Webology (ISSN: 1735-188X)
Volume 18, Number 6, 2021

Publication Research Trends On 'Progress In Nuclear Magnetic Resonance Spectroscopy': A Scientometric Study

Johnson I[1] and Padma P[2]

[1]Research Scholar, Department of Library and Information Science, Madurai Kamaraj University, Madurai, Tamil Nadu, India & College Librarian, Govt. Arts and Science college, Perumbakkam, Chennai-131, Tamil Nadu, India.

[2]Assistant Professor, Department of Library and Information Science, Madurai Kamaraj University, Madurai, Tamil Nadu, India.

ABSTRACT

This study investigated the 383 documents published in the journal 'Progress in NMR Spectroscopy' to evaluate its publication trends of 20 years period from 2001 to 2020 in the field of NMR Spectroscopy. The scientometric analysis highlighted that a total number of 870 authors contributed these documents and most of the documents were reviews (370; 96.6%). The journal has published an average of 19.15 documents per year and the year 2009 has been registered as the highest publication year with 30 documents (7.83%) and the 2006-2010 quarter has been recorded with the highest number of publications (113). The journal has published 102 (26.63%) single-authored documents and the rest of them were multi-authored documents with a collaboration index of 2.77. Luchinat C was the most productive author; University of Florence of Italy contributed the highest number of affiliation; the 'nuclear magnetic resonance' was the most relevant keyword. The year 2003 has witnessed the highest mean TC per article (121.375) even though the same year has been recorded as the lowest publication year. Though the USA was the most productive country with 175 contributions, the European countries combined together have predominantly contributed 438 papers as well as scored high average article citations.

Keywords: Scientometrics, Publication productivity, Citation Analysis, Nuclear Magnetic Resonance Spectroscopy, NMR Spectroscopy, Progress in NMR Spectroscopy.

1. Introduction

Scientometrics emerges as a significant discipline in recent yearsand is considered as the science of science. Scientometrics is the science of measuring,analyzing and evaluating the scientific literature output in terms of mathematical methods such as mathematical statistics and computational techniques. It mainly deals with the quantitative features and characteristics of science, scientific research and its process of communication. It comprises all the metric

studies related tothe ways of measuring research quality and its impact, understanding the process of citation analyses, mapping scientific fields, research evaluation and the use of scientific indicators in research policy in the management context. Moreover, scientometrics often attempted to measure the evolution of a scientific domain, the impact of scholarly communications, the patterns of authorship and the continuous process of scientific knowledge production. Scientometrics can be defined as the "quantitative study of science, communication in science and science policy" (Hess, 1997, p.75).

In view of the shrinking of finance and growing competition between nations, the direct societal benefits of a particular field of research have moved into the forefront of quality assessment. Hence, scientometrics is increasingly becoming an integral part of research evaluation and playing a vital role in designing national research policies, allocation of funds, promotions and creation of jobs etc. It provides reliable, transparent and relevant citation-based data to promote a particular field of research. It involves studies in the sociology of science, history of science, growth of literature, the behaviour of scientists, science indicators etc. Scientometric data in the form of indicator-supported procedures have given valuable feed in budgetary decisions. It ultimately helps the economic prosperity and social progress of the society by implanting suitable policymaking.

2. Nuclear Magnetic Resonance Spectroscopy

Nuclear Magnetic Resonance Spectroscopy, most popularly known as NMR Spectroscopy is one of the top analytical methods in modern chemistry that exploits the magnetic properties of certain atomic nuclei. NMR Spectroscopy is based on the NMR phenomena whereby the interaction of radiofrequency (RF) electromagnetic radiation of molecules are observed and recorded when a selected sample is subjected to a strong external magnetic field. It is an incredibly powerful and versatile techniquethat plays a vital role in determining the physical, chemical and biological properties such as structure, interaction, dynamics, reaction state and chemical environment of organic, inorganic molecules. This is an ideal analytical chemistry technique that allows noninvasive, nondestructive and quantitative analytical investigations. In 1938, Isidor Isaac Rabi of Columbia University made the first-ever accurate measurement of nuclear magnetic moments using magnetic resonance absorption of molecular beams and was awarded the Nobel Prize in physics in 1944. Subsequently, Felix Bloch of Stanford University and Edward Purcell of Harvard University independently developed and successfully demonstrated NMR signals for liquids and solids and shared Nobel Prize for condensed matter in Physics in 1952, which is the starting mark of NMR.

3. Progress in Nuclear Magnetic Resonance Spectroscopy

'Progress in Nuclear Magnetic Resonance Spectroscopy' is a renowned international review journal and was founded by Jim Emsley, Jim Feeney and Les Sutcliffe in 1966. Initially, it was flourished by Pergamon Press and published by Elsevier since 1991. It publishes review papers covering the theory and applications of NMR spectroscopy in the fields of chemistry, physics, biochemistry, material sciences, biology, medicine and their related subject fields. The in-depth treatment of fundamental theories and instrumental developments of NMR

spectroscopy made this journal highly reputed and ranked first out of 37 journals in physics, atomic, molecular and chemical. The current impact factor (IF) of this journal is 9.795 and the Cite score is 16.5. This journal is indexed in 8 international databases viz. Research Alert, Current contents, SCI, Web of Science, Scopus, Chemical Abstract, Index to scientific reviews and INSPEC. This is the bimonthly journal, possessing the print ISSN 0079-6565 and electronic version E-ISSN 1873-3301. The journal can be accessed from the website http://www.sciencedirect.com/science/journal/00796565.

