A GLOBAL RESEARCH PRODUCTIVITY OF NUCLEAR CHEMISTRY - A SCIENTOMETRIC STUDY

D. Piriyadharisini
M. Dorairajan
S. Srinivasaragavan

Mrs.D.Piriyadharisini
Research Scholar,
Department of Library and Information Science,
Bharathidasan University,
Tiruchirappalli – 643102
E-mail:
rpriyadharshini079@gmail.com

Dr.M.Dorairajan
Librarian, St.Joseph's College,
Tiruchirappalli – 643102
E-mail:
manavaidorai@gmail.com

Dr. S. Srinivasaragavan
Professor & Head,
Department of Library and Information Science,
Bharathidasan University,
Tiruchirappalli-620 024
E-mail:
maduraiseenoo@yahoo.co.in
Corresponding Author

The term "Nuclear Chemistry" has been used as search term in the International Indexing Database 'Web of Science' which is initially published by Institute for Scientific Information founded by the International Information Scientist Eugene Garfield. It is found from the study that there are 13,013 number of scholarly publications as the outcome of the research carried out in International and National Journals, by 42,345 researchers from 7373 Institutions and research organizations from 119 nations across the Globe. Among these 13,013 numbers of publications 6,965 were as the outcome of sponsored research by funding agencies across the globe. There are 112 research areas as the subject classified found in published research. Of which, the major subject areas such as Chemistry Multidisciplinary (2,651) Nuclear Chemistry (2,207) Physical Chemistry (2,075) Materials Science Multidisciplinary (1,086) Nuclear Science Technology (884) and Organic Chemistry (818) where the research publications proliferated and correlated. The country wise analyze revealed that USA (3841) is the topmost nation with highest Research Productivity which is followed by Germany (1434), China (1322), UK (1165), France (1118) and India (576) which is placed in 9th position in Global research outcome of Nuclear Chemistry.

Keywords: Nuclear Chemistry, Radioactivity, Scientometric Study, Collaborative Research, Bradford's law, Degrees of Collaboration

INTRODUCTION

Nuclear Chemistry may be defined as the study of the changes in the nucleus of the atom. Nuclear chemistry can tell us the structure and properties of the nucleus and of the influence of the structure on the nuclear stability. Nuclear chemistry is dealing with radio activity, nuclear processes

such as nuclear transmutation and nuclear properties. This includes the study of the chemical effect resulting from the absorption of radiation within living animals, plants and other materials. Radiation chemistry control much of radiation biology includes radio therapy in medical applications, the use of radioactive traces within industry, science and environment. The measurement of research productivity performance in universities has become a periodical, routine affair in most of the developed countries. Until a few years ago, criterion for such a measurement remained a question, though various scales were under trial. Today, measuring the research performance of a university applying the scientometrics and bibliometric principles have become an accepted practice in the absence of any other suitable alternative mechanism despite criticism from a section of academic quarters. All kinds of peer reviewed and indexed research publications and their impact factor are taken into account besides a number of socio psychological factors influencing research performance or productivity of scholars involved in science communication.

REVIEW OF LITERATURE

In associate with the present study source wise analysis, author collaboration and average citation per year also highlighted the growth trends on Cyanobacteria literature and make the quantitative and qualitative assessment by analyzing various features of research output and Citation's impact based on the Scopus database. The study reveals that total of 5686 publications were published on Cynobacteria during 2000-2020. Year 2001 has 74.72 mean times cited per article with 137 publications. USA has the highest share 2792 of publications and received 38809 Citations followed by the People's Republic of China with 9201 Citations for 1486 publications (Srinivasaragavan& Gayathri, 2021)).

To differentiate with present study a cluster analysis has been carried out. Authenticity and traceability of olive oil have been a growing concern over the past decades, generating numerous scientific studies, the application of the tools of bibliometric analyses to explore the evolution and strategic orientation of the research focused on olive oil has been analysed. The most productive journals, authors and countries are highlighted, as well as the most cited articles associated with specific analytical techniques (Maléchaux et al., 2020). A bibliometric analysis was used to compare four premier letters journals in organic chemistry: Bioorganic & Medicinal Chemistry Letters, Letters in Organic Chemistry, Organic Letters, and Tetrahedron Letters. The objective of this study is to develop a routine methodology for evaluating and comparing journals with a similar scope based on researchers' immediate needs. This research is of significantly differentiate with the present research, as the researcher focused on subscription rate, open access availability, article processing charges, field categories, maximum page length, acceptance rate and so on(Tomaszewski, 2020).

