



Mapping ethnobotany research in India

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Reviews and Mini reviews

Background: Ethnobotany is the study of the plants used by aboriginal people. It has significant contributions in bioprospecting, drug development and management of natural resources and cultural diversity. Diversity of plants and tribes makes India an ideal place for ethnobotanical research. Therefore, mapping of scholarly publication was conducted on various scientometric indicators to identify the research trends on ethnobotany in India.

Methods: Data for this study were retrieved from Web of Science Core collection database of Clarivate analytics (erstwhile Thomson Reuters), Philadelphia, USA up to year 2018.

Results: The first research paper in SCI journal was published in 1974, and during 1974 to 2018, a total of 2123 papers have been published. The publication trends may be divided in between three phases: first phase was 22 years long (1974–1996) with yearly publications in single digit; second phase was for 10 years (1997–2006) demarked by publications in double digits; third phase was initiated in 2007 producing yearly publications in three digits. These 2123 papers have been contributed by 5458 authors, affiliated to 1927 organizations. Of these, Council of Scientific & Industrial Research (207 records, 3960 citations) is leading in the list of contributing organizations and S. Ignacimuthu (30 records and 1,163 citations) is the most productive author. Analysis of international collaboration revealed that Indian researchers are in collaboration with 79 different countries among which USA (4.8% papers) was major collaborating country. A total of 105 tribes of India have been studied and maximum records were available for *Adi* tribe (17 publications). The most preferred journal was *Indian Journal of Traditional Knowledge* and the top cited article was on antidiabetic plants published in *Journal of Ethnopharmacology* in 2002.

Conclusions: The ethnobotany research in India is increasing despite of emergence of new research areas and depletion of traditional knowledge. The present study will provide a platform for future studies and strengthening the ethnobotanical research in India.

Keywords: Bibliometrics, Ethnobotany, Scientific output, Research trends

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Background

Ethnobotany is the study of the plants used by aboriginal people (Harshberger 1896). The use of plants is a part of complex social-ecological system; it indicates how relationship between nature and human evolve in time and space (Albuquerque *et al.* 2017). This knowledge is essential for the survival of human beings therefore orally transmitting from generation to generation. Classical ethnobotanists document the ways in which ethnic people use the plants (Prance 1991). Since past few decades, ethnobotany has evolved as a multidisciplinary subject incorporating information from other subjects like, anthropology, chemistry, pharmacology, geography, ecology, environmental sciences, economics, linguistics, medicine, horticulture, *etc.* (Gaikward *et al.* 2011).

Contributions of ethnobotany are significant in drug development, germ plasm conservation, crop improvement, selection of new plants for domestication, assessment of cultural position of tribes, study of the distribution of plants, new lines of manufacture, resource management, early identification of species in trade, etc (Farnsworth *et al.* 1985; Balick 1996; Henrich 2000). In absence of proper documentation, western pharmaceutical companies are stealing indigenous knowledge for commercial benefits. Further, traditional knowledge systems are rapidly fading away because biodiversity is depleting, tribes are vanishing, indigenous cultures and languages are disappearing. Convention on Biodiversity (1992) addresses the issues of vanishing and stealing of indigenous knowledge system and establishes international protocols; it binds signatory nations for the following: (a) preservation and maintenance of traditional knowledge; (b) application of traditional knowledge; (c) equitable sharing of benefits from traditional knowledge (Cox 2000; Barsh, 2001). Ethnobotany is vital for human beings, not only because its bioprospecting roles but also for management and maintenance of natural resources and cultural diversity.

India is the home of 705 tribes and rich in plant diversity having 18386 of angiosperms, 79 gymnosperms, 1289 pteridophytes, 2748 bryophytes, 2511 lichens, 15115 fungi and 7357 algae (Dash *et al.* 2018; <https://tribal.nic.in/>). The diversity of tribes and plant wealth make India a perfect place to study the ethnobotany. About 150 years back, British Government in India had realised the fact and utilized traditional knowledge in economic activities. Initiatives for documentation of folk knowledge was taken by Sir George Watt (1873), he explored remote areas and published "Dictionary of Economic products of India" in six volumes (Chakravarthy 1975). In 1925, Bodding had documented medicinal plants of Santhal tribes (Bodding 1925; 1927; 1940; 1983). The actual research on Ethnobotany in India was started by Dr S.K. Jain. He explored many tribal areas, and the first publication was appeared in 1963 (Jain 1963). After that many researchers are involved in research on ethnobotany and publications are coming every year (Shah 2008).

Therefore, bibliometric analysis of research on ethnobotany could serve as an alternative and innovative way of revealing research trends on ethnobotany in India. Also, it helps in assessing India's contribution to the global literature in ethnobotany. Such bibliometric studies have been published on Latin America (Albuquerque *et al.* 2013) and Brazil (Ritter *et al.* 2015; Hanazaki 2015).

In the Indian context, the first bibliometric study was on "Ethnobotany journal" by Dhiman (2000), thereafter, Dhiman & Sinha (2001) investigated impact of collaboration in Ethnobotany in between 1989 to 1999. Different aspects of bibliometrics analysis on "*Indian Journal of Traditional Knowledge*" was published by Shivakumaraswamy & Muthuraj (2015), Pathak & Bharati (2018) and Kolle (2018). No previous mapping of ethnobotany research in India has been done to the best of our knowledge. Therefore, we have done a bibliometric analysis of ethnobotany research indexed in SCI-E contributed from India up to 2018. The following questions were addressed through the study: (i) What is the current status of ethnobotany research in India? (ii) What are the research trends in ethnobotany in India? (iii) How many tribes are studied so far? (iv) Which institute is actively involved in ethnobotany research (vi) Who is the most productive author? (vii) What are the collaboration patterns at national and international level?

