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Microbiology Research in India: A Scientometric Analysis of research output during 2010-2020

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ABSTRACT

The investigation examines the academic output from India between 2010 and 2020, emphasizing the increase in research activity, prolific institutions, sub-disciplines, and the leading journals in microbiology. Data for this analysis were collected from Scopus-Expanded using the search terms "Microbiology in India," "Molecular Biology in India," and "Immunology and Microbiology in India" for the specified years of 2010-2020. A total of 14,616 records were gathered for this research. The All India Institute of Medical Sciences in Chandigarh ranked first with the highest publication count (339). Medicine emerged as the leading sub-discipline, followed by Biochemistry, Genetics and Molecular Biology, Immunology, and Microbiology. The Council of Scientific and Industrial Research, India, was responsible for funding the most publications in this area, taking the top spot among funding bodies. The Journal of PLOS ONE was identified as the most favored journal for researchers in this domain, with Scientific Reports following closely.

Keywords: Scientometrics, Microbiology, Medicine, Molecular Biology, Annual Growth Rate

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1. Introduction

Microbiology is establishing itself as a vital biological science; microorganisms serve as models utilized in molecular biology research. Investigations at the molecular level have provided, and continue to provide, insights into numerous essential questions regarding genetics, metabolism, and cellular structure and function. We are currently witnessing a swift transformation in national research and development priorities. As we approach the COVID-19 era, the fundamental and emerging demands for innovative technologies like R-DNA are being embraced to tackle the crisis. Recombinant DNA technology, often referred to as genetic engineering, is a central focus of the new high-tech advancements in the biological sciences.

The evaluation of a country's research performance, including research institutions and academic organizations, can be effectively carried out using scientometric methods. Scientometrics offers a specialized set of approaches for observing, assessing, and analyzing data resources, as well as for managing information. These studies aim to determine the quantitative and qualitative progress across various fields, particularly in the sciences. The advancements in RDNA have prompted numerous studies. Therefore, examining the quantitative developments in molecular biology research through scientometric techniques is beneficial for stakeholders in this field of knowledge. This review discusses various aspects of research productivity in molecular biology from India, situated within the broader scientific context.

While several studies employing scientometric methods have analyzed the contributions of Indian authors across various fields, there are only a limited number of investigations focused on Indian microbiology research. Various bibliometric techniques were applied to analyze the publication growth rate, citation metrics, authorship trends, and the most productive countries. Numerous research organizations, including ICMR, CSIR, UGC, DBT, and DST, as well as various universities and institutions, provide funding for research, often receiving external support from governmental research agencies.

2. Review of Literature

Bibliometrics primarily focuses on assessing scientific credibility and quantifying clinical impacts. Furthermore, it emphasises understanding the social, intellectual, and conceptual frameworks through bibliographic networks [1; 2]. On one hand, production and satisfaction will be evaluated using bibliometric indicators [3, 4, 5]. Additionally, through a citation classics analysis [6,7], papers with the highest citation rates may be examined. Conversely, bibliographic networks (such as co-words, co-citations, or co-authorships, among others) can be analysed through technology mapping assessments [8, 1]. Consequently, in this thematic series, we encourage researchers to utilise data on research outputs comprising journal articles to help elucidate and comprehend the complexities of the microbiology network through a unique bibliometric analysis.

Therefore, it is published with three current articles. Nai [9] presents an overview of microbiology research in South America, based on bibliometric data, offering an intriguing perspective on the productivity rate (measured by the number of publications) about population size and the number of research institutions. Rodrigues, Nimrichter, and Cordero [10] investigate the advantages of scientific mobility and global collaboration within the microbiology community. Meanwhile, Redfern and Verran [11] delve into "what defines a microbiologist?", helping to dispel the myth that the profession of 'microbiologist' is fading away, instead emphasizing the interdisciplinary and essential role microbiology plays within clinical endeavors.

2. Objectives

The primary aims of this study are:

• To examine the development of Microbiology Research – How microbiology research has evolved, and the attributes of this growth. These efforts will facilitate understanding the structure and importance of the field being studied.

