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BIBLIOMETRIC ANALYSIS OF RESEARCH ON BEE POLLEN: GLOBAL TRENDS AND COLLABORATION PATTERNS

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ABSTRACT

Bee pollen is recognized for its nutritional and health benefits, drawing attention from both the scientific community and consumers as a natural functional food. This study employed bibliometric analysis, using the R program bibliometrix package and VOS viewer, to examine scientific research on bee pollen. We were evaluated 921 articles in the Web of Science databases using the keyword 'bee pollen' published between 2011-2022. Among these, 90.45% were research articles, 6.73% were reviews, 2.06% were meeting abstracts, and 0.76% were book chapters. China led with 562 articles, followed by Brazil (330), Turkey (295), Italy (190), Portugal (189), the USA (175), and Spain (158). Bee pollen was the most used keyword, followed by pollen, propolis, and honey. This is the first bibliometric study to evaluate the researchs on bee pollen, and it is considered important in terms of organizing the scientific studies to be conducted on this subject.

Keywords: Pollen, bee products, bibliometric, honey, bee pollen

ARI POLENİ ARAŞTIRMALARININ BİBLİYOMETRİK ANALİZİ: KÜRESEL EĞİLİMLER VE İŞ BİRLİĞİ ÖRÜNTÜLERİ

ÖZ

Arı poleni, beslenme ve sağlık yararları açısından tanınmış, hem bilimsel toplum hem de tüketiciler tarafından doğal bir fonksiyonel gıda olarak dikkat çekmektedir. Bu çalışmada, R programının bibliyometrik analiz paketi ve VOS görüntüleyici kullanılarak arı poleni üzerine yapılan bilimsel araştırmaları incelemek amacıyla bibliyometrik analiz uygulanmıştır. 'Arı poleni' anahtar kelimesini kullanarak Web of Science veri tabanlarında yapılan arama sonucunda, 2011-2022 yılları arasında yayımlanan 921 makale değerlendirmeye alınmıştır. Bu makalelerin %90.45'i araştırma makalesi, %6.73'ü derleme, %2.06'sı toplantı özetleri ve %0.76'sı kitap bölümleri olarak belirlenmiştir. Çin, 562 makale ile ilk sırayı alırken, onu Brezilya (330), Türkiye (295), İtalya (190), Portekiz (189), ABD (175) ve İspanya (158) izlemiştir. En sık kullanılan anahtar kelimeler arasında arı poleni, polen, propolis ve bal bulunmaktadır. Bu çalışma, sadece arı poleni üzerine yapılan araştırmaları değerlendiren ilk bibliyometrik çalışmadır ve bu konuda yapılacak bilimsel çalışmaların düzenlenmesi açısından önemli görülmektedir.

Anahtar kelimeler: Polen, arı ürünleri, bibliyometrik, bal, arı poleni

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INTRODUCTION

The nutritional and medicinal benefits of honeybee products have long been recognized and valued. Honey and beeswax are perhaps the most well-known primary bee products (Faqihi and Taha, 2022). Also, another well-known bee product is bee pollen, which is valued for both its therapeutic and nutritional qualities (Khalifa et al., 2021). Bee pollen is widely used in the food industry owing to its health benefits and nutritional properties.

Bee pollen is a natural mix of nectar, pollen, and salivary secretions produced by honeybees (*Apis mellifera* L.). It contains proteins, carbohydrates, lipids, and a broad range of secondary metabolites, including fatty acids, amino acids, polyphenols, vitamins, phytosterols, carotenoids, enzymes, co-enzymes, and minerals (Temizer et al., 2018; Salazar-González et al., 2020; Karkar et al., 2021). Due to its constituents, bee pollen is a functional food that provides full nutrition (El Ghouizi et al., 2023). Thanks to this rich content, bee pollen has many important properties such as an antioxidant, antimicrobial, anti-atherosclerotic, and hepatoprotective effect (Temizer et al., 2018; Bridi et al., 2019; Karkar et al., 2021; Soares de Arruda et al., 2021; Adaškevičiūtė et al., 2022).

Ancient texts, including the Bible and ancient Egyptian scriptures, reference the utilization of bee pollen as a natural remedy for diverse ailments (Khalifa et al., 2021). In recent years, scientific research on bee pollen has grown significantly, with a particular focus on its numerous benefits (Tomaszewska et al., 2020; Arung et al., 2021), phenolic components, and capacity to scavenge free radicals (Sarioğlu-Bozkurt et al., 2022). The range of bee pollen products available has also expanded, including granules, tablets, candy bars, oral liquids, and tonics for human consumption (Li et al., 2018). Microbial diversity in bee pollen has also become a more prominent topic in research (Moreno Andrade et al., 2018), which will help determine the potential uses of bee pollen.

