Bibliometric analysis of ethnobotanical research in India (1963-2024): Trends, collaborations and themes based on Scopus

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Research

Abstract

Background: Ethnobotany is a multidisciplinary domain that examines the relationships between ethnic groups and plant life, highlighting the traditional botanical knowledge. This study conducts a bibliometric analysis of ethnobotanical research in India, utilizing Scopus-indexed articles from 1963 to 2024 to investigate trends, collaborations, and emerging themes.

Methods: The study employed bibliometric analysis, a quantitative method that utilized the Scopus database to extract bibliographic information from original scientific papers published in India. Biblioshiny and VOSviewer were used for data processing, analysis, and visualization.

Results: Research output on Ethnobotany in India began in 1963 and has continued to grow, peaking in 2023 with 847 publications, the highest recorded to date. Banaras Hindu University leads among institutions with 304 articles, while Kumar A. emerges as the most influential author, with significant collaborative links and citation impact. India holds the largest volume of publications, with strong international collaborations, particularly with the United States (link strength: 624), followed by Saudi Arabia and Australia. Citation patterns have shifted, with a recent focus on "Chronic Kidney Disease" surpassing "Medicinal Plants of India with Anti-diabetic Potential" in terms of citation count. The study identified Ignacimuthu S. as the most cited author (3237 citations), followed by Kumar A. (3081 citations). The rising frequency of keywords like 'medicinal plants' (602) and 'traditional knowledge' (426) over recent years reflects their emergence as key themes in the evolving landscape of research. The Journal of Ethnopharmacology has seen linear growth since the 1980s, while the Indian Journal of Traditional Knowledge, established in 2007, has become a prominent publication in ethnobotanical studies in India, showing significant growth and remaining a key information source.

Conclusions: The study provides an overview that the ethnobotanical research is progressing in India, with some minor fluctuations, emphasizing the nation's commitment to sustainable development through research efforts and indicating the impact of funding and governmental support on scientific outcomes. The findings can guide future research directions, interdisciplinary collaborations, and policy decisions, highlighting opportunities for preserving traditional knowledge and promoting sustainable development in India.

Keywords: Bibliometrics, Scientometrics, Ethnobotany, Topic trends.

Background

Bibliometrics is a quantitative research methodology employing mathematical and statistical approaches to evaluate the external attributes of scientific publications and forecast contemporary and prospective trends in scientific and technical research (Jiang *et al.* 2023). Bibliometrics employs two primary methodologies, namely performance analysis and bibliometric/science mapping, to ascertain the current research trends within a specific domain. It encompasses the identification of research growth or decreases on a subject, principal contributors, significant sources, collaborators, leading affiliations, citation analysis, co-citation analysis, bibliographic coupling, keyword analysis, and more.

The term ethnobotany, coined by Harshberger in 1895, denotes a multidisciplinary field that examines the associations, interactions, and interrelationships between ethnic human communities, particularly tribes, and the surrounding flora (Vedavathy 2004). Although ethnobotany comprises the study of the relationships between humans and plants, its contemporary usage suggests a focus on indigenous or traditional botanical knowledge. The emergence of ethnobotany as a discipline resulted from the contributions of various other disciplines such as anthropology, botany, ecology, pharmacy, linguistics, medicine, and ethnography (Iwu 2002). Nowadays, ethnobotany has developed as a broad field that consists of many subdisciplines like ethnoagriculture, ethnotaxonomy, ethnomedicobotany, ethnoecology, ethnomycology, ethnogynaecology, ethnotoxicology, ethnopharmacology, ethnopharmacognosy, ethnophytotaxonomy, ethnoveterinary medicine, ethnoforestry, ethnopadiatrics, etc. (Suthari *et al.* 2021; Vedavathy 2004). Furthermore, the applications of ethnobotany have yielded significant transformations and remedies for contemporary issues. The contributions of ethnobotany are substantial in medication development, germplasm conservation, crop enhancement, identification of new plants for domestication, evaluation of the cultural status of tribes, research of the plant dispersion, novel manufacturing processes, resource management, early species identification in commerce, etc. (Farnsworth *et al.* 1985; Balick 1996; Henrich 2000).

Despite significant advancements in Western medicine and medical technologies, traditional knowledge regarding the efficacy of medicinal plants remains prevalent and is actively practiced in numerous countries worldwide. Ethnobotanical knowledge is paramount among various ethnic and cultural groups in remote areas of developing, underdeveloped, and some developed countries, often serving as the primary, if not sole, solution for the medical needs of billions. Ethnobotanical knowledge is believed to have contributed to the development of around 30% of modern pharmaceuticals (Bhattarai and Karki 2004). Realizing the rising demand for healthcare services due to population growth, it is essential to investigate more cost-effective and efficient alternatives. Documenting ethnobotanical practices is essential for preserving this knowledge and ensuring its accessibility for future generations, as well as for sharing information within the scientific community (Idolo *et al.* 2010; Mahmood *et al.* 2011; Suroowan *et al.* 2019).

EnviStats India 2022 indicated that India is a mega-diverse region, encompassing merely 2.4% of the global land area yet exhibiting significant species and ecosystem diversity. India hosts over 2000 distinct ethnic groups, more than 103258 species of fauna, and 55048 species of plants throughout its 10 biogeographic zones. The comprehension of medicinal and aromatic plants developed throughout human history and across civilizations has produced knowledge that addresses various welfare needs, including nutritional and medicinal applications. Most of these plants are grown in forests and natural vegetation, and they are collected by the ethnic rural populations of our country. They possess knowledge of the medicinal applications of various wild plants, derived from ancestral understanding and beliefs, for the effective treatment of diverse diseases. The accumulated knowledge derived from extensive practical observation and application by ancient rishis, saints, prophets, seers, and intellectuals resulted in the establishment of a comprehensive traditional medicine, Ayurveda, in our country (Suthari *et al.* 2021). However, over-harvesting, degradation of medicinal plants, loss of indigenous traditional knowledge from local communities, and the absence of indigenous knowledge in other communities are significant issues that restrict the sharing of traditional knowledge (Channaveeraiah and Entoori 2022).

In the mid-20th century, ethnobotanical research in India gained prominence through the work of Padmashri Dr. E. K. Janaki Ammal, who served as an official programmer in the Economic Botany Section of the Botanical Survey of India. Her research focused on the subsistence food plants utilized by various tribes, particularly in South India (Janaki Ammal 1956). Furthermore, the work of Dr. S.K. Jain involved thorough investigations in Central India, leaving a significant impact on Indian scientists across various fields. Numerous contributions to the field emerged through scientific publications, handbooks, books, and other forms by individual authors and various research institutes, including the Council of Scientific and Industrial Research (CSIR). In the early 1980s, the Department of Environment and Forest, Government of India, provided funding for a nationwide coordinated initiative focused on ethnobiology. This initiated the ethnobotanical investigation in India. It was conducted across more than a dozen institutions, including the Botanical Survey of India (BSI), CSIR, various universities, and other laboratories throughout the country. Subsequently, numerous central and state institutes, universities, and

organizations began to engage in this area, resulting in significant advancements and developments. The Ministry of Ayush, National Medicinal Plants Board (NMPB), Science and Engineering Research Board (SERB), Directorate of Medicinal and Aromatic Plants Research (DMAPR), BSI, University Grants Commission (UGC), Indian Council of Medical Research (ICMR), and various other agencies provide funding for ethnobotanical research and ethnic affairs in the country, contributing to the increase in publication count in recent years. Furthermore, traditional ethnobotanical knowledge plays a crucial role in achieving the Sustainable Development Goals set forth by the United Nations. At least seven of the seventeen Sustainable Development Goals (SDG 1 - no poverty, SDG 2 - zero hunger, SDG 3 - good health and well-being, SDG 12 - responsible consumption and production, SDG 13 - climate action, SDG 15 - life on land, and SDG 17 - partnerships for the goals) are interconnected with traditional ecological knowledge. This highlights the significance of research in ethnobotany and its influence on enhancing human life across various dimensions, including the advancement of a sustainable world.