The study was designated to test the following hypothesis: (i) ethnobotany research in India is declining due to emergence of new research areas in botany and depletion of traditional knowledge; (ii) ethnobotany research is restricted to small universities and institution because it requires comparatively less funds.

The specific objectives of the study were to: (i) map the ethnobotanical research in India; (ii) list research performance on multiple parameters, such as author, year wise citation patterns, document types, highly cited documents, leading institutions, document types, keywords, tribes, journals and collaborations.

Materials and Methods

Data for this study were retrieved from Web of Science Core collection database of Clarivate Analytics on 15th September 2019 by using keyword ETHNOBOTAN* OR Ethnovetr* OR Ethnomed* OR "traditional knowledge" OR "alternative medicine" OR "Herbal medicine" OR "Folk Medicine" in Topic field (<https://clarivate.com/webofsciencegroup/>). Results obtained were refined by India from list of countries and the literatures published after 2018 were excluded. Year wise citations were downloaded by using "create citation report" feature of the Web of Science. This yielded 2123 results and were downloaded in Excel format for further analysis. Impact factor of the journals were obtained from Journal citation report released in year 2019. There were different variants for authors and organization's name therefore records were manually checked to avoid anomaly and standardized the unique names. To find out unique author names, the affiliations were checked and reprint author e-mails, if available. Next

level verification to ensure the correctness of the data, some original papers from publishers' website was also crosschecked to remove anomalies to the best possible level. Web of science does not classify research publications in "ethnobotany". Instead, most of the ethnobotany papers are classified either in the area Plant Sciences or Complementary and Integrative Medicine. Boolean operator 'OR' were used to separate the terms to include all possible synonymous terms used in ethnobotanical research in order to retrieve all available data in the database in ethnobotany. However, there are many Indian publications in ethnobotany which have been published in the journals not indexed in Web of Science viz. *Ethnobotany*, *Journal of Economic and Taxonomic Botany*, *Nelumbo*, *Indian Forester*, etc. Therefore, publications in such journals have not been considered for this study. Search strings are as under:

TOPIC= (ETHNOBOTAN* OR Ethnovetr* OR Ethnomed* OR "traditional knowledge" OR "alternative medicine" OR "Herbal medicine" OR "Folk Medicine") Refined by: COUNTRIES/REGIONS= (INDIA) AND [excluding] PUBLICATION YEARS=(2019) Timespan=All years. Indexes=SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, CCR-EXPANDED, IC. Software VoSviewer

version 1.6.11 were used for co-authorship network, keyword network mapping and other visualisations.

Results and Discussion

Publication outputs and major journals

First research paper on ethnobotany in SCI journal was published in 1974. In between 1974 to 2018, a total of 2123 papers have been published on Indian ethnobotany. Of the total publications, 81.72 % (1735) were appeared as articles, 10.64 % (226) as reviews, 3.29 % (70) as proceedings papers, 1.27 % (27) as meeting abstracts, 1.03 % (22) as editorial materials, 0.65 % (14) as letters, 0.28 % (6) as news items, 0.18 % (4) as notes and 0.04 % (1) as book review (Fig. 1). It has been observed that articles on ethnobotany possess inherent classification under six groups, i.e. (i) Ethnomedicine (745 articles), (ii) Ethnopharmacology (773 articles), (iii) Ethnoecology (42 articles), (iv) Ethnozoology (25 articles), (v) Ethnoveterinary (11 articles) and (vi) Others (139 articles). As depicted in Fig. 2, the publication trends may be divided in between three phases: first phase was 22 years (1974-1996) long with yearly publications in single digit; second phase was for 10 years (1997- 2006), it shows publications in double digits; third phase was initiated in 2007, produced publications in three digits.

