research Centre MGACH & RC	12 (0.01)

Legend: WOS: Web Of Science

documents, 3.44%) and in Scopus was “Beijing University of Chinese Medicine” (30 documents, 0.03%). Details of the top ten organizations in producing scholarly documents in this field are presented in Table 4. This information showed that the Chinese institutes are at the top of herbal medicine research, especially regarding COVID-19. The organization network density and betweenness centrality were 0.003 and 1368.33, respectively.

Top ten authors and also top ten journals in document production based on each database are shown in Table 5 and Table 6, respectively. Lee., M.S. from Korea with 6 publications and Reiter., R.J. from the US with 9 documents were the first ranked authors in producing scientific documents based on WOS and Scopus records, respectively (Table 5). This information revealed that the first authors interested in this topic

and more active in producing related documents are from countries other than China. Table 6 shows the characteristics of main journals publishing documents in the studied field. The majority of the published documents belonged to the Journal of Biomolecular Structure Dynamics with 35 records (9.2%) for WOS and the Chinese Traditional and Herbal Drugs with 72 records (0.1%) for Scopus. It could be concluded that these journals have managed to publish the majority of articles on COVID-19 and had the highest number of citations; the table also shows that the Elsevier publisher owns the highest number of journals that have published documents in this field.

The top 3 highest cited papers, with their citations being updated in 19 November 2020, are presented in Table 7. The article entitled “A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus” published in “Mil Med Res” had the highest number of citations regardless of the database.

The co-authorship network of data from both databases was visualized. Among 1996 authors who collaborated in the WOS database, 106 had published at least two documents. “Bui Thi Phuong Thuy” had the highest total link strength ($n = 30$) with two documents, suggesting he had the greatest collaboration with other authors (Fig. 2). One cluster consisted of 16 authors with a total of 120 links, presenting the most collaboration among these authors (Fig. 2).

From 4326 authors who collaborated in the Scopus database, 69 authors had at least five documents. The author “Li, J.” had the greatest total link strength ($n = 663$). “Li, J.” and “Wang, Y.”, both with 23 documents, had the highest number of related documents. Seven clusters were obtained from the authors, showing seven groups of authors collaborating with each other, and three isolated researchers (Fig. 3). The color of these clusters is to distinguish them. The most active authors are located in the center of the figure. The total network authorship density was 0.002. The analysis betweenness centrality of the author’s network collaborations was 22.99. From 1707 applied keywords in WOS, 115 keywords had at least five frequencies; “COVID-19” ranked as the first keyword with 186 occurrences. In regard to keywords related to herbal medicine, “Traditional Chinese Medicine” was the top keyword with a frequency of 50 (Fig. 4).

In total, 7813 keywords were extracted from the Scopus database. We used 834 keywords that had at least five frequencies for data visualization (Fig. 5). “COVID-19” ranked as the first keyword with 659 occurrences. With regard to keywords related to herbal medicine, “Chinese Medicine” was the top keyword with 252 frequency. 7 clusters that are defined with various colors in Fig. 5 were obtained. Betweenness centrality was shown to be 2819.78, and the density of centrality measures was estimated at 0.005. The co-authorship of countries is illustrated for WOS database in Fig. 6. From 66 countries, 22 countries had at least 4 documents. The US with 57 documents, 567 citations, and 44 total link strength ranked first, followed by China with 145 documents, 2014 citations and 27 total link strength. Finally, 21 items with 4 clusters were obtained (Fig. 6).

The co-authorship of countries for the Scopus database is illustrated in Fig. 7. From 119 countries, 33 countries had at least 5 documents.

China, with 362 documents, was the premier country in producing documents in the Scopus database. India, with 142 documents, and the US, with 101 documents, ranked next (Fig. 7). The degree of interconnectedness among countries or network density was 0.127. The betweenness centrality for the countries network collaborations is estimated to be 43.85.

Using the scientometrics method, the quantitative aspects of the documents published about herbal medicine were described. Due to the short time frame of this study, it is difficult to display the research trend by software. All the authors’ keywords and keywords index databases were illustrated using VOSviewer software. The temporal evolution, given in yellow and green, can determine the research trend that shows overall the frequency of keywords from blue to “yellow”. In the Web of Science database, the yellow keywords are “molecular docking” “flavonoid” and thymoquinone, which were more frequent in new

Table 5

Top ten authors in document production based on WOS and Scopus databases.