Scopus is a globally recognized bibliographic database, extensively used in bibliometric research due to its rigorous indexing standards, structured metadata, and multidisciplinary scope. It provides standardized, peer-reviewed, and citable data necessary for performing reliable trend and network analyses. A bibliometric analysis of ethnobotanical research trends in India, solely on Scopus-indexed publications, does not fully portray the entire field's landscape, but it does allow researchers to examine trends through the prism of peer-reviewed, indexed research, to identify frontier directions, and to forecast the discipline's future trends. This can assist researchers and government decision-makers in identifying critical priorities and comprehending developments within the subject.

Although Pathak and Bharati (2020) conducted a similar analysis on ethnobotanical research trends in India that yielded some insights, there was a gap in comprehensiveness in generating keywords pertinent to the ideas of ethnobotany, which may have retrieved additional important insights. Furthermore, a significant increase in financial and material support for research and development by the nation across all fields has been observed during the previous five years. The strengthened demand among United Nations (UN) member nations for advancing research that supports the Sustainable Development Goals is crucial, as Ethnobotanical Traditional Knowledge is a domain that can ultimately guide the world towards achieving sustainable development. Such an examination can provide insights for future actions as a nation with diversified possibilities in this domain.

This study was initiated to address the research question of whether ethnobotanical research has advanced or declined in the country over the past years and to understand if there have been any changes in trends regarding authorship, collaboration, primary sources, citations, and publication based on the Scopus database, with the following specific objectives:

1. To analyze the annual publication trends in ethnobotany research in India from 1963 to 2024 and identify the key periods of growth or decline.
2. To examine the authorship and collaboration patterns in the field of ethnobotanical research in India.
3. To identify the top journals that publish ethnobotanical research from India and their distribution.
4. To find out the most frequently used keywords and topic trends in the field of study.
5. To conduct a citation analysis to identify highly cited publications, citation networks, and influential researchers in the field of ethnobotanical research in India.

Materials and Methods

This study employed a quantitative research approach using bibliometric analysis to examine the evolution and trends in ethnobotanical research in India from 1963 to 2024 from the Scopus literature. The study gathered the relevant data by extracting the bibliographical details of the original scientific works published in India from the scientific publications listed in the Scopus database on 1st February 2024. Scopus, provided by Elsevier and launched in 2004, is an interdisciplinary and multidisciplinary abstracting and citation database covering approximately 330 disciplines. The database has a comprehensive coverage of scientific content dating back to 1788 and references dating back to the 1970s.

To ensure a comprehensive capture of ethnobotanical research publications from India, a carefully constructed keyword-based retrieval strategy was employed in the Scopus database. Article title, abstract, and keywords were utilized for the search and retrieval of bibliographic data. The search query incorporated a combination of Boolean operators (OR), wildcards (*), and relevant synonymous terms, including Ethnobotan*, Ethnomed*, "traditional knowledge," "Herbal medicine," and "Folk Medicine". Boolean Operator 'OR' was used to differentiate the search terms from each other and to access all the

synonymous terms used in the ethnobotany studies. The document formats were restricted to articles, conference papers, and review papers published in India. The source type was confined to journals, and the language of the publications was limited to English. A total of 8,868 bibliographic records were extracted from the Scopus database in CSV format, pre-processed, and duplicates (n = 15) were removed using the Scientopy software. The final number of bibliographic records amounted to 8,853, was exported to Biblioshiny and VOSviewer for analysis. With the help of the Bibliometrix package / biblioshiny interface provided by the R program, bibliometric analysis, including publication performance analysis and network mapping, was constructed. VOSviewer, an open-source software that can be used for generating network maps based on citation, co-citation, bibliographic coupling, co-authorship, and keyword occurrences, was also utilized in the study for the visualization of the analyzed data. The results analyzed in the study are wholly confined to the scientific works indexed in the Scopus database only, and no other indexing sources/databases were considered. A substantial portion of indigenous knowledge and locally focused studies may be published in non-indexed regional journals or reported in grey literature and institutional repositories. But the wide interdisciplinary coverage, robust metadata structure, and compatibility of Scopus data with bibliometric tools such as VOSviewer and Biblioshiny are essential for structured performance and network analyses. Since the field of ethnobotany research is multidisciplinary, vast, and extensive, the potential keywords for data searching and retrieval can be reformulated infinitely and cannot be restricted to a few options.

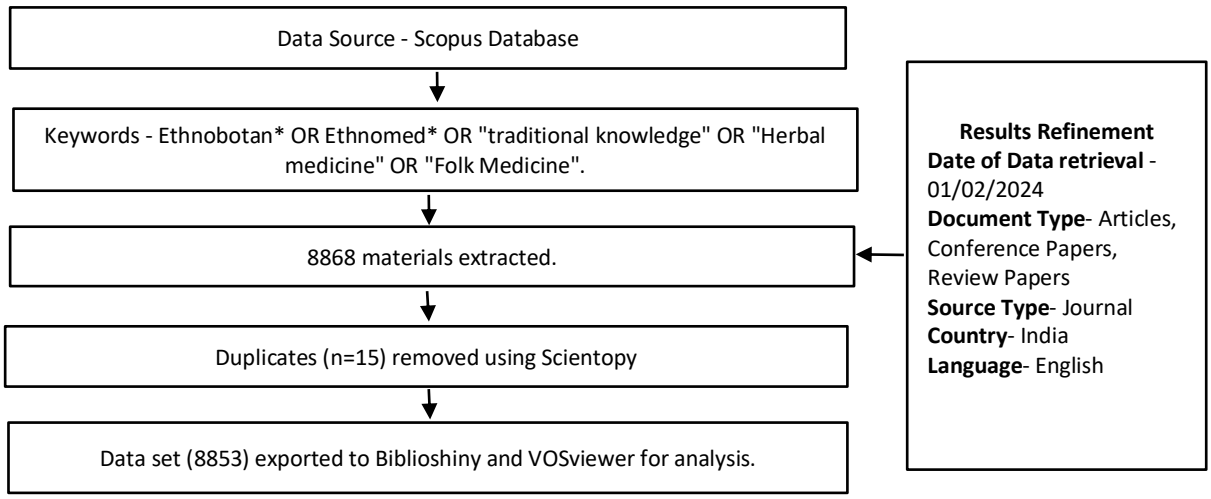

Figure 1. The author's representation of methodology

Results and Discussion

Main Information

An overview and a quantitative summary of the data and its findings obtained from the investigation are given in Table 1. The period covered in the study spans from 1963 to 2024; the total number of documents amounts to 8,853, while the number of sources amounts to 1651. The documents include 6668 articles, 46 conference papers, and 2,139 reviews. Publications in the discipline show an annual growth rate of 7.69%, and the average number of citations per document is 18.32%. Out of a total of 20,254 authors identified, 445 are authors of single-authored papers. There are 549 single-authored documents, while international collaboration is found to be 14.54%.

Table 1. Description of dataset

Description	Results
Timespan	1963:2024
Sources (Journal)	1651
Documents	8853
Annual Growth Rate %	7.69
Document Average Age	8.99
Average citations per doc	18.32
References	421417
Document Contents	
Keywords Plus (ID)	39217
Author's Keywords (DE)	18062

Authors	
Authors	20254
Authors of single-authored docs	445
Authors Collaboration	
Single-authored docs	549
Co-Authors per Doc	4.15
International co-authorships %	14.54
Document Types	
Article	6668
Conference paper	46
Review	2139

Publication Performance Analysis

Annual Scientific Production

Figure 2 depicts the yearly research output on Ethnobotany in India. The earliest publication indexed in the Scopus database dates to 1963. Subsequently, there is a notable deceleration in the publication rate, with several years witnessing zero publications (specifically, from 1964 to 1970, 1972, and 1976). Since 1993, there has been a gradual rise in the number of publications, with occasional fluctuations. In 2011, there were 562 publications, representing a significant increase compared to previous years. Between 2019 and 2023, there is a consistent upward trend in annual scientific output, peaking at 847 articles in 2023, the highest noted thus far. The abrupt decline in publications after 2023 can be attributed to the study encompassing data only until February 1, 2024. However, it is worth mentioning that there are 92 publications as of February 1st, 2024.