4. Review of Literature

4.1.Chemical Literature

Sudhier and Dileep Kumar (2020) investigated the growth trends of Indian research publications of biochemistry between 2004 and 2013 based on 25132 records extracted from the Web of Science database. It revealed that the Indian biochemistry research output was steadily growing and the year 2012 witnessed the highest growth (3491; 13.89%) with an average annual growth rate of 36.84%. **Amin et al. (2019)** conducted a scientometric study of graphene research output from 2010 to 2012 based on 16183 papers retrieved from the Web of Science database. This study found that the year 2010 was significantly the beginning of a new era of graphene research and also the inventors were awarded the Nobel Prize in the same year. **Xiao et al. (2017)** carried out a study of the literature growth and research trends on Organic Photovoltaic (OPV) technology from 1984 to 2016 based on the data available in the Web of Science core collection. A total number of 40,069 records were extracted, which included 35,231 journal articles. This study inferred that the inverted device structure and tandem solar cells were the emerging trends and perovskite solar cell was the newly developed significant branch of organic solar cells. **Hosamani and Bagalkoti (2016)** investigated the Indian chemistry literature output as reflected in the Web of Science database between 1999 and 2013 and India had contributed 46420 records. This study let out that the Indian chemistry research output had grown steadily as well as collaborative during the study period. **Konur (2016)** presented a scientometric overview of the researches in surface chemistry of materials, nanomaterials and nanobiomaterials as retrieved from SCI, SCIE and SSCI databases from the inception to 2014. A total of 6,91,666 records were collected of which 6,80,589 were articles and reviews. This study brought out the facts that this research field had been raised since 1991 with increased research output. **Sagar et al. (2014)** attempted to explore the publication status and growth of radioisotope research based on the data retrieved from the Web of Science database between 1993 and 2012. A total number of 31488 records and 482549 citations received were analyzed. This study illustrated that exponential growth of publication was observed. **Kademani et al. (2007)** analysed the growth of analytical chemistry research output in nuclear science and technology as reflected in the INIS database between 1970 and 2005. A total of 8224 records from 53 countries were extracted. In spite of this research being started only with 7 publications in 1970, a tremendous explosion of literature was witnessed and the year 1985 produced the highest number (636).

4.2.Individual Chemistry Journals

Jayabal and Balasubramanian (2018) examined the publication trends in the field of Chemical Engineering and Technology by analysing the scientific literature output (646 papers) of the Indian Journal of Chemical Technology during 2008-2017 with data collected from journal website. This study indicated that the state of Tamilnadu (232; 15.06%) remained as the top contributor followed by Maharashtra (191; 12.40%). **Vijayakumar and Gomathi (2018)** made a scientometric analysis of 996 publications of the Journal of Chemical Sciences, a bi-monthly journal published by the Indian Academy of Sciences during 2004-2013, with data collected from the volumes 114-125 of the journal. This study disclosed that the year 2013 published a large number of articles and also received a maximum number of citations (4656; 15.93%). **Bala and Singh (2014)** evaluated the scholarly publications of the Indian Journal of Bio-Chemistry & Bio-Physics, an open access bimonthly journal published by NISCAIR during the period 2009-2013. A total number of 316 publications were retrieved from 'NISCAIR Online Periodicals Repository (NOPRI). The scientometric analysis brought out that the highest number of articles were published in 2013 (72; 22.78%) and a majority of contributions came from India (68.9%) followed by China (14.9%). **Emsley and Feeney (2007)** described the genesis, history, aims and goals of the journal 'Progress in NMR Spectroscopy'. Since 1966, it covered all the aspects of a wide range of applications in chemistry, biology and medicine. Over the 40 years, this journal covered the milestones of NMR advancements till 2006 and many clever innovations in NMR.

5 Aim of the Study

The aim of the present study is to evaluate publication trends, citation analysis and degree of collaboration of the journal 'Progress in NMR spectroscopy' during 2001 to 2020.

6. Objectives of the Study

The objectives of the present scientometric study are enumerated as follows.

- To reveal the year-wise distributionof the journal of 'Progress in Nuclear Magnetic Resonance Spectroscopy'.
- To investigate the authorship pattern and co-authorship pattern of the contribution.
- To identify the annual growth rate, relative growth rate, doubling time, activity index and degree of collaboration.
- To find out the most productive authors, institutions and countries.
- To examine the number of citations received by the articles with respect to year and bring out the highly cited articles.
- To determine the frequently used keywords and
- To disclose the organization-wise distribution of articles.

7. Materials and Methods

The present study is a quantitative study. The data for the present study is extracted from the WoS Core Collection database on 9th December 2021 by using the keywords "nuclear magnetic resonance spectroscopy" OR "NMR spectroscopy" for the span of 20 years between 2001 and 2020 (Vol. No.38 to 121). Each volume of the journal has been critically analysed to examine the year-wise growth, authorship pattern, citation impact, key words used and organization-

wise distribution. Biblioshiny – bibliometrix package of 'R' and MS Excel are used for data analysis.

8. Data analysis and interpretation

Table 8.1 Main Information

Description	Results
Time span	2001:2020
Sources (Journals, Books, etc)	1
Documents	383
Average years from publication	10.2
Average citations per documents	66.18
Average citations per year per document	6.139
References	1
DOCUMENT TYPES	
Biographical-item	1
Correction	4
Editorial material	8
Review	370
DOCUMENT CONTENTS	
Keywords Plus (ID)	2201
Author's Keywords (DE)	1307
AUTHORS	
Authors	870
Author Appearances	1006
Authors of single-authored documents	91
Authors of multi-authored documents	779
AUTHORS COLLABORATION	
Single-authored documents	102
Documents per Author	0.44
Authors per Document	2.27
Co-Authors per Documents	2.63
Collaboration Index	2.77
SOURCE IMPACT	
h index	91
g index	138
m index	4.33
Total Citations	25347

Table 8.1 exhibits the publication trends of the journal 'Progress in Nuclear Magnetic Resonance Spectroscopy' during the study period of 20 years in a nutshell from 2001 to 2020. A total number of 383 documents were published throughout the course of the study in which

370 documents (96.6%) were reviews and the rest were editorial materials, corrections and biographical item. The documents contain 2201 keywords plus (ID) and 1307 Author's keywords. There were 870 authors contributed the 383 documents and the total number of author appearances was 1006. Out of the 870 authors, a majority of the authors (779) have contributed multi-authored documents and only a limited number of 91 authors alone contributed the single-authored documents. While considering the author's collaboration, the journal published 102 (26.63%) single-authored documents and the document per author is 0.44. It also shows that the author per document is 2.27, co-authors per document are 2.63 and it has a collaboration index of 2.77.