Bibliometric analysis is a common and informative method for examining and interpreting massive volumes of scientific data. Nowadays, bibliometric analysis has gained popularity in scientific studies. There are many studies conducted with bibliometric analysis in different research fields (Donthu et al., 2020; Guo et al., 2020; Yu et al., 2020; Rejeb et al., 2022; Tlili et al., 2022). Numerous research areas have been the subject of bibliometric analysis, including artificial intelligence in COVID-19 research (Karbasi et al., 2023), mathematics education (Phan et al., 2022), tungsten-based nanomaterials (Gu et al., 2023), educational technology research trends (Murnaka, 2021), additive manufacturing in orthopaedics (Javaid and Haleem, 2019), and endogenous retroviruses (Zaib et al., 2022). However, in the literature, there are few bibliometric studies on honey bee products and apitherapy. Şenel and Demir (2018) used bibliometric analysis to investigate apitherapy in complementary therapies between 1980 and 2016. In this study, they used the Web of Science database and found that Brazil, came in first with 889 published papers, followed by the United States, China, Japan, and Turkey. The most frequently used terms were propolis, flavonoids, *Apis mellifera*, bee venom, and apoptosis. Zakaria et al. (2021) did a bibliometric analysis of honey-related publications from 2011 to 2020 to determine the trend of honey research. The United States was the top country conducting research on honey, while Food Chemistry was the top journal. The top author keywords in terms of co-occurrence were "honey," "antioxidant," "chemometric," "Manuka honey," and "antibacterial". Durazzo et al. (2021) extracted bibliometric data from the Scopus online database using keywords (honey* and health*) that focused on honey and health. Stefanis et al. (2023) did a bibliometric analysis using the Scopus database, R, and Web of Science (WoS) viewer from 2001 to 2022 to determine the outline of honey's antioxidant and antimicrobial properties. In addition, there are some bibliometric analyses on bee studies. Decourtye et al. (2019) used bibliometric analysis with science data from the Web of Science in the last 30 years (1986–2016) to explore how the impact of threats on bee populations was investigated in the published literature (a retrospective overview) and what

further studies are needed to offer mitigation options (a prospective overview). Ziegler et al. (2021) investigated papers related to the reduction in *A. mellifera* mortality through bibliometric analysis. Data on patent families were collected on the Orbit platform, while data on scientific articles were collected on the Scopus database, with a time interval of 1980–2019.

Bibliometric analysis allows researchers and other partners to obtain detailed knowledge of the field of study.

This study was conducted because there is no existing research employing bibliometric analysis using the keyword "bee pollen". The current study was undertaken to identify and analyze publication trends related to bee pollen over the last 10 years. In this way, periods of active research with bee pollen were identified, and shifts or changes in the themes investigated were assessed. Another objective is to identify key authors, institutions, or countries contributing to research in this field by analyzing co-authorship patterns and citation networks of bee pollen. At the same time, by analyzing citation patterns in the field of bee pollen, it was determined which articles received the most citations, and the most influential studies or publications in this field were identified. The main themes or topics in the field of bee pollen research were identified. The aim of this study is to provide a comprehensive view of bee pollen studies and to contribute to future research on this matter.

MATERIAL-METHODS

Materials

This study focuses on academic documents related to bee pollen. The data for this study was collected from the electronic database "Web of Science" (Thomson Reuters, New York, NY, USA). The word "bee pollen" has been searched for in the WOS database according to all fields. The keyword search was conducted in the research areas belonging to the main headings of natural, life, physical, environmental, health, environmental, health, agricultural and food, biomedical, social, and applied sciences. The search encompassed academic documents written between January 2011 and January 2023. The time frame of the search was chosen to capture a defined period of research production and enable the identification of trends and patterns within that time (Wang and Ma, 2015). Consequently, in this investigation, research data about bee pollen from the last ten years was employed. Therefore, screening results between 2011 and 2022 in the bibliometric analysis of bee pollen gave a valuable tool to gain insight into the current state of research and identify future research opportunities. We included the documents, book chapters (n=7), meeting abstracts (n=19), and reviews (n=62) written in English. Documents written in languages other than English were excluded.

Purpose:

The purpose of this study was to conduct a bibliometric analysis for the evaluation of research on bee pollen. Specifically, we aimed to gain insight into the current state of bee pollen research, identify keywords, key authors, institutions, countries, cooperations, and identify emerging trends in research in this field.

Scope:

This study focused on academic documents related to bee pollen. The Web of Science is a widely recognized web-based tool that provides access to a vast collection of bibliographic and citation information from leading scholarly journals. It is particularly suitable for bibliometric analysis due to its comprehensive coverage and the ability to perform straightforward queries (Kahn, 2011; Zahedi et al., 2014). By utilizing Web of Science, we could leverage its reliable source of citation data, track the impact of research over time, and identify key authors, institutions, and emerging trends in research (Song et al., 2021).

Methods

All numerical data utilized in this study, were taken from Web of Science database and loaded into R studio Bibliometrix package and VOSviewer. To evaluate the scientific research on bee pollen, we utilized the R-based Biblioshiny program, which can be accessed at https://bibliometrix.org/ (Büyükkıdık, 2022).

This program offers several advantages for bibliometric analysis, including flexibility, reproducibility, integration with statistical analysis, an extensive package ecosystem, and support from the active R community.

The R-based Biblioshiny program allowed us to process and analyzed the collected data using various bibliometric techniques. These techniques include network analysis, text mining, data visualization, and statistical analysis. By leveraging the capabilities of R and the bibliometric packages it provides, we were able to gain comprehensive insights into the research landscape surrounding bee pollen. A software program called VOSviewer (Leiden University, Leiden, Netherlands) was used to see and explore maps made from bibliographic data (Van Eck and Waltman, 2010) VOS stands for visualization of similarities. It is a free Java program that may be downloaded and utilized. This program was used in this study to analyze and visualize the co-occurrence of keywords and the co-citation of references.

