© 2026 Journal of Pharmacy & Pharmacognosy Research, 14 (1), 2383, 2026
ISSN 0719-4250
https://jppres.com

DOI: https://doi.org/10.56499/jppres_14.1.2383

Review

Honey's antiviral research landscape: A 28-year bibliometric analysis (1996–2024)

[Panorama de la investigación antiviral de la miel: un análisis bibliométrico de 28 años (1996-2024)]

Che Muhammad Khairul Hisyam Ismail[1,2], Azlini Ismail[3*], Azzmer Azzar Abdul Hamid[1,2], Mohd Ridzuan Mohd Abd Razak[4], Khairani Idah Mokhtar[3], Widya Lestari[3], Basma Ezzat Mustafa Alahmad[3]

[1]Department of Biotechnology, Kulliyyah of Science, International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia.
[2]Research Unit for Bioinformatics & Computational Biology (RUBIC), Kulliyyah of Science, International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia.
[3]Department of Fundamental Dental and Medical Sciences, Kulliyyah of Dentistry, International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia.
[4]Herbal Medicine Research Centre, Institute for Medical Research, National Institutes of Health, 40170 Shah Alam, Selangor, Malaysia.
*E-mail: dr_azlini@iium.edu.my

Abstract

Context: Honey, a natural bee product, has been widely used for its therapeutic properties, including potential antiviral effects.

Aims: To evaluate global research trends on honey's antiviral properties through a bibliometric analysis.

Methods: A bibliometric analysis was conducted using the Scopus database for documents published between 1996 and 2024. Data were extracted using specific search queries and analysed using Bibliometrix R, Excel, Publish or Perish, and Zotero software.

Results: A total of 83 documents were retrieved and analysed. There was a marked rise in global research interest in honey's antiviral properties, with a sharp increase in publications during the COVID-19 pandemic. Thematic mapping indicated that while honey is a central topic, most studies remain preclinical or review-based, with limited translational research.

Conclusions: Research on honey's antiviral effects is expanding, yet more mechanistic and clinical investigations are required to substantiate its therapeutic potential.

Keywords: antiviral; bibliometric analysis; Bibliometrix R; COVID-19; honey; research trends; Scopus.

Resumen

Contexto: La miel, un producto natural de las abejas, se ha utilizado ampliamente por sus propiedades terapéuticas, incluyendo posibles efectos antivirales.

Objetivos: Evaluar las tendencias globales de investigación sobre las propiedades antivirales de la miel mediante un análisis bibliométrico.

Métodos: Se realizó un análisis bibliométrico utilizando la base de datos Scopus para documentos publicados entre 1996 y 2024. Los datos se extrajeron mediante consultas de búsqueda específicas y se analizaron con los programas informáticos Bibliometrix R, Excel, Publish or Perish y Zotero.

Resultados: Se recuperaron y analizaron 83 documentos. Se observó un marcado aumento en el interés mundial por la investigación sobre las propiedades antivirales de la miel, con un marcado incremento de las publicaciones durante la pandemia de COVID-19. El mapeo temático indicó que, si bien la miel es un tema central, la mayoría de los estudios siguen siendo preclínicos o basados en revisiones, con una investigación traslacional limitada.

Conclusiones: La investigación sobre los efectos antivirales de la miel está en expansión; sin embargo, se requieren más investigaciones mecanicistas y clínicas para corroborar su potencial terapéutico.

Palabras Clave: análisis bibliométrico; antiviral; Bibliometrix R; COVID-19; miel; tendencias de investigación; Scopus.

ARTICLE INFO
Received: February 15, 2025.
Accepted: November 5, 2025.
Available Online: January 8, 2026.

AUTHOR INFO
ORCID: 0000-0002-6392-0491 (CMKHI) 0000-0002-7456-7865 (KIM) 0000-0002-8941-540X (AI) 0000-0002-7477-2228 (WL) 0000-0003-2404-6890 (AAAH) 0000-0001-9953-4536 (BEMA) 0000-0002-9589-5892 (MRMAR)

INTRODUCTION

Honey is a natural substance produced by honeybees (*Apis* spp.) from floral nectar. The nectar undergoes enzymatic changes before being stored in the honeycomb, where it dehydrates and forms a thick, sticky, sweet substance known as honey (Alaerjani & Mohammed, 2024; Kumar et al., 2024). It is composed mainly of sugars and water, along with smaller amounts of vitamins, minerals, amino acids, organic acids, flavonoids, phenolic compounds, and aromatic substances (Machado De-Melo et al., 2018; Tafere, 2021). Fructose and glucose are the primary sugar components, representing 51 to 69% of honey's composition, with a fructose-to-glucose ratio of 1:1.3 (Erwan et al., 2020; Sathianarayanan et al.; 2024). Among the minerals, potassium (K), sodium (Na), phosphorus (P), magnesium (Mg), and calcium (Ca) are the most abundant (Kek et al., 2017; Yaman et al., 2024). Protein, although present in small amounts (0.7%), exists in both complex and simple forms as amino acids. Nearly all physiologically important amino acids are present in honey, with proline being the predominant one (Alvarez-Suarez et al., 2013; Tafere, 2021). The composition of honey varies due to factors such as geographical area, climate, bee species, floral sources, and storage conditions (Puscas et al., 2013). Darker-coloured honey usually contains higher phenolic content, while lighter-coloured honey tends to have lower phenolic content (Bogdanov et al., 2004; Gheldof & Engeseth, 2002; Tafere, 2021).

Honey has historically been utilised not only as a food source but also as a traditional remedy for a variety of human diseases, such as cardiovascular diseases, diabetes, cancer, neurodegenerative diseases, pulmonary diseases, liver diseases, and ulcers (Ghaffari et al., 2012; Hossen et al., 2017; Shaikh et al., 2024). The presence of multiple bioactive compounds in honey, such as phenolic acids, organic acids, polyphenols, and flavonoids, contributes to its wide range of health-promoting effects, such as antioxidant, anti-inflammatory, anti-ulcerous, anti-hyperlipidaemic, and anti-cancer, anti-bacterial, and antiviral properties (Estevinho et al., 2008; Gheldof & Engeseth, 2002; Swellam et al., 2003; Velásquez et al., 2022).

With regard to the antiviral potential of honey, several studies have documented the antiviral effects of honey against several viruses, including the rubella virus, the herpes simplex virus (HSV), the varicella zoster virus (VSV), the influenza virus A/WSN/33 (H1N1), and the respiratory syncytial virus (RSV) (Al-Waili, 2004; Hashemipour et al., 2014; Watanabe et al., 2014; Zeina et al., 1996). The antiviral effect of honey is said to be attributed to several factors, including osmotic effects, low pH, and the presence of various natural compounds such as hydrogen peroxide, phenolic acids, flavonoids, and lysozyme (Lima et al., 2021; Samarghandian et al., 2017). In addition, Al-Hatamleh et al. (2020) have highlighted that specific phytochemicals in honey, such as methylglyoxal, chrysin, caffeic acid, galangin, and hesperidin, have potential antiviral and immunomodulatory effects against the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).

Bibliometric analysis has recently gained growing interest among researchers and academics as a method for identifying patterns, trends, and the impact of research within a specific field or domain, utilising different frameworks and tools. The process typically involves retrieving relevant publications from scientific databases, followed by data cleaning, refinement, and analysis to generate meaningful interpretations (Akhavan et al., 2016; Donthu et al., 2021). It assesses publication productivity and performance, as well as the contributions of authors, institutions or countries, and evaluates research impact through citation-based metrics, within a specific research topic (Lim & Kumar, 2024).

The existing bibliometric analyses on honey have explored the broad research aspects of honey (Vit et al., 2023; Zakaria et al., 2021), honey bee pollen (Çobanoğlu, 2023), honey bee propolis (Vit et al., 2024), pesticide content in honey (Andreo-Martinez et al., 2020; Jaramillo-Zárate & Londoño-Giraldo, 2023), its antioxidant and anti-bacterial properties (Stefanis et al., 2023). While bibliometric reviews have assessed only two biological activities of honey, which are antioxidant and antibacterial properties, focused bibliometric analyses on its antiviral research profile are sparse. Thus, this study aims to fill this gap by analysing global research trends and identifying knowledge gaps in antiviral research on honey from 1996 to 2024. Mapping progress in this niche field could provide valuable insights, supporting the exploration of honey as a supplement therapy for managing viral infections.

MATERIAL AND METHODS

Study design and framework

The study design was a bibliometric analysis. The Population, Intervention, Comparison, and Outcomes (PICO) framework for this analysis was defined as follows: 'Population' was scientific publications related to the antiviral properties of honey, 'Intervention' was honey, 'Comparison' was not applicable, while 'Outcomes' were publication output and research trends, authors and collaborations patterns, journals publishing on honey and antiviral studies, geographical and institutional distribution and cooperation, as well as citation, co-citation, and co-word analyses.

Literature searching

The bibliometric analysis was conducted using the Scopus (Elsevier) database in October 2024. The Scopus database was selected as the search engine for this study, as it is the most widely recognised and frequently used resource for analysing scientific publications, providing broad coverage across various disciplines (Giti et al., 2023; Yang et al., 2013).

Search strategy

The search string keywords used were (TITLE-ABS-KEY("honey") AND TITLE-ABS-KEY("antiviral")) AND NOT TITLE-ABS-KEY("honey bee" OR "Apis").

Eligibility, inclusion and exclusion criteria

Articles were screened based on their titles, abstracts, and keywords. The inclusion criteria were as follows: (1) Publications indexed in Scopus, (2) Contains keywords: "honey" AND "antiviral" (3) Published within the year of 1996 to 2024, (4) Document types either articles, reviews, conference papers, editorials, notes, books/book chapters, or short surveys, and (5) Written in English. The exclusion criteria were as follows: (1) Retracted documents, and (2) Duplicates.

Selection process

The selection process was conducted by one researcher, who screened titles and abstracts for relevance. No automation tools were used in the selection process, but Zotero was used to manage references and detect retractions.

Data extraction and bibliometric analysis

The Scopus search results were exported in .CSV and .RIS formats. Among the variables extracted were author(s), title, year, journal, citations, author affiliation, keywords, citations per year, co-authorship networks, country contribution, and journal impact metrics (h-index, g-index, CiteScore, SCImago Journal Rank (SJR)). The documents were then imported and analysed using the following softwares: (1) Microsoft Excel was used to calculate publication frequencies and percentages, as well as to generate charts and graphs; (2) Bibliometrix R (Aria & Cuccurullo, 2017) was applied to create, visualise, and cluster the bibliometric networks, such as co-authorship, co-citation relationships, co-words analysis, word cloud, conceptual structure map, and thematic mapping; (3) Harzing's Publish or Perish software was employed to calculate citation metrics, aiding in the evaluation of research impact; (4) Zotero Reference Manager (Sadeghi et al., 2013) was used to verify retractions and prevent the inclusion of retracted papers, ensuring accuracy in the document count. This tool enables comprehensive analysis of publication trends, citation metrics, and the structural relationships within the research landscape of honey- and antiviral-related studies. This study is intended to analyse publication output and growth research trends, authors and collaborations, journals publishing on honey and antiviral studies, geographical and institutional distribution and cooperation, citations, co-citation, and co-words analyses.