The study revealed a significant increase in scientific output since 2019, underscoring the ongoing growth of ethnobotanical research in India over the past five years. The observed growth is significantly more rapid than that of the third phase, which commenced in 2007, as Pathak and Bharati (2020) noted in their study. Aside from India, Ritter *et al.* (2015) observed the growth of ethnobotanical research in Brazil, although the results produced are less significant than those from India.

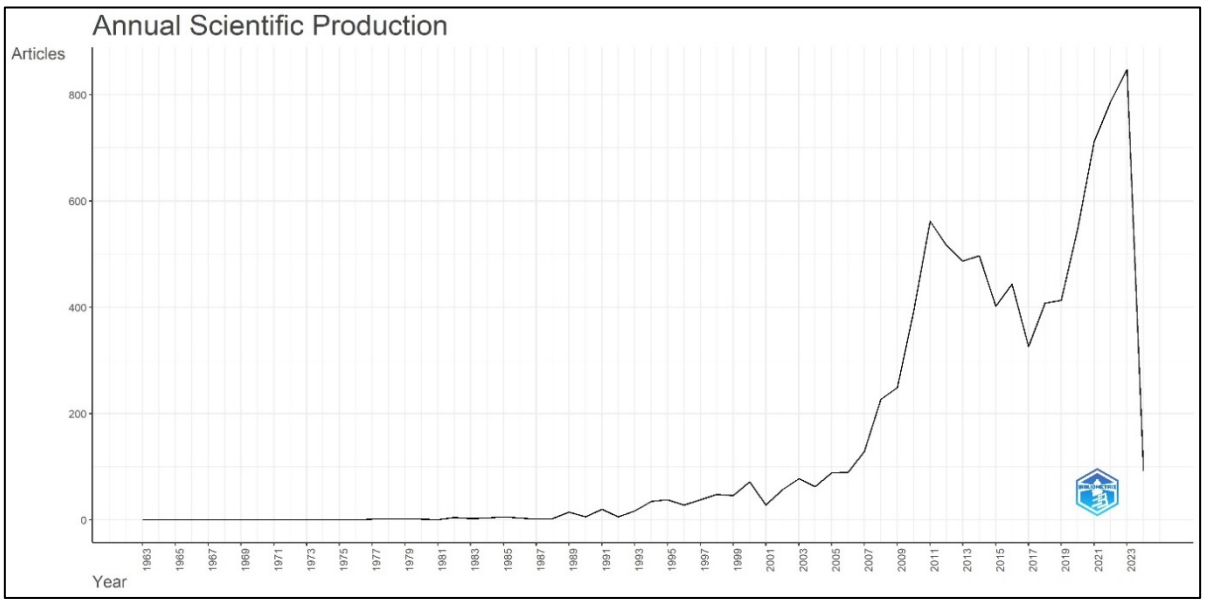

Figure 2. Annual Scientific Production

Figure 3 graphically displays the 10 most significant authors in the field of ethnobotanical studies in India. Kumar A is the most prolific author with 193 publications, followed by Kumar S (136), Singh S (112), Sharma A (102), Singh A (97), Kumar V (96), Sharma S (90), Kumar D (75), Kumar M (75), and Singh B (70) contributions.

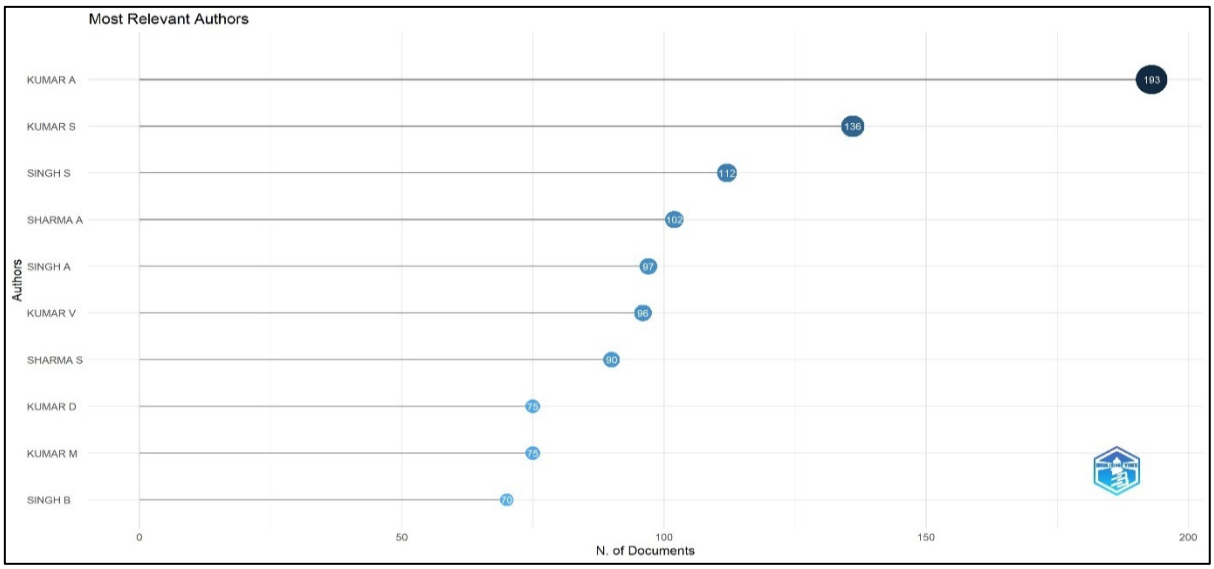

Figure 3. Most Relevant Authors

Most Relevant Affiliations

The 25 most significant affiliations, together with the respective number of publications published by each, are displayed in Table 2. With 304 publications, Banaras Hindu University ranks first among the affiliating institutions, followed by Jadavpur University (274), Lovely Professional University (258), the University of Kashmir (203), and Integral University (189) in the top five positions, and so on.

A comparison of the findings with the observations of Pathak & Bharati (2020) reveals a substantial transition in the institutions engaged in ethnobotanical research in the country. The Council of Scientific & Industrial Research (CSIR) and the Indian Council of Agricultural Research (ICAR), once leaders in the field, were ultimately supplanted by Banaras Hindu University. The absence of CSIR and ICAR in this study can be explained by the focus on identifying the individual institution with the highest contribution, neglecting the collective contributions of CSIR and ICAR, which encompass numerous institutes across the country. Jadavpur University, which was previously ranked third in the investigation, now occupies the second position, a finding that supports the previously mentioned results. Lovely Professional University has published 258 publications, the University of Kashmir with 203 publications, and Integral University with 189 publications hold third, fourth, and fifth positions, respectively. Loyola College Chennai and Assam University, previously ranked 9th and 10th, are now ranked 22nd and 14th in this study. Of the top 11 colleges in 2020, only two retained their positions within the top 25 rankings, while the remainder were supplanted by other institutions. This indicates the shift in focal areas of ethnobotanical research by institutions.

Co-Authorship Pattern

The evolution of trends in co-authorship patterns within the scientific area throughout time, exhibited in Figure 4, comprises authors who have made a minimum of 10 publications. Among the 19949 authors, 286 satisfy the defined criteria. Those authors who engage in extensive engagement or collaboration are allocated a certain colour. They have been partitioned into 21 clusters, and the network consists of 1973 links, representing a total link strength of 3623. This statistic illustrates a significant tendency toward collaboration among authors in the discipline of Ethnobotany.

Among the 21 clusters, cluster 1 exhibits the most extensive collaboration network, including 37 authors. Individual nodes correspond to the number of publications. The largest node in the network corresponds to Kumar A, who was identified as the most influential author and holds a position in cluster 5, which comprises 24 authors. Kumar A exhibits the greatest link strength at 263, followed by Kumar S at 172 and Singh S at 149. The connection strength values suggest that these authors exhibit a considerable level of collaboration.

The co-authorship pattern findings indicate that the recent shift in Indian ethnobotanical research publication over the past five years diverges from the results reported.

