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Global publication trends in apitherapy research: A bibliometric analysis in the context of complementary health

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Abstract

In this study, global publications on apitherapy published between 2017 and 2025 were analysed using bibliometric methods. The data were retrieved from the Web of Science (WoS) Core Collection database and analysed using VOSviewer and R software. Bibliometric performance indicators, network visualisation, thematic evolution, and factor analysis were applied to evaluate the field's structure and development. The results indicated that apitherapy research demonstrated a continuous upward trend during the study period, with an average annual growth rate of 7.79%. China, Brazil, and Iran were identified as the most productive countries, while Türkiye ranked tenth. Karadeniz Technical University was among the top contributing institutions. The majority of publications were concentrated in the fields of molecular biology, pharmacology, and biochemistry. "Propolis" was identified as the most frequently used keyword. Thematic evolution analysis revealed that "bee" and "bee venom" were prominent in earlier years, whereas "propolis" and "melittin" gained increasing prominence in recent years. Factor analysis demonstrated that the literature was primarily structured around basic science and clinical research themes. Overall, this study provides a comprehensive bibliometric evaluation of global research trends, intellectual structure, and thematic development in apitherapy, and offers valuable insights to guide future research.

Keywords: Bee Products, Citation analysis, Propolis, Integrative medicine, Research trends

INTRODUCTION

The global increase in disease burden, emerging infectious diseases, financial pressures, and advances in medicine have led to changes in patient expectations (Hacker 2024; Naghavi et al. 2024). In particular, these changes have contributed to a growing interest in complementary and alternative medicine (CAM). Interest in CAM-based approaches continues to rise, and consequently, the number of scientific studies on the subject has also increased (Calcagni et al. 2019; Yıldırım, 2026). In this context, examining the scientific literature on complementary health practices, such as apitherapy, is important for developing evidence-based health applications.

Apitherapy involves the use of bee products for the prevention and treatment of diseases (Hellner et al. 2007). These products include not only traditional bee products (honey, pollen, propolis, royal jelly, beeswax, bee bread, apilarnil) but also immunologically active molecules such as hive air, antimicrobial peptides, and fatty acids (El-Didamony et al. 2024). The application of apitherapy covers a wide range, from disease prevention to treatment (Sağlık Bakanlığı 2025). In terms of properties and effects, apitherapy exhibits antioxidant, antibacterial, anti-inflammatory, anticarcinogenic, antidiabetic, wound-healing, gastroprotective, and cardioprotective activities (Khan et al. 2017, Pasupuleti et al. 2017). Therefore, the applications of apitherapy range from disease treatment to the cosmetic industry. (Khan et al. 2017, Pasupuleti et al. 2017). They have been used in the treatment of various conditions such as diabetic foot ulcers, wound 52 healing after eyelid surgery, eczema, tuberculosis, constipation, type 2 diabetes, and neurological disorders 53 (Fratellone et al. 2016; Imran et al. 2015; Malhotra et al. 2017; Ulusoy 2012; Zakerkish et al. 2019). The broad range of 55 applications of apitherapy products has led to both quantitative and qualitative growth in the scientific literature 56 on this topic.

Despite this expansion, studies that comprehensively examine the structure, research trends, and production capacity of the apitherapy literature remain limited. The first comprehensive bibliometric analysis of apitherapy examined the period from 1980 to 2016 (Şenel and Demir 2018). More recent bibliometric analyses have focused on a single apitherapy product, such as bee venom

(Şenel and Dalı 2019) or bee pollen (Temizer and Çobanoğlu 2023), or on specific diseases (Wen et al. 2025). Therefore, there is a need for a holistic bibliometric analysis of recent apitherapy literature. This study contributes to the literature by evaluating global publication trends in apitherapy from 2017 to 2025. In this context, the aim of the study is to analyze publications related to the apitherapy literature using bibliometric methods.

MATERIALS AND METHODS

Data Source and Search Strategy

The literature search was conducted in the Web of Science Core Collection (WoS) database. The search strategy in the Topic field used the following keywords with Boolean operators: "apitherapy" OR "apiterapi" OR "bee venom" OR propolis OR "royal jelly" OR "bee pollen" OR "honey".

Inclusion and Exclusion Criteria

The inclusion criteria of the study were as follows: (1) publications published between 1 January 2017 and 31 December 2025, excluding 2026 since the year was not yet complete, (2) studies classified as articles and reviews, and (3) publications written in English. After applying the inclusion criteria, 12,684 publications remained. In line with the study's aim, the Web of Science (WoS) categories were restricted to health-related fields to focus on publications on the therapeutic and clinical applications of apitherapy products. The selected categories included: Integrative & Complementary Medicine; Medicine, General & Internal; Pharmacology & Pharmacy; Oncology; Immunology; Biochemistry & Molecular Biology; Health Care Sciences & Services; Health Policy & Services; Public, Environmental & Occupational Health. This restriction was applied only at the initial filtering stage and was not used during the analysis. Thus, the resulting dataset was intended to reflect the healthcare and clinical context. As a result, records that did not meet the inclusion criteria were excluded, leaving a final dataset of 3,762 publications. The study selection process is summarized in the PRISMA flow diagram, shown in Figure 1.