Risk of bias assessment

Although bibliometric studies are exempt from conventional risk-of-bias tools, steps were taken to minimise selection and reporting bias by using Scopus, which is a comprehensive database, avoiding retracted and duplicate articles, and ensuring an objective and reproducible keyword strategy. The use of a structured search string and automated export from Scopus reduced the risk of selection bias.

Synthesis methods

The bibliometric synthesis was conducted using multiple tools to capture distinct analytical perspectives. The Bibliometrix R package was employed to generate co-authorship networks, co-word occurrence maps, and thematic and conceptual mappings. Descriptive statistics, including publication trends, were compiled in Microsoft Excel. Citation metrics were obtained through Harzing's Publish or Perish software. Due to the bibliometric nature of this review, no meta-analysis or statistical synthesis of study findings was conducted.

Reporting bias assessment

Not applicable due to the descriptive nature of bibliometric analysis.

Certainty of evidence

Not applicable, as no clinical or experimental data were evaluated.

RESULTS

Publication output and growth trends

A total of 83 documents were identified from the Scopus database, spanning from 1996 to 2024. The cumulative citation count for these documents was 2970, yielding an average citation rate of 106.07 per year. The h- and g-index was found to be 24 and 54, respectively (Table 1). Among the retrieved documents, original articles constituted the majority (60.2%, n = 50/83), followed by review articles (28.9%, n = 24/83) (Fig. 1). Other document types contributed marginally, such as notes and conference papers, each making up 2.4% (n = 2/86), while the remaining categories accounted for

1.2% (n = 1/83). Fig. 2 shows the trend in publications on honey and antivirals. The development trend showed three distinct phases: a consistent growth phase (1996-2012), a moderate increase phase (2013-2018), and a rapid growth phase (2019-2024), peaking in 2022. However, a declining trend was observed after 2023.

Geographical and institutional contributions

Corresponding authors from India led the research on the topic with ten publications, followed by corresponding authors from Iran with six publications and China with four publications (Fig. 3). In terms of geographical contribution over time (Fig. 4), Pakistan led with a total of 23 publications, followed by India (21), Iran (18), United States of America (16), and Saudi Arabia (13). In addition, Fig. 4 also shows that India has made a notable increase in publications on this topic after 2020, becoming a leading contributor by 2023. Iran showed a steady growth in publications on this topic from around 2011, with a significant acceleration after 2018. The USA has maintained a steady rise in publications since 2003. Saudi Arabia exhibited slower growth than other countries but showed a noticeable rise after 2020. Pakistan showed minimal activity in publications on honey and its antiviral properties until around 2020. Still, a noticeable increase occurred after this point, with a steady upward trajectory observed from 2021 onwards. However, when analysed by country, the most cited country on the topic was Switzerland, with 833 total citations, followed by India (368) and Iran (359) (Fig. 5).

Table 1. Summary of bibliometric performance analysis on the topic of honey and antiviral studies.

Bibliometric performance analysis	Data
Publication years	1996-2024
Citation years	28 (1996-2024)
Papers	83
Citations	2970
Citations/year	106.07
Citation/paper	35.78
Citation/author	1010.54
Papers/author	32.4
h-index	**24**
g-index	**54**

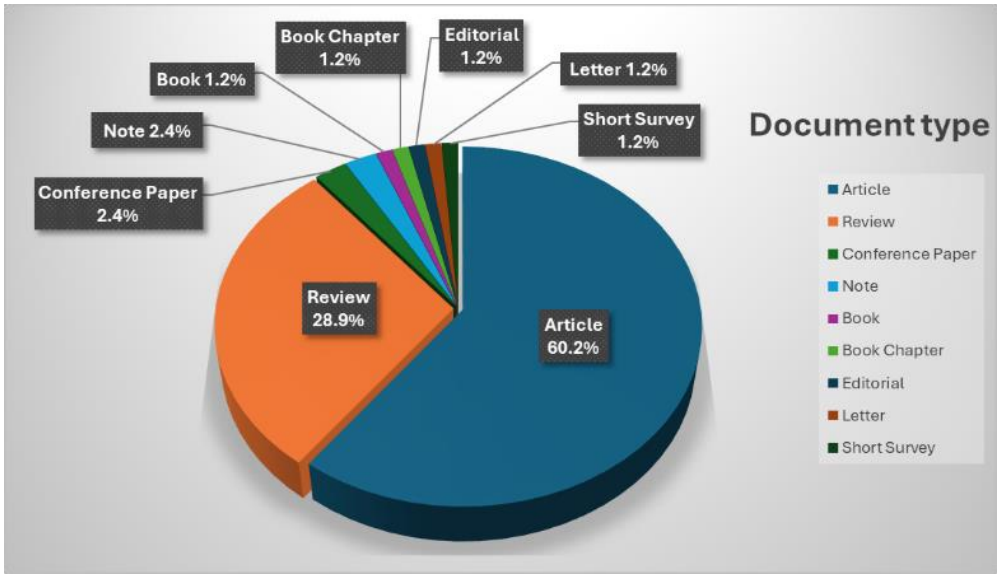

Figure 1. Distribution of retrieved publications by document type on the topic of honey and antiviral research.

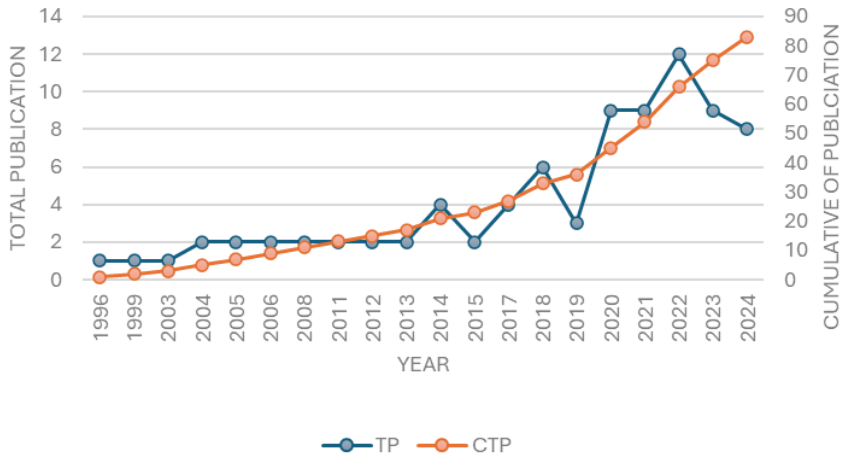

Figure 2. Annual and cumulative publication trends on honey and antiviral research (1996– 2024).
TP: total publication, CTP: cumulative total of publication.

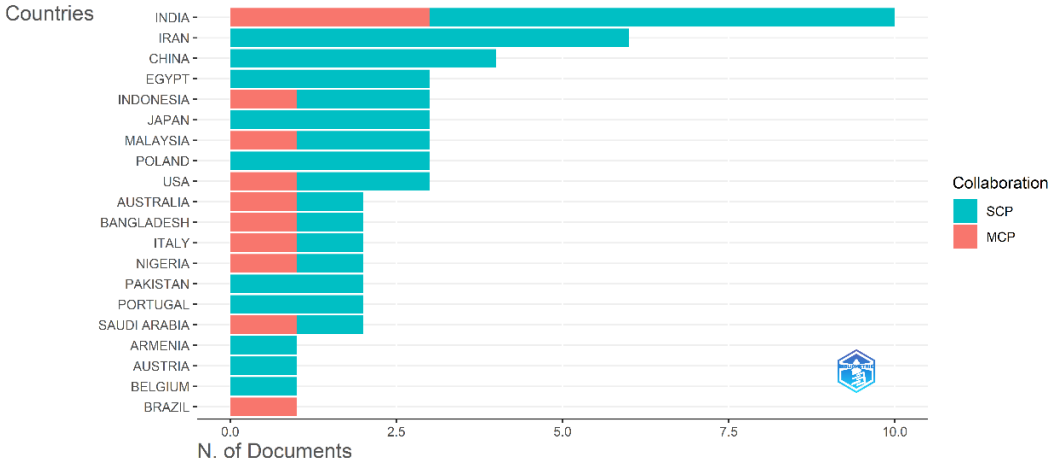

Figure 3. Geographic distribution of countries of corresponding authors in honey and antiviral publications.
SCP: single country publication, MCP: multiple countries publication.

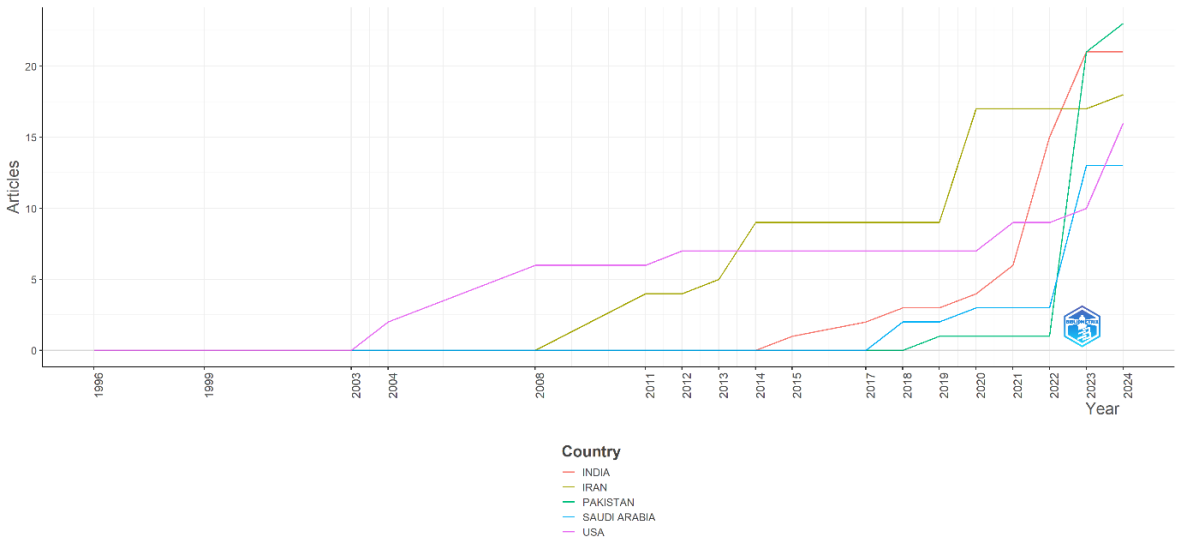

Figure 4. Timeline of country-level contributions to honey and antiviral research (1996– 2024).