RESULTS AND DISCUSSION

In this study, 921 documents related to bee pollen, published between 2011 and 2022, were detected in the database WOS. Among the 921 documents, 833 (90.45%) were research articles, 62 (6.73%) were reviews, 19 (2.06%) were meeting abstracts, and 7 (0.76%) were book chapters. The most published documents were determined in 2022, with a total of 143 and the fewest were determined in 2011, with a total of 21 (Table 1). Except for 2013, the number of publications has increased in each subsequent year. The average citations per document and per document per year were 15.88 and 2.70, respectively. When we examine the graph, the number of citations has been decreasing since 2019 (Table 1). This was thought to be typical, given the amount of time that had passed since its publication.

Table 1. Annual total citiation and published documents number

Year	MeanTCperArt[1]	N[2]	MeanTCperYear[3]	CitableYears
2011	41.1	21	3.16	13
2012	41.8	35	3.48	12
2013	37.29	28	3.39	11
2014	30.65	43	3.06	10
2015	26.16	62	2.91	9
2016	19.42	74	2.43	8
2017	18.7	80	2.67	7
2018	18.83	81	3.14	6
2019	15.13	92	3.03	5
2020	9.38	128	2.35	4
2021	5.84	134	1.95	3
2022	1.63	143	0.81	2

1: The average number of total citations per article; 2: the total number of articles; 3: the mean total citations per year

The top ten journals publishing the highest number of articles about bee pollen with their article numbers are given in Table 2. The journal that published the most articles on this subject was Molecules with 46 manuscripts, followed by 38 manuscripts for the Journal of Apicultural Research and 21 articles for Foods. The research field of the Journal of Apicultural Research is bee science. The other top ten journals dealt with analytical chemistry, the chemistry and biochemistry of agriculture, and food. The most cited journals were Molecules, Plos One, and

Journal of Agricultural and Food Chemistry, respectively (Table 2). The fact that the two most cited articles were published in PLoS One and Molecules demonstrates that these journals are also active in the field.

Table 2. The top 10 journals that publish the most articles and their citiation numbers on bee pollen

Journal	Article number	Citation
Molecules	46	1075
Journal of Apicultural Research	38	344
Foods	21	101
Journal f Microbiology Biotechnology and Food Sciences	20	76
Lwt-Food Science and Technology	20	395
Journal of Apicultural Science	16	210
Journal of Agricultural and Food Chemistry	14	488
Plos One	13	890
Antioxidants	12	157

Table 3 lists the most cited documents, including author, publication year, journal title, total citations, and total citations per year. First and nineth were the research papers examining the relationship between bee pollen and bees death. The 8th most-cited article examined the macronutrients in bee pollen and their effectiveness in bee nutrition. Of the other most-cited articles, the 5th, 6th, and 7th are reviews, and the 3rd, 4th, and 10th are research studies, and they all discussed the bioactive properties and therapeutic features of bee pollen.

Table 3. The specifics of the most-cited global article

	Paper	Type	Total Citations	TC[3] per Year
1	Krupke Ch, 2012, Plos One	R[1]	544	45.33
2	Imran M, 2019, Molecules	D[2]	235	47.00
3	Pascoal A, 2014, Food Chem Toxicol	R	215	21.50
4	Morais M, 2011, Food Chem Toxicol	R	193	14.85
5	Cornara L, 2017, Front Pharmacol	D	188	26.86
6	Denisow B, 2016, J Sci Food Agric	D	185	23.13
7	Komosinska-Vassev K, 2015, Evid-Based Complement Altern Med	D	181	20.11
8	Vaudo Ad, 2016, Proc Natl Acad Sci U S A	R	180	22.50
9	Kasiotis Km, 2014, Sci Total Envron	R	170	17.00
10	Feas X, 2012, Molecules	R	169	14.08

1: Research; 2: Review; 3: Total citiations

Figure 1. represents the top ten countries on the theme of bee pollen. China was at the top of the list of nations with the most documents (562). It was followed by Brazil (330) and Turkey (295). Italy, Portugal, the USA, and Spain were among the countries that publish the most articles about bee pollen. The high number of documents on the theme of bee pollen in certain countries can

be attributed to various factors. Overall, the cause-effect relationships underlying the prominence of certain countries in bee pollen research can be attributed to factors such as favorable climates, diverse flora, abundant resources, and long-standing cultural practices related to bee product utilization. China, for instance, ranked at the top with 562 documents. This was primarily due to its extensive landmass and diverse flora, creating an ideal climate for apiculture. As a result, China has emerged as the world's largest manufacturer, consumer, and exporter of bee products, including bee pollen (Yang et al., 2013). Similarly, Brazil, located in the southern hemisphere between latitudes 0-30, benefits from a rich biodiversity and favorable climatic conditions (Roesch et al.,2009). This enabled a diverse range of bee species and abundant floral resources, leading to Brazil's significant contribution to bee pollen research and publication output. The favorable conditions in terms of climate and abundant resources have fostered a long-standing tradition of utilizing bee pollen as a functional food in China.