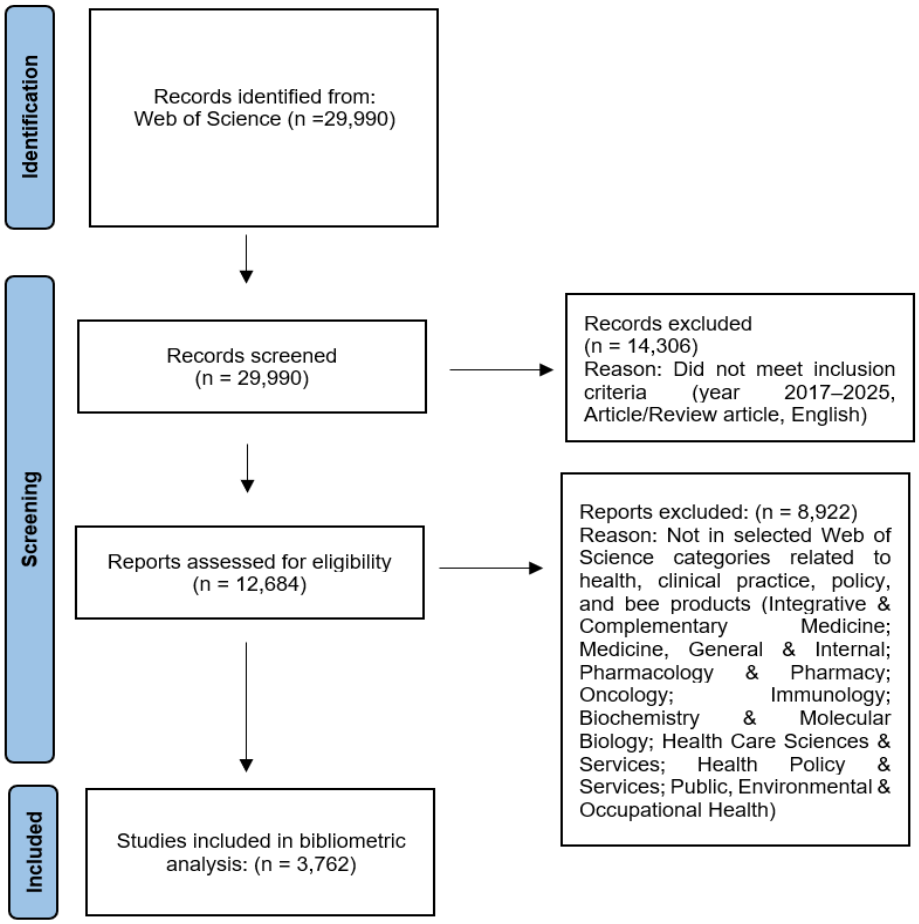

Figure 1. PRISMA Diagrams

Data Analysis

Bibliometric analysis was employed in this study. Within this framework, the analysis was conducted in accordance with the bibliometric methodological framework and guidelines developed by Donthu et al. (2021). This approach allows for the systematic examination of the performance structure of the literature. The analyses were carried out using VOSviewer and R. VOSviewer was used for network analysis and visualisation, and for generating keyword co-occurrence maps and international collaboration networks. In addition, statistical analyses, thematic evolution analysis, and factor analyses were performed in the R software environment using the bibliometrix package and the biblioshiny interface. By combining VOSviewer and R, a holistic approach was adopted to reveal the thematic and temporal development of the apitherapy literature.

Study Limitations

This study has several limitations. First, the analyses were conducted solely using the Web of Science (WoS) database, and studies indexed in other databases such as Scopus and PubMed were not included. Therefore, the findings are limited to data obtained from the WoS database. Second, only studies published in English were included in the analysis, while publications in other languages were excluded. Finally, although the use of category-based filtering strengthened the study in the context of health and complementary medicine, it may have led to the exclusion of some borderline interdisciplinary studies.

RESULTS

Within the scope of the study, a dataset comprising 3,762 publications published between 2017 and 2025 was obtained from the Web of Science database. The basic descriptive information related to these publications is presented in Table 1. These data were analysed to reveal the scope and structure of scientific production in the apitherapy literature.

The analysed publications were published across 686 sources, including journals and book chapters, and the average annual publication growth rate was 7.79%. A total of 153,834 references were used in the analysed publications, and the average number of citations per publication was found to be 18.55.

Table 1. Basic descriptive characteristics of the publications analysed

Timespan	**2017-2025**
Sources (Journals, Books, etc)	686
Documents	3762
Annual Growth Rate %	7.79
Document Average Age	4.53
Average citations per doc	18.55
References	153834
Document Contents	
Keywords Plus (ID)	6966
Author's Keywords (DE)	8986
Authors	
Authors	19120
Authors of single-authored docs	86
Authors Collboration	
Single-authored docs	89
Co-Authors per Doc	6.33
International co-authorships %	25.78
Document Types	
Article	3032
Article; book chapter	13
Article; early access	24
Article; proceedings paper	6
Article; retracted publication	1
Review	679
Review; book chapter	3
Review; early access	4

Accordingly, the literature on apitherapy is characterised by a comprehensive and multidisciplinary knowledge base, and academic interest in the field has increased. The annual distribution of apitherapy-related publications from 2017 to 2025 is shown in Figure 2.