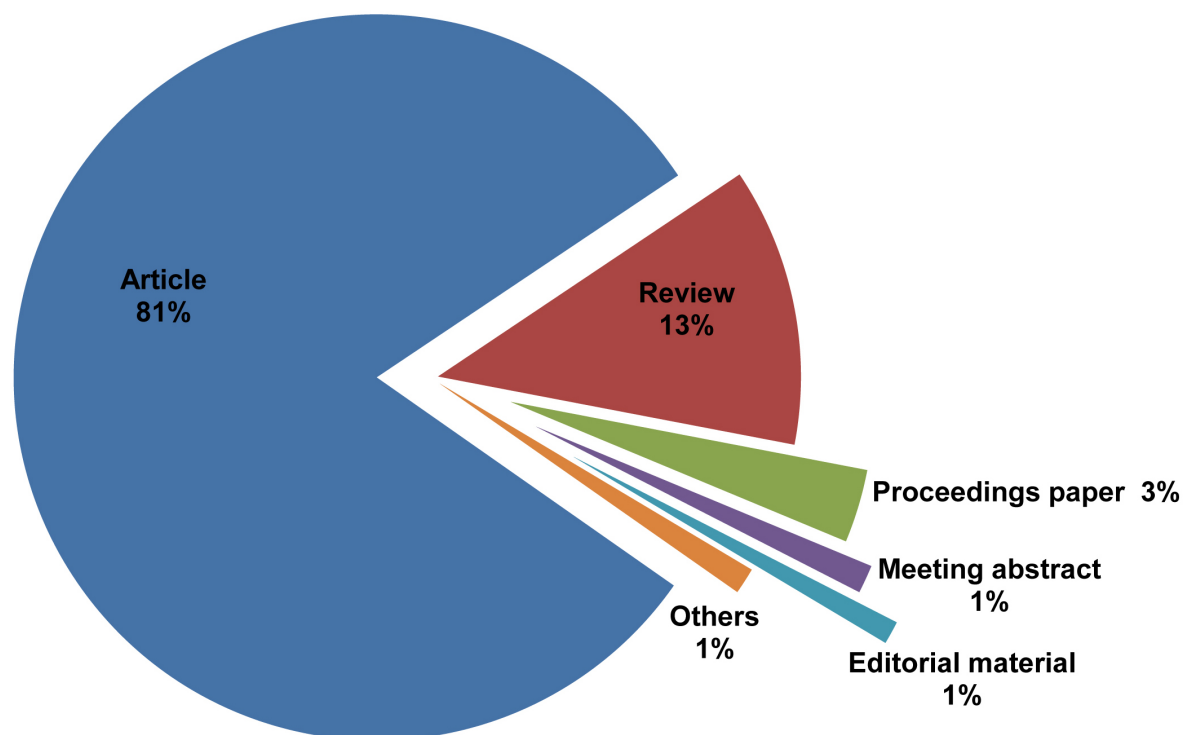


Figure 1. Distribution of publication by document type

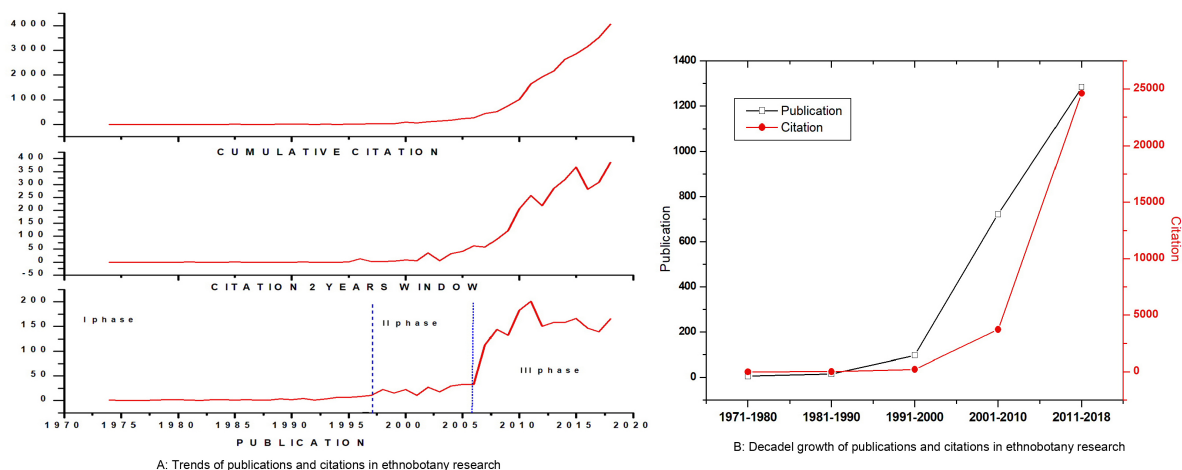


Figure 2. Trends of publication in ethnobotany

It was observed that in between 1975-77 and in 1982 there was zero publication on ethnobotany in SCI journals. The quantum jump in third phase is due to inclusion of an Indian journal (i.e. *Indian Journal of Traditional Knowledge*) in the SCI databases in 2007 (Pathak & Bharati 2018). Table 1 confirms this fact because *Indian Journal of Traditional Knowledge* is the most preferred journal with 368 (17.33%) records. However, the oldest journal with highest impact factor is *Journal of Ethnopharmacology*, but it

ranks second amongst the most preferred with 258 (12.153%) records. It may be due to the *Journal of Ethnopharmacology* accepts few articles on traditional ethnobotany, therefore, publication in the journal is little tough. The published research on ethnobotany appeared in 576 periodicals. Of these, top two journals (*Indian Journal of Traditional Knowledge* and *Journal of Ethnopharmacology*) shares 29.48 % of the total records and top 10 journals shares 42.53% of publications (Table 1).

Table 1. Ten most preferred journals by Indian authors in Ethnobotany

Source Titles	IF	P	P (%)	C	C (%)	C/P
<i>Indian Journal of Traditional Knowledge</i>	0.92	368	17.334	2210	7.74	6.01
<i>Journal of Ethnopharmacology</i>	3.41	258	12.153	8156	28.55	31.61
<i>Pharmaceutical Biology</i>	2.49	63	2.967	702	2.46	11.14
<i>Current Science</i>	0.75	48	2.261	994	3.48	20.71
<i>Journal of Medicinal Plants Research</i>	NA	33	1.554	415	1.45	12.58
<i>Journal of Ethnobiology and Ethnomedicine</i>	2.27	31	1.46	1106	3.87	35.68
<i>Fitoterapia</i>	2.43	28	1.319	492	1.72	17.57
<i>Indian Journal of Pharmacology</i>	1.04	26	1.225	161	0.56	6.19
<i>Genetic Resources and Crop Evolution</i>	1.29	25	1.178	107	0.37	4.28
<i>Evidence Based Complementary and Alternative Medicine</i>	1.98	23	1.083	440	1.54	19.13

Abbreviations: IF, impact factor (JCR 2018), P, publications; C, citations; C/P, average citations

Authorship pattern, productivity and organisations

It has been observed that publication by single author is 7.63 % only (Fig. 3). Whereas the joint venture was most productive with group of 2 authors with 22.42 % (476 records) share, followed by contributions of three authors 22.14 % (470 records), four authors 17.85 % (379 records), five authors 12.20 % (259 records), etc. Author co-authorship

network is prepared in cluster schema of VOSviewer and summarized in Fig. 4. The size of nodes depicts the quantity of contributions by respective authors and edges show the strength of links between the authors. Author co-authorship network identified 354 items, 21 clusters, 1527 links and 1749 total link strength. The top cluster was with 26 items and nine clusters have more than 20 items, it indicates high level of collaboration among authors.