• To pinpoint the key subject areas of Research Grasping the constituent sub-domains of a discipline first allows us to outline the scope and boundaries of the field. This analysis will explore how themes and dimensions contribute to the formation of the domain.

• To analyse the Bibliographic forms of Publications, how researchers utilise various platforms to share their findings in microbiology, and what is the predominant method employed? Tracking this preferred mode will assist users in prioritizing information searches within this field.

• To identify Leading Authors and Highly Cited Articles, and to determine which authors are making contributions and to what extent. Acknowledging the contributions of various authors will aid in giving appropriate recognition.

• To examine the Collaborative and Co-authorship index. The degree of collaboration provides insight into the network present within the studied field. Visualizing these networks can enhance understanding of the contributions made by different groups and institutions. It will also shed light on how collaboration influences productivity.

• To prepare the rank list of Journals in Microbiology

The top contributing journals of the field can be recognised once we track the highly productive and highly impactful medium.

• To identify the various types of Research Institutions

The top contributing institutions will be recognised once we list them based on their productivity.

3. Methodology

The study utilises 10 years of publication data from 2011 to 2020 on India in the field of microbiology, as defined in the Scopus database classification. Additionally, it utilised citation data to measure the quality and visibility of Indian research output. A total of 14616 records were downloaded. The data were analysed according to the study's objectives. The analysis is based on all documents, including articles, conference proceedings papers, reviews, letters, errata, short surveys, and book chapters, as recorded in the Scopus database.

4. Analysis

4.1 Pattern and growth of research output

Microbiology research has shown an increase in publications over the past ten years, with a minimum of 807 publications observed in 2011 and a maximum publications in 2019 is 1809.

The graph (Fig. 1) shows a continuous increase from 2013 to 2016, and from 2017 to 2020, it exhibits an up-and-down pattern in alternate years.

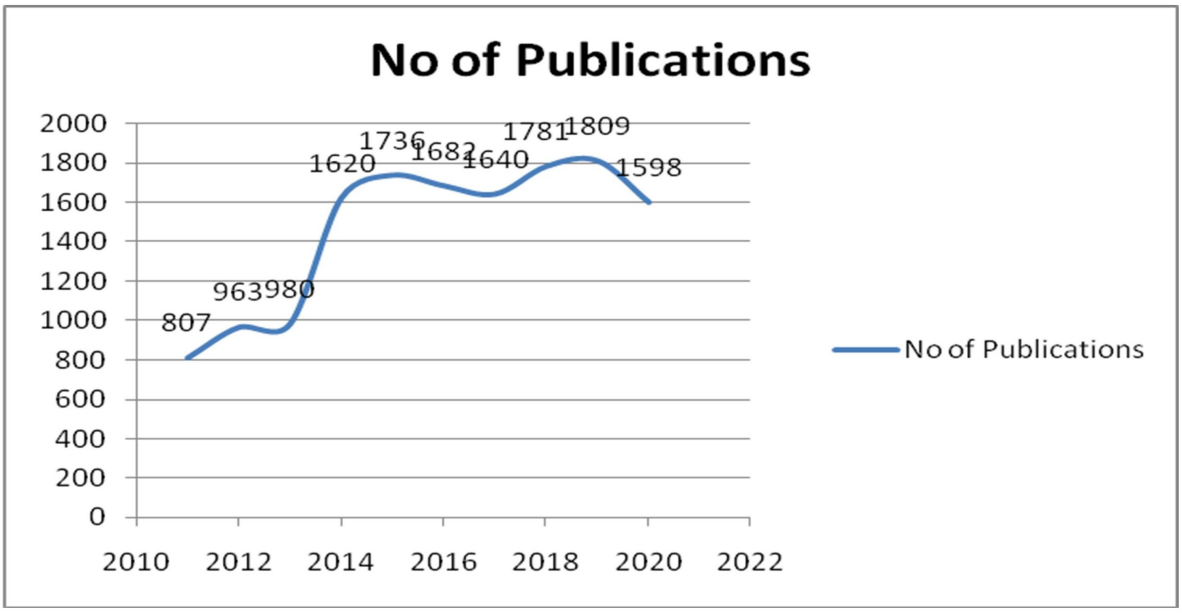

Figure 1. Growth pattern of Microbiology publication output

Growth rate is being measured with Compound Annual Growth Rate (CAGR) (*Choi et al., 2011*). The mathematical formula of CAGR is as below:

$$CAGR = \left(\frac{\text{Beginning Value}}{\text{Ending Value}} \right)^{1/N-1} -1$$