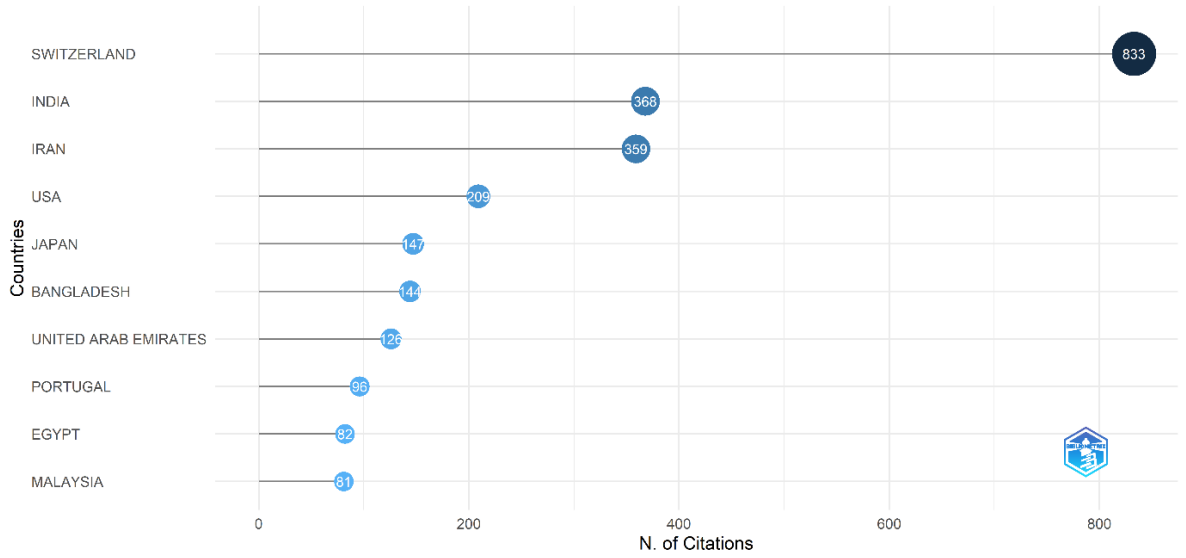

Figure 5. Top cited countries in honey and antiviral research.

Table 2. Top journals publishing on honey and antiviral studies based on the performance metrics.

Journal	TP	TC	Publisher	Cite Score	SJR Score	SNIP Score
Archives of Medical Research	2	140	Elsevier	12.5 (2023)	1.076 (2023)	0.844 (2023)
Molecules	2	96	Multidisciplinary Digital Publishing Institute (MDPI)	7.4 (2023)	0.744 (2023)	1.064 (2023)
BMJ Open	2	52	BMJ Publishing Group	4.4 (2023)	0.971 (2023)	0.8995 (2023)
International Journal of General Medicine	2	52	Dove Medical Press	2.2 (2022)	0.521 (2022)	0.627 (2023)
Pharmaceuticals	2	38	Multidisciplinary Digital Publishing Institute (MDPI)	6.1 (2023)	0.845 (2023)	0.977 (2023)

TP: Total Publications, TC: Total Citations, SJR Score: SCImago Journal Rank, SNIP Score: Source Normalised Impact per Paper (SNIP) score.

Journal and publication performance analysis

Table 2 lists the top journals publishing on the topic of honey and antiviral. Overall, most of the top five journals publish at least two publications on the topic of honey and antiviral. In contrast, the other journals publish only one article each. Bradford's law was applied to show the dispersion of scientific literature on the topic. Fig. 6 shows the core source by Bradford's law, illustrating that the top five journals producing the highest number of articles on the research topic are Archives of Medical Research, BMJ Open, International Journal of General Medicine, Molecules, and Pharmaceuticals. These journals form the core zone, while the remaining articles were scattered across a broader range of journals with fewer contributions.

In terms of citations (Table 2), the Archives of Medical Research journal received 140 citations, making it the most cited journal on this topic; the Molecules journal followed with 96 citations. BMJ Open and the International Journal of General Medicine received a similar total of 52 citations. Out of the five journals, the Archives of Medical Research journal under the Elsevier publisher attained the highest cite score rank measured in 2023, with a score of 12.5, while the Molecules journal ranked second with a cite score of 7.4, followed by the Pharmaceuticals journal with a cite score of 6.1. Based on the SCImago Journal Rank (SJR) score, the Archives of Medical Research journal achieved the highest score (1.076), followed by the BMJ Open and Pharmaceuticals journals, with SJR scores of 0.971 (2023) and 0.845 (2023), respectively. Ranking by the Source Normalised Impact per Paper (SNIP) score, the Molecules journal received the highest score of 1.064 in 2023 on the topic of honey and antiviral, followed by the Pharmaceuticals journal and the BMJ Open journal with SNIP scores of 0.977 (2023) and 0.8995 (2023), respectively.

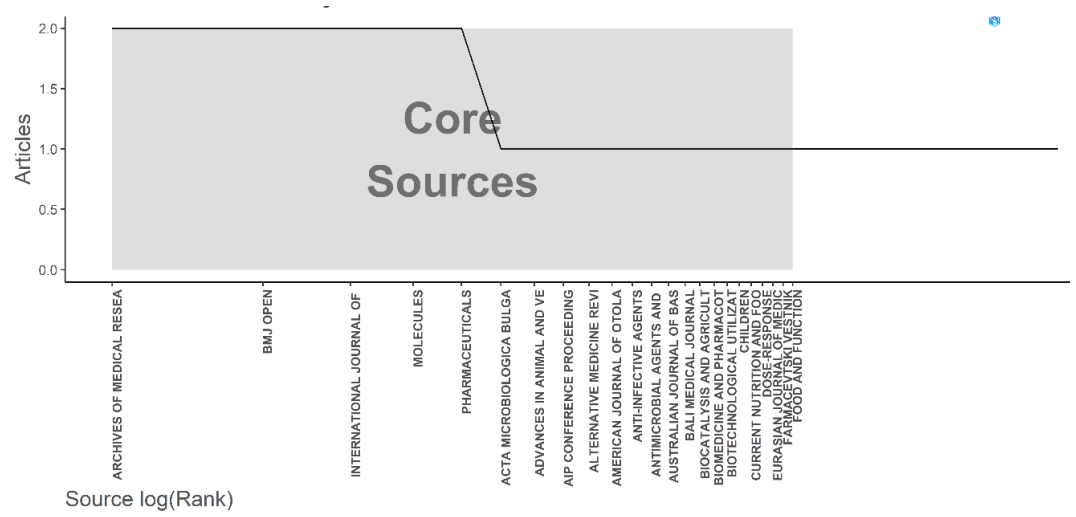

Figure 6. Bradford's law plot demonstrating core journals in the field of honey and antiviral studies.

Table 3. Most cited articles on the topic of honey and antiviral studies.

Authors	Title	Year	Source type	Total citation	Cite/year
Bogdanov S, Jurendic T, Sieber R, Gallmann P	Honey for nutrition and health: a review	2008	Review	833	52.06
Mani R, Natesan V	Chrysin: sources, beneficial pharmacological activities, and molecular mechanism of action	2018	Review	312	52
Davoudi-Monfared E, Rahmani H, Khalili H, Hajiabdolbaghi M, Salehi M, Abbasian L, Kazemzadeh H, Yekaninejad MS	A randomized clinical trial of the efficacy and safety of interferon β-1a in treatment of severe COVID-19	2020	Article	232	58
Al-Waili NS	Topical honey application vs. acyclovir for the treatment of recurrent herpes simplex lesions	2004	Article	126	6.3
Watanabe K, Rahmasari R, Matsunaga A, Haruyama T, Kobayashi N	Anti-influenza viral effects of honey *in vitro*: potent high activity of manuka honey	2014	Article	123	12.3
Sathe SK, Seeram NP, Kshirsagar HH, Heber D, Lapsley KA	Fatty acid composition of California grown almonds	2008	Article	114	7.13
Alam S, Sarker MMR, Afrin S, Richi FT, Zhao C, Zhou J-R, Mohamed IN	Traditional herbal medicines, bioactive metabolites, and plant products against COVID-19: update on clinical trials and mechanism of actions	2021	Review	83	27.67
Al-Hatamleh MAI, Hatmal MM, Sattar K, Ahmad S, Mustafa MZ, Bittencourt MC, Mohamud R	Antiviral and Immunomodulatory effects of phytochemicals from honey against COVID-19: potential mechanisms of action and future directions	2020	Review	77	19.25
Shahzad A, Cohrs RJ	*In vitro* antiviral activity of honey against varicella zoster virus (VZV): a translational medicine study for potential remedy for shingles	2012	Article	73	6.08
Zeina B, Othman O, Al-Assad S	Effect of honey versus thyme on Rubella virus survival *in vitro*	1996	Article	71	2.54

In terms of publication, the article published by Bogdanov and colleagues titled "*Honey for nutrition and health: a review*", received the highest number of citations, with a total of 833, followed by the publication by Mani, R. and Natesan, V. titled "*Chrysin: sources, beneficial pharmacological activities, and molecular mechanism of action*", which received 312 citations. The third most cited publication was by Davoudi-Monfared, titled "*A randomised clinical trial of the efficacy and safety of interferon β-1a in treatment of severe COVID-19*", which received a total citation of 232. In comparison, each of the remaining publications contributed less than 130 citations (Table 3). When considering the cite/year score, the same publication, "*A randomised clinical trial*

of the efficacy and safety of interferon β-1a in treatment of severe COVID-19" recorded the highest score of 58, followed by "*Honey for nutrition and health: a review*" and "*Chrysin: sources, beneficial pharmacological activities, and molecular mechanism of action*" with the cite/year scores of 52.06 and 52, respectively.

Authors, affiliation, and collaboration dynamics

Lotka's law graph was constructed using the Bibliometric R package to visualise the development trend of authors publishing on the topic of honey and antiviral (Fig. 7). Overall, the analysis demonstrated that 94.4% of authors published at least one publication on the topic (n = 336/356) and the remaining 5.6% of authors published at least two publications (n = 20/356). Table 4 summarises the top 6 authors in the field of honey and antiviral research, along with their corresponding affiliations. Authors were ranked based on their total citations and citations per year. All six authors published two publications on the topic. Among them, five authors, Haruyama T, Kobayashi N, Matsunaga A, Rahmasari R, and Watanabe K, shared the highest total citation count (140) and the citations/year score (70). The second most-published author in this domain was Mohamud R., with a total citation count of 80 and a citations/year score of 40. In terms of affiliations, Shaikh Zayed Postgraduate Medical Institute and the University of Rzeszów were the leading contributors to honey and antiviral research, with a total of six publications. Universiti Sains Malaysia follows closely with five publications. King Saud University, Tehran University of Medical Sciences, University of Veterinary and Animal Sciences, and Yokohama University of Pharmacy all shared third place in terms of contributions; each published four works on the topic (Fig. 8).