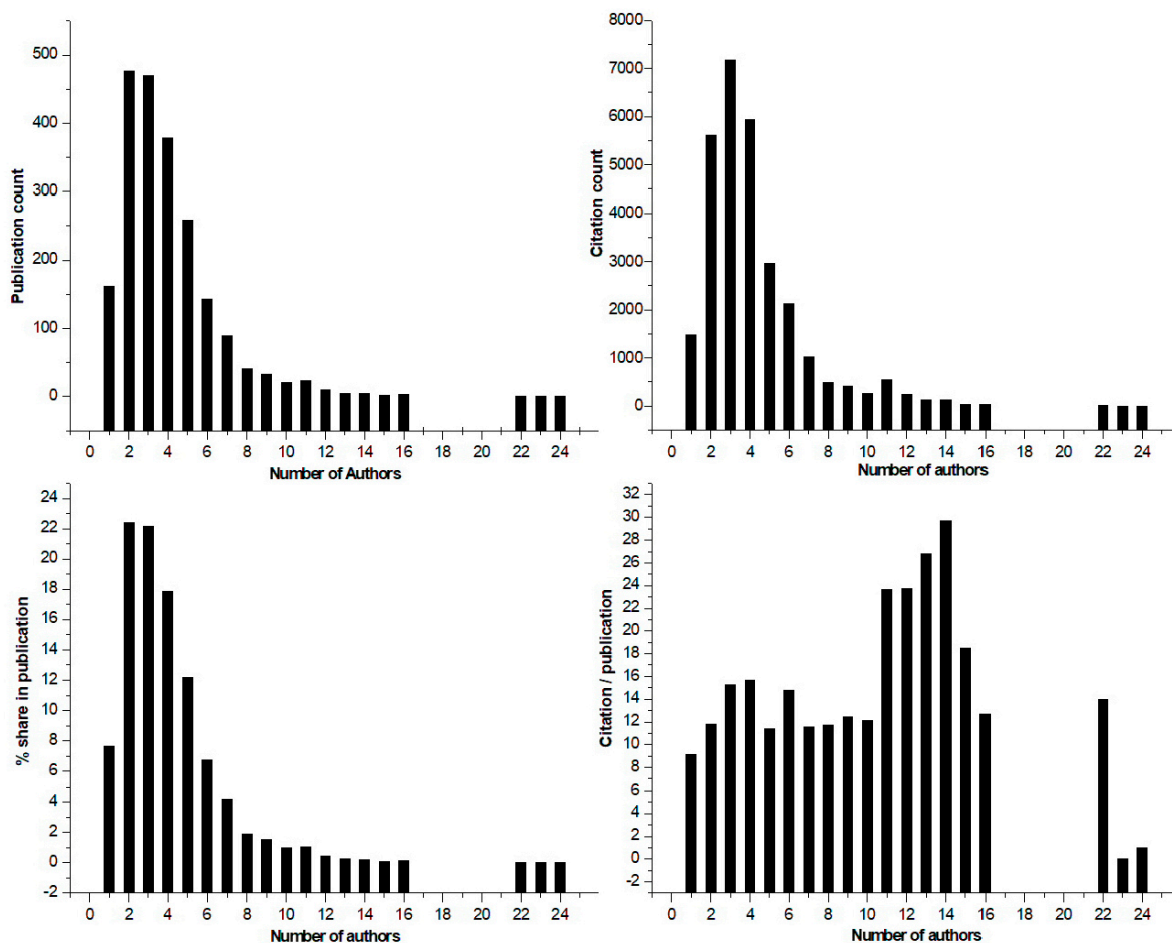


Figure 3. Authorship pattern

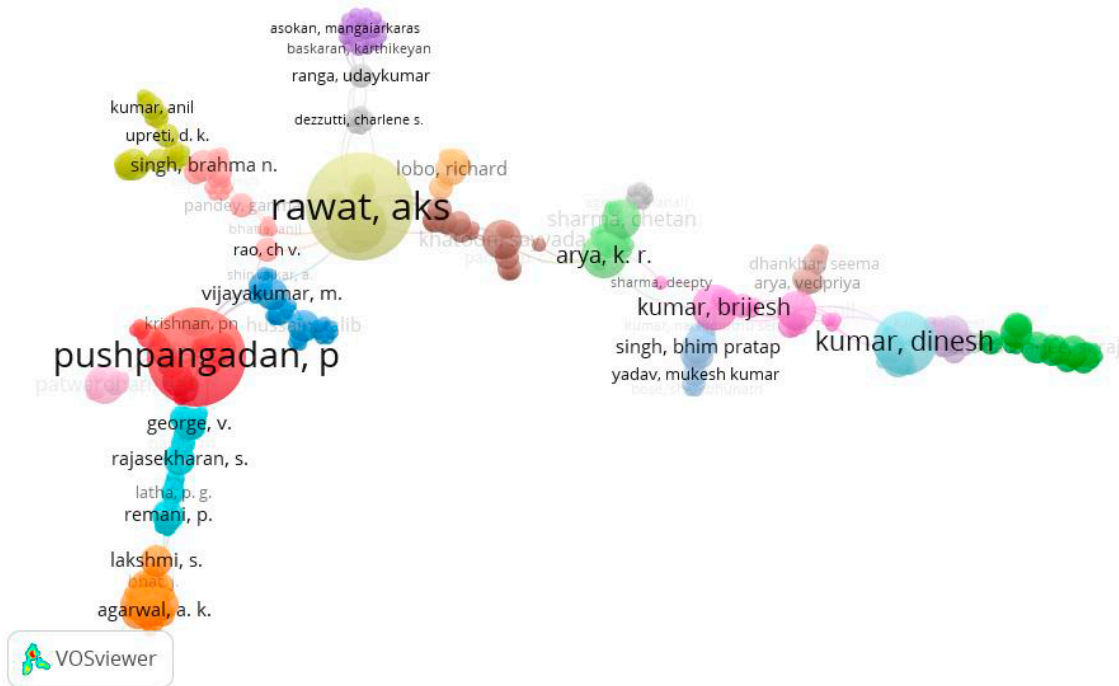


Figure 4. Author co-authorship network

A total of 1927 organizations have contributed in publications on ethnobotany. Of these, Council of Scientific & Industrial Research is the most productive (207 records, 3960 citation) and followed by Indian Council of Agricultural Research (109 records, 824 citations) but both organizations include number of laboratories/institutions. Further, the h-index was highest for Council of Scientific & Industrial Research (Table 2). Among the CSIR laboratories, National Botanical Research Institute has maximum publications (28) and citations (849). Overall, citations and impact were the highest for Loyola College (1295 citations and 38.09 average citations), it may be due to S. Ignacimuthu (30 records and 1163 citations) and M. Ayyanar (15 records and 584 citations) have been affiliated to this college. Organization network map (Fig. 5) visualized the number of records by respective organizations and link strength between the organizations. There are 63 clusters, 1217 items, 3244 links and 3672 link strength have been identified. The topmost cluster contains 36 items and 54 clusters have more than 10 items, it indicates collaboration among institution is very high though few institutions are involved in the ethnobotany research.

As Fig. 6 revealed, 30 publications are the highest number of papers in India which was produced by two authors namely, S. Ignacimuthu (1163 citations and 38.76 impact) and R.K. Singh (149 citations and 4.96 impact). S. Ignacimuthu has comparatively more citations and better h-index and p-index therefore, he is the most productive author in India. An author productive analysis revealed that 5,458 authors contributed 2123 publications with average 2.57. Contribution by top 15 most productive authors was 11.58 % and majority of the authors (77.20 %) have published only one record in SCI journals and 12.47 % of authors have two publications only (Fig. 3). Majority of authors have published either one or

two records, because a large number of researchers in India are treating ethnobotany research as supplementary research topic.

International collaboration pattern

In between 1974 to 2018, a total of 1961 collaborative publications appeared on ethnobotany. Domestic collaborations resulted in 1437 papers while international collaboration with 79 countries yielded 524 papers (24.68%). Of these, USA was major collaborator with 102 (4.8 %) publications, followed by Saudi Arabia 36 (1.6 %), England 28 (1.3 %), South Korea 26 (1.2%), etc. (Table 3). Fig. 7 shows major collaborating countries, the size of node represent number of records and loops shows collaborations. There are 79 items in 21 clusters with 365 link and 939 link strength, the top three cluster wise countries are as follows:

Cluster 1 (10 countries): Brazil, Canada, Chile, Colombia, Iran, Lebanon, Pakistan, Russia, Spain, Tajikistan.

Cluster 2 (9 countries): Indonesia, Malaysia, Nepal, Peoples R China, Philippines, Singapore, Taiwan, Thailand, Vietnam.

Cluster 3 (8 countries): Australia, Belgium, Bhutan, Germany, Peru, Sri Lanka, Sweden, Tanzania.

Highly cited articles

Publications on Ethnobotany attract relatively less citations than modern disciplines of botany. Keeping this fact in mind, we have studied highly cited articles and summarised top 10 records in Table 4. The article on anti-diabetic plants by Grover *et al.* (2002) published in *Journal of Ethnopharmacology* is on the top in citation analysis with 778 citations. Among the top ten cited records, two are published in domestic journal (*i.e.* *Current Science*) and 8 are in foreign journals. Out of eight, four are in *Journal of Ethnopharmacology*.

Table 2. The 10 most productive institutions in ethnobotany research

Organizations	Records	Citations	Impact	h-index
Council of Scientific & Industrial Research	207	3960	19.13	32
Indian Council of Agricultural Research	109	824	7.56	14
Jadavpur University	54	921	17.06	18
Botanical Survey of India	40	319	7.98	13
G B Pant National Institute of Himalayan Environment Sustainable Development	39	726	18.62	15
North Eastern Hill University	38	323	8.50	11
Indian Institute of Technology System	36	972	27.00	15
Jamia Hamdard University	34	376	11.06	12
Loyola College Chennai	34	1295	38.09	18