Year	No of Publications	Cumulative Total	AGR	CAGR
2011	807	807	-	-
2012	963	1770	19.33	0.8380
2013	980	2750	1.76	0.6751
2014	1620	4370	65.30	0.3920

2015	1736	6106	7.16	0.3694
2016	1682	7788	-3.11	0.3586
2017	1640	9428	-2.49	0.3384
2018	1781	11209	8.59	0.3005
2019	1809	13018	1.57	0.2797
2020	1598	14616	-11.66	0.2788

Table 1. Growth Pattern of Microbiology Publications

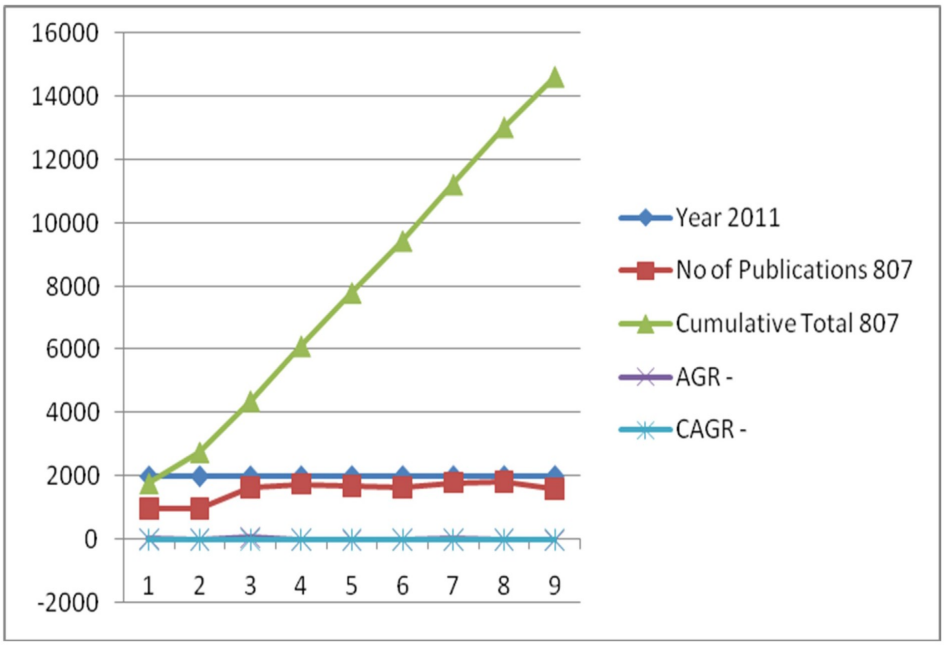

Figure 1. Growth trend of Microbiology research

4.2 Medium of Research Communication

Table 2 represents that the primary source of publications covered by the Scopus database on Microbiology research is Journal articles with 12260 publications (83.88%), followed by Review articles with 1142 publications (7.81%). Letter ranks in third position with 452 publications (3.09%), Note occupies fourth position with 236 publications (1.61%), Book Chapter ranks 5th with 183 publications (1.25%), and the remaining forms are less than one per cent as represented in the table. The results indicated that the research outputs on the subject for the period covered by the study are primarily published in the form of Journal Articles.