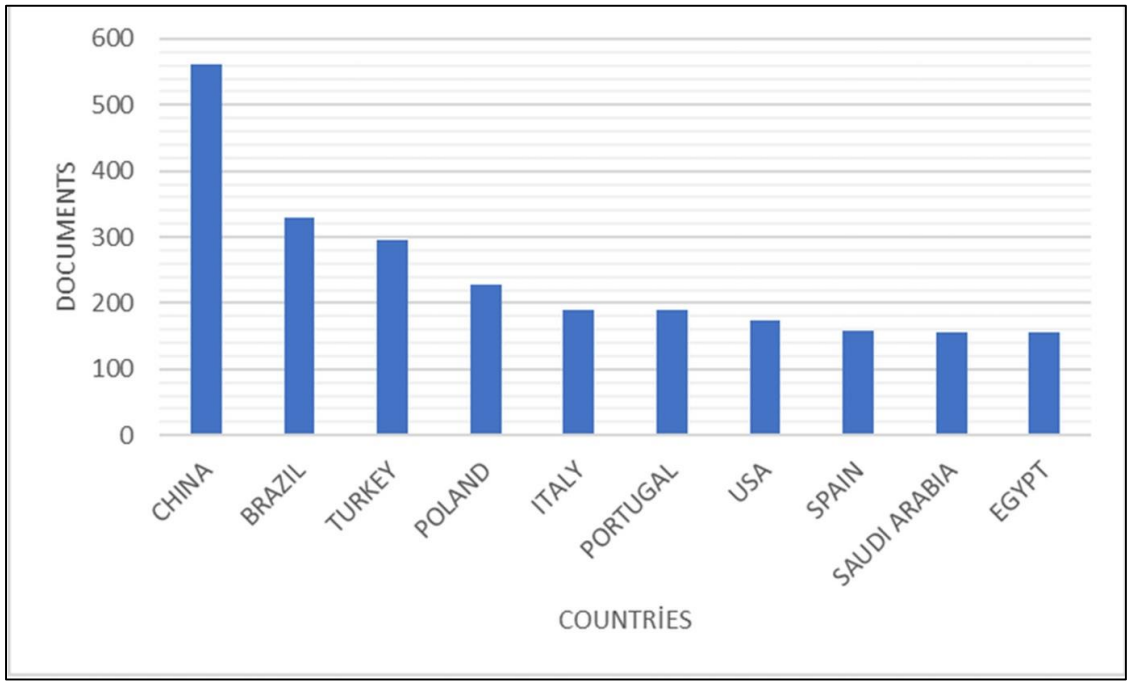

Figure 1. Countries' scientific production

Figure 2. highlights the average citation by country and shows that China (1855), USA (1336) and Poland (1306) have a total citation than others. Since the countries with the most publications, except for Saudi Arabia and Egypt, were also on the list of the most cited countries. Although China was the country with the highest number of publications (Figure 1) and citations, it ranks 9th with 13.90 in the average number of citations per article (Figure 2). Although USA ranked 7th among the countries with the most publications (175), it ranked 2nd in total citations and 1st in average citations per article. Turkey was the 3rd country with the highest number of publications, it ranked 3rd in total citations and 10th in average citations per article. Although Iran and Greece were not among the top 10 countries that publish the most, they were the 9th and 10th in total citations and the 4th and 3rd in average citations per article, respectively.

Keywords and keyword plus assessment provided valuable insights into the aims and related topics of this study. In Table 4, the authors' keywords and keyword plus, which are derived from references in published papers, are presented.

These sets of keywords often overlap, highlighting their strong association with the subject. Notably, the top 20 keywords emphasized the source of pollen, the bioactivity of bee pollen, and various aspects of bee products.