Assam University	32	202	6.31	8
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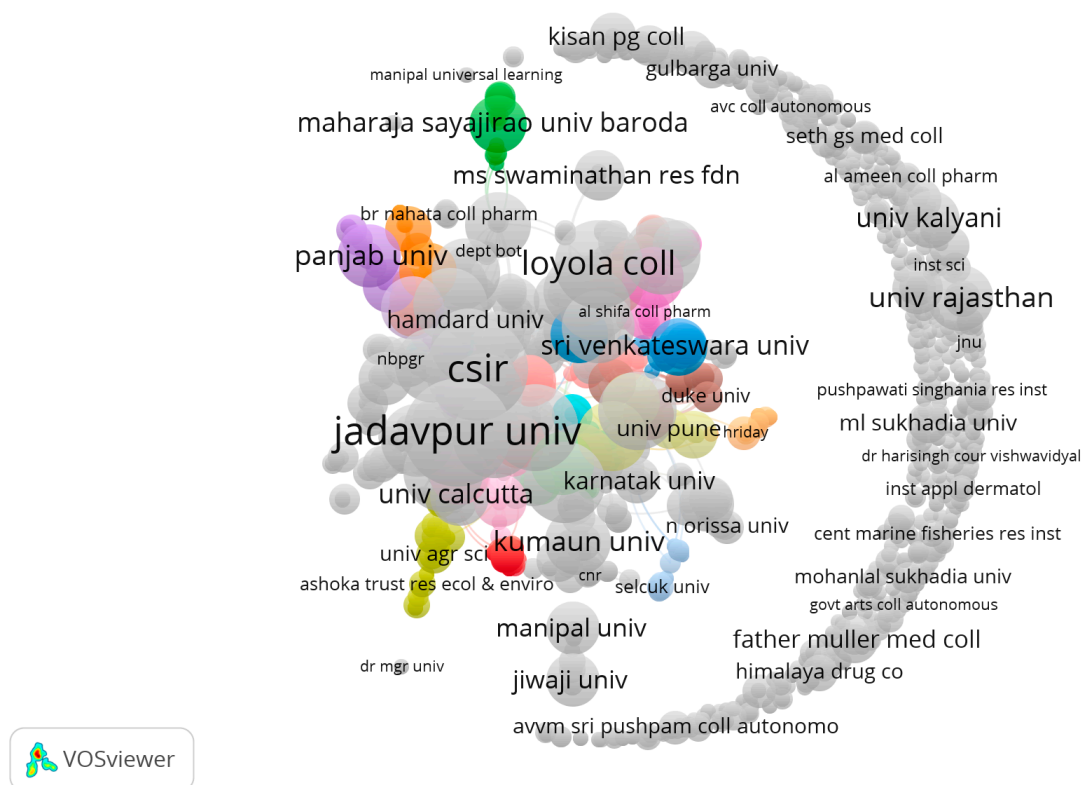