Table 8.2 Year wise distribution of papers

Year	Articles	%	Cumulative Total	Cumulative %
2001	16	4.18	16	4.18
2002	18	4.70	34	8.88
2003	8	2.09	42	10.97
2004	18	4.70	60	15.67
2005	18	4.70	78	20.37
2006	22	5.75	100	26.12
2007	19	4.96	119	31.08
2008	15	3.92	134	35.00
2009	30	7.83	164	42.83
2010	27	7.05	191	49.88
2011	20	5.22	211	55.10
2012	21	5.48	232	60.58
2013	20	5.22	252	65.80
2014	20	5.22	272	71.02
2015	17	4.44	289	75.46
2016	18	4.70	307	80.16
2017	17	4.44	324	84.60
2018	20	5.22	344	89.82
2019	19	4.96	363	94.78
2020	20	5.22	383	100
Total	**383**	**100**		
Average papers per year = 383/20			**19.15**	

Table 8.2 reveals that the journal has published an average of 19.15 documents per year and the year 2009 has been registered as the highest publication year with 30 documents (7.83%) whereas the year 2003 has been registered as the lowest publication year with only 8 documents (2.09%). While analyzing the publication trends of the journal, the quarter 2006 to 2010 has been recorded with the highest number of publications (113) followed by 2011 to 2016 (98), 2016 to 2020 (94) and 2001 to 2005 (78). Hence it is observed that the journal has published a lower number of documents during the 2001-2005 quarter and the number of publication was increased from 2006 to 2010 quarter and witnessed the little decrease thereafter

and maintained a gradual number of publications during the quarters 2011 to 2015 and 2016 to 2020. However, in another point of view, the journal has published almost the same number of documents from 2001 to 2010 (191 publications, 49.88%) and 2011 to 2020 (192 publications, 50.12%). Therefore, it is observed that no significant growth or any marginal downfall of publication occurred during the study period.

Table 8.3 Most productive authors (more than one publication)

Element	h_index	g_index	m_index	TC	NP	PY_start
Luchinat C	5	5	0.250	557	5	2002
Parigi G	4	4	0.200	530	4	2002
Krivdin LB	4	4	0.800	151	4	2017
Williamson MP	3	3	0.333	732	3	2013
Bertini I	3	3	0.150	557	3	2002
Holmes E	3	3	0.143	548	3	2001
Lindon JC	3	3	0.143	548	3	2001
Nicholson JK	3	3	0.143	548	3	2001
Mitchell J	3	3	0.188	310	3	2006
Blackledge M	3	3	0.176	290	3	2005
Bryce DL	3	3	0.150	237	3	2002
Reichert D	3	3	0.150	176	3	2002
Wu G	3	3	0.214	150	3	2008
Salvi N	2	3	0.286	60	3	2015
Clore GM	2	2	0.125	591	2	2006
Schwieters CD	2	2	0.125	591	2	2006
Kimmich R	2	2	0.111	568	2	2004
Bohmer R	2	2	0.095	430	2	2001
Orekhov VY	2	2	0.095	405	2	2001
Dalvit C	2	2	0.100	349	2	2002
Bain AD	2	2	0.105	328	2	2003
Blumich B	2	2	0.143	324	2	2008
Fan TWM	2	2	0.143	272	2	2008
Lane AN	2	2	0.143	272	2	2008
Chandrasekera TC	2	2	0.200	262	2	2012
Gladden LF	2	2	0.200	262	2	2012
Jaszunski M	2	2	0.143	258	2	2008
Jones JA	2	2	0.095	248	2	2001
Ramamoorthy A	2	2	0.167	224	2	2010
Berger S	2	2	0.118	222	2	2005
Jerschow A	2	2	0.118	219	2	2005
Billeter M	2	2	0.095	211	2	2001
Guntert P	2	2	0.105	206	2	2003

Korzhnev DM	2	2	0.095	206	2	2001
Vieth HM	2	2	0.200	205	2	2012
Wasylishen RE	2	2	0.100	205	2	2002
Freeman R	2	2	0.105	204	2	2003
Kruk D	2	2	0.200	204	2	2012
Kupce E	2	2	0.105	204	2	2003
Felli IC	2	2	0.125	180	2	2006
Pierattelli R	2	2	0.125	180	2	2006
Ando I	2	2	0.095	170	2	2001
Pell AJ	2	2	0.286	163	2	2015
Pintacuda G	2	2	0.286	163	2	2015
Schanda P	2	2	0.154	156	2	2009
Brindle KM	2	2	0.118	153	2	2005
Kettunen MI	2	2	0.118	153	2	2005
Gerothanassis IP	2	2	0.167	152	2	2010
Ashbrook SE	2	2	0.111	140	2	2004
Wimperis S	2	2	0.111	140	2	2004
Hoch JC	2	2	0.250	139	2	2014
Mobli M	2	2	0.250	139	2	2014
Madhu PK	2	2	0.167	135	2	2010
Asakura T	2	2	0.095	132	2	2001
Krishnan VV	2	2	0.154	130	2	2009
Pileio G	2	2	0.167	129	2	2010
Laurencin D	2	2	0.222	121	2	2013
Hodgkinson P	2	2	0.118	117	2	2005
Ivanov Kl	2	2	0.250	110	2	2014
Kozminski W	2	2	0.167	110	2	2010
Stanek J	2	2	0.167	110	2	2010
Yurkovskaya AV	2	2	0.250	110	2	2014
Desvaux H	2	2	0.154	103	2	2009
Rastrelli F	2	2	0.118	102	2	2005
Barker PB	2	2	0.125	101	2	2006
Lian LY	2	2	0.095	97	2	2001
Kazimierczuk K	2	2	0.167	93	2	2010
Lesot P	2	2	0.154	91	2	2009
Peters JA	2	2	0.182	91	2	2011
Domenici V	2	2	0.133	90	2	2007
Berthault P	2	2	0.154	87	2	2009
Babailov SP	2	2	0.143	83	2	2008
Chevelkov V	2	2	0.125	81	2	2006
Sprangers R	2	2	0.167	77	2	2010
Freed JH	1	2	0.083	76	2	2010