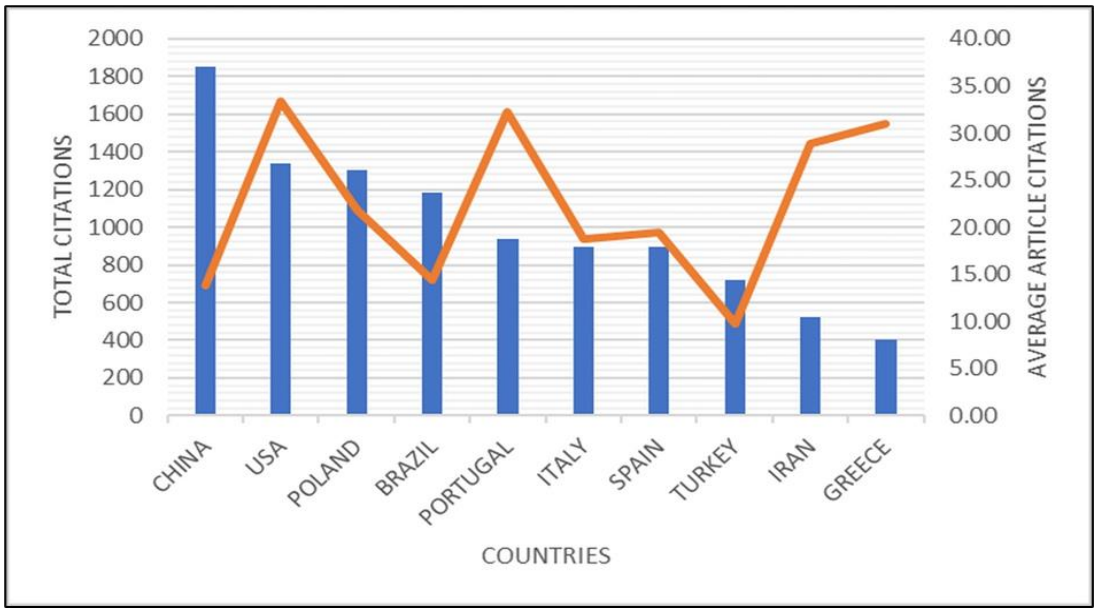

Figure 2. The total and the average citation by country

Table 4. The top 20 most keywords and keywords plus

	Author Keywords		Keywords Plus	
	Words	Occurrences	Words	Occurrences
1	bee pollen	343	chemical-composition	147
2	pollen	103	bee pollen	131
3	propolis	60	propolis	96
4	honey	59	antioxidant	94
5	antioxidant activity	45	honey	94
6	apis mellifera	44	honeybee-collected pollen	92
7	antioxidant	41	antioxidant activity	91
8	flavonoids	35	quality	74
9	bee products	33	origin	72
10	polyphenols	29	extract	61
11	bee bread	28	pollen	60
12	phenolic compounds	24	bioactive compounds	54
13	fatty acids	22	capacity	53
14	antimicrobial activity	17	extracts	53
15	nutrition	16	hymenoptera	48
16	royal jelly	16	botanical origin	43
17	antioxidant capacity	14	flavonoids	41
18	bioactive compounds	14	extraction	38
19	chemical composition	14	phenolic-compounds	37
20	oxidative stress	14	products	37

To explore the relationships among these keywords, a co-occurrence analysis was conducted using all 2511 keywords as the unit of analysis. By setting a minimum threshold of 10 occurrences per keyword, a subset of 41 keywords met this criterion. Figure 3 visually depicts the co-occurrence analysis, providing insights into the connections between these top 41 keywords and their relationships. In the co-occurrence analysis, a total of 268 links were identified among the keywords, representing the frequency of their co-occurrence in the analyzed literature. These links illustrated the interconnectedness between various keywords and shed light on their relationships. The cumulative strength of these links, totaling 797, signified the overall strength of the relationships among the keywords. This analysis unveiled the intricate web of connections between different research areas within the domain of bee pollen. The identified relationships highlight the interplay between factors such as the source of pollen, the bioactivity of bee pollen, and the diverse applications of bee products. Understanding these relationships aids in comprehending the broader scope of research and the interdependencies between various aspects of bee pollen studies. In summary, the co-occurrence analysis of the top 41 keywords revealed the relationships and interconnectedness between different research areas. The identified links and their cumulative strength provided insights into the frequency and overall strength of these relationships, contributing to a deeper understanding of the subject matter. The first cluster focused on the nutritional aspects and products related to bees. It included keywords such as amino acids, antioxidants, *Apis mellifera*, bee pollen, bee-pollen, beekeeping, broiler, fatty acids, minerals, nutrition, and protein. Researchers in this cluster were explored the nutritional composition and benefits of bee products, highlighting their potential role in human nutrition and health (Bayram, 2021). Keywords in the second cluster, including antimicrobial activity, antioxidant activity, antioxidant capacity, bee products, botanical origin, flavonoids, functional food, HPLC, and polyphenols, indicated research on the biological properties and chemical composition of bee products (Sawicki et al., 2022). Scientists investigated the potential bioactive compounds, functional properties, and health benefits associated with these products, paving the way for their utilization as functional foods. The third cluster delved into the analytical techniques and specific aspects of honey and related products. Keywords like GC-MS, honey, honeybee, LC-MS/MS, mycotoxins, pesticides, quechers, and royal jelly suggest research focused on quality control, contaminants, and the chemical characterization of honey and its derivatives (Pang et al., 2022). Scientists in this cluster developed and applied analytical methods to ensure the safety and authenticity of honey products. Keywords in the fourth cluster, including antioxidants, apoptosis, bees, oxidative stress, phenolic compounds, and pollen, highlighted investigations into the roles of antioxidants, phenolic compounds (Mayda et al., 2020), and oxidative stress in relation to bees and apoptosis. Researchers were explored the effects of oxidative stress on bee health, the potential protective properties of antioxidants, and the underlying mechanisms involved in bee cell death (apoptosis). This cluster centered around the study of bioactive compounds, chemical composition, and the use of propolis. Keywords such as bioactive compounds, chemical composition, food analysis, probiotic, and propolis indicated research on the identification, quantification, and functional properties of bioactive compounds in propolis (Kocot et el., 2018). Scientists in this cluster also investigated the application of propolis as a potential natural product in food and health industries. Keywords bee bread and fermentation define the end cluster, which focuses on the concept of bee bread and its relationship to fermentation processes (Di Cagno et al., 2019).

These clusters provided an organized framework for understanding the different aspects and areas of research within the field of bee-related studies, allowing researchers to explore the interconnectedness of these topics and facilitate knowledge sharing and collaboration.