Figure 5. Collaboration network of organisations

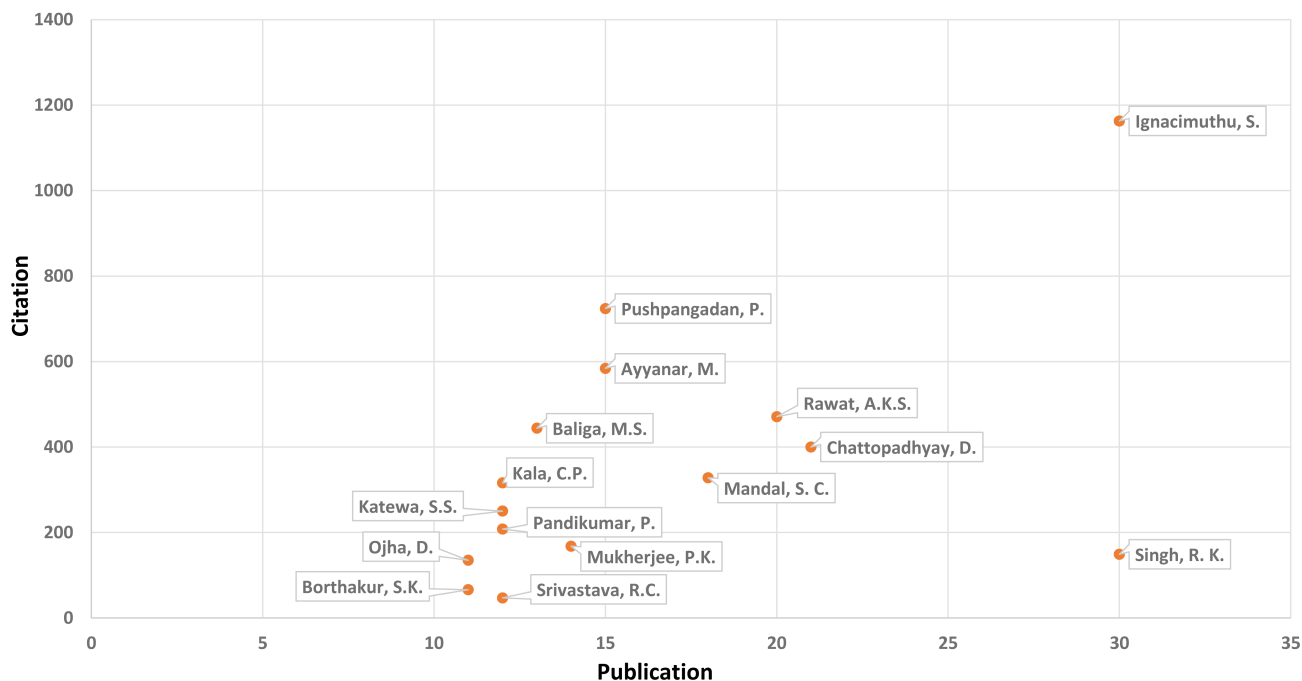


Figure 6. Top 15 most productive authors

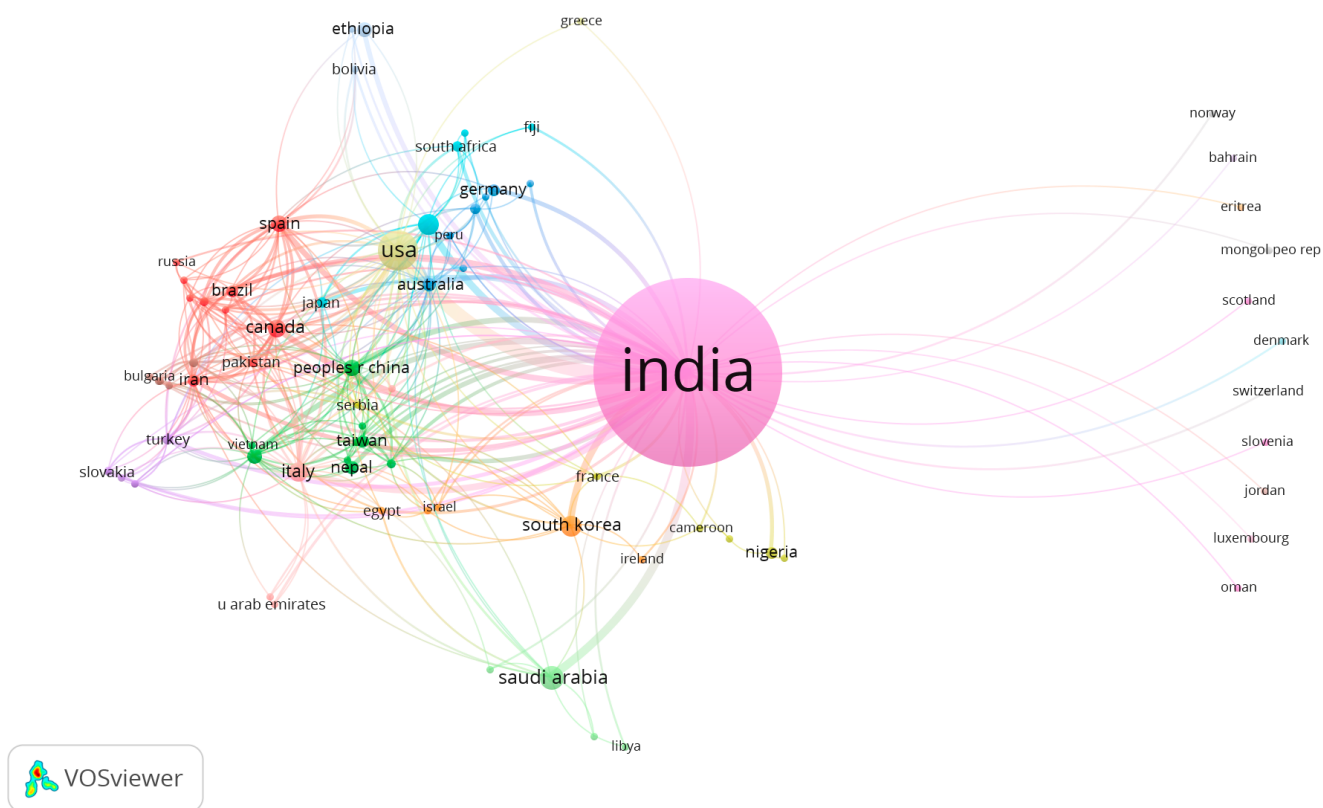


Figure 7. Collaboration network of India

Table 3. Major international collaborations with India in Ethnobotany research

Country	Record	% age
USA	102	4.805
Saudi Arabia	36	1.696
England	28	1.319
South Korea	26	1.225
Italy	22	1.036
Canada	20	0.942
Spain	17	0.801
Peoples R China	16	0.754
Malaysia	15	0.707
Australia	13	0.612
Ethiopia	13	0.612
Nepal	12	0.565
Germany	11	0.518
Brazil	10	0.471
Taiwan	10	0.471

Most studied tribes of India

The analysis demonstrated that publications are available on 105 tribes of India. Most studied tribe is *Adi* of Arunachal Pradesh (17 publications), followed by *Kani* tribe living in western Ghats of Kerala (14 publications), *Malayaii* of Kerala (12 publications), *Monpa* of Arunachal Pradesh (11 publications), *Korku* of Madhya Pradesh (9 publications), *Tharu* tribes living on Indo-Nepal boarder areas (8 publications), *Naga* of Nagaland and Manipur (7 publications), *Gond* tribe living in many parts of India (6 publications), *Bhotia* of Himalayan Belt, *Garo* of Meghalaya, *Gujjar* living in many parts of Northern India, *Jaunsari* of Uttarakhand, *Paliyar* living in southern Western Ghat (5 publications each), etc (Fig. 8).

Table 4. Top 10 highly cited article in ethnobotany research in India

Title	Authors	Source Title	Publication Year	Total Citations
Medicinal plants of India with anti-diabetic potential	Grover, JK; Yadav, S; Vats, V	<i>Journal of Ethnopharmacology</i> , 81 (1): 81-100	2002	778