Table 2. Most Relevant Affiliations

Sl. No.	Affiliation	Articles
1	BANARAS HINDU UNIVERSITY	304
2	JADAVPUR UNIVERSITY	274
3	LOVELY PROFESSIONAL UNIVERSITY	258
4	UNIVERSITY OF KASHMIR	203
5	INTEGRAL UNIVERSITY	189
6	BHARATHIAR UNIVERSITY	188
7	SHOOLINI UNIVERSITY OF BIOTECHNOLOGY AND MANAGEMENT SCIENCES	188
8	DIBRUGARH UNIVERSITY	185
9	KING SAUD UNIVERSITY	175
10	UNIVERSITY OF MADRAS	174
11	SAVEETHA UNIVERSITY	171
12	UNIVERSITY OF MYSORE	163
13	UNIVERSITY OF DELHI	161
14	ASSAM UNIVERSITY	154
15	ANNAMALAI UNIVERSITY	145
16	MAHARSHI DAYANAND UNIVERSITY	139
17	NATIONAL BOTANICAL RESEARCH INSTITUTE	139
18	UNIVERSITY OF CALCUTTA	125
19	AMITY UNIVERSITY	124
20	JSS COLLEGE OF PHARMACY	123
21	SRI VENKATESWARA UNIVERSITY	120
22	LOYOLA COLLEGE	115
23	UNIVERSITY OF NORTH BENGAL	112
24	KUVEMPU UNIVERSITY	111
25	NORTH-EASTERN HILL UNIVERSITY	111

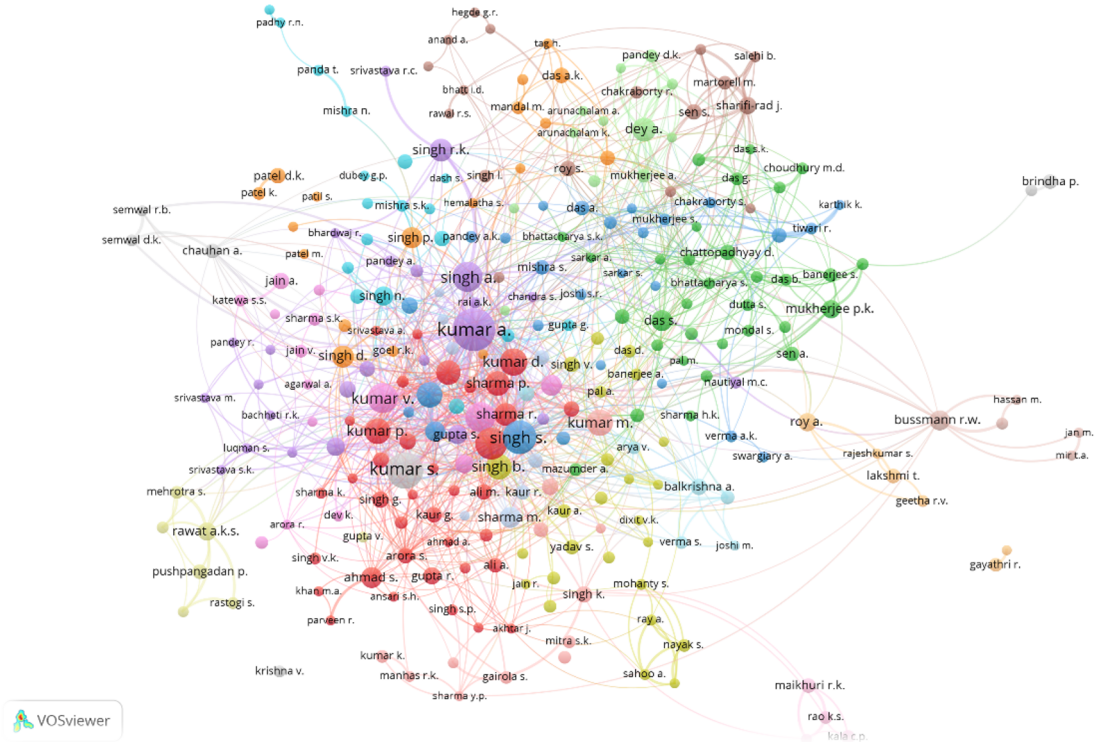

Figure 4. Co-authorship Pattern- Network Visualization

Country Collaboration

Figure 5 shows the collaboration network of countries with at least 10 documents. Out of 165 countries, 53 meet the criteria, and they are arranged in 7 clusters. There are 829 links and a total link strength of 4934. Cluster 1 shows the greatest number of collaborating countries (n= 15) including Austria, Belgium, Brazil, Canada, China, India, Indonesia, Japan, Mexico, Netherlands, Norway, Switzerland, Taiwan, Thailand, and the United States.

The size of the nodes (circles) represents the number of publications of the country, whereas the links show the size or strength of collaboration among countries. From Figure 5, India forms the biggest node, meaning that India has the largest number of publications about 'Ethnobotany in India'. The link between India and the United States is thicker than that of the countries. From Table 3, the total link strength between India and the United States is 624, indicating that India collaborated heavily with the United States compared to other countries. Saudi Arabia ranks second in terms of collaboration with India, with a total link strength of 568. This is followed by Australia with a link strength of 334.

The collaboration pattern of the nation remains consistent in the top two positions, with the USA (TLS- 624) and Saudi Arabia (TLS- 568) exhibiting results like those reported by Pathak & Bharati (2020). During this period, Australia (TLS-334) rose from 10th to 3rd place in terms of collaboration, whereas England fell from 3rd to 8th place. Countries including China, Iran, Pakistan, Malaysia, Italy, and Egypt have ascended into the top 10 rankings in terms of collaboration.

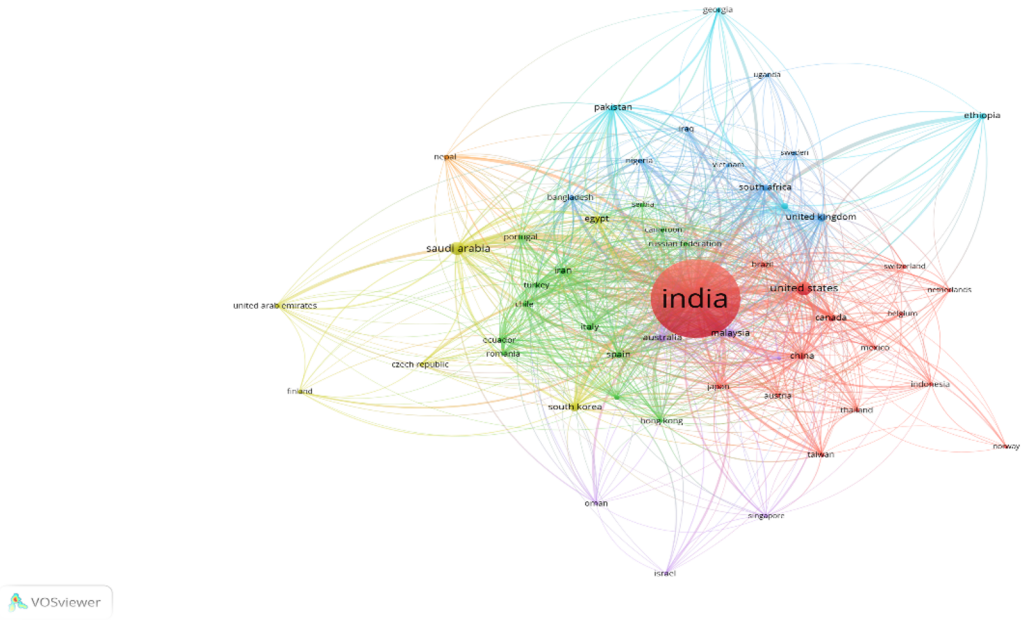

Figure 5. Countries Collaborating with India- Network Visualisation

Table 3. Countries Collaborating with India according to Total Link Strength (TLS)

Sl. No	Country	TLS
1	United States	624
2	Saudi Arabia	568
3	Australia	334
4	China	288
5	Iran	270
6	Pakistan	268
7	Malaysia	261
8	United Kingdom	233
9	Italy	232
10	Egypt	229

Average Citations Per Year

Figure 6 illustrates the annual average citations, peaking in the year 2002, revealing substantial fluctuations in the average annual citations of articles on ethnobotany in India.