Meirovitch E	1	2	0.083	76	2	2010
Shapiro YE	1	2	0.083	76	2	2010
Song YQ	2	2	0.154	71	2	2009
Bell JD	2	2	0.133	70	2	2007
Liang BY	2	2	0.125	70	2	2006
Tamm LK	2	2	0.125	70	2	2006
Blumler P	2	2	0.125	68	2	2006
Tugarinov V	2	2	0.167	59	2	2010
Tekely P	2	2	0.100	56	2	2002
Dotsch V	2	2	0.133	54	2	2007
Lohr F	2	2	0.133	54	2	2007
Mote KR	2	2	0.222	54	2	2013
Nielsen NC	2	2	0.200	42	2	2012
Smith SO	2	2	0.125	42	2	2006
Ravera E	2	2	0.333	39	2	2016
Chen Z	2	2	0.286	35	2	2015
Frahm J	2	2	0.111	35	2	2004
Bodenhausen G	1	2	0.091	32	2	2011
Wiegand T	2	2	0.667	21	2	2019
Kuchel PW	2	2	0.200	12	2	2012

Though 870 authors have contributed a total number of 383 documents during the study period of 2001 to 2020, the authors of more than one publication who are displayed in Table 8.3, 95 authors have alone contributed 208 documents (54.31%) and Luchinat C was the most productive author with 5 documents (557 TC) followed by Parigi G (530 TC) and Krivdin LB (151 TC) with 4 documents each. Moreover, 11 authors contributed 3 documents each and 81 authors contributed 2 documents each. It is quite interesting to note that the second most productive author Krivdin LB has scored the highest m index of 8 even though he obtained 151 TC andstarted his publication only in 2017.

Table 8.4 Most Prolific Author (Single Publication)

Based on TC (>200)				**Based on m-index**		
Author	**TC**	**PY_start**		**Author**	**m_index**	**PY_start**
Kuszewski JJ	551	2006		Schutz S	0.5	2020
Anoardo E	519	2004		Akoka S	0.5	2020
Van Zijl PCM	332	2006		Dickie B	0.5	2020
Zhou JY	332	2006		Parker GJM	0.5	2020
Kovacs H	330	2005		Parkes LM	0.5	2020
Moskau D	330	2005		Remaud GS	0.5	2020
Spraul M	330	2005		Aroulanda C	0.5	2020
Casanova F	315	2008		Berdague P	0.5	2020
Perlo J	315	2008		Farjon J	0.5	2020

Saalwachter K	295	2007		Giraud N	0.5	2020
Fielding L	265	2007		Lafon O	0.5	2020
Adams RW	247	2012		Meddour A	0.5	2020
Duckett SB	247	2012		Merlet D	0.5	2020
Green GGR	247	2012		Sen S	0.5	2020
Green RA	247	2012		Day IJ	0.5	2020
Mewis RE	247	2012		Evans R	0.5	2020
Williamson DC	247	2012		Golowicz D	0.5	2020
Diezemann G	244	2001		Kasprzak P	0.5	2020
Hinze G	244	2001		Orekhov V	0.5	2020
Rossler E	244	2001		Alderson TR	0.5	2020
Jaravine VA	225	2011		Pritisanac I	0.5	2020
Helgaker T	221	2008		Boutin C	0.5	2020
Pecul M	221	2008		Carret G	0.5	2020
Edden RAE	217	2012		Garwood M	0.5	2020
Puts NAJ	217	2012		Jansen P	0.5	2020
Corzilius B	215	2017		Martineau-Corcos C	0.5	2020
Kaushik M	215	2017		Merkt F	0.5	2020
Thankamony ASL	215	2017		Mullen M	0.5	2020
Wittmann JJ	215	2017		De Biasi F	0.5	2020
Brand T	213	2005		Howe PWA	0.5	2020
Cabrita EJ	213	2005		Mancin F	0.5	2020
Holzgrabe U	202	2010		Demetriou E	0.5	2020
Mcnally DJ	202	2011		Golay X	0.5	2020
Simpson AJ	202	2011		Kujawa A	0.5	2020
Simpson MJ	202	2011		Grey CP	0.333	2019
Stockman BJ	202	2002		Barskiy DA	0.333	2019

The most prolific authors who have scored more than 200 TC based on a single publication are exhibited in Table 8.4 and reveal that Kuszewski JJ has been placed on top position with a score of 551 TC followed by Anoardo E with 519 TC. In addition to that 7 authors scored more than 300 TC and 27 authors scored more than 200 TC. While observing the overall tally of authors who have scored more than 200 TC, 4 authors namely Corzilius B, Kaushik M, Thankamony ASL and Wittmann JJ have appeared even though their papers were published only in 2017. Moreover, 34 authors have scored m index of 0.5 and two authors have scored m index of 0.333.

Table 8.5 Country-wise production

Region	Continent	Frequency	%
USA	North America	175	24.41
UK	Europe	103	14.36

Germany	Europe	95	13.24
France	Europe	60	8.37
Italy	Europe	34	4.74
Canada	North America	33	4.60
Japan	Asia	33	4.60
Switzerland	Europe	26	3.63
Russia	Europe	17	2.37
Spain	Europe	17	2.37
Netherlands	Europe	15	2.09
Sweden	Europe	13	1.81
Australia	Australia	12	1.67
Poland	Europe	11	1.53
China	Asia	9	1.25
Israel	Asia	8	1.12
India	Asia	7	0.98
Denmark	Europe	6	0.84
Belgium	Europe	5	0.70
Finland	Europe	5	0.70