Ayurveda and traditional Chinese medicine: A comparative overview	Patwardhan, B; Warude, D; Pushpangadan, P; Bhatt, N	<i>Evidence-Based Complementary and Alternative Medicine</i> , 2(4): 465-473	2005	246
Medicinal plants used by traditional healers in Kancheepuram District of Tamil Nadu, India	Muthu, Chellaiah; Ayyanar, Muniappan; Raja, Nagappan; Ignacimuthu, Savarimuthu	<i>Journal of Ethnobiology and Ethnomedicine</i> , 2	2006	209
Herbal medicine	Kamboj, VP	<i>Current Science</i> , 78(1): 35-39	2000	202
Ayurveda and natural products drug discovery	Patwardhan, B; Vaidya, ADB; Chorghade, M	<i>Current Science</i> , 86(6):789-799	2004	174
Ethnopharmacological approaches to wound healing-exploring medicinal plants of India	Kumara, B.; Vijayakumar, M.; Govindarajan, R.; Pushpangadan, P.	<i>Journal of Ethnopharmacology</i> , 114(2): 103-113	2007	173
Indian medicinal herbs as sources of antioxidants	Ali, Shahin Sharif; Kasoju, Naresh; Luthra, Abhinav; Singh, Angad; Sharanabasava, Hallihosur; Sahu, Abhishek; Bora, Utpal	<i>Food Research International</i> , 41(1): 1-15	2008	172
Indian medicinal plants as a source of antimycobacterial agents	Gautam, Raju; Saklani, Arvind; Jachak, Sanjay M.	<i>Journal of Ethnopharmacology</i> , 110(2): 200-234	2007	155
Medicinal and therapeutic potential of Sea buckthorn (<i>Hippophae rhamnoides</i> L.)	Suryakumar, Geetha; Gupta, Asheesh	<i>Journal of Ethnopharmacology</i> , 138(2): 268-278	2011	154
Potential synergism of natural products in the treatment of cancer	Hemalswarya, S; Doble, M	<i>Phytotherapy Research</i> , 20 (4): 239-249	2006	152