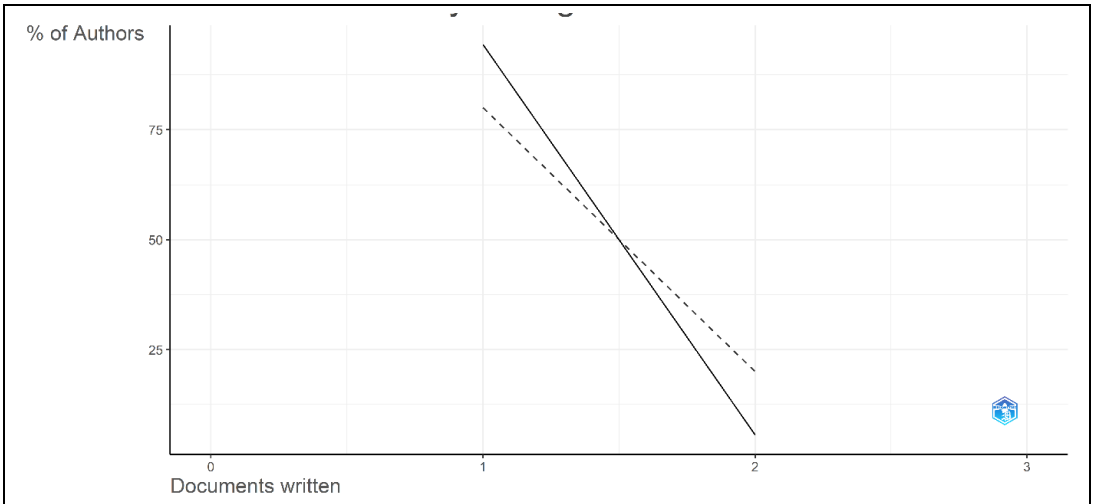

Figure 7. Lotka's law applied to author productivity in honey and antiviral publications.

Table 4. Top contributing authors to honey and antiviral research.

Authors	Affiliation	TP	NCP	TC	C/P	C/CP	*h-index*	*g-index*
Haruyama, Takahiro	AVSS, Central Research Center, Okinawa, Japan	2	2	140	70	70	2	2
Kobayashi, Nobuyuki	AVSS Corporation, Central Research Center, Nagasaki, Japan	2	2	140	70	70	2	2
Matsunaga, Ayaka	Graduate School of Biomedical Sciences, Laboratory of Molecular Biology of Infectious Agents, Nagasaki, Japan	2	2	140	70	70	2	2
Rahmasari, Ratika	Universitas Indonesia, Laboratory of Microbiology and Biotechnology, Depok, Indonesia	2	2	140	70	70	2	2
Watanabe, Ken	Nagasaki University, Nagasaki, Japan	2	2	140	70	70	2	2
Mohamud, Rohimah	School of Medical Sciences, Universiti Sains Malaysia, Department of Immunology, Kubang Kerian, Malaysia	2	2	80	40	40	2	2

TP: Total Publications, NCP: Number of Cited Publications, TC: Total Citations, C/P: Citations per Publication, C/CP: Citations per Cited Publication.

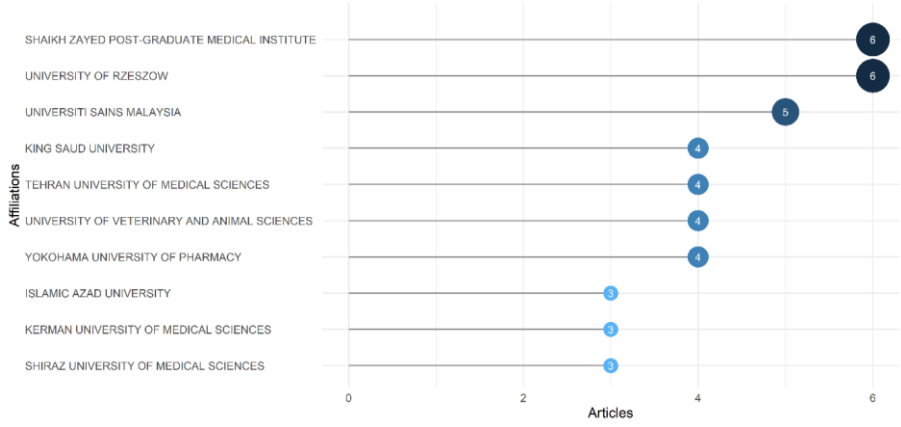

Figure 8. Institutional contributions to honey and antiviral literature.

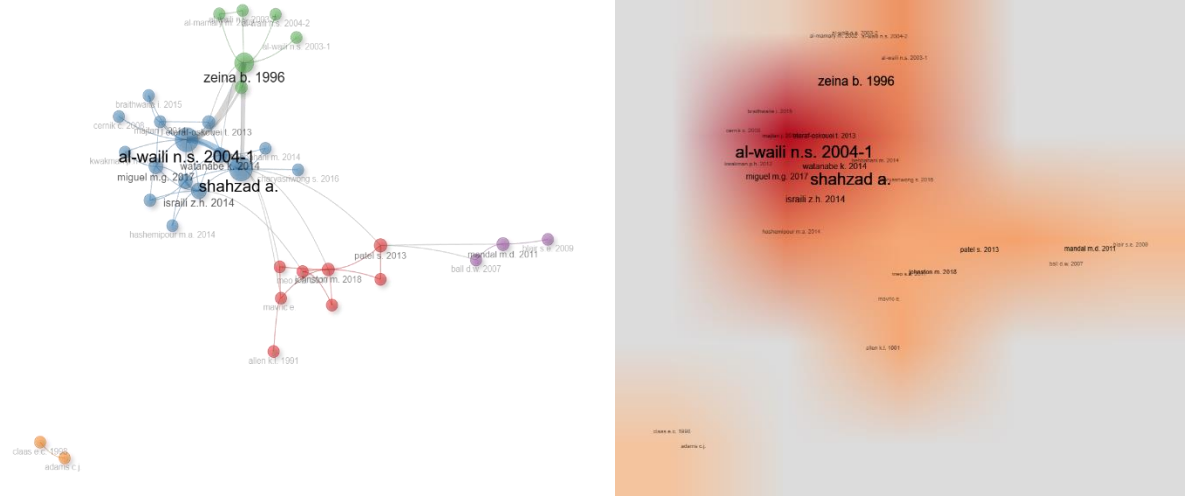

Figure 9. (A) Co-citation network map among authors in honey and antiviral research. **(B)** Density visualisation of author co-citation network in the domain of honey and antiviral studies.

A co-citation mapping network was then constructed using the Bibliometrix R package to analyse collaboration dynamics among authors (Fig. 9). The network was divided into five clusters. In Cluster 1 (blue), Al-Waili and Shahzad were identified as the most frequently co-cited authors on the topic. In Cluster 2 (red), Johnson and Patel were the leading co-cited authors. Cluster 3 (green) was primarily characterised by Zeina's contributions as the most cited author. In Cluster 4 (purple), Mandal was identified as the author with the highest number of co-citations. Finally, Cluster 5 (orange) consists of two key contributors who share significant co-citation on honey and antiviral research.

Connection of countries, institutions, and journals

The connection between countries, institutions, and journals was then visualised using a three-field plot based on a Sankey diagram, created with Bibliometric R (Fig. 10). The height of the rectangular nodes in the diagram was proportional to the frequency of occurrence of each country, institution, and journal within the collaboration network. The figure shows that Pakistan had the most connections with leading contributing institutions, including Sheikh Zayed Postgraduate Medical Institute, the University of Veterinary and Animal Sciences, King Edward Medical University, and Harvard Medical School. Iran ranked second in terms of connections, with major contributing institutions such as Tehran University of Medical Sciences, Islamic Azad University, Shiraz University of Medical Sciences, and Kerman University of Medical Sciences. Malaysia, on the other hand, ranked third with contributing institutions of Universiti Sains Malaysia, King Saud University, and King Khalid University. Among journals, Molecules received the most contributions

from several countries on topics in honey and antiviral research, including Malaysia, Saudi Arabia, Poland, and Jordan. The second-highest number of contributions came from the Biocatalysts and Agricultural Biotechnology journal, with contributions from Indonesia, Malaysia, and Jordan. The remaining contributions came from two or fewer countries.

Co-occurrence of keywords, topic trends and relevance

Bibliometrix R was then used to extract the occurrence of keywords used by authors on the research topic. The co-occurrence of keywords has been clustered into two distinct thematic clusters (Fig. 11). The analysis showed that Cluster 1 (red) has strongly interconnected nodes, and the keywords are centred around honey and human, interconnected with biological and therapeutic properties, including antioxidant, antimicrobial, antineoplastic, antiviral, anti-infective, and anti-inflammatory activities. Conversely, Cluster 2 (blue) comprises keywords linked to viral infections and clinical applications, such as anti-virus/antiviral agents, controlled therapy, randomised controlled trial, SARS-CoV-2, apitherapy, drug safety, comparative study, and treatment outcome. Notably, the keyword 'honey' appears as a central connecting node between the two clusters. In terms of word count, honey (76), human (71), article (32), antiviral activity (28), anti-virus agent (25), non-human (23), controlled study (22), acyclovir (21), adult (19), and male (18) were the most frequently used words by authors on the topic of honey and antiviral (Fig. 12). The word cloud map of co-occurring keywords shows that the top three most frequently used terms by authors in the context of honey and antiviral research were human, honey, and article (Fig. 13).

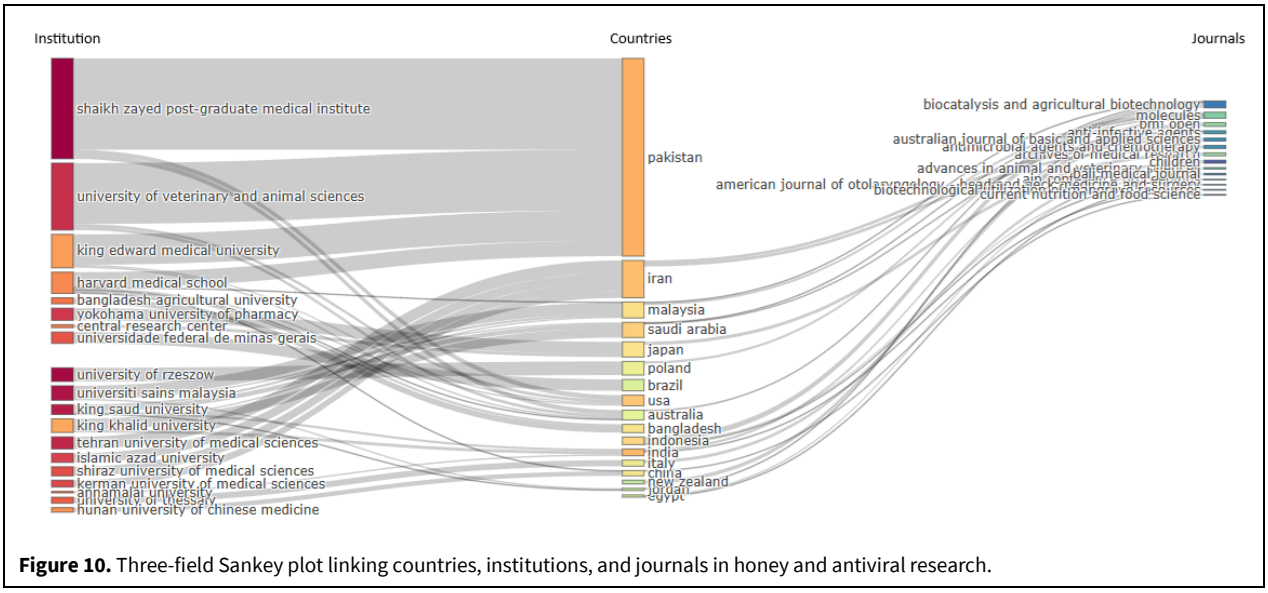

Figure 10. Three-field Sankey plot linking countries, institutions, and journals in honey and antiviral research.