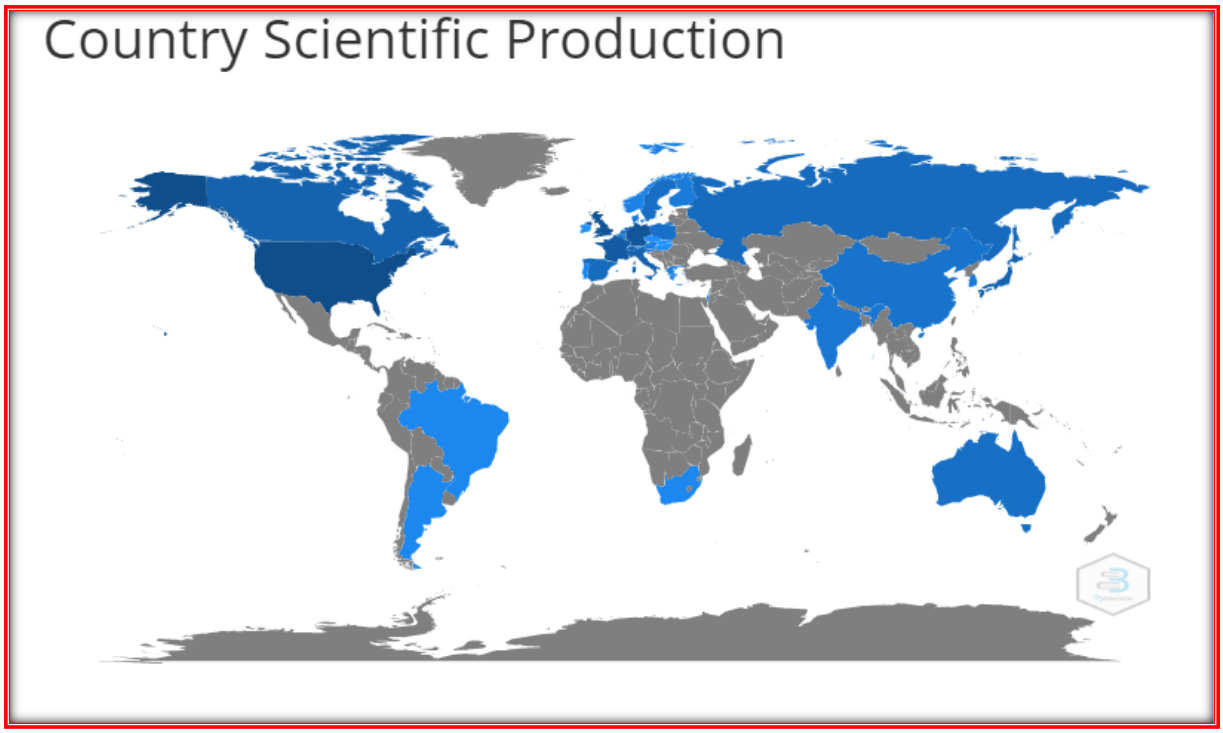

Figure 8.1: Country-wise distribution of Research Output

Figure 8.1 depicts the 34 countries, which have contributed a total number of 383 documents and Table 8.5 discloses the top 20 countries in this field. USA has the lionshare of 175 contributions followed by UK with 103 contributions and Germany with 93 contributions. It is understood that most of the contributions were made from the North American and

European countries whereas Japan was the only country, which has contributed a considerable number of publications (33) among the other Asian and other continental countries. Thus, European countries combined together have predominantly contributed 426 contributions and proved that these countries were excelled in the publications of the journal 'Progress in Nuclear Magnetic Resonance Spectroscopy'.

Table 8.6 Most Relevant countries by Corresponding Authors

Country	Articles	Freq	SCP	MCP	MCP_Ratio
USA	89	0.23670	81	8	0.0899
United Kingdom	58	0.15426	52	6	0.1034
Germany	45	0.11968	33	12	0.2667
France	27	0.07181	23	4	0.1481
Canada	21	0.05585	19	2	0.0952
Switzerland	20	0.05319	15	5	0.2500
Italy	17	0.04521	13	4	0.2353
Japan	12	0.03191	7	5	0.4167
Russia	11	0.02926	7	4	0.3636
Netherlands	9	0.02394	9	0	0
Australia	8	0.02128	5	3	0.3750
Israel	7	0.01862	3	4	0.5714
Spain	7	0.01862	7	0	0
Sweden	7	0.01862	3	4	0.5714
Poland	5	0.01330	1	4	0.8000
China	4	0.01064	3	1	0.2500
Denmark	4	0.01064	3	1	0.2500
Finland	3	0.00798	2	1	0.3333
Greece	3	0.00798	3	0	0
India	3	0.00798	2	1	0.3333
Norway	3	0.00798	1	2	0.6667
Belgium	2	0.00532	2	0	0
Slovenia	2	0.00532	2	0	0
Austria	1	0.00266	1	0	0
Brazil	1	0.00266	1	0	0
Czech Republic	1	0.00266	1	0	0
Hungary	1	0.00266	1	0	0
Ireland	1	0.00266	1	0	0
Korea	1	0.00266	1	0	0
Portugal	1	0.00266	1	0	0
Singapore	1	0.00266	1	0	0
South Africa	1	0.00266	1	0	0

The 32 most relevant countries based on corresponding authors are displayed in Table 8.6 along with the number of articles, frequency, SCP, MCP and MCP ratio. Figure 8.2 represented the top 20 corresponding author's countries and brought to light the fact that the same list of top 4 most producing countries viz. the United States, United Kingdom, Germany and France are retaining the same places here also. The corresponding authors belonging to these top 4 countries are responsible for the production of 219 articles whereas the rest of the countries altogether contributed only 157 articles. Hence it is vividly clear that the top 4 countries not only predominate the overall production but also contributed the highest corresponding authors.