No.	WOS Authors	Institute/ Country	Scopus Frequency n (%)	Authors	Institute/ Country	Frequency n (%)
1	Lee., M.S.	Korea Inst Oriental Med, Korea	6 (1.58)	Reiter., R. J.	University of Texas Health Science Center at San Antonio, US	9 (0.02)
2	Reiter., R. J.	UT Hlth San Antonio, US	6 (1.58)	Sun., R.	Shandong University, China	6 (0.01)
3	Wang., L.	Inner Mongolia Med Univ, China	6 (1.58)	Gurav., S. S.	Goa College of Pharmacy, India	4 (0.01)
4	Zhang., J. H.	Tianjin Univ Tradit Chinese Med, China	6 (1.58)	He., Y.	Tasly Holding Group Co., China	4 (0.01)
5	Ang., L. 4 (1.05)	Korea Inst Oriental Med, Korea Lin., Z.J.	Beijing University of Chinese Medicine, China	4 (0.01)		
6	Dong., L.	Hosp Chengdu Univ Tradit Chinese Med, China	4 (1.05)	Liu., C.X.	State Key Laboratories of Pharmacodynamics and Pharmacokinetics, China	4 (0.01)
7	Gurav., S. S.	Goa Univ, India	4 (1.05)	Prasad., S. K.	Rashtrasant Tukadoji Maharaj Nagpur University, India	4 (0.01)
8	Lee., H.W.	Korea Inst Oriental Med, Korea	4 (1.05)	Qiao., Y.J.	Beijing University of Chinese Medicine, China	4 (0.01)
9	Li., H.	Hong Kong Baptist Univ, China	4 (1.05)	Shakya., A.	Dibrugarh University, India	4 (0.01)
10	Prasad., S. K.	RTM Univ, India	4 (1.05)	Sinha., S. K.	Mohanlal Sukhadia University, India	4 (0.01)

Legend: WOS: Web Of Science

Table 6

Top ten journals in document production based on WOS and Scopus databases.

No.	Journals	WOS Publisher	IF (2019)	Frequency n (%)	Scopus Journals	Publisher	SJR (2019)	Frequency n (%)
1	Journal of Biomolecular Structure Dynamics	Taylor & Francis	3.31	35 (9.25)	Chinese Traditional and Herbal Drugs	Zhong cao yao bian ji bu	0.13	72 (0.10)
2	Integrative Medicine Research	Elsevier	2.172	17 (4.49)	Journal of Biomolecular Structure And Dynamics Medicine	Taylor & Francis	0.5	39 (0.06)
3	Pharmacological Research	Elsevier	5.893	13 (3.43)	Medicine	Elsevier	0.64	26 (0.04)
4	Medicine	Elsevier	1.552	12 (3.17)	International Journal of Research In Pharmaceutical Sciences	JK Welfare & Pharmascope Foundation	0.12	23 (0.03)
5	Phytotherapy Research	Wiley	4.087	12 (3.17)	Pharmacological Research	Elsevier	1.61	22 (0.03)
6	Traditional Medicine Research	Hong Kong Gold Orchid Science and Technology Co	-	8 (2.11)	Zhongguo Zhongyao Zazhi	Zhongguo Zhong yi yan jiu yuan Zhong yao yan jiu suo	0.16	22 (0.03)
7	Chinese Medicine	BioMed Central	2.96	6 (1.58)	Phytomedicine	Urban & Fischer Verlag	0.96	14 (0.02)
8	Frontiers in Medicine	Frontiers Media S.A	3.9	6 (1.58)	Phytotherapy Research	Wiley	0.91	14 (0.02)
9	Chinese Journal Of Integrative Medicine	Springer	1.545	5 (1.32)	Life Sciences	Elsevier	1.03	11 (0.01)
10	Life Sciences	Elsevier	3.647	5 (1.32)	Medical Hypotheses	Eden Press	0.43	10 (0.01)

Legend: WOS: Web Of Science, IF: Impact factor, SJR: SCImago Journal Rank.

Table 7

The top 3 papers with the highest citation based on WOS and Scopus databases.