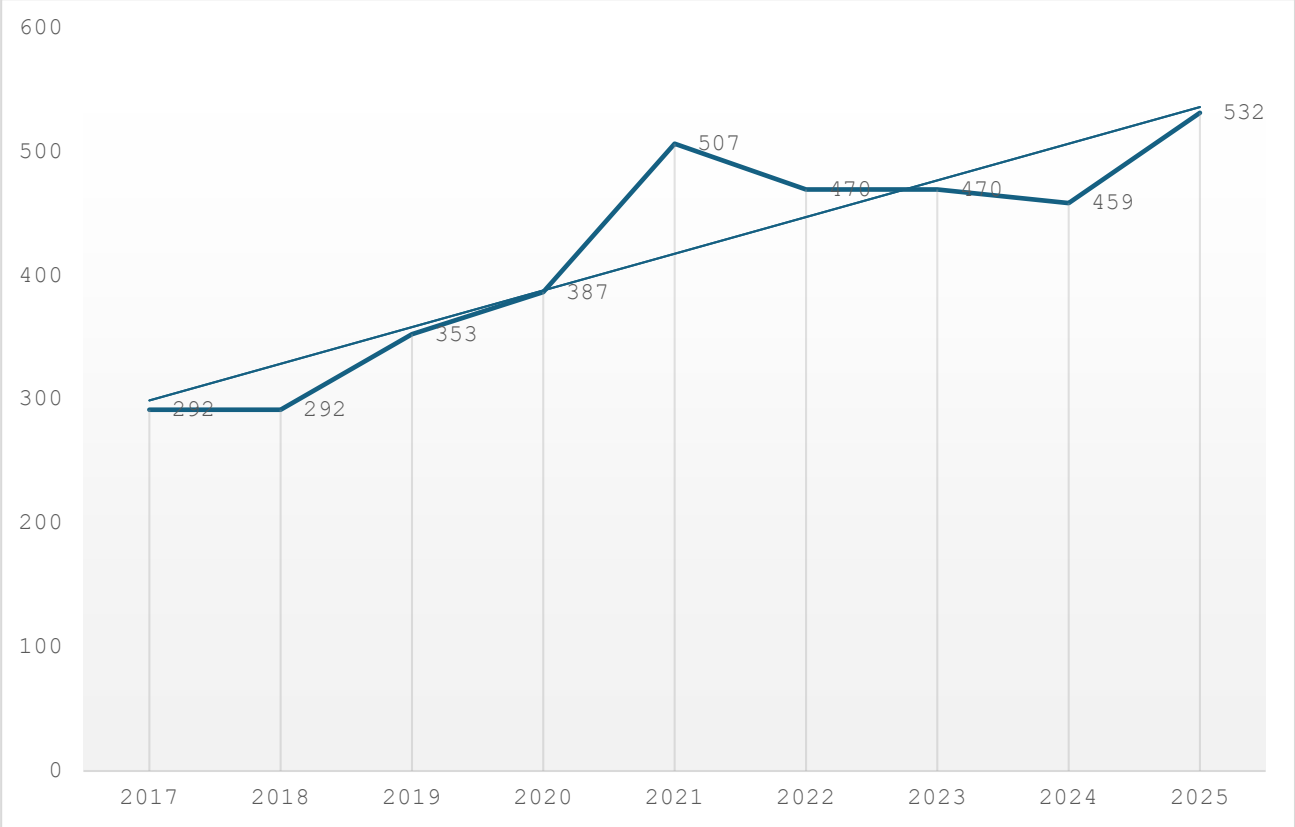

Figure 2. Annual distribution of publication counts between 2017 and 2025

Between 2017 and 2025, the number of publications fluctuated but generally increased (Figure 2). During the examined period, the number of publications grew from 292 in 2017 to 532 in 2025, corresponding to an approximate annual growth rate of 7.8%. Regarding the scientific output of countries, the top ten countries were China (1,508), Brazil (1,344), Iran (1,160), India (641), Saudi Arabia (606), Egypt (601), South Korea (576), Poland (540), the USA (523), and Türkiye (491). Figure 3 illustrates international collaboration among countries. In the international collaboration analysis, node size represents the number of publications, and the links indicate international cooperation. China, Brazil, and the USA occupy the centre of the network and exhibit strong collaborations with multiple countries. Türkiye was identified as the 10th-highest-publishing country and was connected to multiple clusters, also showing collaboration with the USA and European countries. At the institutional level, the top three organisations were the Egyptian Knowledge Bank (Egypt – 519 publications), Universidade de São Paulo (Brazil – 186 publications), and Tehran University of Medical Sciences (Iran – 114 publications). Türkiye Karadeniz Technical University ranked 10th with 87 publications.

Within the scope of the analysis, studies were published across 679 sources, and information on the top 10 journals with the most publications is presented in Figure 4. While the publications are concentrated in certain journals, Molecules ranked first with 337 publications. Overall, publications are predominantly in journals related to complementary approaches, such as molecular sciences, pharmacology, and biochemistry.