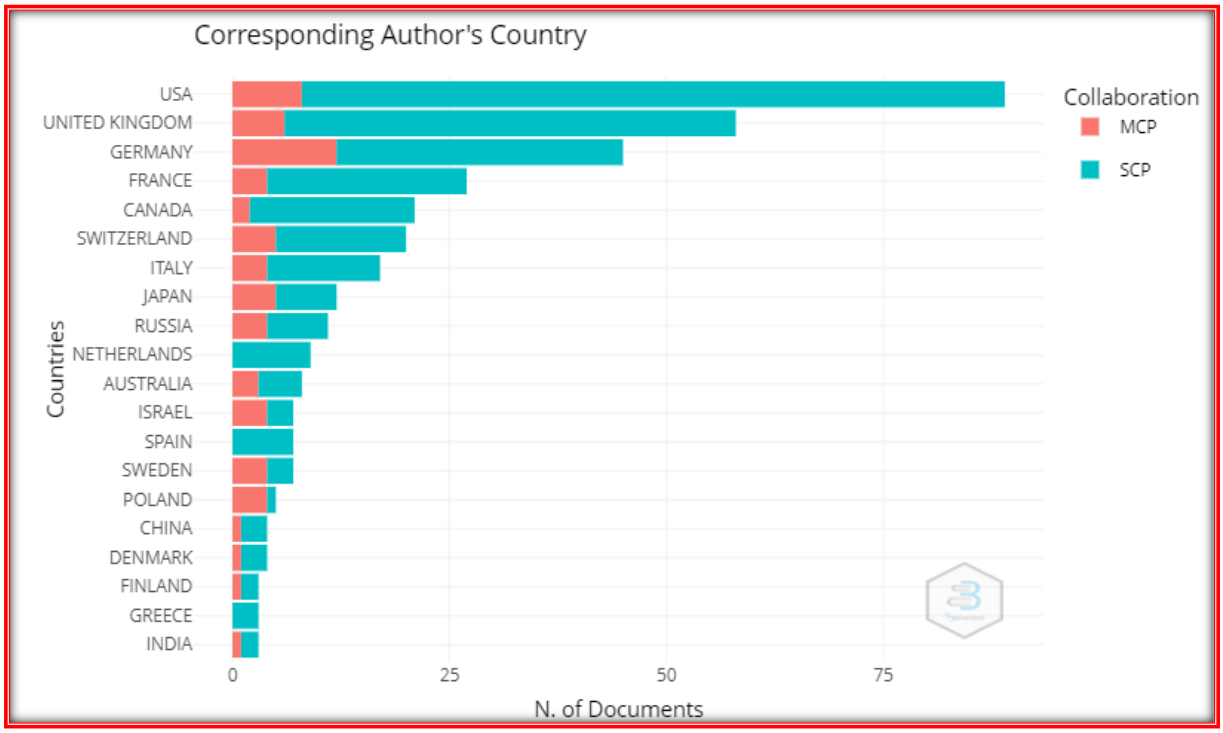

Figure 8.2: Corresponding Author's Countries

Table 8.7 Most cited countries

Country	Total Citations	Average Article Citations
USA	5398	60.7
United Kingdom	4363	75.2
Germany	4076	90.6
Switzerland	1552	77.6
Canada	1512	72.0
Italy	1456	85.6
France	1272	47.1
Japan	771	64.2
Sweden	763	109.0
Australia	581	72.6
Russia	544	49.5

Spain	456	65.1
Finland	378	126.0
Norway	360	120.0
Netherlands	354	39.3
Israel	337	48.1
Poland	214	42.8
Greece	198	66.0
Austria	184	184
India	145	48.3

Figure 8.3 displays the top 20 most cited countries and reveals the fact that the top three countries namely the USA, UK and Germany have received the highest number of 5398, 4363 and 4076 total citations respectively. But in terms of average article citations as represented in Table 8.7, Germany gained the highest average article citations (90.6) followed by the UK (75.2) and the USA (60.7). The average article citation column has brought to light another fact that though the European countries like Austria, Finland, Norway and Sweden have contributed a limited number of publications (4, 5, 3 and 5 respectively) and they have surprisingly received the highest average article citation score of 184, 126, 120 and 109 respectively.

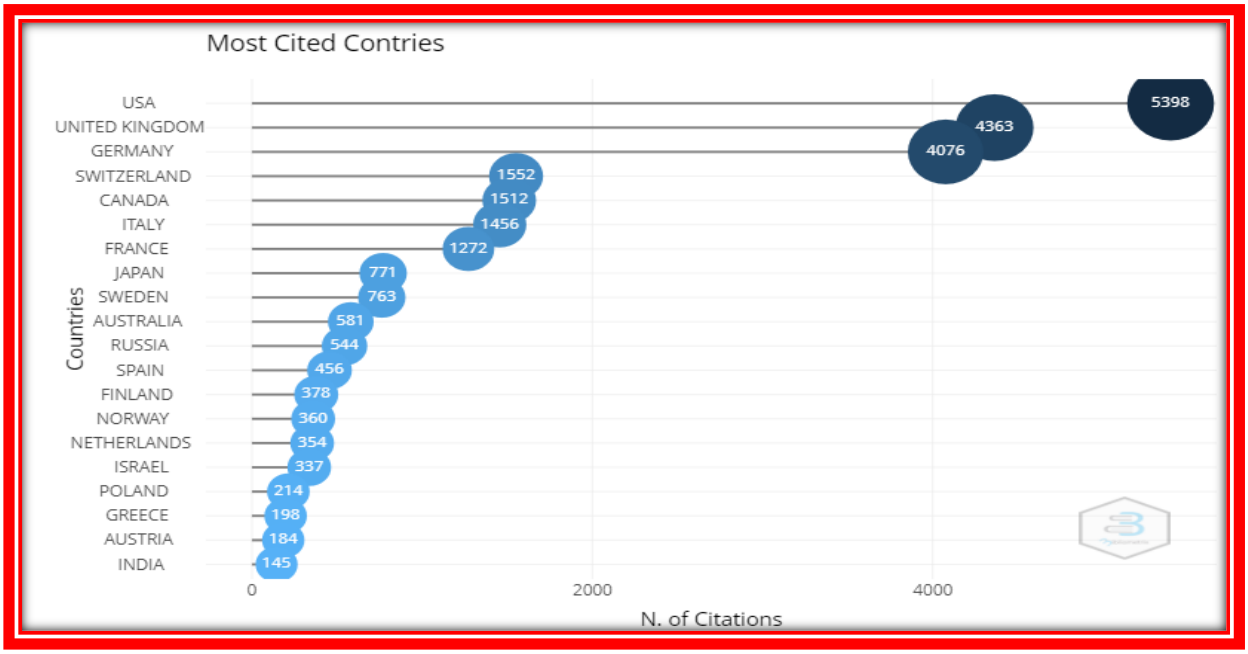

Figure 8.3: Most cited countries

Most relevant affiliation

The total numbers of 383 documents came from 382 different affiliations and the top 20 affiliations are portrayed in Figure 8.4. The top 20 institutes are responsible for 138 documents. University of Florence, Italy has the highest number of publications (13) followed by Johns Hopkins University, Baltimore, Maryland, USA (12).