Document Type	Count	Percentage
Journal Article	12260	83.88
Review	1142	7.81
Letter	452	3.09
Note	236	1.61
Book Chapter	183	1.25
Book	91	0.62
Editorial	83	0.56
Conference Paper	75	0.51
Erratum	51	0.34
Short Survey	31	0.21
Retracted	6	0.04
Data Paper	2	0.01
Undefined	4	0.02

Table 2. Bibliographic forms

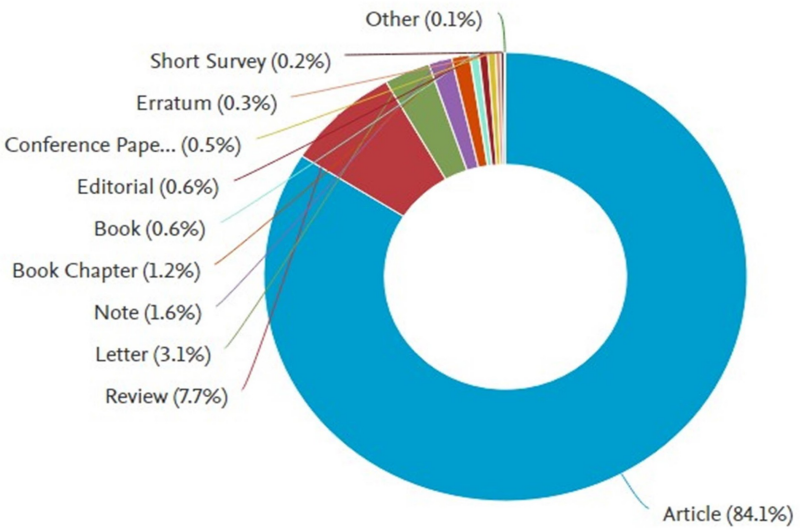

Figure 2. Forms of publications

4.3 Collaboration Coefficient

The collaboration coefficient is calculated using the formula provided in the Data and Methodology Section. The measurement method of CC is defined by Ajiferuke [12], which is based on the work of Price and Beaver.[13] The average CC 0.72 of India was recorded between the years 2011 and 2020. In Table 3, the highest CC, 0.73, came in 2019, and the lowest, 0.55, came in 2011. The study indicated that the CC pattern of Indian authors decreased in 2011, with more than four authors. Collaboration dominates the Indian collaboration pattern. 1799 Two-author collaborations have been obtained in 14616 publications. It appears that the three-author pattern, with 2173 publications, is slightly less prevalent than four-author collaborations. We also studied the collaboration patterns of other countries, but did not conclude that more than four authors generally dominate in any other collaboration pattern.

Year	Single Author	TwoAuthor	Three Author	Four Author	Mega Author	Total	CC
2020	46	172	236	286	858	1598	0.71
2019	31	220	235	303	1020	1809	0.73
2018	39	212	269	299	962	1781	0.72
2017	32	207	235	269	897	1640	0.71
2016	29	185	269	318	881	1682	0.72
2015	42	205	270	319	900	1736	0.72
2014	29	230	256	324	781	1620	0.71
2013	34	129	189	210	418	980	0.56
2012	28	125	197	163	450	963	0.70
2011	18	114	17	159	343	807	0.55
Total	328	1799	2173	2650	7510	14616	0.72

Table 3. Collaboration Coefficient

According to Subramanyam[40] the degree of collaboration of authors is determined by the formula

C=Nm/Nm +Ns

where C Degree of collaboration in a discipline

Nm = Number of multi-authored papers

Ns= No. of single-authored papers

The results, as represented in Table 4, indicate a degree of collaboration ranging from 0.97 to 0.98. This suggests that most microbiology publications are collaborative efforts. However, the value of the degree of cooperation remains almost stable during the study period.

Year	Single Author	Multi Author	Total	Degree of Collaboration
2020	46	1552	1598	0.97
2019	31	1778	1809	0.98
2018	39	1742	1781	0.98
2017	32	1608	1640	0.98
2016	29	1653	1682	0.98
2015	42	1694	1736	0.97
2014	29	1591	1620	0.98
2013	34	946	980	0.96
2012	28	935	963	0.97
2011	18	789	807	0.97
Average	328	14288	14616	0.98

Table 4. Degree of Collaboration

4.4 Subject Profile of Microbiology Research

The entire output in microbiology research is classified into 27 disciplines. On categorising the total Indian microbiology research output under broad subjects, it is observed that the majority of the publications are in the topic of Medicine, as shown in Table 5. Analysis of microbiology research output shows that 42.91 per cent (6273) of the total papers are in medicine, followed by Immunology and Microbiology, (32.75%) share 4788