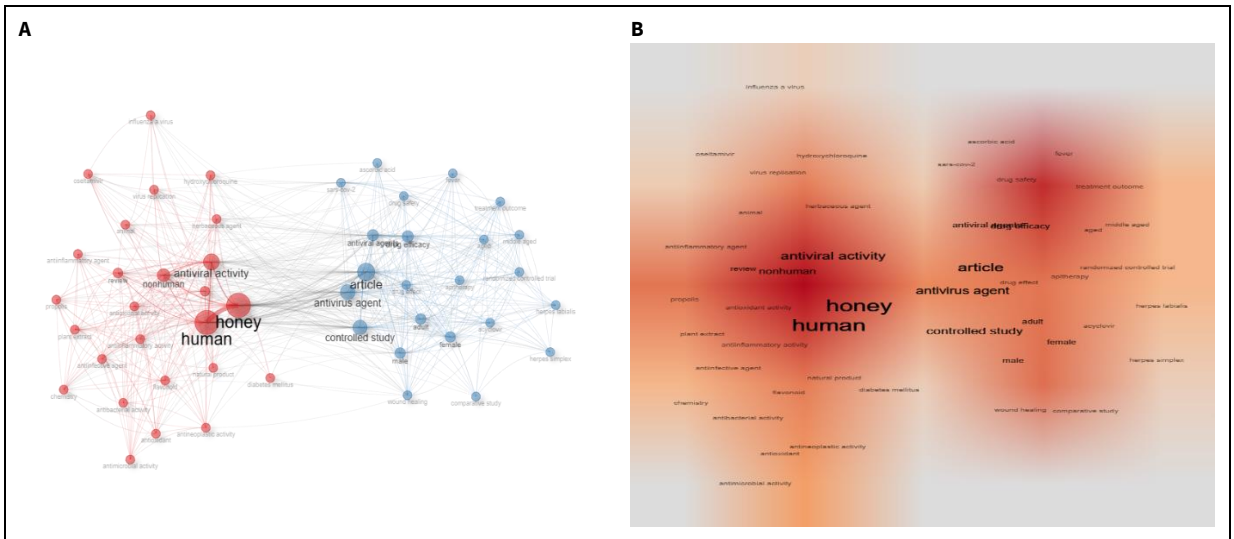

Figure 11. Keyword co-occurrence clustering map: research themes on honey and antiviral applications.
The keywords were clustered into cluster 1 (red) and cluster 2 (blue).

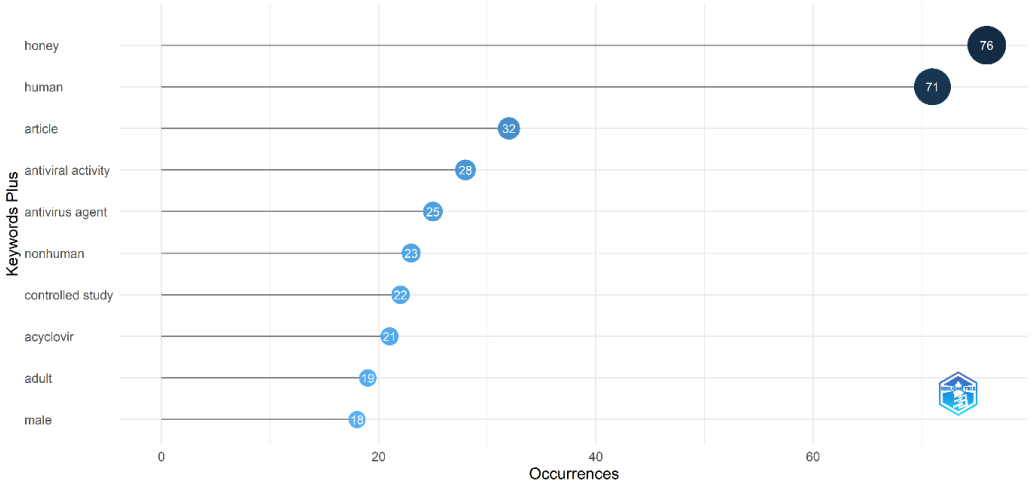

Figure 12. Frequency distribution of author keywords in honey and antiviral studies.

Figure 13. Word cloud of the most frequently used terms in honey and antiviral research. Human and honey are the mostly used keywords on the research topic.

When looking at the trend topic chart, the initial focus of research on honey and its antiviral properties was primarily on comparative studies, recurrent diseases, herpes simplex, plant extracts, and acyclovir. However, after 2014, the scope of research began to expand significantly (Fig. 14). The rapid increase in research topics related to honey and antiviral from 2014 to 2024 reflects the growing recognition of honey's potential as an antiviral agent, anti-inflammatory, antidiabetic, and antioxidant.

The multiple correspondence analysis was then performed to generate a conceptual structure map of co-occurrence keywords used by authors. The keywords clustered within the red area indicate the central concept in the research field (Fig. 15). This conceptual map reveals three main thematic groupings. The first cluster, located on the left, comprises terms such as antioxidant activity, anti-inflammatory activity, antimicrobial activity, antineoplastic activity, flavonoid, propolis, and plant extract. The second cluster, near the centre, includes honey, virus replication, antiviral activity, ascorbic acid, and wound healing. The third cluster, positioned on the right, features terms such as randomised controlled trial, drug safety, acyclovir, herpes labialis, adult, and aged.

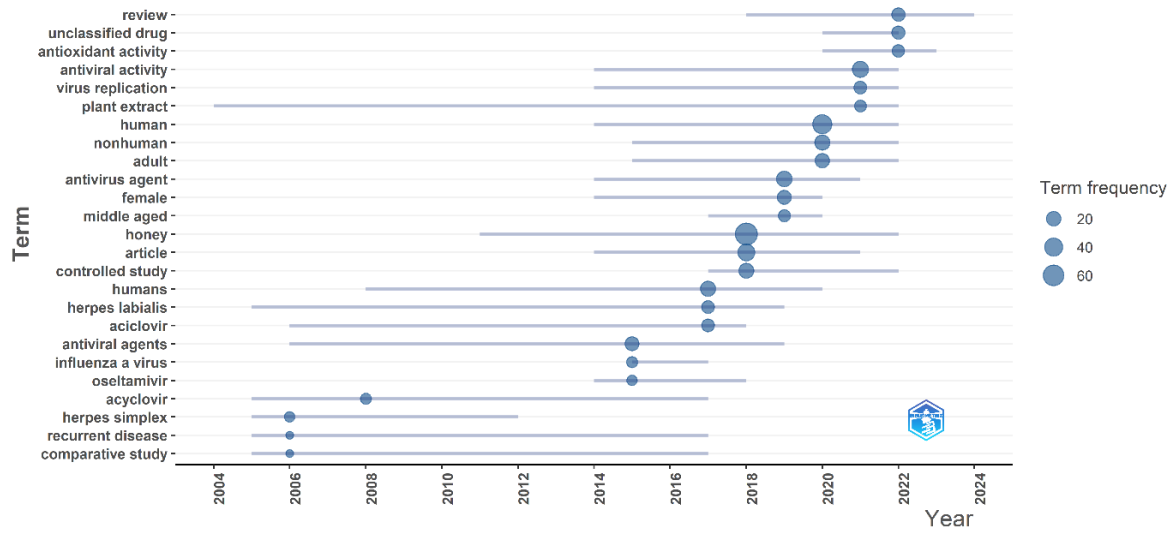

Figure 14. Trend topics timeline: evolution of key terms in honey and antiviral literature (2004–2024).

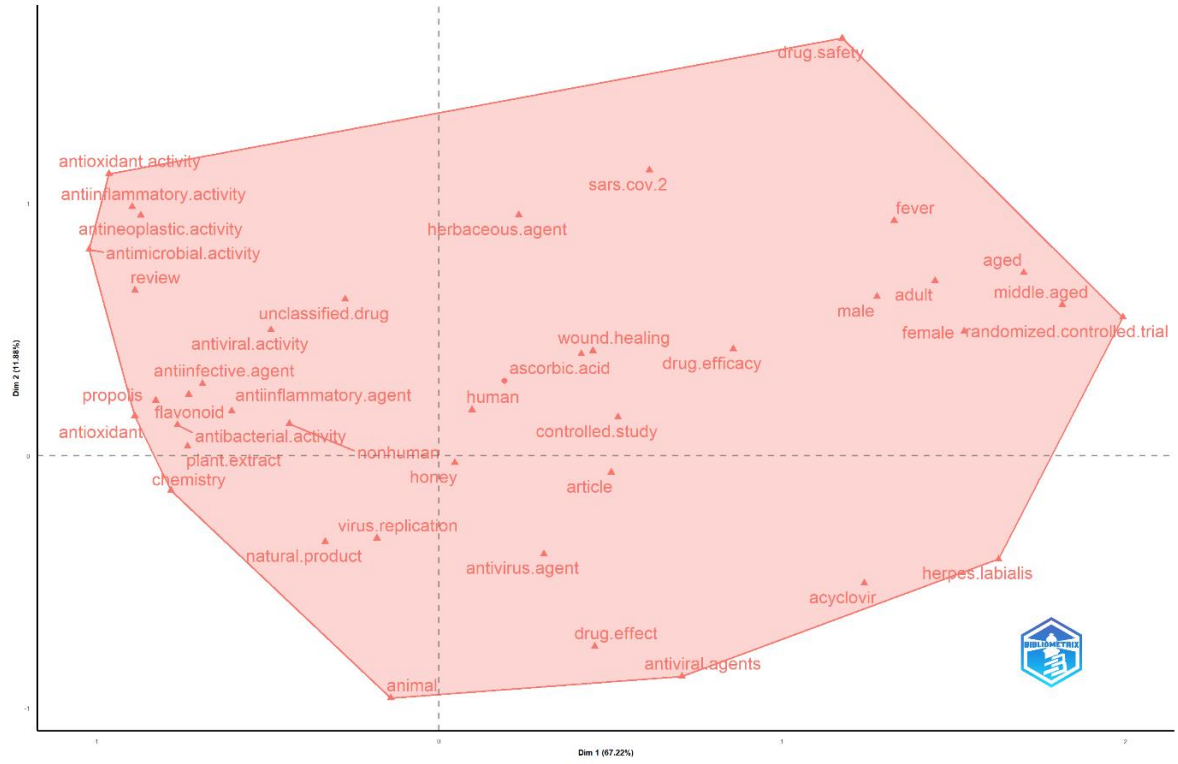

Figure 15. Conceptual structure map based on multiple correspondence analysis of keywords.

The thematic map was further constructed to explore the relevance of the topic of honey and antiviral (Fig. 16). The terms 'honey', 'human', and' article' were under the classification of motor themes and niche themes, while the 'anti-bacterial activity', 'anti-infective agent', and 'antioxidant' were under the classification of intermediate themes in between niche themes and emerging or declining themes. On the other hand, 'antiviral activity', 'non-human', and 'review' were classified as basic themes.