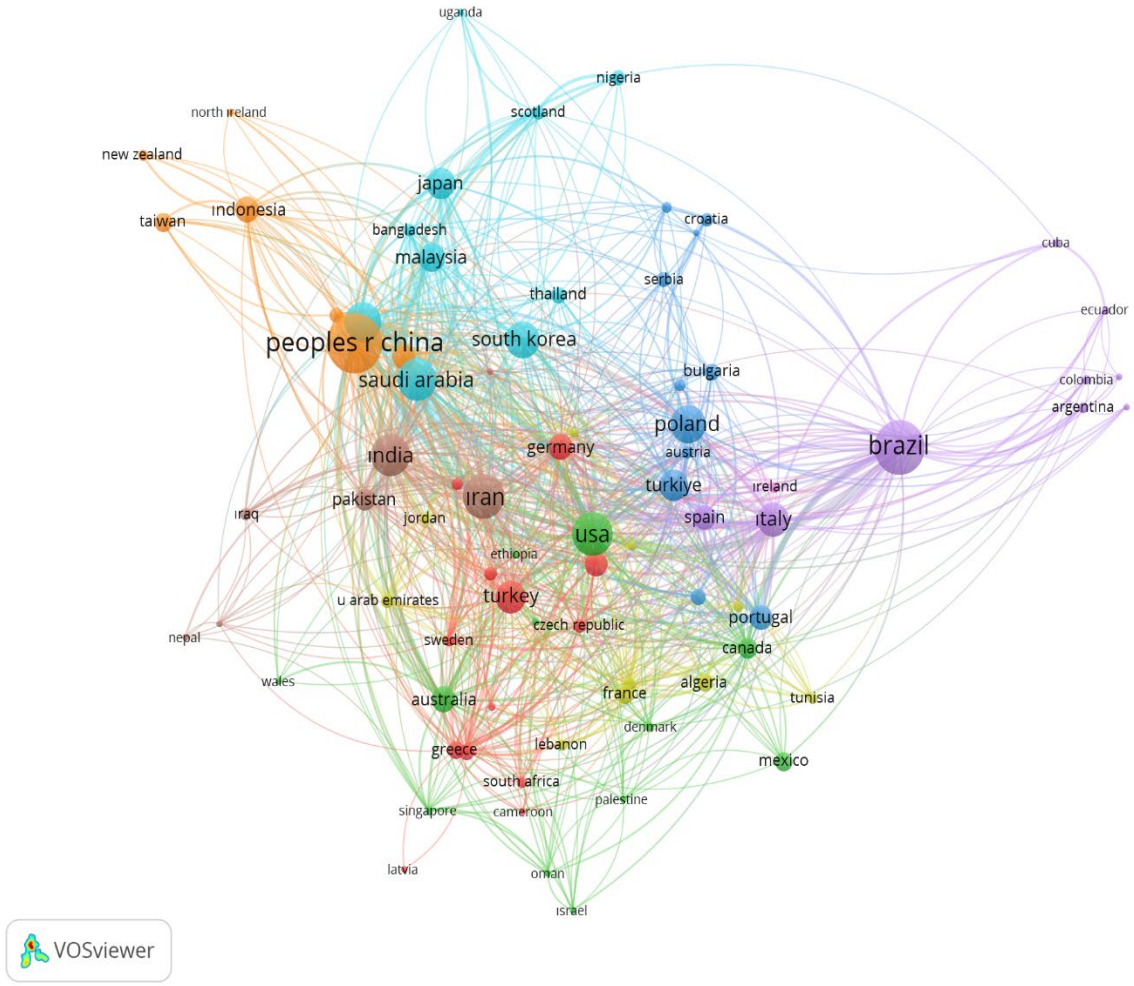

Figure 3. Country-level co-authorship network

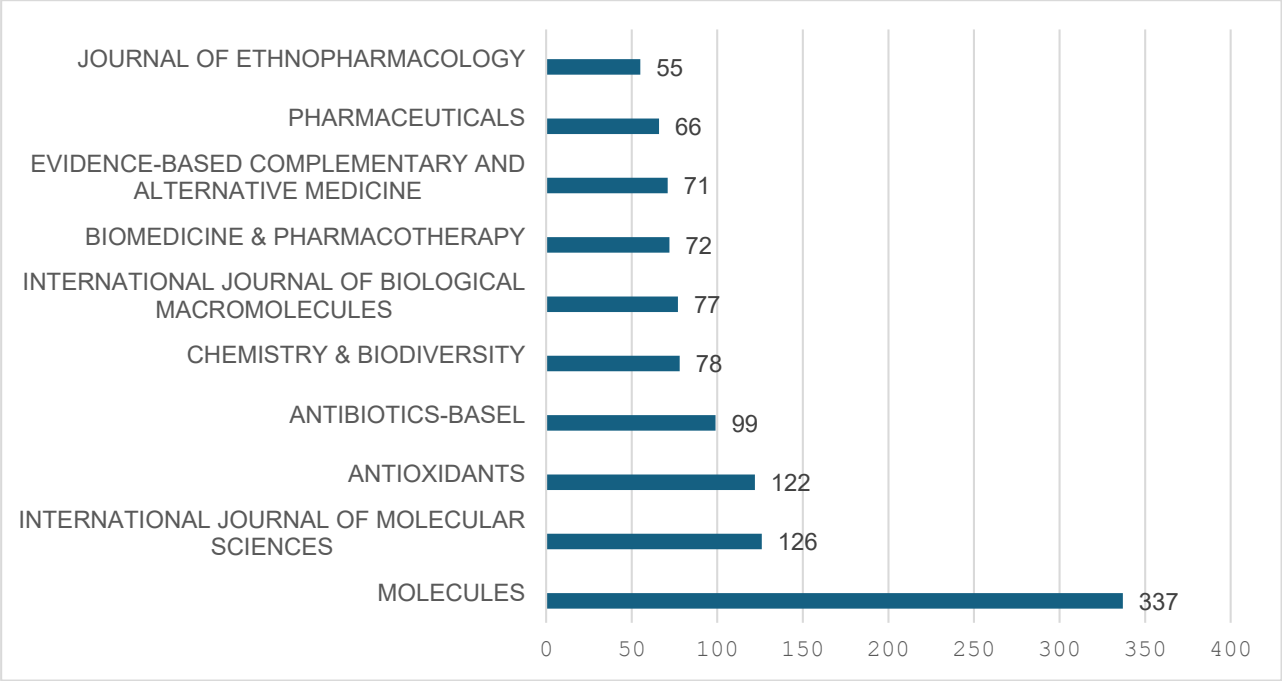

Figure 4. Top 10 journals with the highest number of publications

Table 3 presents detailed information on the top 10 most-cited articles. It was found that these highly cited publications appeared in high-impact, interdisciplinary journals. The article by Imran et al. (2019), published in Molecules, ranked first with 582 citations. When considering the average annual citation counts, the study by Durham et al. (2023) demonstrates a significant impact in a short time, despite being published recently, with a high normalised citation value of 23.72. Overall, the citation distribution indicates that the research is concentrated in certain journals and around pioneering studies.

Table 3. Detailed information on the most-cited publications

Article Title	First Author and Year	Journal Name	Total Citations per Year	Total Citation	Normalized Citations
Kaempferol: a key emphasis to its anticancer potential	Imran et al., 2019	Molecules	72.75	582	17.34
Antibacterial properties of propolis	Przybyłek et al., 2019	Molecules	57.78	520	15.52
Chemical and pharmacological aspects of caffeic acid and its activity in hepatocarcinoma	Espindola et al. 2019	Frontiers in Oncology	57.88	463	13.79