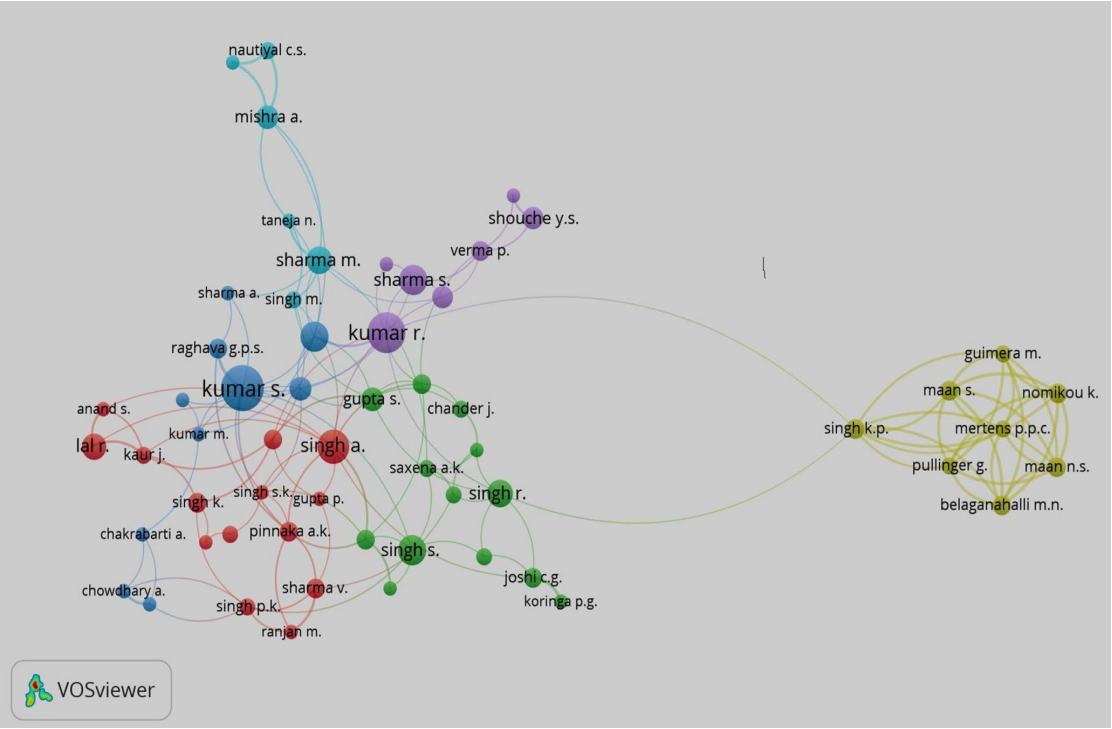

Figure 3. Collaboration visualization

papers and biochemistry, Genetics and Molecular Biology share 4768 papers (32.62%) and Agricultural and biological sciences with(16.53 % share and 2417papers).

Subject	Count	Percentage
Medicine	6273	42.91
Immunology and Microbiology	4788	32.75
Biochemistry, Genetics and Molecular Biology	4768	32.62
Agricultural and Biological Sciences	2417	16.53
Environmental Science	1658	11.34
Pharmacology, Toxicology and Pharmaceutics	971	6.64
Chemical Engineering	897	6.13
Multidisciplinary	786	5.37
Chemistry	552	3.77
Engineering	442	3.02
Energy	337	2.30

Dentistry	325	2.22
Veterinary	277	1.89
Material science	268	1.83
Physics and Astronomy	167	1.14
Economics, Econometrics and Finance	115	0.78
Neuro Science	99	0.67
Earth and Planetary Science	94	0.64
Nursing	88	0.60
Health Profession	82	0.56
Computer Science	77	0.52
Social Science	54	0.36
Mathematics	27	0.18
Arts and Humanities	11	0.07
Business, Management and Accounting	10	0.06
Decision Science	5	0.03
Psychology	1	0.01