No.	WOS Paper	IF (2019)	Scopus Citation number	Paper	Cite Score (2019)	Citation number
1	A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version).	2.325	458	A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version).	3.4	531
2	Drug treatment options for the 2019-new coronavirus (2019-nCoV).	1.553	256	Genome Composition and Divergence of the Novel Coronavirus (2019-nCoV) Originating in China.	27.6	415
3	Network-based drug repurposing for novel coronavirus 2019-nCoV/SARS-CoV-2.	6.255	220	A Review of Coronavirus Disease-2019 (COVID-19).	2.3	390

Legend: WOS: Web Of Science, IF: Impact factor

research. In addition, the keywords in the Scopus database illustrated the research trends: “spike glycoprotein”, “drug repurposing”, “antiviral activity”, “compare study”, “Traditional Medicine” and “plant extract”. In interpreting the illustration of the data set of this research, it seems

that the research process has tended towards these topics.

Simultaneously with VOSviewer software, all keywords were illustrated with ScientoPy software. This software illustrated the most frequent keywords used by the authors: “cytokine storm”,

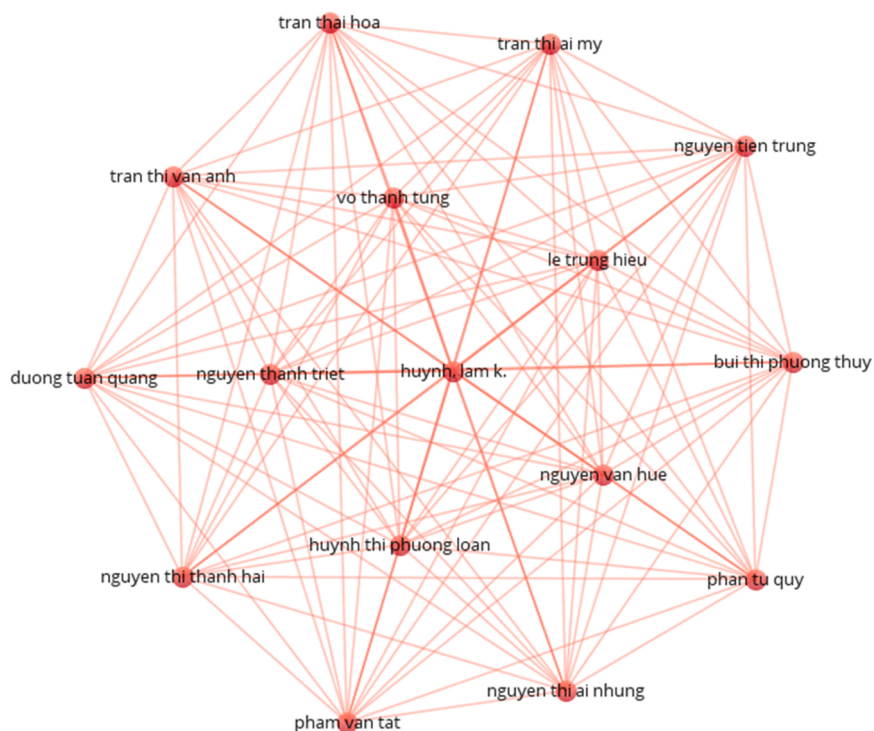


Fig. 2. Network visualization of co-authorship in WOS.



Fig. 3. Network visualization of co-authorship in Scopus.

"phytochemicals", "quercetin", "molecular docking" and "Traditional Chinese Medicine". Also, "Chinese medicine", and "herbaceous agent" were the high-frequency indexing keywords in these databases. Therefore, it is difficult to identify research trends using this software that are

recognized in the period of one year of studies and these types of studies cannot show the trends exactly and requires manual assessing in other types of studies. A subject evolution graph of the publications was visualized by the SciencioPy software based on WOS and Scopus records.