DISCUSSION

Honey is well-known for its numerous health benefits, in addition to its widespread use in food and beverages. Previous bibliometric studies have primarily examined the general aspects of honey, its antioxidant

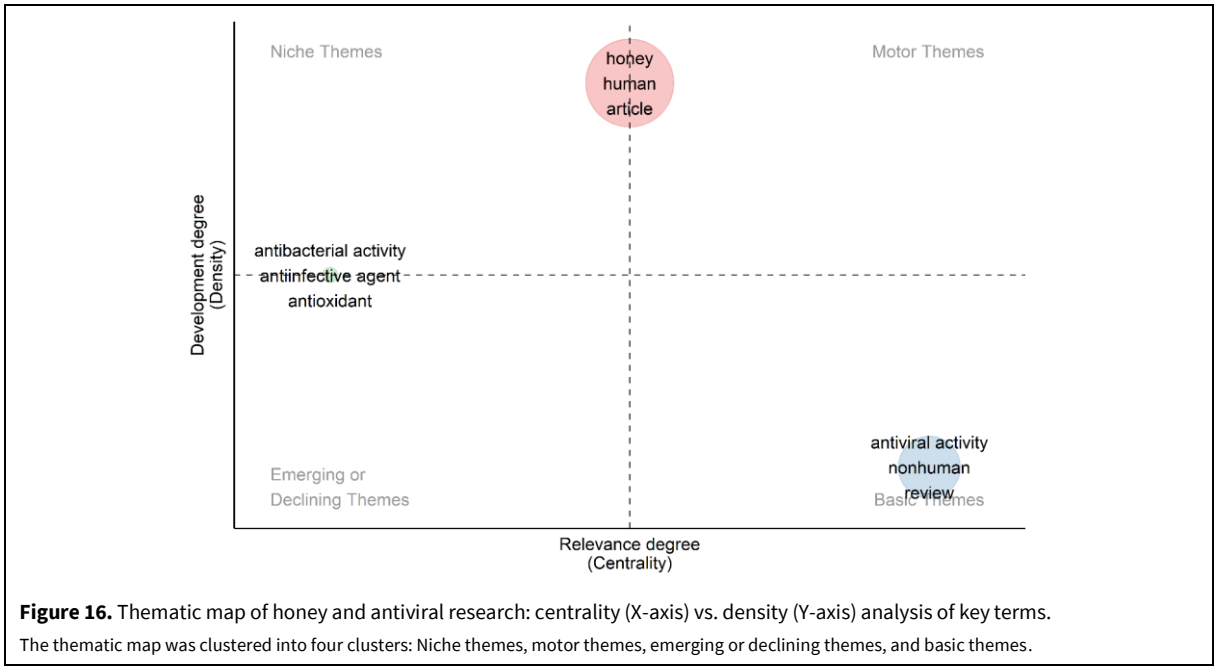

Figure 16. Thematic map of honey and antiviral research: centrality (X-axis) vs. density (Y-axis) analysis of key terms.
The thematic map was clustered into four clusters: Niche themes, motor themes, emerging or declining themes, and basic themes.

and anti-bacterial properties, as well as related products such as bee pollen and propolis (Andreo-Martinez et al., 2020; Çobanoğlu, 2023; Jaramillo-Zárate & Londoño-Giraldo, 2023; Stefanis et al., 2023; Vit et al., 2023; 2024; Zakaria et al., 2021). In contrast, bibliometric analyses focusing on the antiviral activity of honey remain limited, highlighting a clear research gap that this study aims to address through a comprehensive bibliometric evaluation.

In terms of publication output and growth trend, our analysis reveals that research on honey and antiviral activity has increased rapidly from 1996 to 2024, as indicated by an upward trend in cumulative publications. There has been a noticeable surge in publications, particularly since 2019. Over the five years from 2019 to 2024, a total of 50 publications on the topic were produced, compared to 33 publications over the preceding 25 years. This pattern of cumulative research output suggests an exponential growth of publications in this field. The surge in research publications on honey and antiviral topics, particularly those related to SARS-CoV-2, could be attributed to the global health crisis caused by the COVID-19 pandemic. The initial outbreak in Wuhan, China, prompted a significant increase in research on natural products, including honey, as potential therapeutic agents or supplementary treatments for viral infections (Huang et al., 2020; Verma & Gustafsson, 2020). This interest was driven by the diverse array of bioactive compounds in honey, which exhibited antiviral, anti-inflammatory, and immunomodulatory effects (Mackin et al., 2023). However, a decline in publication growth from 2023 onwards was also noted, which may be attributed to the widespread vaccination efforts against SARS-CoV-2. These efforts might have shifted research priorities away from antiviral agents, leading to a decrease in research focusing on the topic.

While assessing the geographical and institutional contributions, most research on honey and antivirals originated in Asia, with India and Iran emerging as leading contributors. Both countries consistently ranked among the top three in both publication output and citation impact, reflecting their active role in advancing this field. This regional dominance of Asia was consistent with the bibliometric study by Stefanis et al. (2023), which found that Asia accounted for the majority of documents on honey's antioxidant and antimicrobial properties, with India, Turkey, Malaysia, and Saudi Arabia among the top contributors. Such findings underscore Asia's strong research capacity and growing influence in honey. The differences in research output and quality across countries and continents were evident, reflecting economic resources, research infrastructure, and policy priorities that shape global research distribution (Liu et al., 2024).

Meanwhile, Switzerland was found to be the leading country in citation performance. A notable example is the highly cited review "*Honey for Nutrition and Health: A Review*" by Bogdanov et al. (2008), published in the Journal of the American College of Nutrition. This work, led by researchers from the Swiss Bee Research Centre, Agroscope in Bern, comprehensively discussed honey's nutritional, therapeutic, and bioactive properties, including antimicrobial and antiviral potentials. Its strong citation record shows Switzerland's impactful role in advancing global honey research.

The quantity of peer-reviewed publications is a crucial metric for assessing the developmental trends in a

specific research discipline or field of study (Van Nunen et al., 2018). This study shows a clear core of five journals that together publish the largest share of honey–antiviral papers. This matches Bradford's law of scattering, which states that articles on a given subject are concentrated in a small set of core journals, with the remainder scattered across many other titles. At the same time, the small per-journal counts beyond the core imply that most other journals contain only one or a few relevant items. Similarly, a prior bibliometric analysis of COVID-19 publications on chest and infectious diseases identified core journal sets, reflecting rapid publication in general medical and multidisciplinary outlets during an emergent period (Gülhan & Kurutkan, 2021).

Citation counts serve as significant indicators of scientific influence and quality evaluation (Öztürk et al., 2024). This study found that the Archives of Medical Research journal was the most cited journal on the topic of honey and antiviral, exhibiting the influence and impact of this journal on the research topic (Garousi & Fernandes, 2016). In terms of the most cited authors, Haruyama T, Kobayashi N, Matsunaga A, Rahmasari R, and Watanabe K received a total of 140 citations, followed by Mohamud, with a total of 80 citations, while Beasley, Braithwaite, Semprini, Shortt, and Singer received a similar total of 52 citations.

While examining the author's dynamics, it was found that the author's productivity on the topic of honey and antiviral did not fully conform to Lotka's law. This well-established principle explains how scientific productivity is distributed across fields. By definition, Lotka's law states that the number of authors making n contributions is roughly $1/n^a$ of the number of authors making a single contribution, where a is typically close to 2. This implies that the number of authors contributing a particular number of papers is inversely proportional to the number of papers they contribute (Kushairi & Ahmi, 2021; Lotka, 1926). In this study, the proportion of authors publishing two publications was lower than the value predicted by the inverse square relationship. Based on Lotka's law, with 336 authors publishing a single paper, the expected number publishing two papers would be approximately 84 ($336 \div 2^2$). This is considerably higher than the observed 20 authors found in this study. Single-paper contributors, therefore, dominated the author's productivity in this field. A similar pattern was reported by Gülhan & Kurutkan (2021) in a bibliometric analysis of COVID-19 publications in the field of chest and infectious disease research. This deviation from Lotka's distribution may be attributed to the rapid, recent increase in research output following the emergence of COVID-19, which limited the number of repeat contributors.

Co-authorship networks, on the other hand, serve as a valuable tool for mapping scientific collaboration, where authors are represented as nodes and their joint publications as links. This network analysis can reveal the dynamics of collaboration within the research community, indicating collaborative research efforts. A data diagram is a flow-based visualisation tool that illustrates the strength of connections between entities through the thickness of the flows. In bibliometric research, it has been increasingly used to map and interpret collaborative patterns across countries, institutions, and journals (Donthu et al., 2021; Zupic & Čater, 2015). In our analysis of honey and antiviral research, the Sankey plot revealed an intense concentration of contributions from Pakistan, primarily driven by institutions such as the Sheikh Zayed Postgraduate Medical Institute and the University of Veterinary and Animal Sciences. Iran ranked second, with key institutions including Tehran University of Medical Sciences and Shiraz University of Medical Sciences, while Malaysia followed with notable contributions from Universiti Sains Malaysia. The visualisation also highlighted Molecules as the main publishing outlet across multiple countries, whereas other journals, such as Biocatalysis and Agricultural Biotechnology, displayed more limited, country-specific contributions. This finding suggests that while research output is globally dispersed, a few countries and journals dominate the scholarly communication on honey and antiviral studies.

Co-word analysis is an important bibliometric method that examines the co-occurrence of keywords in the literature to identify the relationships and connections between research topics (Schroeder et al., 2018). 'Honey' and 'human' are the most frequently used keywords by authors on the topic of honey and its antiviral properties, with 76 and 71 occurrences, respectively. The terms ‘antiviral activity’ and ‘anti-virus agent’ appeared 28 and 26 times, respectively. The keyword co-occurrence network offers valuable insights into how research on honey's antiviral properties is structured. The presence of two clear thematic clusters suggests that the field is somewhat divided. On the one hand, many studies have focused on honey's biological activities, such as its antioxidant, anti-inflammatory, antimicrobial, anti-infective, and antiviral effects, which are primarily attributed to compounds such as flavonoids and polyphenols (Ahmed et al., 2018; Mandal & Mandal, 2011). On the other hand, a growing number of publications are exploring honey's potential as an adjunct or alternative therapy, particularly in the context of COVID-19 and other viral diseases, in which honey is increasingly evaluated through clinical and translational studies (Al-Hatamleh et al., 2020; Samarghandian et al., 2021). The keyword honey serves as a central connector between these two domains,

with the interconnecting lines highlighting emerging cross-disciplinary links in which insights into honey's bioactive properties are being integrated with applied research in therapeutic and clinical contexts.