Table 5. Subject-wise distribution of Research

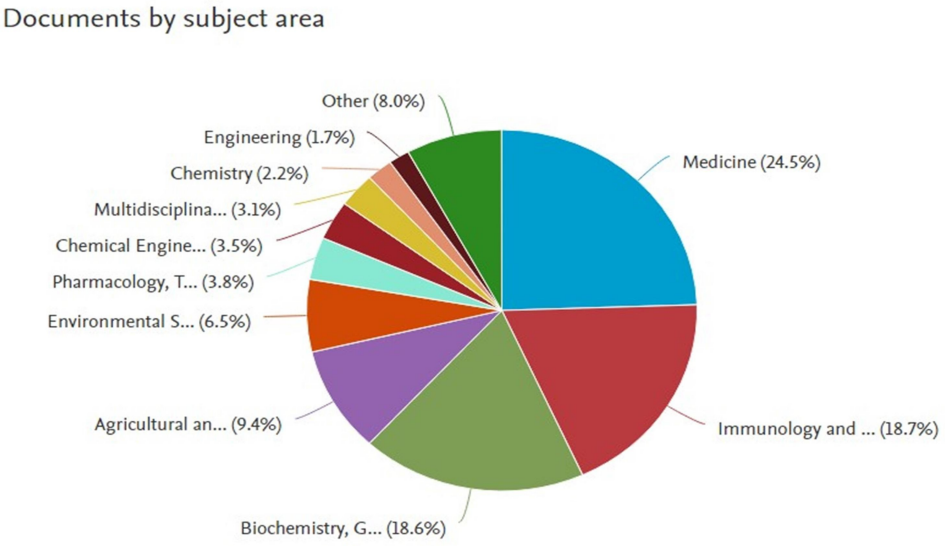

Figure 4. Subject Distribution

4.5 Prolific Authors

Author	Count	Percentage	Rank
Chakrabarti A	116	0.73	1
Veeraraghavan. B	91	0.56	2
Chowdhary. A	85	0.53	3
Sharma, s	81	0.50	4
Rodrigues, C	71	0.44	5
Ramamurthy, T	65	0.40	6
Lal R	62	0.38	7
Kapil A	58	0.36	8
Meis J F	57	0.35	9
Ramana	57	0.35	9
Sasikala C	57	0.35	9

Table 6. Prolific Authors

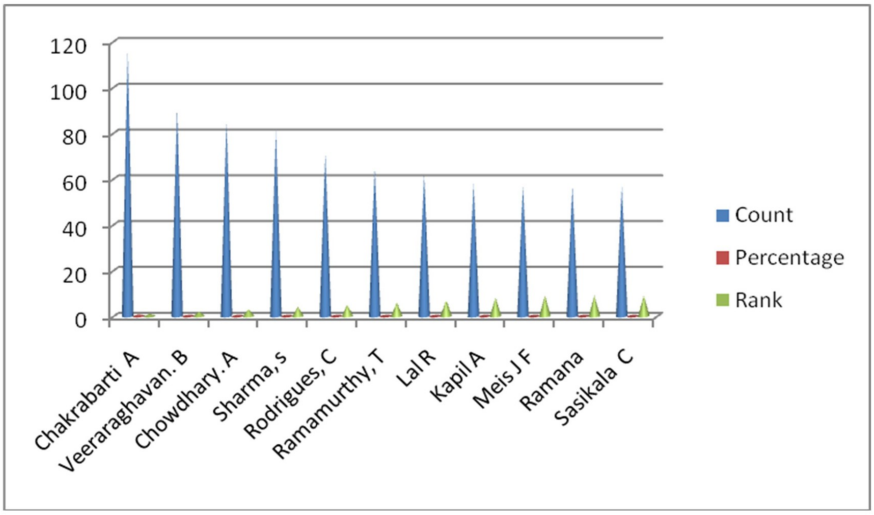

Figure 5. Productive Authors

Table 6 depicts the top contributions in Microbiology research during the period of study. A total number of publications is contributed by authors ranging from single authors to 160 authors in a single paper. It shows that Chakrabarti A is the most productive author, contributing 116 papers (0.73%), followed by Veeraraghavan. B with 91 papers (0.56 %) and Chowdhary. A total of 26 (0.53 %) papers.