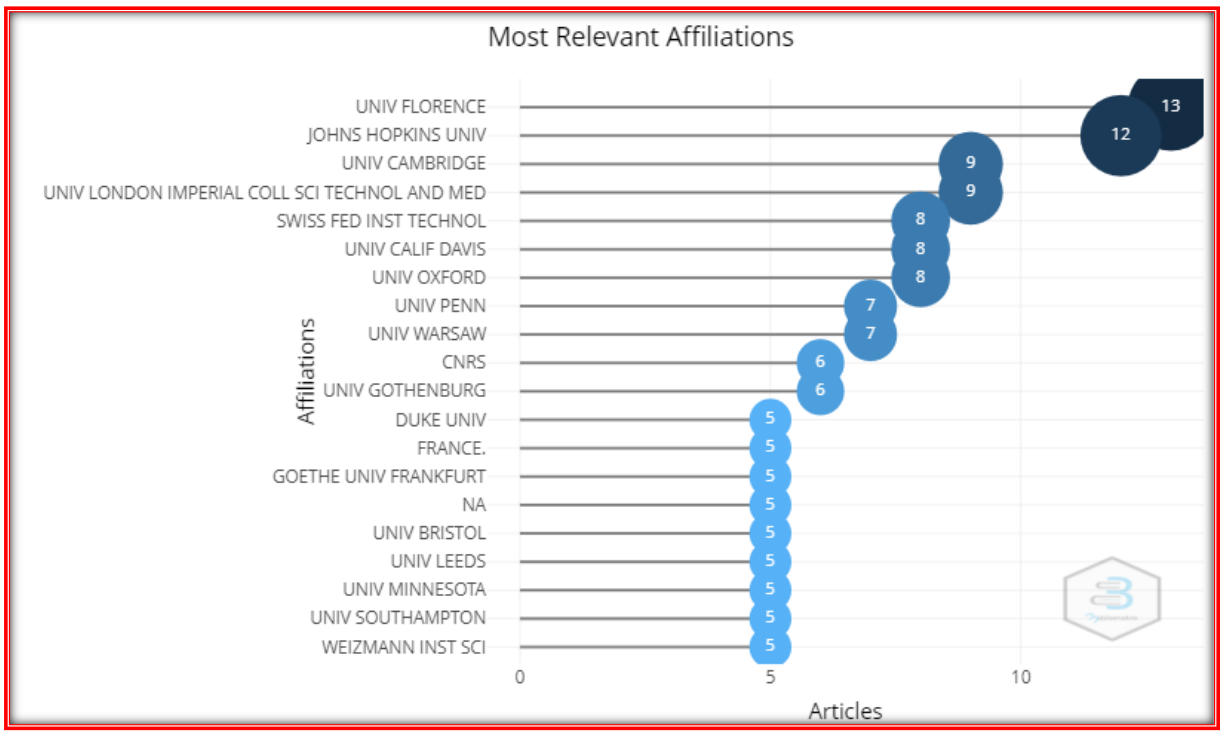

Figure 8.4: Most relevant Affiliations

Tale 8.8 Annual Total Citation

Year	N	Mean TC per Article	Mean TC per Year	Citable Years
2001	16	108.12500000	5.406250000	20
2002	18	93.16666667	4.903508772	19
2003	8	121.37500000	6.743055556	18
2004	18	95.94444444	5.643790850	17
2005	18	93.61111111	5.850694444	16
2006	22	99.86363636	6.657575758	15
2007	19	78.68421053	5.620300752	14
2008	15	94.80000000	7.292307692	13
2009	30	52.96666667	4.413888889	12
2010	27	61.18518519	5.562289562	11
2011	20	84.15000000	8.415000000	10
2012	21	76.71428571	8.523809524	9
2013	20	83.75000000	10.468750000	8
2014	20	56.55000000	8.078571429	7
2015	17	30.29411765	5.049019608	6
2016	18	36.22222222	7.244444444	5
2017	17	50.00000000	12.500000000	4
2018	20	24.45000000	8.150000000	3
2019	19	23.26315789	11.631578950	2
2020	20	7.70000000	7.700000000	1

The annual total citations (TC) are shown in Table 8.8 as Mean TC per article and Mean TC per year based on the number of documents published and citable years. The year 2003 has witnessed the highest mean TC per article (121.375) even though the same year has published a minimum number of documents. Meanwhile, the year 2017 has been recorded as the highest Mean TC per year (12.5) followed by the year 2019 (11.6315) and indicated that the documents published in these years received the largest number of citations.

Table 8.9 Most Global Cited Documents

Paper	DOI	TC	TC per Year	N.TC
Williamson MP, 2013, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2013.02.001	686	76.2222	8.1910
Schwieters CD, 2006, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2005.10.001	551	34.4375	5.5175
Kimmich R, 2004, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2004.03.002	519	28.8333	5.4094
Bertini I, 2002, ProgNucl Mag Res Sp	10.1016/S0079-6565(02)00002-X	361	18.0500	3.8748
Lindon JC, 2001, ProgNucl Mag Res Sp	10.1016/S0079-6565(00)00036-4	361	17.1905	3.3387
Zhou JY, 2006, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2006.01.001	332	20.7500	3.3245
Kovacs H, 2005, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2005.03.001	330	19.4118	3.5252
Blumich B, 2008, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2007.10.002	315	22.5000	3.3228
Saalwachter K, 2007, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2007.01.001	295	19.6667	3.7492
Bain AD, 2003, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2003.08.001	293	15.4211	2.4140
Fielding L, 2007, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2007.04.001	265	17.6667	3.3679
Green RA, 2012, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2012.03.001	247	24.7000	3.2197
Bohmer R, 2001, ProgNucl Mag Res Sp	10.1016/S0079-6565(01)00036-X	244	11.6190	2.2566
Blackledge M, 2005, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2004.11.002	232	13.6471	2.4783
Orekhov VY, 2011, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2011.02.002	225	20.4545	2.6738
Helgaker T, 2008, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2008.02.002	221	15.7857	2.3312

Puts NAJ, 2012, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2011.06.001	217	21.7000	2.8287
Thankamony ASL, 2017, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2017.06.002	215	43.0000	4.3000
Brand T, 2005, ProgNucl Mag Res Sp	10.1016/j.pnmrs.2005.04.003	213	12.5294	2.2754
Stockman BJ, 2002, ProgNucl Mag Res Sp	10.1016/S0079-6565(02)00049-3	202	10.1000	2.1682

The top 20 most globally cited articles published by the journal during the study period are specified in Table 8.9. All these papers have got 200 plus total citations. It is clear that the top global cited paper is by Williamson, MP (2013) which received the highest total citations, TC per year and Normalized TC (686; 76.2222; 8.191) followed by the paper of Schwieters, CD (2006) and Kimmich, R (2004) that received more than 500 total citations. However, the paper authored by Thankamony, ASL (2017) has received the second largest TC (43) per year even though it was ranked 18th based on the TC.