Disentangling metabolic functions of bacteria in the honey bee gut	Kešnerová et al., 2017	PLOS Biology	50.56	455	13.58
The interplay between cytokines, inflammation, and antioxidants: mechanistic insights and therapeutic potentials of various antioxidants and anti-cytokine compounds	Bhol et al., 2024	Biomedicine & Pharmacotherapy	51	408	12.15
Unravelling the molecular determinants of bee sensitivity to neonicotinoid insecticides	Manion et al., 2018	Current Biology	40.44	364	10.86
Phenolic compounds in honey and their associated health benefits: a review	Cianciosi et al., 2018	Molecules	35.7	357	9.93
Phenolic compounds in honey and their relationship with antioxidant activity, botanical origin, and color	Becerril-Sánchez et al., 2021	Antioxidants	33	330	9.18
Flavonoids as potential wound-healing molecules: emphasis on pathways perspective	Zulkefil et al., 2023	Journal of Molecular Sciences	29.9	299	8.32
Allergen immunotherapy: past, present and future	Durham et al., 2023	Nature Reviews Immunology	72.25	289	23.72

Figure 5 presents the keyword cloud graph. In the keyword cloud, the size of each word represents its frequency of use in the literature. Within this context, the top 10keywords are propolis (1,055), honey (470), in vitro (426), oxidative stress (403), antioxidant (395), bee venom (345), apoptosis (338), antioxidant activity (326), chemical composition (315), and inflammation (250).