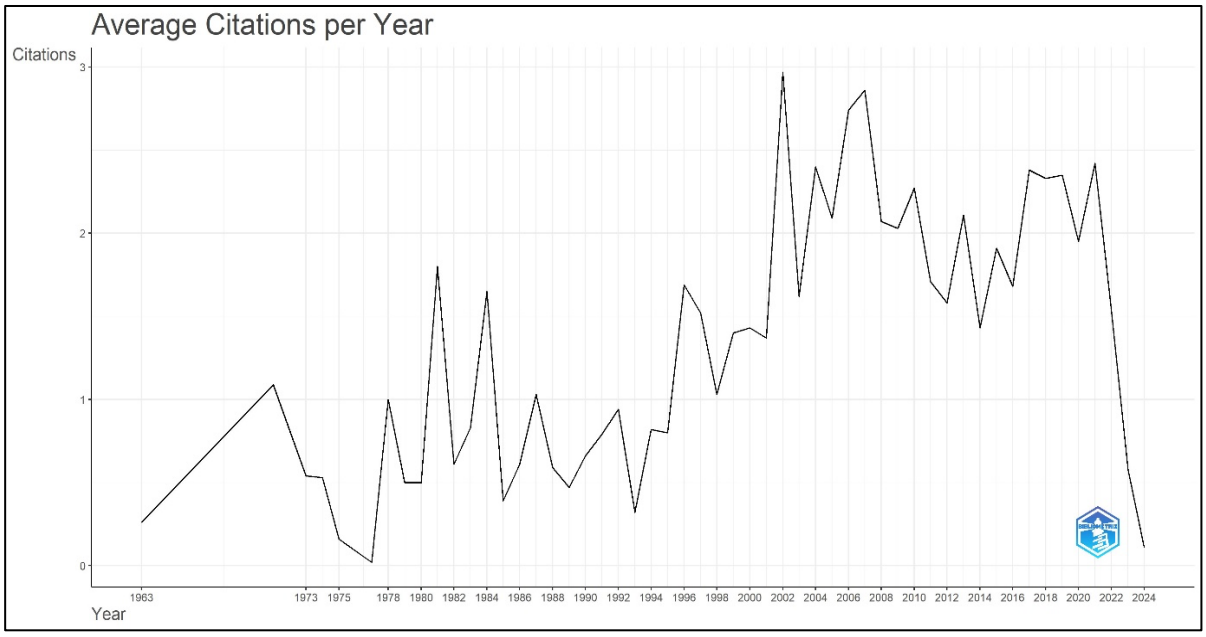

Figure 6. Average Citations per Year

Document citation analysis

Figure 7 shows the network visualization of the document citation pattern for the documents with a minimum of 25 citations. There are 917 documents that are divided into 41 clusters. The largest of the clusters (cluster 1) contains 51 documents.

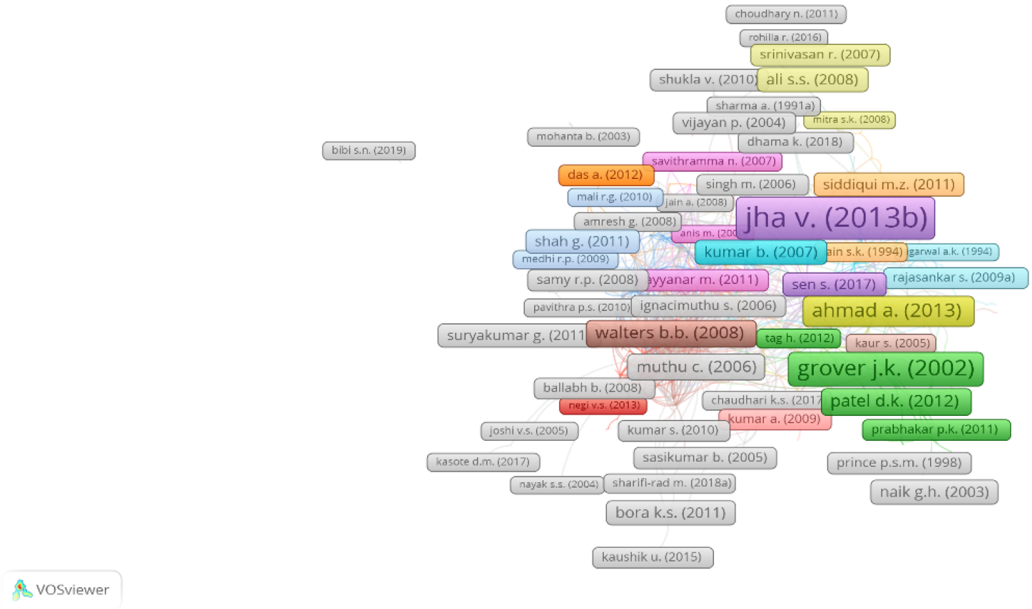

Figure 7. Document Citation Analysis- Network Visualisation

Table 4 presents the ten documents with the highest citation counts. The article 'Chronic Kidney Disease: Global Dimension and Perspectives', authored by Vivekanand Jha, Guillermo Garcia, Kunitoshi Iseki, et al., published in The Lancet in 2013, holds the highest citation count at 2,906. The subsequent work is 'Medicinal Plants of India with anti-diabetic potential' authored by J.K. Grover, S. Yadav, and V. Vats, published in the Journal of Ethnopharmacology in 2002, which garnered 1,362

citations. “A review on the therapeutic potential of Nigella sativa: A miracle herb” by Aftab Ahmad, Asif Husain et al., published in the Asia Pacific Journal of Tropical Biomedicine (2013), is ranked third with 893 citations. ‘Indian Herbs and Herbal Drugs Used for the Treatment of Diabetes’ is ranked fourth with 602 citations, while ‘Essential Oils Used in Aromatherapy: A Systematic Review’ follows closely with 597 citations.

A significant change has been observed in the most cited article and the citation analysis of sources within ethnobotanical research. The article "Chronic Kidney Disease: Global Dimension and Perspectives" has surpassed "Medicinal Plants of India with Anti-diabetic Potential" in citation count, with 2906 citations compared to 1362, thereby modifying the statistics previously reported by Pathak & Bharati (2020). Furthermore, three additional articles not previously recognised as highly cited sources are now positioned third, fourth, and fifth, indicating a shift in the landscape of influential works.

Table 4. Top ten documents by citations

Sl. No.	Document	Author(s)	Journal	Citations
1	Chronic Kidney Disease: Global dimension and perspectives	Vivekanand Jha, Guillermo Garcia, Kunitoshi Iseki et al.	The Lancet, 2013	2906
2	Medicinal Plants of India with anti-diabetic potential	J.K. Grover, S. Yadav, V. Vats	Journal of Ethnopharmacology, 2002	1362
3	A review on therapeutic potential of *Nigella sativa*: A miracle herb	Aftab Ahmad, Asif Husain et al.	Asia Pacific Journal of Tropical Biomedicine, 2013	893
4	Heavy metal induced oxidative stress and its possible reversal by chelation therapy	S J S Flora, Megha Mittal, Ashish Mehta	The Indian Journal of Medical Research	784
5	Indian Herbs and Herbal Drugs Used for the Treatment of Diabetes	Manisha Modak, Priyanjali Dixit, Jayant Londhe et al.	Journal of Clinical Biochemistry and Nutrition, 2007	602
6	Essential Oils Used in Aromatherapy: A Systemic Review	Ali, B. et al.	Asia Pacific Journal of Tropical Biomedicine, 2015	597
7	Ethnobiology, socioeconomics and management of mangrove forests: A review	Bradley B. Walters, Patrik Rönnbäck, John M. Kovacs, Beatrice Crona, Syed Ainul Hussain, Ruchi Badola, Jurgenne H. Primavera, Edward Barbier, Farid Dahdouh-Guebas	Aquatic Botany	550
8	Comparative antioxidant and anti-inflammatory effects of [6]-gingerol, [8]-gingerol, [10]-gingerol and [6]-shogaol	Swarnalatha Dugasani, Mallikarjuna Rao Pichika, Vishna Devi Nadarajah, Madhu Katyayani Balijepalli, Satyanarayana Tan dra, Jayaveera Narsimha Korlakunta	Journal of Ethnopharmacology	526
9	An overview on antidiabetic medicinal plants having insulin mimetic property	DK Patel, SK Prasad, R Kumar, S Hemalatha	Asian Pacific Journal of Tropical Biomedicine	519
10	Comparative evaluation of hypoglycaemic activity of some Indian medicinal plants in alloxan diabetic rats	Ajit Kar, B.K. Choudhary, N.G. Bandyopadhyay	Journal of Ethnopharmacology	478

It is important to recognize the foundational contributions of Dr. S.K. Jain, whose extensive fieldwork, institutional leadership, and bibliographic compilations have profoundly shaped Indian ethnobotany. His works, including the ‘Bibliography of Indian Ethnobotany’, published periodically, are invaluable resources for understanding indigenous plant knowledge in India. Due to limitations in Scopus indexing, particularly for publications before 2000 and those in regional or

non-indexed outlets, Dr. Jain's monumental contributions are underrepresented in this dataset. This is a limitation of the indexing platform, not of his enduring scholarly impact.