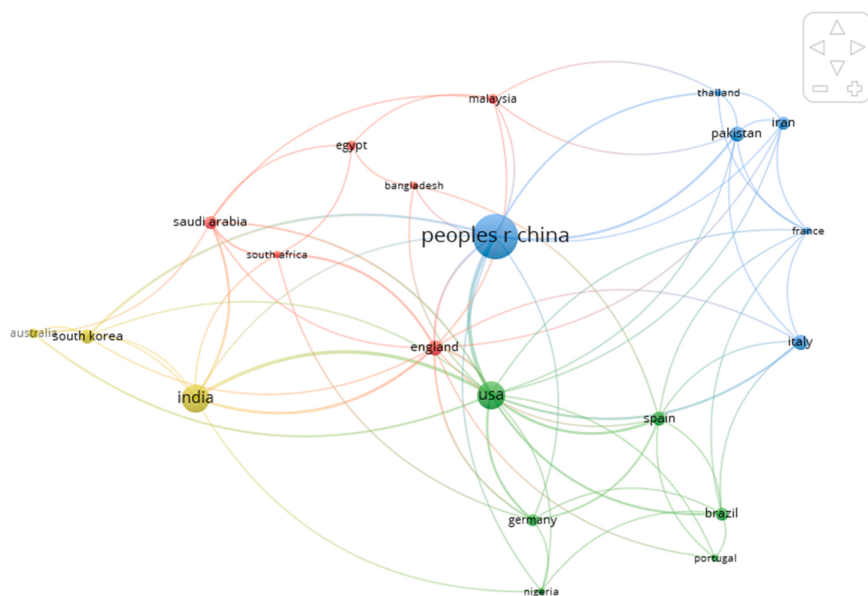


Fig. 6. Network visualization of co-authorship of countries in WOS.

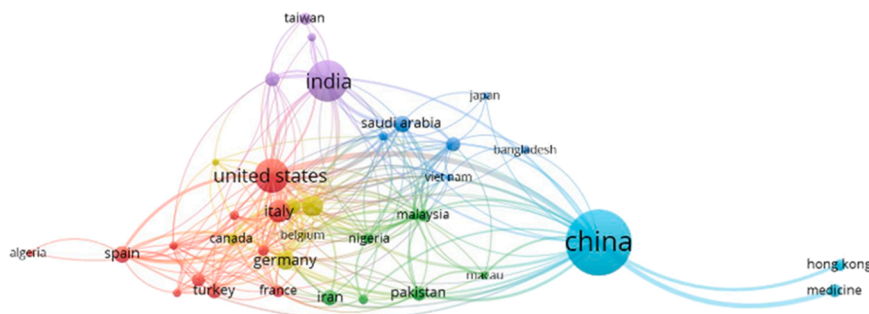


Fig. 7. Network visualization of co-authorship of countries in Scopus.

appropriate strategies for effective prevention and management of COVID-19 (Sanders et al., 2020).

Two Chinese institutes, “Chengdu University of Traditional Chinese Medicine” and “Beijing University of Chinese Medicine”, were ranked as the top institutes in the production of scientific documents in this field in WOS and Scopus databases, respectively. China was the premier country in producing relevant documents. The US and India were in the second and third ranks. These findings point out to the historical research trend of Traditional Chinese Medicine regarding the use of medicinal plants in the prevention and treatment of many disorders (Lee et al., 2020; Park et al., 2020). This was similar to the Ng study (2020) on the global research trends of coronavirus, which showed China, the US, India, and Italy as the premier countries in producing documents in this topic.

The top ten journals publishing documents in our studied field were classified as high-impact and high-quality international journals. This result indicates the worldwide attention towards this topic. Among these top 10 sources, the “Journal of Biomolecular Structure Dynamics” with an impact factor (IF) (2019) of 3.31, published 35 related documents in WOS, and the “Chinese Traditional and Herbal Drugs” had 72 documents in Scopus. These journals published the highest number of documents in the field of herbal medicine and COVID-19. Bradford’s law was used to scatter the Sources of Information on Specific Subjects. In many disciplines, this pattern is called a Pareto distribution. The results of this study showed that the research on the use of herbal medicines in COVID-19 was published in core scientific journals. The list of the core journals in the two databases was diverse, but findings showed the top 10 sources (Nicolaisen and Hjørland, 2007).

The top-cited papers had the greatest contribution in the high IF (2019) Journal. The top-cited paper in both WOS and Scopus databases was a practice guideline entitled “A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version)”. This paper was published in “Mil Med Res” journal with an IF (2019) of 2.325, cited 458 times in WOS, and 531 times in Scopus. Since the IF could reflect the importance of any published document, publishing in a high IF (2019) journal may show the worldwide importance of the subject (Rashrash et al., 2017). The high citation number is a reflection of high availability and visibility to other researchers.