4.6. Prolific Journals

Name of the Journal	Country	Publisher	Rank	Count	IF	H-Index
Indian Journal of Medical Microbiology	India	Indian Association of Medical Microbiologists	1	417	0.988	48
Plos One	USA	Public Library of Science	2	381	3.24	332
Scientific Reports	UK	Nature Research	3	313	5.133	213
Indian Journal of Medical Research	India	Indian Council of Medical Research	4	273	1.503	87
International Journal of Systematic And Evolutionary Microbiology	UK	Society for General Microbiology	5	237	2.4	173
Journal of Basic Microbiology	Germany	Wiley-VCH GmbH	6	206	2.281	54
Microbial Pathogenesis	UK	Elsevier Ltd	7	194	3.738	71
World Journal of Microbiology And Biotechnology	USA	Springer	8	184	2.477	90
Journal of Applied Microbiology	UK	The Society for Applied Microbiology	9	177	3.772	156
Bio resource Technology	UK	Elsevier Academic Press	10	174	7.539	294

Table 7. Top-Ranked Journals

Top-Ranked Journals

Table 7 shows the top 10 journals used for publishing the papers. A maximum of 417 papers are published in the Indian Journal of Medical Microbiology, followed by PlOS One with 381 publications.

Analysis of the data on the distribution of microbiology output indicates that the Indian Microbiology literature is scattered across journals published in India and abroad. Of the ten journals, eight are of international origin and only two are of Indian origin. It is found that the Indian Journal of Medical Microbiology, India, tops the list with the highest number of publications, at 417 (2.85%), followed by PLOS ONE, USA, with 381 (2.60%) papers, and Scientific Reports, with 313 (2.14%) publications. Among the top-ranked journals, two Indian journals, published by IAMM and ICMR, are included.

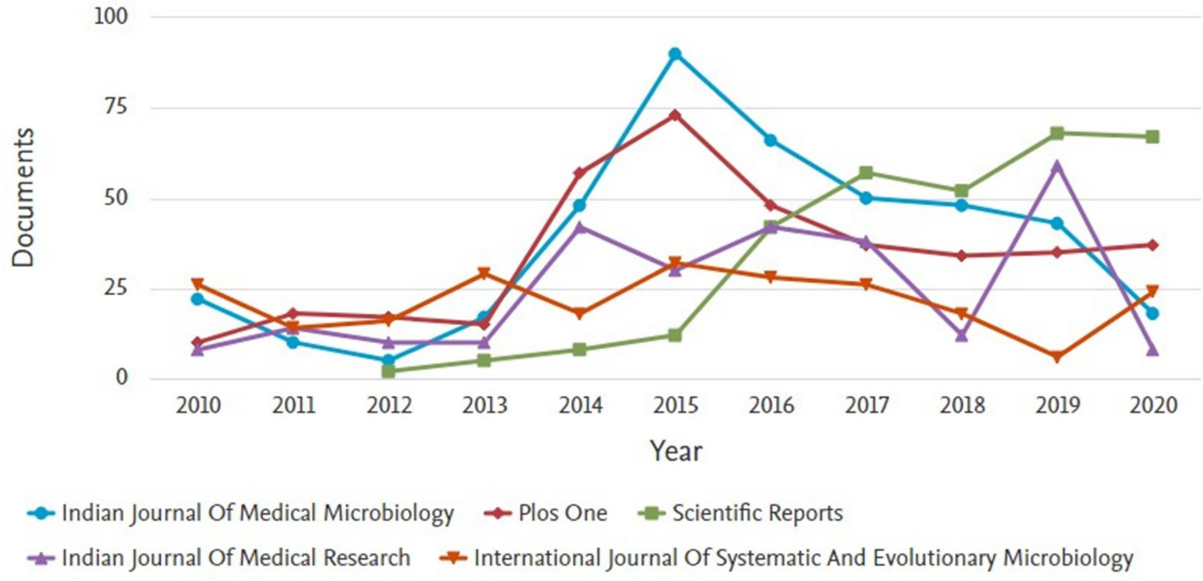

Figure 6. Contributing Journals

4.7 Prolific Institutions

It has been found that numerous Indian institutions have made significant contributions to microbiology research. Some of these institutions are owned by the central and state governments. The table represents the types of various institutions of Indian Microbiology research. Postgraduate Institute of Medical &Research, Chandigarh ranked first, followed by the All India Institute of Medical Science.