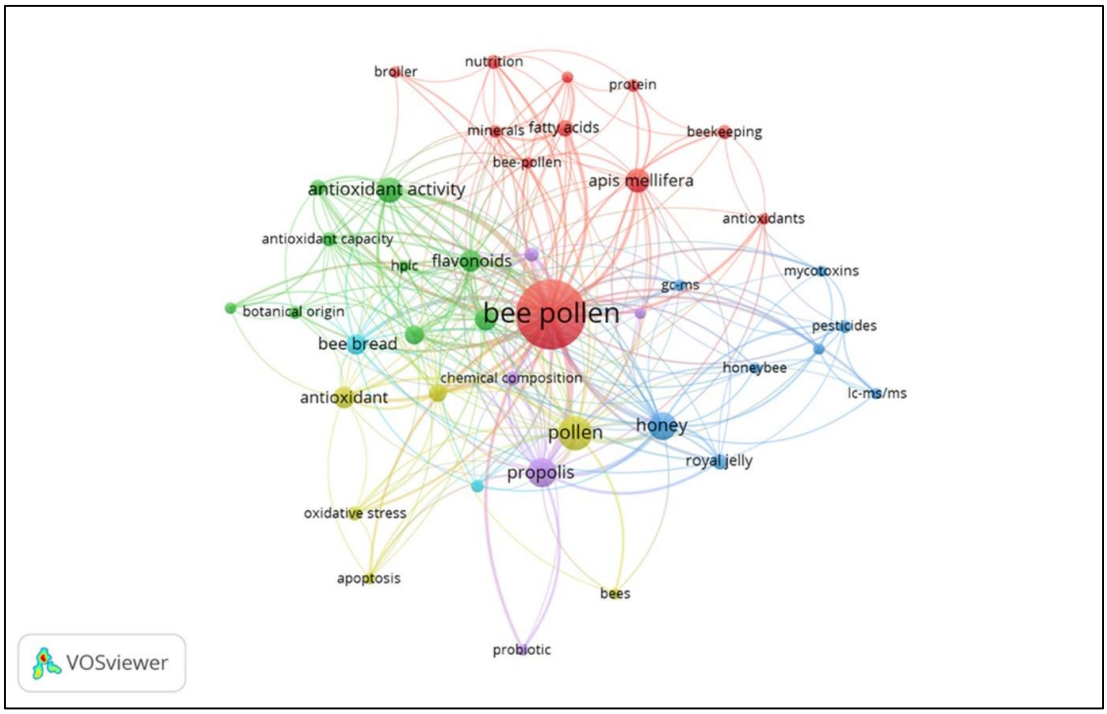

Figure 3. Co-occurrence analysis in the most popular 41 keywords

The collaboration map in Figure 4 illustrates the worldwide cooperation among researchers studying bee pollen. Each collaboration between countries was limited to less than five occurrences. The study utilized VOSviewer to perform a co-occurrence analysis with co-authors as the unit of analysis. To meet the minimum threshold of 5 occurrences per country, 46 out of 85 countries satisfied the criteria. The analysis revealed a total of 200 links among the countries, representing the frequency of co-occurrence in the research documents. The cumulative strength of these links was calculated as 408, indicating the overall strength of the relationships between the countries.

Figure 4 displays the cooperation links among the countries using lines, while 10 different colors represent the collaboration clusters of the countries. The identified clusters were as follows: Cluster 1: Belgium, Canada, Chile, France, Lithuania, Netherlands, and Ukraine.; Cluster 2: Australia, Indonesia, Iran, Japan, South Korea, Thailand, and USA; Cluster 3: England, Greece, India, Mexico, Serbia, and Slovenia; Cluster 4: Austria, Bulgaria, Germany, Romania, and Turkey; Cluster 5: Egypt, Malaysia, Pakistan, Sweden; Cluster 6: Argentina, Brazil, Morocco, and Portugal; Cluster 7: Czech Republic, Iraq, Poland, Slovakia; Cluster 8: Colombia, Italy, Spain; Cluster 9: Algeria, Saudi Arabia, Tunisia; Cluster 10: People's Republic of China and Taiwan.

Regarding the co-authorship map of countries, it was worth mentioning that out of the 85 countries represented, 46 countries fulfilled the minimum threshold of five documents for co-authorship. Evaluating the total link strength, Egypt emerged as the most influential country with 59 documents, 1009 citations, and a total link strength of 81 (Figure 4). Following closely, Saudi Arabia held the second position with 52 documents, 668 citations, and the same total link strength of 81. Peoples Republic of China secured the third most influential spot, contributing with 141 documents, 2260 citations, and a total link strength of 64. Among the cooperation links between countries, the highest number of collaborations were observed between Arabia and Egypt, Brazil-Portugal, China-USA, and Italy-Egypt.