Author citation analysis

Figure 8 illustrates the author's citation analysis through network visualisation for authors with a minimum of 10 publications. The 292 authors meeting the criteria were divided into 11 clusters. In terms of the number of citations, the author Ignacimuthu S. ranks first with 3237 citations over 39 publications and is followed by Kumar A. with 3081 citations over 185 documents, and Kumar S. with 2549 citations over 130 publications.

Table 5 shows the ranking of authors according to the number of citations, and Table 6 shows the ranking of authors according to total link strength. Out of the 292 authors meeting the criteria, Kumar A. has the highest link strength (678), followed by Dey A. (568), Ayyanar M. (468), and so on.

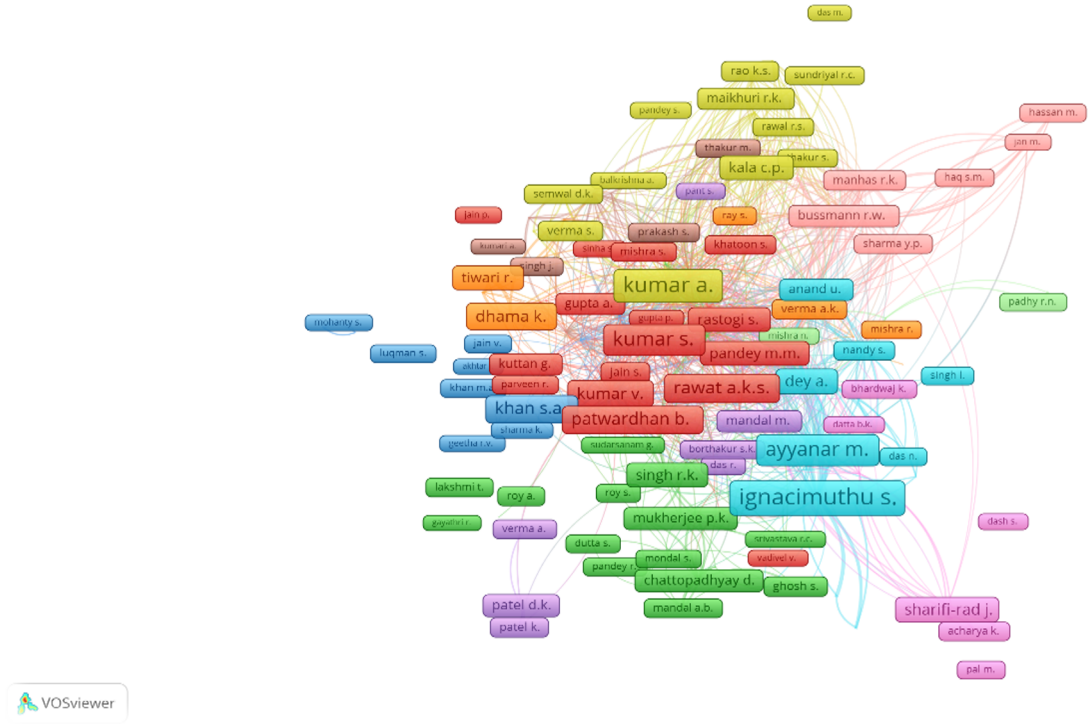

Figure 8. Author Citation Analysis- Network Visualisation

Table 5. Ranking of authors according to the number of citations

Sl. No.	Author	No. of Documents	No. of Citations
1	Ignacimuthu S.	39	3237
2	Kumar A.	185	3081
3	Kumar S.	130	2549
4	Ayyanar M.	32	2485
5	Sharma A.	101	2082
6	Rawat A.K.S.	35	2006
7	Patwardhan B.	17	1793
8	Khan S.A.	13	1738
9	Yadav S.	22	1729
10	Singh S.	111	1705

Table 6. Ranking of authors according to total link strength

Sl. No.	Author	Documents	Citations	TLS
1	Kumar A.	185	3081	678
2	Dey A.	55	1242	568
3	Ayyanar M.	32	2485	468
4	Ignacimuthu S.	39	3237	451
5	Gairola S.	18	603	412
6	Kumar M.	69	1028	377
7	Kumar S.	130	2549	376
8	Bussmann R.W.	40	775	368
9	Sharma J.	12	637	364
10	Singh B.	64	1690	332

The network visualisation of the author's citation analysis indicated that Ignacimuthu S. is the most cited author, with 3,237 citations across 39 publications. Kumar A. follows with 3,081 citations from 185 documents. Kumar A. has published over four times more documents than Ignacimuthu; however, he remains the most cited author, indicating the quality of his works and supporting the finding regarding the most referred publications. Kumar A. exhibits the highest link strength at 678, followed by Dey A. with a strength of 568.

Most relevant author keywords

Figure 9 represents the top ten most relevant author keywords. These include ‘medicinal plants’ (602), ‘traditional knowledge’ (426), ‘antioxidant’ (395), ‘ethnomedicine’ (394), ‘herbal medicine’ (374), ‘ethnobotany’ (363), ‘phytochemicals’ (209), ‘phytochemistry’ (205), ‘ayurveda’ (189) and ‘traditional medicine’ (189).

The frequently used author keywords, including ethnomedicine, herbal medicine, antioxidant, ayurveda, and oxidative stress, exhibit minimal change from Pathak & Bharati (2020) to the current context. While those terms continue to be utilised, phrases like medicinal plants and traditional knowledge have gained greater prominence among researchers. Batooli *et al.* (2023) also found that 'medicinal plants' was the most often utilised keyword in Iran. Terms such as ethnobotany, phytochemicals, and phytochemistry have been employed in ethnobotanical research throughout history. The term 'medicinal plants' appears 602 times and is associated with 163 other keywords, resulting in a total link strength of 9207.