Thematic mapping analysis utilised the keywords used by authors to provide the research topics, essential expressions, and the relationship between them. The network analysis of word occurrence describes the key themes and patterns, and then summarises the research topic into four different topologies of theme (Akter et al., 2021). The upper right quadrant (Q1) represents driving themes, while the lower right quadrant (Q4) contains underlying themes. The upper left quadrant (Q2) features highly specialised themes, and the lower left quadrant (Q3) is characterised by emerging or disappearing themes (Agbo et al., 2021). When examining thematic mapping on the topic of honey and antiviral properties, the terms 'honey', 'human', and 'article' were positioned between Q1 and Q2. This finding indicates that honey is both an essential and influential topic within the field, demonstrating strong centrality and steady development. The co-occurrence of human and article alongside honey reflects a strong emphasis on clinical or human-related investigations, as well as the frequent documentation of honey research in scholarly publications, reinforcing its position as a driving theme in the domain. The terms 'antibacterial activity', 'anti-infective agent', and 'antioxidant' are located between Q1 and Q3, highlighting their role as key drivers of current trends in the field. These topics are actively researched but may still be in their early stages of development, with moderate conceptual maturity. Their intermediate position suggests they could evolve into more central and established themes or be overshadowed by stronger emerging areas such as antiviral activity, depending on future research directions. In contrast, the terms 'antiviral activity', 'non-human', and 'review' were in Q4, suggesting that they represent established knowledge or concepts that are fundamental to the field but not actively driving current research. This positioning indicates that much of the available evidence is concentrated in preclinical or experimental studies and is often consolidated through reviews, rather than driven by novel or translational research. Therefore, advancing this area will require more targeted and original investigations, beginning with preclinical mechanism of action studies to comprehend the antiviral action prior to extending to well-designed human clinical studies. Such efforts would strengthen the evidence base on the antiviral properties of honey and help transition the theme from a foundational to a more dynamic research focus.

This study has several limitations, including the use of only the Scopus database for data retrieval. Restricting the analysis to a single source may have excluded relevant literature indexed in other databases such as Web of Science and PubMed. Nevertheless, Scopus is one of the largest and most comprehensive abstract and citation databases, covering a wide range of disciplines and providing high-quality scholarly content, which strengthens its suitability for bibliometric studies (Shaheen, 2025). The literature comparing Scopus and Web of Science indicates that both databases have significant overlap, especially in core journals, and that using Scopus alone is often sufficient for many bibliometric analyses, particularly in the social sciences, management, and health research fields (Öztürk et al., 2024). However, future studies may consider using additional databases to capture a more representative and diverse body of literature. Another limitation is that the data extraction and screening process has been carried out by a single researcher. While this ensured consistent application of the inclusion and exclusion criteria, it may have introduced a risk of selection bias or inadvertent omission of relevant studies. Involving multiple reviewers in future work could enhance the reliability and transparency of the selection process. The use of a limited keyword set in the search strategy may have led to the exclusion of some relevant articles, a standard limitation in bibliometric analyses (Romanelli et al., 2021). Nonetheless, the application of logical Boolean operators helped improve the precision and relevance of the retrieved results.

Despite these limitations, the study provides meaningful insights into publication trends and research gaps, and offers a valuable foundation for guiding future investigations on the antiviral potential of honey. Future research should prioritise mechanistic preclinical work to clarify how honey and its bioactive compounds exert antiviral effects, supported by standardised profiling of different honey types. Translational research should then progress to well-designed clinical trials assessing the efficacy and safety of interventions for viral infections beyond COVID-19. Strengthening this evidence base through collaborative, interdisciplinary approaches would enable honey's antiviral potential to move from preliminary observations to validated clinical application. Until supported by high-quality clinical trials, honey should be viewed as a potential adjunct, not a replacement, to standard antiviral therapies (Yupanqui Mieles et al., 2022). In the meantime, the growing body of evidence on the antiviral activity of honey may support the use of honey in complementary medicinal frameworks, especially in regions where traditional remedies are commonly used (Ahmed et al., 2018).

CONCLUSION

This bibliometric analysis provides a comprehensive overview of the research landscape concerning

honey's antiviral properties over 28 years. A notable increase in publication frequency was observed during the COVID-19 pandemic, underscoring heightened scientific interest in honey research as a potential natural antiviral agent. Despite the growing body of literature in this area, mechanistic, *in vivo*, and clinical research remains scarce. Future work should prioritise preclinical studies to clarify molecular mechanisms, dose–response relationships, and potential synergistic effects with existing antivirals, followed by well-designed clinical trials to validate efficacy and safety. Strengthening this evidence base would help transition honey's antiviral potential from broad claims to scientifically grounded applications. Future bibliometric studies incorporating multiple databases and standardised methodologies could further enhance the comprehensiveness of trend analysis. Bridging the current research gap may facilitate the evidence-based integration of honey as a complementary antiviral therapy in clinical practice.

CONFLICT OF INTEREST

The research was conducted entirely free from any involvement in commercial, financial, or personal matters that might be perceived as a possible conflict of interest or that could have influenced the outcomes or interpretation of the study.

ACKNOWLEDGMENTS

This project was funded by the Ministry of Higher Education, Malaysia, through the Fundamental Research Grant Scheme (FRGS/1/2022/SKK10/UIAM/02/3).

DATA AVAILABILITY STATEMENT

The raw bibliographic data were retrieved from the Scopus database (subscription required) and processed using the Bibliometrix R package. The processed datasets and analysis scripts are available from the corresponding author upon reasonable request.

GENERATIVE ARTIFICIAL INTELLIGENCE (AI)

The authors used ChatGPT (Open AI) to improve the language and readability of the manuscript. The authors reviewed and edited the content and take full responsibility for its accuracy. No images were generated or manipulated using AI tools.

REFERENCES

Agbo FJ, Oyelere SS, Suhonen J, Tukiainen M (2021) Scientific production and thematic breakthroughs in smart learning environments: A bibliometric analysis. Smart Learn Environ 8: 1. https://doi.org/10.1186/s40561-020-00145-4

Ahmed S, Sulaiman SA, Baig AA, Ibrahim M, Liaqat S, Fatima S, Jabeen S, Shamim N, Othman NH (2018) Honey as a potential natural antioxidant medicine: An insight into its molecular mechanisms of action. Oxid Med Cell Longev 2018: 8367846. https://doi.org/10.1155/2018/8367846

Akhavan P, Ebrahim NA, Fetrati MA, Pezeshkan, A (2016). Major trends in knowledge management research: A bibliometric study. Scientometrics 107: 1249–1264. https://doi.org/10.1007/s11192-016-1938-x

Akter S, Uddin MH, Tajuddin AH (2021) Knowledge mapping of microfinance performance research: A bibliometric analysis. Int J Soc Econ 48(3): 399–418. https://doi.org/10.1108/IJSE-08-2020-0545

Al-Hatamleh MAI, Hatmal MM, Sattar K, Ahmad S, Mustafa MZ, Bittencourt MC, Mohamud R (2020) Antiviral and Immunomodulatory effects of phytochemicals from honey against COVID-19: Potential mechanisms of action and future directions. Molecules 25(21): 5017. https://doi.org/10.3390/molecules25215017

Al-Waili NS (2004) Topical honey application vs. acyclovir for the treatment of recurrent herpes simplex lesions. Med Sci Monit 10(8): MT94–MT98.

Alaerjani WMA, Mohammed MEA (2024) Impact of floral and geographical origins on honey quality parameters in Saudi Arabian regions. Sci Rep 14: 8720. https://doi.org/10.1038/s41598-024-59359-y

Alam S, Sarker MMR, Afrin S, Richi FT, Zhao C, Zhou J-R, Mohamed IN (2021) Traditional herbal medicines, bioactive metabolites, and plant products against COVID-19: Update on clinical trials and mechanism of actions. Front Pharmacol 12: 671498. https://doi.org/10.3389/fphar.2021.671498

Alvarez-Suarez JM, Giampieri F, Battino M (2013) Honey as a source of dietary antioxidants: Structures, bioavailability and evidence of protective effects against human chronic diseases. Curr Med Chem 20(5): 621–638. https://doi.org/10.2174/092986713804999358

Andreo-Martinez P, Oliva J, Gimenez-Castillo JJ, Motas M, Quesada-Medina J, Camara MA (2020) Science production of pesticide residues in honey research: A descriptive bibliometric study. Environ Toxicol Pharmacol 79: 103413. https://doi.org/10.1016/j.etap.2020.103413

Aria M, Cuccurullo C (2017) Bibliometrix: An R-tool for comprehensive science mapping analysis. J Informetr 11(4): 959–975. https://doi.org/10.1016/j.joi.2017.08.007

Bogdanov S, Jurendic T, Sieber R, Gallmann P (2008). Honey for nutrition and health: A review. J Am Coll Nutr 27(6): 677–689. https://doi.org/10.1080/07315724.2008.10719745

Bogdanov S, Ruoff K, Oddo LP (2004) Physico-chemical methods for the characterization of unifloral honeys: A review. Apidologie 3 (suppl 1): S4–S17. http://dx.doi.org/10.1051/apido:2004047

Çobanoğlu DN, Kizilpinar Temizer İ, Candan ED, Yolcu U, Güder A (2023) Evaluation of the nutritional value of bee pollen by palynological, antioxidant, antimicrobial, and elemental characteristics. Eur Food Res Technol 249: 307–325. https://doi.org/10.1007/s00217-022-04117-5

Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM (2021) How to conduct a bibliometric analysis: An overview and guidelines. J Bus Res 133: 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Davoudi-Monfared E, Rahmani H, Khalili H, Hajiabdolbaghi M, Salehi M, Abbasian L, Kazemzadeh H, Yekaninejad MS (2020) A randomized clinical trial of the efficacy and safety of interferon β-1a in treatment of severe COVID-19. Antimicrob Agents Chemother 64(9): e01061-20. https://doi.org/10.1128/aac.01061-20

Erwan E, Harun M, Muhsinin M (2020) The honey quality of *Apis mellifera* with extrafloral nectar in Lombok West Nusa Tenggara Indonesia. J Sci Educ 1: 1–7. https://doi.org/10.29303/jossed.v1i1.482

Estevinho L, Pereira AP, Moreira L, Dias LG, Pereira E (2008) Antioxidant and antimicrobial effects of phenolic compounds

extracts of Northeast Portugal honey. Food Chem Toxicol 46(12): 3774–3779. https://doi.org/10.1016/j.fct.2008.09.062

Garousi V, Fernandes JM (2016) Highly-cited papers in software engineering: The top-100. Inf Softw Technol 71: 108–128. https://doi.org/10.1016/j.infsof.2015.11.003

Ghaffari A, Somi MH, Safaiyan A, Modaresi J, Ostadrahimi A (2012) Honey and apoptosis in human gastric mucosa. Health Promot Perspect 2(1): 53–59. https://doi.org/10.5681/hpp.2012.007

Gheldof N, Engeseth NJ (2002) Antioxidant capacity of honeys from various floral sources based on the determination of oxygen radical absorbance capacity and inhibition of *in vitro* lipoprotein oxidation in human serum samples. J Agric Food Chem 50(10): 3050–3055. https://doi.org/10.1021/jf0114637

Giti A, Rashedi V, Jalilzadeh Afshari P, Golchin M (2023) Citation review and scientific visualization of articles published in the Iranian Rehabilitation Journal (IRJ) 2003-2023 in the Scopus database. Iran Rehabil J 21(3): 399–410. http://dx.doi.org/10.32598/irj.21.3.327.3

Gülhan, PY, Kurutkan MN (2021) Bibliometric analysis of COVID-19 publications in the field of chest and infectious diseases. Duzce Med J 23(1): 30–40. https://doi.org/10.18678/dtfd.826465

Hashemipour MA, Tavakolineghad Z, Arabzadeh S, Iranmanesh Z, Nassab SAHG (2014) Antiviral activities of honey, royal jelly, and acyclovir against HSV-1. Wounds 26: 47–54.