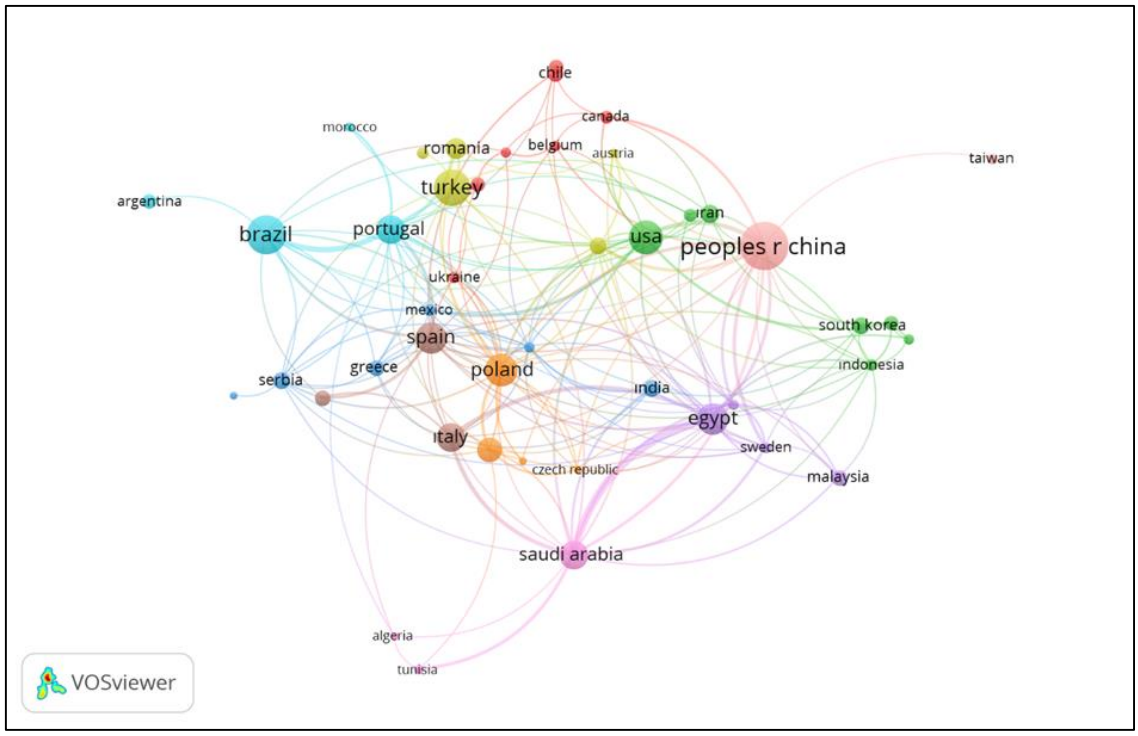

Figure 4. The co-authorship map of countries

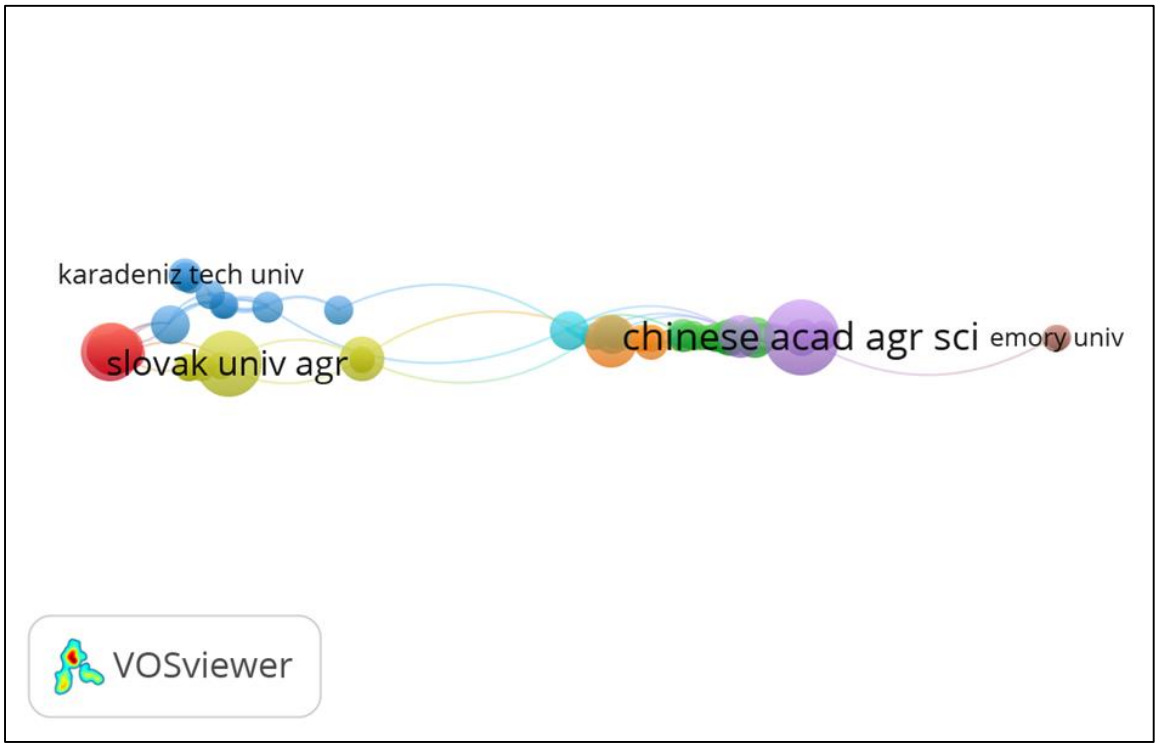

Figure 5. The co-authorship map of organizations

In the co-authorship map of organizations, it was worth noting that out of the 1083 countries represented, 79 countries met the threshold of having at least five documents. Figure 5 displays the organizations with the highest total link strength at the center of the map. The diameter of a node in the figure is directly proportional to the number of co-authorship links it has with other nodes. This visual representation allowed for an intuitive analysis of the contribution and proximity of major research institutions.

Based on the available data, the Chinese Acad Agr Sci (Chinese Academy of Agricultural Sciences) exhibited the strongest total link strength with a value of 43, indicating extensive collaboration with other organizations. Jiangsu University ranked second with a total link strength of 37, showcasing significant collaborative connections. Uppsala University followed closely in third place with a total link strength of 34. These findings highlighted the prominent research contributions and close associations of these respective institutions within the co-authorship network.

According to the co-authorship map presented in Figure 6, there were a total of 3.573 authors involved. Among them, 78 authors surpassed the threshold of having at least five papers published. Evaluating the total link strength, it was found that Peter Hascik had the highest influence with 17 documents, 107 citations, and a total link strength of 56. Following closely, Jose Bernal had the second highest influence with 20 documents, 233 citations, and a total link strength of 53. Miroslava Kacaniova secured the third position in terms of influence, contributing with 21 documents, 282 citations, and a total link strength of 51.