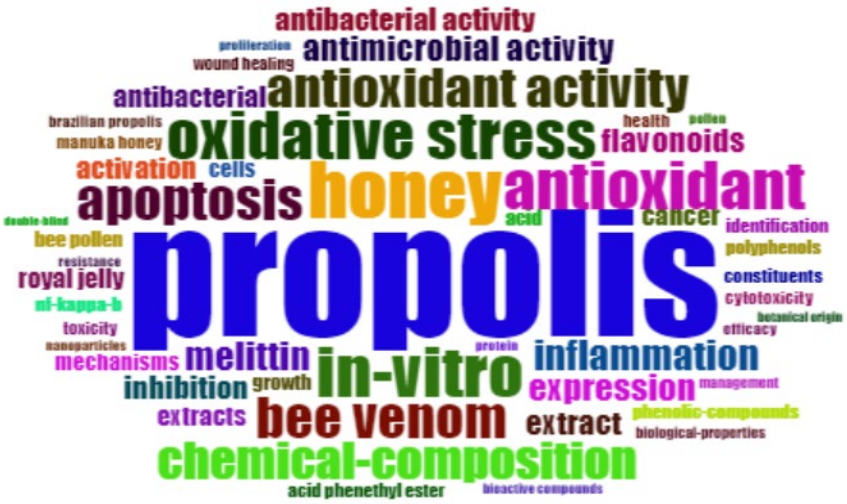

Figure 5. Keyword cloud graph

The co-occurrence analysis of keywords is presented in Figure 6. The results indicate the presence of multiple thematic clusters within the research field. In the map, the keywords “propolis” and “honey” are located at the centre, acting as connectors between different themes. The first thematic cluster, shown in red, highlights the keywords “bee venom,” “toxicity,” and “apitherapy,” which stand out relative to other terms. This cluster primarily represents studies focusing on the safety and clinical aspects of bee venom. The second cluster, shown in green, emphasises the keywords “oxidative stress,” “apoptosis,” and “antioxidant,” reflecting the concentration of experimental studies on bee products. In the third cluster, depicted in blue, the keywords “antioxidant activity” and “chemical composition” are prominent, indicating a focus on analytical studies. The final cluster highlights “antimicrobial activity” and “wound healing” as central terms, representing research on infection control and antibiotic resistance. Overall, the findings suggest that apitherapy research is concentrated around molecular mechanisms and therapeutic applications.

Figure 7 illustrates the evolution of keywords over time. The examination of the thematic evolution map shows that apitherapy research has gradually shifted from applied mechanisms toward more holistic themes. An analysis by year indicates that in 2017, concepts related to complementary medicine such as bee, bee venom, anaphylaxis, and traditional medicine were prominent; in 2018–2019, concepts focused on biological products (*e.g.*, propolis, royal jelly) emerged; in 2020–2021, concepts associated with cellular and biomedical mechanisms (*e.g.*, apoptosis, cancer) were emphasized; in 2022–2023, concepts linked to current health issues such as immunity and infections (*e.g.*, honey, propolis, COVID-19) gained prominence; and in 2024–2025, concepts related to molecular components and evidence-based clinical research (*e.g.*, melittin, systematic review, flavonoids) became prominent.