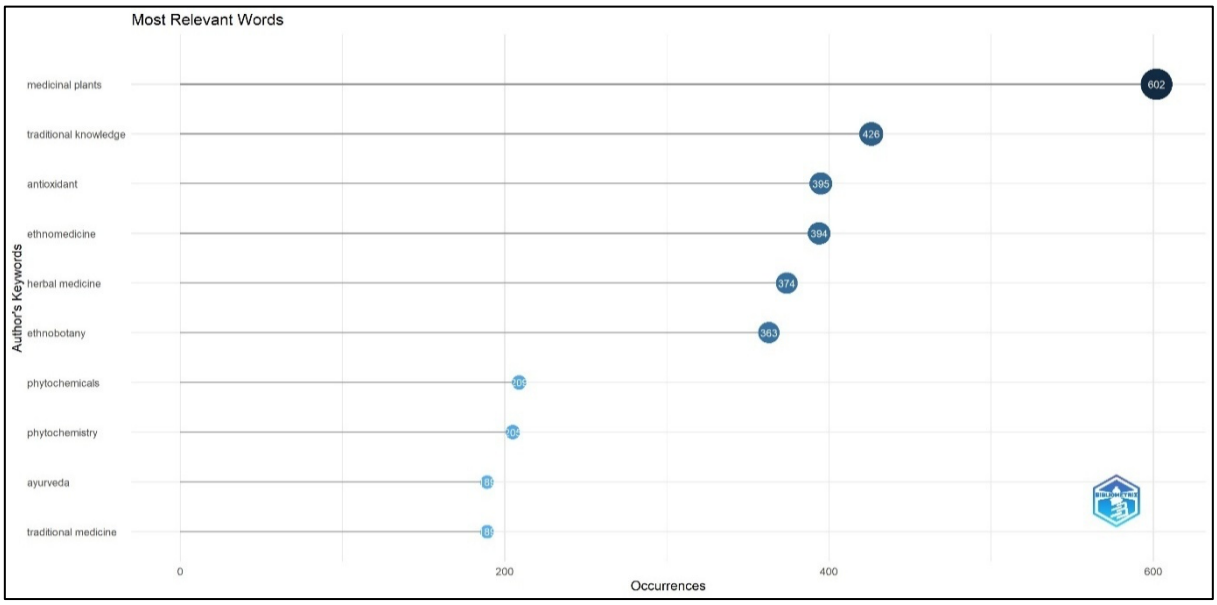

Figure 9. Most Relevant Keywords

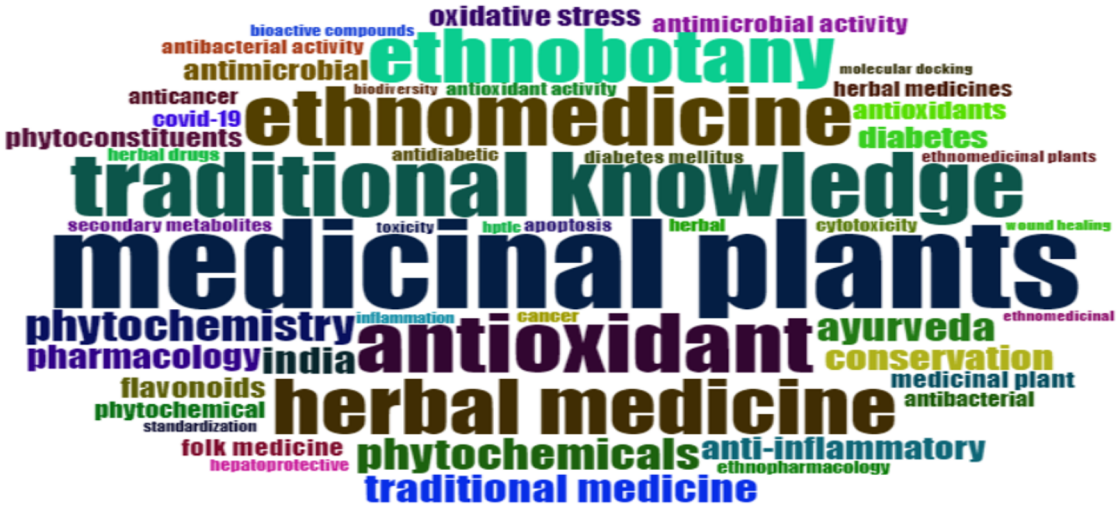

Figure 10. Wordcloud of the most relevant keywords

Keyword co-occurrence

Figure 11 shows the network visualisation of keyword co-occurrence, in which keywords with at least 20 occurrences are considered. Out of 18098 keywords, 208 meet the criteria, and these keywords are divided into 6 clusters, each represented by a different colour.

The node size shows the number of occurrences of a particular keyword. As shown in Figure 11, the keyword 'medicinal plants' has the largest node, indicating that it is the keyword with the greatest number of occurrences (602 occurrences). The second largest node represents the keyword 'traditional knowledge' (427 occurrences). The lines or the links from each node represent the co-occurrence of the keywords, and nodes with the same colour indicate they are part of the same cluster. Keywords belonging to the same cluster indicate that they share similar contexts or are associated with similar research themes. The thickness of the link indicates the strength of co-occurrence between the keywords.

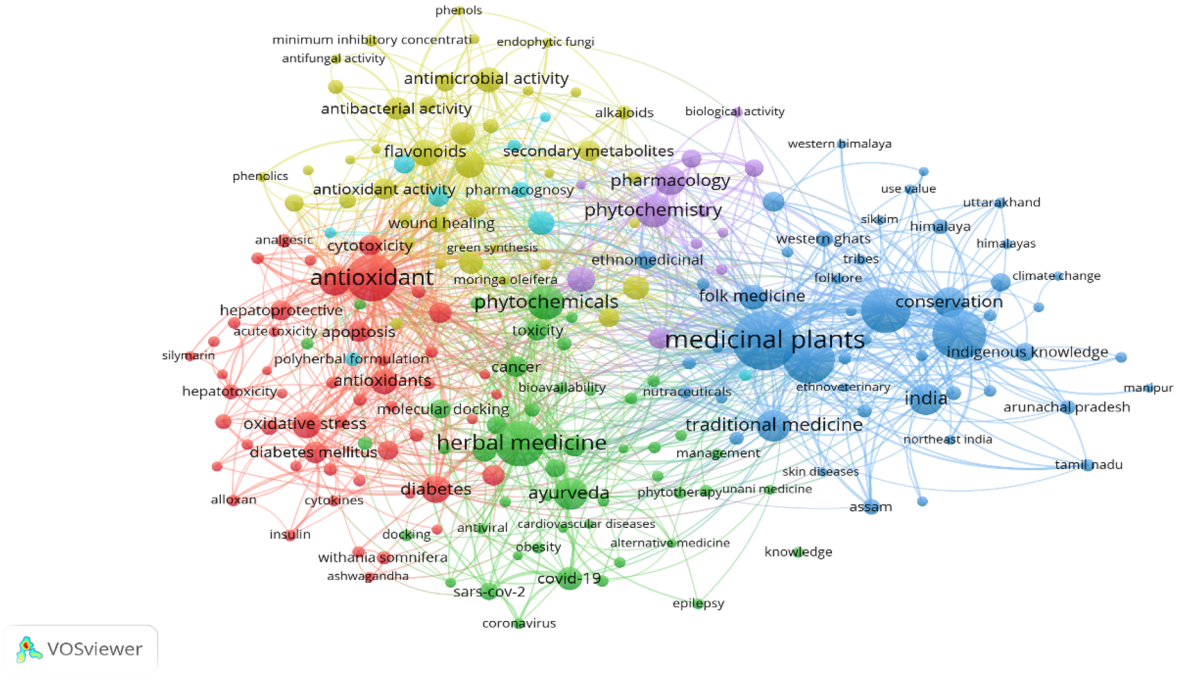

Figure 11. Keyword Co-occurrence Network Visualisation

Cluster 1, shown in red color, has the greatest number of keywords, amounting to 50. The keyword with the highest number of occurrences, 'medicinal plants', belongs to cluster 3. It has 163 links, meaning that the term has co-occurred with 163 keywords. It has a total link strength of 9207. The link strength of the co-occurrence varies. For example, the term 'medicinal plants' has co-occurred with the term 'ethnobotany', and this link has a link strength of 64. It has co-occurred with the term folk medicine with a link strength of 21.

Most relevant sources

Figure 12 shows the most relevant journals in the field of Ethnobotany in India. The Indian Journal of Traditional Knowledge is the top journal with 414 publications, followed by the Journal of Ethnopharmacology with 412 publications, while the Research Journal of Pharmacology and Technology ranks third with 200 publications. Others include the International Journal of Pharmacy and Pharmaceutical Sciences (172), the Asian Journal of Pharmaceutical and Clinical Research (131), International Journal of Pharmaceutical Sciences Review and Research (130), Indian Journal of Natural Products and Resources (129), International Journal of Pharma and Bio Sciences (127), Indian Drugs (103), Pharmacognosy Journal (99). These are the top ten journals with the greatest number of publications.

The Indian Journal of Traditional Knowledge and the Journal of Ethnopharmacology have consistently served as the primary outlets for ethnobotanical research findings in India, a trend that continues into the current study period.