The authors also visualized the co-occurrence and co-authorship of data extracted from the two databases. This study was used to test Lotka’s law of scientific publication productivity. Lotka’s Law, originally used to explain scientific productivity, and describes the frequency of publications by authors in any given field. The results of the publications in herbal medicines for COVID-19 did not confirm Lotka’s law (Tran and Aytac, 2021).

The word COVID-19 was the keyword with the highest rate of co-occurrence in both databases. For the herbal medicine concept, “Chinese Medicine” had the highest proportion of keywords in this database and “Traditional Chinese Medicine” had the most frequency. This finding is in line with the results of Ng (2020), which indicates that TCM was the most common concept in herbal medicine for COVID-19 treatment. Furthermore, in the Web of Science database, “molecular docking”, “flavonoid” and “thymoquinone” were more frequent, whereas “spike glycoprotein”, “drug repurposing”, “antiviral activity”, “compare

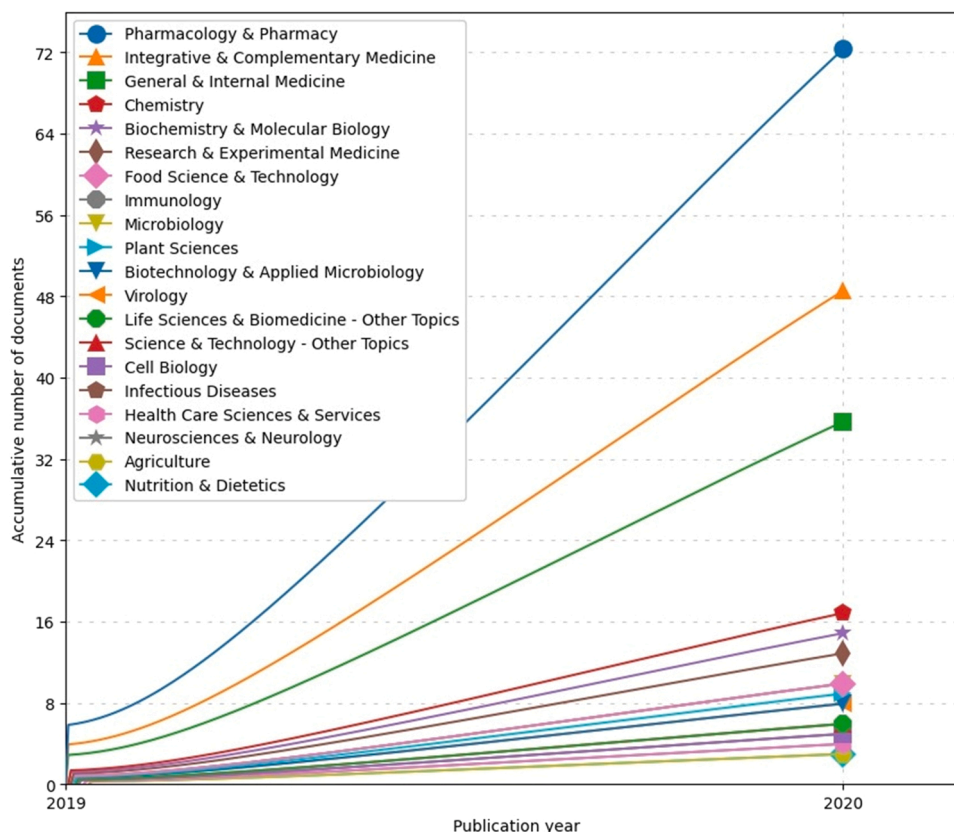


Fig. 8. Subject evolution graph of publications based on WOS and Scopus records by ScientoPy.

study”, “Traditional Medicine” and “plant extract” were most frequent in the Scopus database. In a similar study conducted by Yang et al. (2020), five main research topics were identified as, “prevention and management of COVID-19”, “exploration of active compounds of Chinese medicine in treatment”, “expert consensus of COVID-19 treatment”, “etiology and pathogenesis of COVID-19”, and “clinical research of TCM”.