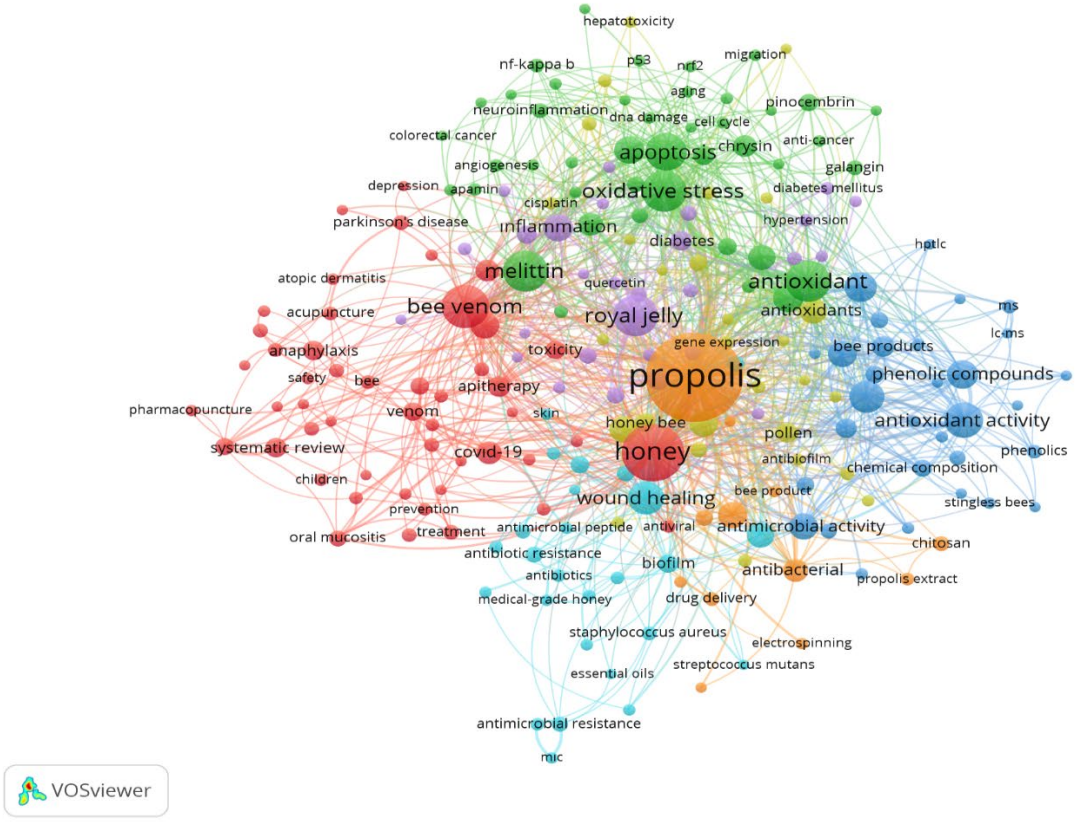

Figure 6. Co-occurrence network of author keywords in apitherapy research

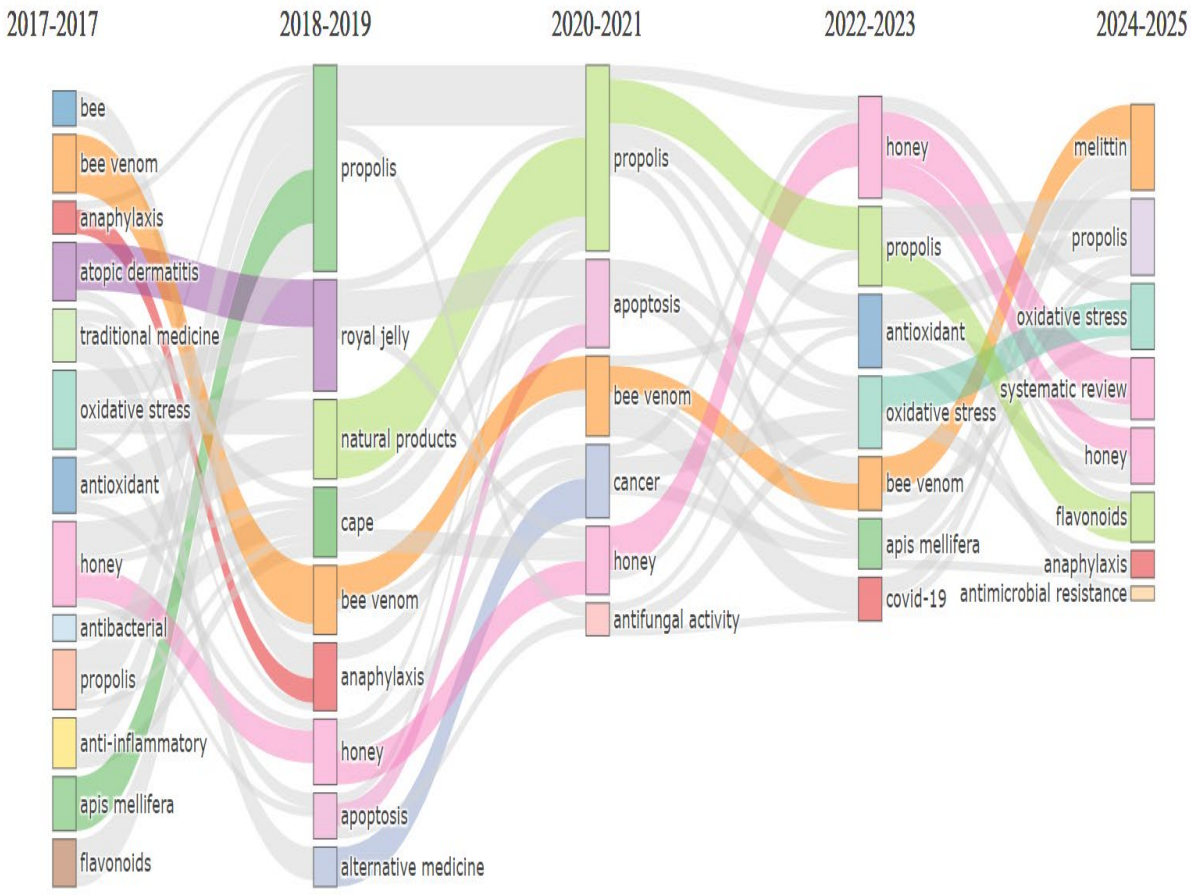

Figure 7. Thematic evolution of keywords

A factor analysis was conducted to understand the research structure of the apitherapy literature. The results of the factor analysis are presented in Figure 8. Examination of the results indicates that studies in the apitherapy literature are concentrated in two main dimensions.

In Figure 8, Dim 1, which explains 57.34% of the total variance, represents descriptive studies, while Dim 2, accounting for 19.02% of the variance, corresponds to clinical research. Most studies positioned on Dim 1 focus on biological processes and chemical composition. The concepts “apitherapy” and “traditional medicine” are located on Dim 2. These findings indicate that apitherapy in complementary medicine is approached holistically, encompassing both basic science and clinical research perspectives.