Most relevant keywords

Figure 8.5 demonstrates the 50 significant keywords that are used in the total number of 383 documents. Since the journal is dedicated to the field of nuclear magnetic resonance spectroscopy it is obvious that the keyword 'nuclear magnetic resonance' is spread over most of the documents and appeared 179 times (22%), the highest in number than the other keywords. The other keywords 'solid-state NMR' and 'residual dipolar couplings' are appeared 48 and 44 times respectively.

Figure 8.5: Frequently used Keywords

9. Limitations of the study and Direction for Further Research

- Since this study used Biblioshiny – shiny interface of Bibliometrix tool of R software, other researchers may employ other metric tools like Bibexcel, VOS Viewer, Histcite to get different perspective of the journal research output.
- The present study analyzed the research output of 20 years period i.e. 2001-2020. The study can be extended to cover the research output of longer periods or the research output of entire life of the journal.

10 Suggestions

- The Indian contribution is somewhat less, compared to other Asian and European countries. Enough research support in terms of money, materials, infrastructure and human resources should be extended to enhance the contribution of Indian researchers.
- Some of the papers are available in open access while other papers are subscription based. Subscription papers also may be made available in open access mode, once the embargo period is exhausted. This will increase the visibility of the journal.

11. Conclusion

The publication trends of the journal revealed some remarkable facts that most of the publications are reviews and there is neither significant growth nor noticeable downfall of publication. The annual citation dynamics illustrated that the year 2003 received the highest number of mean TC even though the same year witnessed the lowest number of publications. Though the USA was the most productive country and also received the highest number of annual TC, the European countries combined together produced more papers as well as received the highest number of citations. Since the NMR spectroscopy is a versatile analytical technique and the scope of the field is enlarging through the years, this study would be helpful to the researchers, scientists and policymakers to know about the scholarly output and its impact of the journal 'Progress in Nuclear Magnetic Resonance Spectroscopy'.

REFERENCES

Amin, R., Ayoub, A., &Wani, Z. A. (2019). Scientometric Analysis of Graphene. Library Philosophy and Practice (e-journal). 2994.https://digitalcommons.unl.edu/libphilprac/2994

Bala, M., & Singh, M. P. (2014).A scientometric study of Journal of Bio-chemistry and Bio-physics (IJBB). Library Philosophy and Practice (e-journal). 1168. http://digitalcommons.unl.edu/libphilprac/1168

Bornmann, L., Mutz, R., & Daniel, H. D. (2008). Are there better indices for evaluation purposes than the h index? A comparison of nine different variants of the h index using data from biomedicine. Journal of the American Society for Information Science and technology, 59(5), 830-837.

Egghe, L. (2006). Theory and practise of the g-index. Scientometrics, 69(1), 131-152.

Emsley, J. W., & Feeney, J. (2007). Forty years of progress in nuclear magnetic resonance spectroscopy. Progress in Nuclear Magnetic Resonance Spectroscopy, 50(4), 179-198.

Hess, D. J. (1997). Science studies: an advanced introduction. NYU press.

Hirsch,J.E. (2005). An index to quantify an individual's scientific research output. Proceedings of the National Academy of Sciences of the United States of America, 102(46), 16569–16572.

Hosamani, S. C., & Bagalkoti, V. T. (2016). Scientometric Analysis of Indian Chemistry Literature as Reflected in Web of Science Database. International Research Journal of Social Sciences, 5(2), 6-17.

Jayabal, R., & Balasubramanian, K. (2018). A Scientometric Study of Indian Journal of Chemical Technology. Library Philosophy and Practice (e-journal). 2004. http://digitalcommons.unl.edu/libphilprac/2004

Kademani, B. S., Kumar, A., & Kumar, V. (2007, January 4-6). Analytical Chemistry in Nuclear Science and technology: a scientometric mapping. In Proceedings of BARC golden jubilee year DAE-BRNS topical symposium on role of analytical chemistry in nuclear technology, Mumbai (Inida). (pp.135-148). Analytical Chemistry Division, BARC.

Konur, O. (2016). Scientometric overview regarding the Surface Chemistry of Nanobiomaterials. In Surface Chemistry of Nanobiomaterials (pp. 463-486). William Andrew Publishing.

Sagar, A., Kademani, B. S., Bhanumurthy, K., & Ramamoorthy, N. (2014). Research trends in radioisotopes: a scientometric analysis (1993-2012). DESIDOC Journal of Library & Information Technology, 34(4), 349-358.

Schwieters, C. D., Kuszewski, J. J., & Clore, G. M. (2006). Using Xplor–NIH for NMR molecular structure determination. Progress in Nuclear Magnetic Resonance Spectroscopy, 48(1), 47-62.

Sudhier, K. G., & Dileep Kumar, V. (2020). Scientometric Profile of Biochemistry research in India: a Study based on Web of Science. DESIDOC Journal of Library & Information Technology, 40(01), 388-396.

Vijayakumar, R., & Gomathi, P. (2018).A scientometric study of 'The Journal of Chemical Sciences' publications from 2004–2013. Journal of Advancements in Library Sciences, 2(2), 48-52.

Williamson, M. P. (2013). Using chemical shift perturbation to characterise ligand binding.Progress in Nuclear Magnetic Resonance Spectroscopy, 73, 1–16. https://doi.org/10.1016/j.pnmrs.2013.02.001

Xiao, F., Li, C., Sun, J., & Zhang, L. (2017). Knowledge Domain and Emerging Trends in Organic Photovoltaic Technology: A Scientometric Review Based on CiteSpace Analysis. Frontiers in Chemistry, 5, 67. https://doi.org/10.3389/fchem.2017.00067