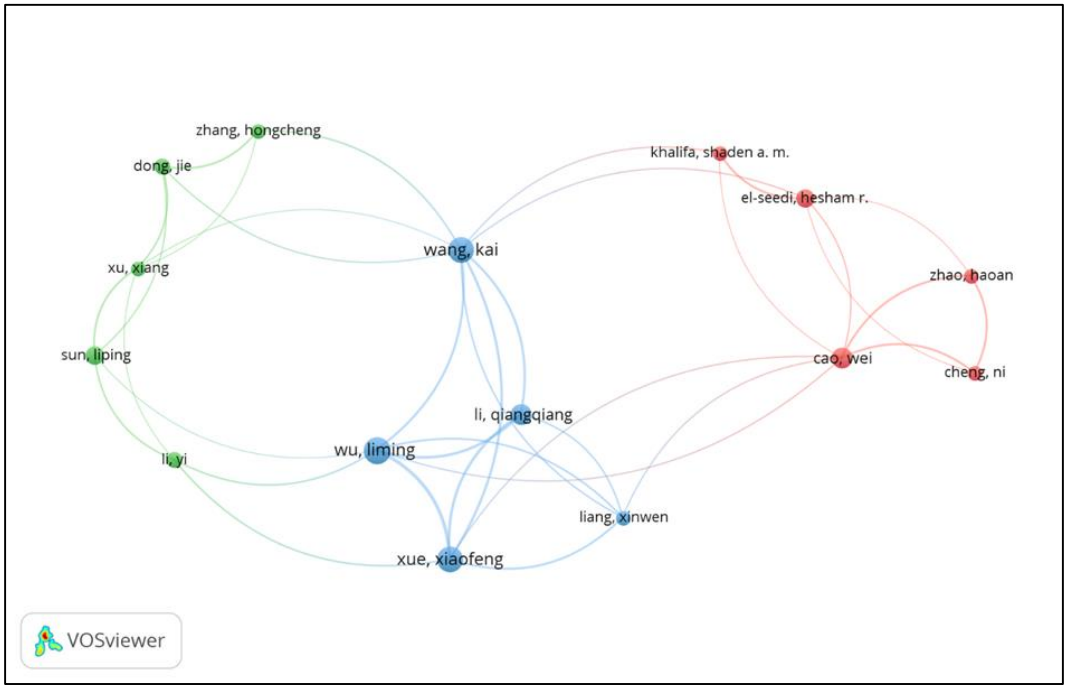

Figure 6: The co-authorship map

Bibliometric analysis is a potent tool that incorporates the quantitative study of scholarly publications and citations to learn more about the state of a certain field's research (De Bellis, 2009). Researchers can find patterns, trends, and linkages within a given field of study by examining various bibliographic data, including publication counts, citation counts, author affiliations, journal impact factors, and co-citation networks. To search the WoS database, Şenel and Demir (2018), used the keywords honey, bee venom, royal jelly, propolis, and apitherapy. A total of 6917 articles

from the beginning of 1980 to the end of 2016 were found in their WoS database search. We used only the keyword bee pollen with this study. Therefore, we evaluated 921 publications between the beginning of 2011 and the beginning of 2023.

Stefanis et al. (2023) aimed to offer a bibliometric analysis of the honey's antibacterial and antioxidant effects in 2001 to 2022. Articles (273) and reviews (81) made up the majority of the 383 results, and the yearly growth rate of published submissions reached 17.5%. In this study, all data on bee pollen between 2011 and 2022 were analyzed.

The fact that our study was the first in the bibliometric analysis of bee pollen studies and that there was no other study to compare, despite the recent increase in interest in studies, was a sign of the insufficiency of the statistical literature in this field.

CONCLUSIONS

Because of its distinctive composition, bee pollen is used as a nutritional supplement, and researchers have shown that it has powerful health benefits, including being an antioxidant, antiallergen, anti-inflammatory, antiulcer, immune-stimulating, antibacterial, and anticarcinogenic. The bibliometric analysis of bee pollen studies provides valuable insights into the research environment surrounding this natural product. By applying bibliometric techniques to the existing literature on bee pollen, this study was able to identify key trends and gaps in the field.

The analysis revealed that interest in bee pollen research has steadily increased over the years, pointing to the growing importance and potential applications of this product. Researchers have investigated various aspects of bee pollen, such as its chemical composition, nutritional properties, therapeutic potential, and environmental impacts.

Furthermore, the bibliometric analysis sheds light on the most prolific and influential authors, institutions, and countries in the field, highlighting collaboration networks and knowledge sharing patterns. This information can help researchers identify potential collaborators and facilitate resource exchange.

The analysis also identified emerging research topics and areas of limited scope, providing opportunities for future research. Overall, bibliometric analysis of bee pollen studies serves as a valuable tool for researchers and industry stakeholders. It has not only provided a comprehensive overview of the existing knowledge base but also guided future research efforts.

AUTHOR CONTRIBUTION

DNÇ, İKT: Writing original draft, review & editing, Investigation, Supervision, conceptualization, bibliometric analysis.

CONFLICT OF INTEREST

The authors of this article declare that they have no known competing financial interests or personal relationships that could have appeared to affect this work.

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