Institute Name	Contribution	Rank
Postgraduate Institute of Medical &Research Chandigarh	578	1
All India Institute of Medical Science	458	2
University of Delhi	442	3
Council of Scientific and Industrial Research India	311	4
Banaras Hindu University	309	5
Indian Council of Agricultural Research	293	6
Christian Medical College	286	7

Indian Council of Medical Research	265	8
Institute of Microbial Technology India	224	9
Indian Institute of Science	217	10

Table 8. Prolific Institutions

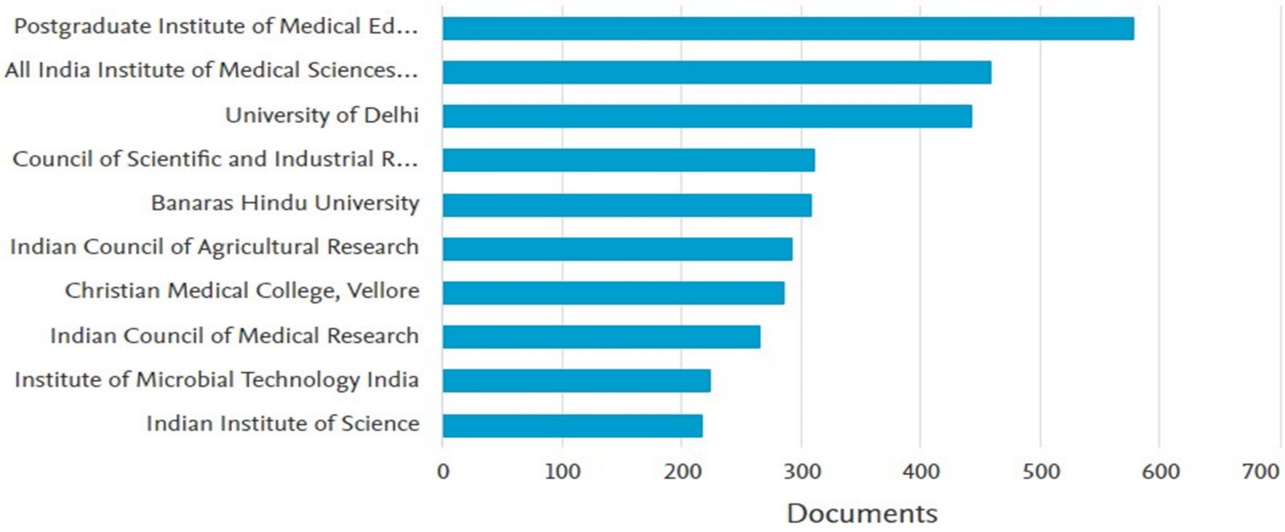

Figure 7. Institution analysis

5. Conclusion

The purpose of the study is to examine the trend of Microbiology Research in India, using the number of papers covered by Scopus. India contributed 14,616 microbiology publications to Scopus-indexed journals during the study period. The cumulative Indian research output in microbiology increased from 807 papers in 2011 to 14616 in 2020. It is a good indicator that India's publication output has been continuously rising over the last ten years. The study has identified the areas of research in microbiology, journals used for communication, highly cited papers, etc. India's publication output is 14,616, and the global publication share is 4.17 per cent. The world Microbiology contribution during the period is 3,50,103, and India's average annual growth rate is 36.84 per cent. In terms of subject-wise contribution, the most significant publication share comes from medicine (42.91%). The most productive institution contributing to microbiology research is the Post Graduate Institute of Medical Research, Chandigarh. The study's outcome will be beneficial to faculty members and microbiologists actively engaged in microbiology research, policymakers, and stake-holders in the country.

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