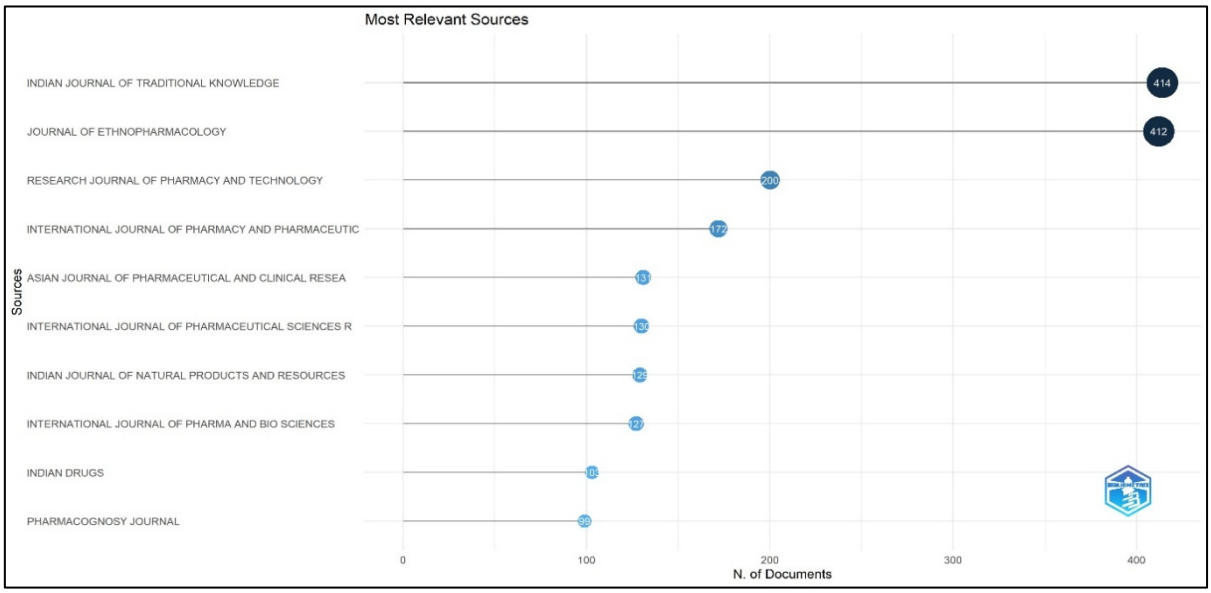

Figure 12. Most Relevant Sources

Analysis of sources

Figure 13 shows the publication trends of the top ten journals among the 24 core journals as identified by Bradford's Law. As shown in Figure 13, the Journal of Ethnopharmacology, which ranks second in terms of ethnobotanic publications, shows a steady growth in publications, starting with just two publications in the year 1982 when the journal was indexed by the Scopus database. The Indian Journal of Traditional Knowledge, which ranks first in terms of publications, shows a tremendous growth in publications in the field, beginning with 55 publications in the year 2008, when it was first indexed by Scopus.

The Indian Journal of Traditional Knowledge, established in 2007, has emerged as a prominent publication in the field of ethnobotanical studies in India since its inception. Since 2007, the journal has experienced significant growth and remains a primary source. However, the Journal of Ethnopharmacology has exhibited linear growth in its field since its inception in the 1980s.

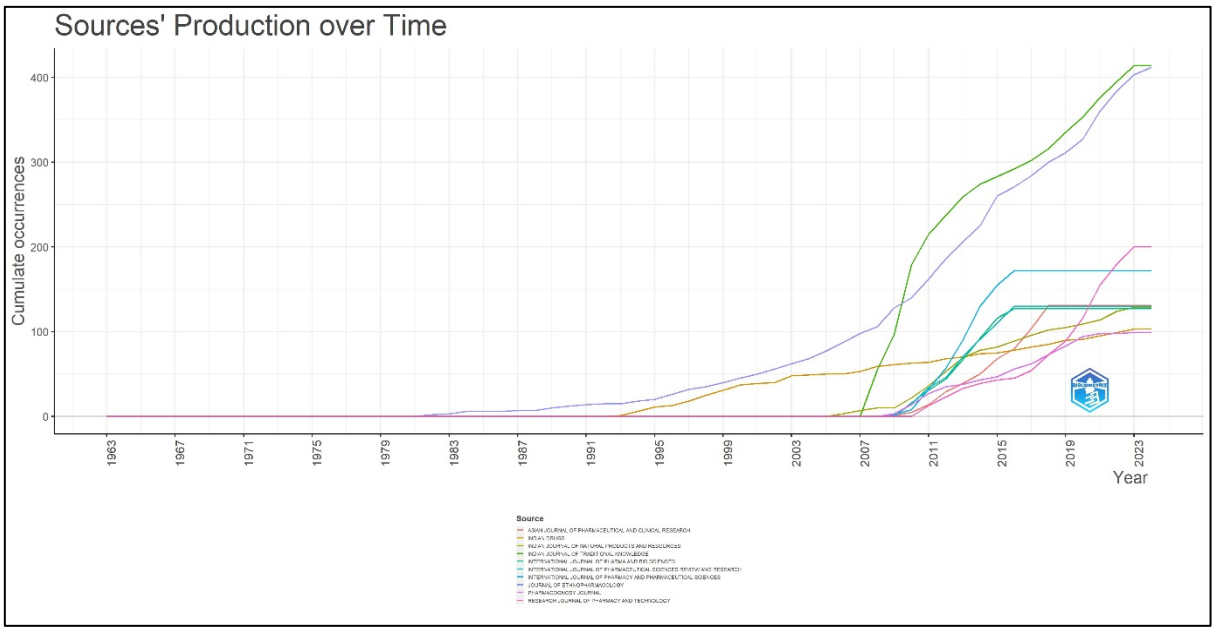

Figure 13. Sources Production over Time

Conclusion

This bibliometric analysis provides a comprehensive, data-oriented examination of the trends in ethnobotanical research in India, spanning from 1963 to 2024, utilising literature indexed in Scopus. The results indicate a notable increase in research endeavours in recent years, reaching a high point in 2023, which demonstrates an expanding national and international focus on traditional knowledge systems, especially with sustainable development issues. The findings also show a change in institutional leadership, with new academic contributors, such as Banaras Hindu University and Jadavpur University, replacing the overall production count of research by the individual institutions of the CSIR and ICAR. This suggests that research production in the sector has become more diverse and decentralised. India is further positioned as a major actor in the global ethnobotanical debate by its strong international cooperation, particularly with the United States and Saudi Arabia. Kumar A and Ignacimuthu S were identified as the most produced and cited authors of the field, while The Indian Journal of Traditional Knowledge, published by the National Institute of Science Communication and Policy Research (CSIR-NIScPR), is the most published source. Recurring themes, such as "medicinal plants" and "traditional knowledge," are highlighted through keyword co-occurrence analysis, which suggests thematic consolidation and identifies potential areas for further investigation. This study offers insightful information about the development, patterns of collaboration, and topical trends in ethnobotanical research in India and acts as a fundamental resource for scholars, funding organisations, and governments who want to support sustainable, multidisciplinary development and preserve traditional knowledge.

The study admits certain methodological constraints of bibliometric analysis due to its quantitative nature. The exclusive use of the Scopus database may underrepresent important contributions published in previous decades or regional/non-indexed sources, including the pioneering work of Dr. S.K. Jain, even while it ensures data quality and compliance with bibliometric tools. Similarly, keyword-based search techniques, while common in bibliometric studies, have the potential to produce small errors by including works that are only loosely related. These restrictions do not call into question the analysis's validity, but they do draw attention to the necessity for future research to incorporate other databases (such as the Indian Citation Index, archives, institutional repositories and Shodhganga), bibliographic compilations of early pioneers like Dr. S. K. Jain, refinement in keywords using controlled vocabulary or thematic coding and supplementing bibliometrics with qualitative or ethnographic information. The study opens the door for more inclusive, context-rich research on the topic by pointing out the literature's advantages and disadvantages.

Declarations

List of abbreviations: BSI: Botanical Survey of India; CSIR: Council of Scientific and Industrial Research; DMAPR: Directorate of Medicinal and Aromatic Plants Research; ICAR: Indian Council of Agricultural Research; ICMR: Indian Council of Medical Research; NIScPR: National Institute of Science Communication and Policy Research; NMPB: National Medicinal Plants Board; SDG: Sustainable Development Goal; SERB: Science and Engineering Research Board; UGC: University Grants Commission; UN: United Nations; TLS: Total Link Strength

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Author contributions: R.M.B. designed, collected the data, analyzed it, and wrote the text. A.R. supervised the research work, participated in the theoretical background, monitored data collection and analysis, helped with discussions, revisions, and wrote the final version of the text.

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