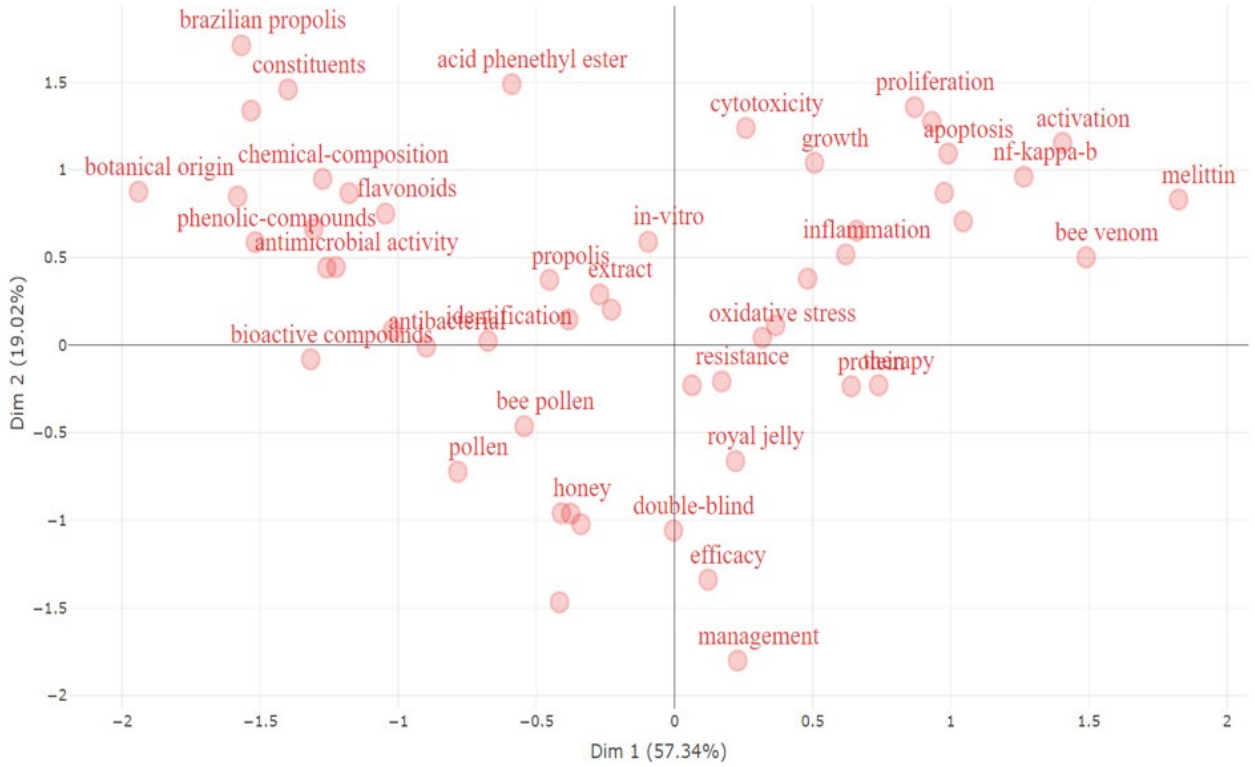

Figure 8. Conceptual Structure Map Based on Factorial Analysis of Abstract Terms

DISCUSSION

The study analysed apitherapy literature published between 2017 and 2025 using bibliometric methods. The findings revealed that the apitherapy literature increased at an annual growth rate of 7.79% during this period. The number of publications rose from 323 in 2017 to 532 in 2025. This trend may be attributed to the growing interest in complementary and alternative medicine in recent years, which in turn may have led to an increase in scientific publications.

Country-based analyses indicate that Türkiye ranked 10th among the top three contributing countries, while China, Brazil, and Iran ranked 1st, 2nd, and 3rd, respectively. Similarly, among the most contributing institutions, Karadeniz Technical University in Türkiye also ranked tenth. Therefore, Türkiye's presence among the top ranks both at the country and institutional levels is a noteworthy finding.

Journal analyses revealed that Molecules was the leading journal in apitherapy, with the highest publication output. Additionally, four of the ten most cited studies were published in this journal. Overall, the journals with the highest publication and citation counts were primarily in the fields of molecular science, biochemistry, and pharmacology. This trend likely reflects that research in the literature mainly focuses on the biological and molecular effects of apitherapy products.

Keyword analysis showed that "propolis," "honey," and "bee venom" were the most frequently recurring terms. Previous bibliometric analyses focusing on "bee venom" and "propolis" support this finding. The results of bibliometric studies indicate that the popularity of these concepts has increased over time, and more studies have been conducted on the topic each year (Şenel and Dalı 2019; Wang et al. 2026). Evaluation of the evolution of keywords revealed that general terms such as "bee" and "bee venom" were gradually replaced by more specific terms, such as "melittin" and "propolis." Factor analysis of the study's concepts further indicated that the research primarily focused on basic and clinical studies.

A review of the literature identified only one study similar to the present research. The study was conducted to perform a bibliometric analysis of apitherapy studies in the WoS database from 1980 to 2016.

Upon examination of the findings, it was determined that the total number of publications during the relevant period was 6,917. It was observed that the countries with the highest number of publications were Brazil, China, and the USA, while Türkiye ranked fourth. The keyword analysis conducted in the study revealed that the most frequently used terms were "propolis," "bee venom," and "flavonoids" (Şenel and Demir 2018). When these findings are compared with the present study, it is seen that Brazil and China have maintained their leading positions in publication output, while Türkiye continues to be among the significant contributing

countries. Between 1980 and 2025, “propolis” remained the most frequently recurring term, indicating a thematic core in apitherapy research that has remained consistent over time.

This study conducted a comprehensive bibliometric analysis of the current scientific structure of apitherapy research published between 2017 and 2025. The findings revealed that the number of publications in the apitherapy literature has gradually increased and continues to grow. It was determined that the publications were predominantly in the field of basic sciences, while a limited number focused on clinical applications and healthcare services. This difference across research areas indicates the need for more healthcare service- and practice-oriented studies. In this research, the leading countries and institutions in apitherapy were identified, and the main research areas were revealed. Thus, researchers had the opportunity to observe research trends and gaps in apitherapy. In addition, since the previous bibliometric analysis covered the period 1980-2016, the analysis period in this study spans 2017-2025. In this way, current global research trends were presented, and an important contribution to the literature was made. Future studies should focus on multidisciplinary, practice-oriented research, particularly on integrating apitherapy into healthcare systems, its role in complementary and integrative medicine, and its implications for healthcare management and policy development.

AI Usage Declaration: AI has not been used to prepare the manuscript, except for references and grammar assistance.

Author Contributions: DÖZ: Conceptualization, Data curation, Writing – Original draft preparation, Supervision

Conflict of Interest: The author declares no conflict of interest.

Data Availability: The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request

Ethical Approval: This study did not require ethical approval, as it is based on a bibliometric analysis of publicly available data.

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