Author's keywords analysis and research area

Subject analysis based on author keywords are summarised in the Fig. 9, it shows 148 clusters, 5128 items, 21307 links and total link strength 22873. The top cluster contains 92 items and there are 49 cluster have identified which possess 50 or more items. Application of bibliometrics to the author's key words is important because it potentially detect trending research topics in past and present (Pesta *et al.* 2018).

Published ethnobotany research covered 98 research areas identified by Web of Science in SCI databases. The three most common areas were Plant Sciences (902 records; accounting for 42.45%

of the total), Pharmacology & Pharmacy (742 records; accounting for 34.95 % of the total) and Integrative & Complementary Medicine (387 records; accounting for 18.22 % of the total). Together the top three research areas accounting for 95.66% of publication share, other preferred areas are chemistry (4.52% records), Science & Technology (4.47% records), Agriculture (4.05% records), Environmental Sciences & Ecology (3.53% records), Biochemistry & Molecular Biology (3.43% records), Medical Laboratory Technology (3.2% records), Biotechnology & Applied Microbiology (3.2% records) and Food Science & Technology (2.82% records).



Figure 8. The 22 most studied tribes of India

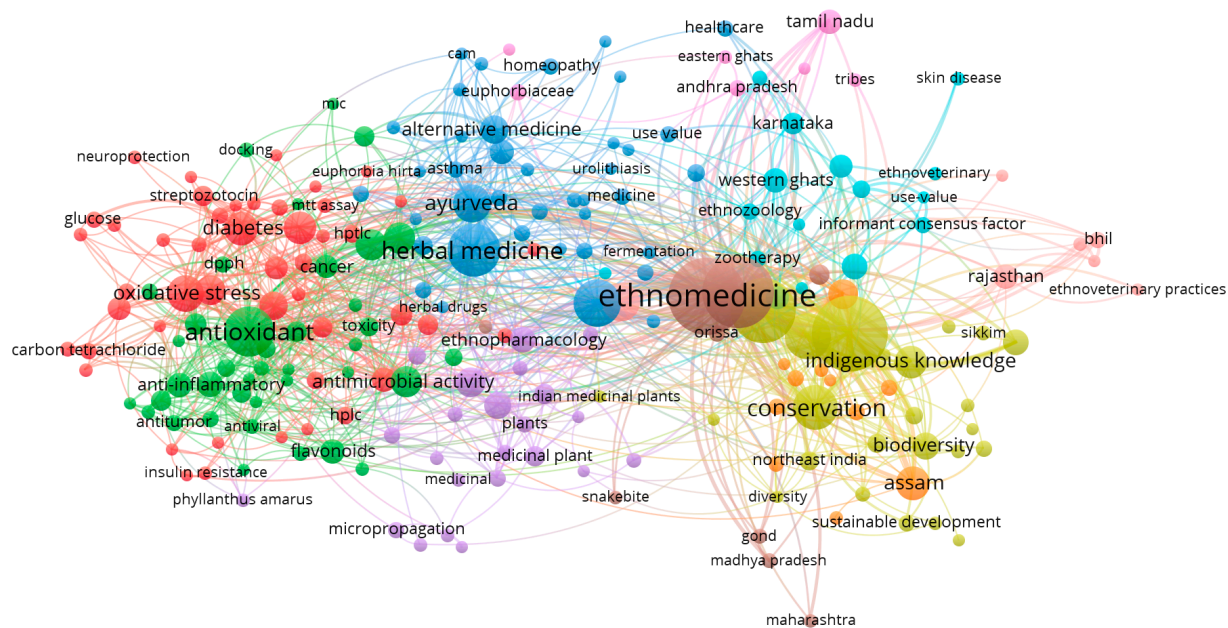


Figure 9. Author key word analysis network

Conclusions

The ethnobotany research in India is increasing despite of emergence of new research areas and depletion of traditional knowledge. Since 2007, publications are increasing may be due to the inclusion of *Indian Journal of Traditional Knowledge* in SCI databases and overall research grants and strength of researchers have been increased in recent past. A total of 2123 publications have been contributed by 5458 authors were affiliated to 1927 organisations. It indicates that many organisations and large number of researchers were conducted ethnobotanical research. Contrary to our hypothesis big laboratories like Council of Scientific & Industrial Research and Indian Council of Agricultural Research are the top contributors in ethnobotany research. On the basis of the observations on publication growth, we may speculate exponential growth in the publications on ethnobotany in near future. The present study will provide complementary information to the researchers with a realistic view of the current status of ethnobotany research in India.

Declarations

This study is limited to research publications indexed in science science-expanded up to year 2018 only.

List of abbreviations: Not Applicable

Ethics approval and consent to participate: Not Applicable

Consent for publication: Not Applicable

Availability of data and materials: Data used for this publication is available with the Authors.

Competing interests: No financial and non-financial competing interests.

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Authors' contributions: Manohar Pathak retrieved the data for the study, KA Bharati drafted the manuscript. Both the authors revised and corrected the manuscript.

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