The co-authorship network could be considered as a useful indicator to show research collaborations between different academic institutions and their researchers (Giuliani et al., 2010; Fonseca Bde et al., 2016). For co-authorship mapping, two authors “Li, J.” and “Wang, Y.” had the highest number of published documents in Scopus and the greatest total link strengths. Regarding the WOS database, “Bui Thi Phuong Thuy” had the greatest total link strength. The first ranked author in visualizing co-authorship was from the US followed by China. This article calculated the Betweenness Centrality for countries, organizations, authors, and keywords. This approach, using graph network analysis, can be developed rapidly. For example, the Betweenness Centrality measure is often used in scientific communication networks based on the shortest paths going through a node with the aim of identifying the most influential individuals. It can discover previously unknown or unnoticed relationships between emerging medical concepts. This analysis approach for large collections of literature will be developed (Cernile et al., 2021).

COVID-19 is a global threat and requires international collaboration. For such domains, in addition to these two international databases, the first step can begin by searching the Dimensions database to use the number of tweets and Mendeley readers as indicators of potential research relevance (Singh et al., 2021). Considering the continuity of COVID-19 and published herbal medicine studies, it is expected that more concrete results will be achieved by evaluation of the trend of scientific publications in this field.

The strengths of this study need attention. Firstly, the authors

focused on scientific productions indexed in WOS and Scopus databases and analyzed their records separately. Both of these database are known as the most comprehensive and reliable international databases. Secondly, the time trend of retrieved documents based on month of publication were assessed. The main limitation of this study was the discrepancy in time of published documents between the two databases. Therefore, the authors considered the publication time of documents based on Scopus indexing time. On the other hand, this study provides a scientometric assessment with emphasize on the quantitative aspects of the research; as a result, details about the subject trends or herbal plants used in the treatment of COVID-19 are beyond the scope of the current research. Having this limitation in mind, attempts were made to span the characteristics of collected published documents in a way that these characteristics could be useful for both practical and scientific purposes. In more detail, all of the keywords in herbal medicine articles with VOSviewer software was visualized. We also added the subject evolution graph of publications based on Scopus records with ScientoPy software. However, conducting more research on this topic would be warranted.

5. Conclusions

Nowadays, COVID-19 is one of the most important topics in the scientific community. In this study, we aimed to show an overview of publications on the use of herbal medicine in treating COVID-19 disease and assessed their quantity in WOS and Scopus databases. We attempted to gather and analyze all the published data and illustrate the status of publications and their main features in the studied field using certain software to better understand the most important details. The characteristics of the publications, such as the most active authors, organizations and countries, were identified. Also, co-authorship and co-occurrence networks were illustrated.

This study helps scientists to identify the active researchers and organizations in field of herbal medicine and COVID 19 in order to

produce an opportunity for young researchers to collaborate with them and publish more useful literature. This study also helps to identify the gaps in conducted studies and shows top journals, keywords, authors, highly cited papers and the networks between authors. Our results also showed that the characteristics of collected data might be different if we look at different databases. This is an important note for researchers as they should be cautious in interpreting the data and perhaps look at all available databases to have more robust conclusions. Clearly, to improve the quality and efficiency of research output, strengthening of the collaboration between authors should be considered.

Similar to other studies, such as Atlasi et al. (2021), our study showed that the countries with the highest infection rate are more interested in publishing about coronavirus disease, and such publications are growing in number. However, there is a need to evaluate these publications once in a while and the results of this evaluation should be published to provide more effective and cost-efficient further research, focusing on important aspects of research and the existing gaps. This would be helpful for prevention, control, and treatment of coronavirus. The main limitation of the study was that it was impossible to provide details about the subject trends or herbal plants used in the treatment of COVID-19.

It is suggested that more studies be carried out in future about the treatment of this disease, especially regarding the specific species of herbal medicine, in order to identify the best plants used and studied in various continents and countries and identify the main scientific groups active in the field. Also, it is better to research other national and international databases, in addition to using various software programs, to further evaluate publications produced related to this topic and introduce more detail with more aspects on the studies.

Author contributions

RA: Methodology, Data curation, Validation, Writing – original draft preparation; **AR:** Methodology, Data curation, analysis, Reviewing and editing; **OT-M:** Supervision, Data curation, Validation, Writing – reviewing and editing. **SA:** Data curation, Reviewing and editing; **VO:** Data curation, Writing – reviewing and editing; **BL:** Validation, Reviewing and editing.

All of the authors approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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