Hossen MS, Ali MY, Jahurul M, Abdel-Daim MM, Gan SH, Khalil MI (2017) Beneficial roles of honey polyphenols against some human degenerative diseases: A review. Pharmacol Rep 69(6): 1194–1205. https://doi.org/10.1016/j.pharep.2017.07.002

Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X (2020) Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 395(10223): 497–506. https://doi.org/10.1016/S0140-6736(20)30183-5

Jaramillo-Zárate MJ, Londoño-Giraldo LM (2023) Pesticides in honey: bibliographic and bibliometric analysis towards matrix quality for consumption. Braz J Food Technol 26: e2022112. https://doi.org/10.1590/1981-6723.11222

Kek SP, Chin NL, Tan SW, Yusof YA, Chua LS (2017) Classification of honey from its bee origin via chemical profiles and mineral content. Food Anal Methods 10: 19–30. https://doi.org/10.1007/s12161-016-0544-0

Kumar R, Kumar S, Kanwar SS (2024) Biomedical Perspectives of Herbal Honey. In: Biomedical Perspectives of Herbal Honey. Singapore: Springer, pp. 89–167. https://doi.org/10.1007/978-981-97-1529-9_7

Kushairi N, Ahmi A (2021) Flipped classroom in the second decade of the Millenia: A bibliometrics analysis with Lotka's law. Educ Inf Technol 26: 4401–4431. https://doi.org/10.1007/s10639-021-10457-8

Lim WM, Kumar S (2024) Guidelines for interpreting the results of bibliometric analysis: A sensemaking approach. Glob Bus Organ Excell 43(2): 17–26. https://doi.org/10.1002/joe.22229

Lima WG, Brito JC, Da Cruz Nizer WS (2021) Bee products as a source of promising therapeutic and chemoprophylaxis strategies against COVID-19 (SARS-CoV-2). Phytother Res 35(2): 743–750. https://doi.org/10.1002/ptr.6872

Liu Y, Wang M, Yu N, Zhao W, Wang P, Zhang H, Sun W, Jin N, Lu H (2024) Trends and insights in dengue virus research globally: A bibliometric analysis (1995–2023). J Transl Med 22: 818. https://doi.org/10.1186/s12967-024-05561-5

Lotka A (1926) The frequency distribution of scientific productivity. J Wash Acad Sci 16(12): 317–323.

Machado De-Melo AA, Almeida-Muradian LBD, Sancho MT, Pascual-Maté A (2018) Composition and properties of *Apis mellifera* honey: A review. J Apic Res 57(1): 5–37. https://doi.org/10.1080/00218839.2017.1338444

Mackin C, Dahiya D, Nigam PS (2023) Honey as a natural nutraceutical: Its combinational therapeutic strategies applicable to blood infections—septicemia, HIV, SARS-CoV-2, malaria. Pharmaceuticals 16(8): 1154. https://doi.org/10.3390/ph16081154

Mandal MD, Mandal S (2011) Honey: Its medicinal property and antibacterial activity. Asian Pac J Trop Biomed 1(2): 154–160. https://doi.org/10.1016/S2221-1691(11)60016-6

Mani R, Natesan V (2018) Chrysin: Sources, beneficial pharmacological activities, and molecular mechanism of action. Phytochemistry 145: 187–196. https://doi.org/10.1016/j.phytochem.2017.09.016

Öztürk O, Kocaman R, Kanbach DK (2024) How to design bibliometric research: an overview and a framework proposal. Rev Manag Sci 18: 3333–3361. https://doi.org/10.1007/s11846-024-00738-0

Puscas A, Hosu A, Cimpoiu C (2013) Application of a newly developed and validated high-performance thin-layer chromatographic method to control honey adulteration. J Chromatogr A 1272: 132–135. https://doi.org/10.1016/j.chroma.2012.11.064

Romanelli JP, Gonçalves MCP, de Abreu Pestana LF, Soares JAH, Boschi RS, Andrade DF (2021). Four challenges when conducting bibliometric reviews and how to deal with them. Environ Sci Pollut Res 28(43): 60448–60458. https://doi.org/10.1007/s11356-021-16420-x

Sadeghi S, Rezvanian A, Jamali S, Zomorodian MJ (2013) Zotero: A reference manager for researchers. Interdiscip J Virtual Learn Med Sci 4(3): 56–64.

Samarghandian S, Farkhondeh T, Samini F (2017) Honey and health: A review of recent clinical research. Pharmacogn Res 9(2): 121–127. https://pmc.ncbi.nlm.nih.gov/articles/PMC5424551/

Sathe S, Seeram N, Kshirsagar H, Heber D, Lapsley K (2008) Fatty acid composition of California grown almonds. J Food Sci 73: C607–C614. https://doi.org/10.1111/j.1750-3841.2008.00936.x

Sathianarayanan M, Hemani K, Gaonkar S (2024) Analysis of sugar composition in honey samples using HPLC separation and RI detection. BTRA Scan LIII(2): 5–8.

Schroeder NL, Nesbit JC, Anguiano CJ, Adesope OO (2018) Studying and constructing concept maps: A meta-analysis. Educ Psychol Rev 30: 431–455. https://doi.org/10.1007/s10648-017-9403-9

Shaheen H (2025) Social media marketing research: A bibliometric analysis from Scopus. Futur Bus J 11: 41. https://doi.org/10.1186/s43093-025-00465-2

Shahzad A, Cohrs RJ (2012) *In vitro* antiviral activity of honey against varicella zoster virus (VZV): A translational medicine study for potential remedy for shingles. Transl Biomed 3(2): 2. https://pmc.ncbi.nlm.nih.gov/articles/PMC3401066/

Shaikh A, Ahmad F, Teoh SL, Kumar J, Yahaya M F (2024) Unveiling the therapeutic potential of kelulut (stingless bee) honey in Alzheimer's disease: Findings from a rat model study. Antioxidants 13(8): 926. https://doi.org/10.3390/antiox13080926

Stefanis C, Stavropoulou E, Giorgi E, Voidarou CC, Constantinidis TC, Vrioni G, Tsakris A (2023) Honey's antioxidant and antimicrobial properties: A bibliometric study. Antioxidants 12(2): 414. https://doi.org/10.3390/antiox12020414

Swellam T, Miyanaga N, Onozawa M, Hattori K, Kawai K, Shimazui T, Akaza H (2003) Antineoplastic activity of honey in an experimental bladder cancer implantation model: *In vivo* and *in vitro* studies. Int J Urol 10(4): 213–219. https://doi.org/10.1046/j.0919-8172.2003.00602.x

Tafere DA (2021) Chemical composition and uses of honey: A review. J Food Sci Nutr Res 4(3): 194–201. https://doi.org/10.26502/jfsnr.2642-11000072

Van Nunen K, Li J, Reniers G, Ponnet K (2018) Bibliometric analysis of safety culture research. Saf Sci 108: 248–258. https://doi.org/10.1016/j.ssci.2017.08.011

Velásquez P, Montenegro G, Valenzuela L, Giordano A, Cabrera-Barjas G, Martin-Belloso O (2022) k-Carrageenan edible films for beef: honey and bee pollen phenolic compounds improve their antioxidant capacity. Food Hydrocoll 124(Part A): 107250. https://doi.org/10.1016/j.foodhyd.2021.107250

Verma S, Gustafsson A (2020) Investigating the emerging COVID-19 research trends in the field of business and management: A bibliometric analysis approach. J Bus Res 118: 253–261. https://doi.org/10.1016/j.jbusres.2020.06.057

Vit P, Ekundayo TC, Wang Z (2023) Mapping six decades of stingless bee honey research: Chemical quality and bibliometrics. Interciencia 48(8): 380–387.

Vit P, Wang Z, Zakaria R (2024) Stingless Bees (1955–2021) and Other Bees (1945–2021) in Propolis Research. A Bibliometric Review of Scholarly Articles. In: Vit P, Bankova V, Popova M, Roubik DW (eds), Stingless Bee Nest Cerumen and Propolis, Volume 1. Cham: Springer, pp. 117–135. https://doi.org/10.1007/978-3-031-43274-3_6

Watanabe K, Rahmasari R, Matsunaga A, Haruyama T, Kobayashi N (2014) Anti-influenza viral effects of honey *in vitro*: Potent high activity of manuka honey. J Altern Complement Med 45(5): 359–365. https://doi.org/10.1016/j.arcmed.2014.05.006

Yaman K, Nicolescu A, Tepe O, Cornea-Cipcigan M, Aydoğan-Çoşkun B, Mărgăoan R, Şenoğul D, Topal E, Bouari CM (2024) Physicochemical, antimicrobial properties and mineral content of several commercially available honey samples. Appl Sci 14(18): 8305. https://doi.org/10.3390/app14188305

Yang L, Chen Z, Liu T, Gong Z, Yu Y, Wang J (2013) Global trends of solid waste research from 1997 to 2011 by using bibliometric analysis. Scientometrics 96: 133–146. https://doi.org/10.1007/s11192-012-0911-6

Yupanqui Mieles J, Vyas C, Aslan E, Humphreys G, Diver C, Bartolo P (2022) Honey: an advanced antimicrobial and wound healing biomaterial for tissue engineering applications. Pharmaceutics 14(8):1663. https://doi.org/10.3390/pharmaceutics14081663

Zakaria, R, Ahmi A, Ahmad AH, Othman Z, Azman KF, Ab Aziz CB, Ismail CAN, Shafin N (2021) Visualizing and mapping a decade of literature on honey research: A bibliometric analysis from 2011 to 2020. J Apic Res 60(3): 359–368. https://doi.org/10.1080/00218839.2021.1898789

Zeina B, Othman O, Al-Assad S (1996) Effect of honey versus thyme on Rubella virus survival *in vitro*. J Altern Complement Med 2(3): 345–348. https://doi.org/10.1089/acm.1996.2.345

Zupic I, Čater T (2015) Bibliometric methods in management and organization. Organ Res Methods 18: 429–472. https://doi.org/10.1177/1094428114562629

AUTHOR CONTRIBUTION:

Contribution	Ismail CMKH	Ismail A	Abdul Hamid AA	Mohd Abd Razak MR	Mokhtar KI	Lestari W	Alahmad BEM
Concepts or ideas		x	x	x	x	x	x
Design		x	x	x	x	x	x
Definition of intellectual content		x	x	x	x	x	x
Literature search	x	x					
Experimental studies							
Data acquisition	x						
Data analysis	x	x	x	x			
Statistical analysis							
Manuscript preparation	x						
Manuscript editing		x	x		x		
Manuscript review	x	x	x	x	x	x	x

Citation Format: Ismail CMKH, Ismail A, Abdul Hamid AA, Mohd Abd Razak MR, Mokhtar KI, Lestari W, Alahmad BEM (2026) Honey's antiviral research landscape: A 28-year bibliometric analysis (1996–2024). J Pharm Pharmacogn Res 14(1): 2383. https://doi.org/10.56499/jppres_14.1.2383

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Open Access: This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/ licenses/by/4.0/), which permits use, duplication, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.