Ho et al. (2018) analysed the papers published by Brunei Scientists for the period of "1973-2016" in the Science Citation Index Expanded and compare results with other tropical countries. As like of the present study, the paper also analysed the document wise distribution in

terms of Web of Science Subject Categories, Publication Type, along with country wise research collaboration. While the present study has also been analysed the degree of collaboration, the relevance of Bradford's law of Scattering.

As of the present study, document types, languages, performance of publications covering annual outputs, productive journals, Web of Science categories, countries, and institutions were analysed from the data download from Science Citation Expanded for the Metal Organic Frame works (MOFs) Ho and Fu (2016). Nuclear Science and Technology research publications originated from Ghana and listed in the International Nuclear Information System (INIS) Database have been assessed using the simple document counting method. Geographical distribution, annual growth and the subject areas of the publications as well as communication channels, key journals and authorship trends. Were analysed. As like of the present study there is growth in number of publications over the years, Allied Research Areas with the focus on Life Sciences, Plant Cultivation, Nutrition followed by chemistry and environmental sciences, the major source of the publication is the journal article (Agyeman & Bilson, 2015).

Scientometrics is the study of the quantitative aspects of the process of science as a communication system. It is centrally, but not only, concerned with the analysis of citations in the academic literature. In recent years it has come to play a major role in the measurement and evaluation of research performance. In this review the researchers consider: the historical development of scientometrics, sources of citation data, citation metrics and the "laws" of scientometrics, normalisation, journal impact factors and other journal metrics, visualizing and mapping science, evaluation and policy, and future developments (Mingers &Leydesdorff, 2015) In correlation with present study the Science Citation Index Expanded data of National Taiwan University used for performance analysis for the period of 2000-2009, The Institutional Contribution and International Collaboration and the subject categories were also studied. Ming (2011) A similar research on the outcome Nuclear Energy from Dutch region has been carried out, assessing the research records downloaded from the same ISI. As bibliometric study particularly analysing the year wise publication output, international visibility, international co-operation, and interdisciplinary in a study of nuclear energy research in the 1980's (Van Leeuwen & Tijssen,1993).

It is to mention that the previous Scientometrics and Bibliometrics studies carried out various subjects using the Science Citation Expanded Database but not on Nuclear Chemistry and also not highlighted the citation Scores in terms of Total Local Citation Score (TLCS) and Total Global Citation Score (TGCS) as of the present study.

SIGNIFICANCE OF THE STUDY

As there is no study exclusively on global research product of Nuclear Chemistry, particularly by analyzing the records from web of science database, which is the top most indexing and citation database, the present research aimed at highlighting proliferation of publications on source, geographical region, the

citations and application of Bradford's law on the research articles indexed in the Web of Science during the study period. It is also significant that the presenters highlighted the impact of authors and the sources where the research carried out by identifying Total Local Citation Score (TLCS), Total Global Citation Score (TGCS), TLCS per Year, TLGS per year and Total cited references. It also revealed the Global citations and Local citations scores of various institutions and the top twenty-five productive countries.

OBJECTIVES OF THE STUDY

The specific objectives of the study are:

- To find out year-wise publication of articles published in Nuclear Chemistry in Web of Science indexed journals and the sources.
- To reveal the dominant sources distributed the publications on the Nuclear Chemistry research output.
- To examine the growth rate and exponential growth rate of Nuclear Chemistry research output globally.
- To estimate the trend of publications in Nuclear Chemistry.
- Identifying country wise research outcome of Nuclear Chemistry Research.

METHODOLOGY

The publication productivity of Nuclear Chemistry is carried out from 1989 to 2021 in this study. During the period of study 13013 articles on Nuclear Chemistry was published globally in various research journals. It is a descriptive study that aimed at analyzing the research output on the search term used "Nuclear Chemistry" as phrase search in the Science Citation Index Expanded Science, Social Science, Arts, and Humanities. The document was downloaded and analysed using the tools Histcite and MS Excel. Simple frequency and percentage analysis has been used along with Degree of Collaboration by Subramanyam's Formula and Broadfords law.

ANALYSIS AND INTERPRETATION

Year wise Distribution of Nuclear Chemistry Research Publication Outcome

It is found from the data on publications as indexed by Web of Science on Nuclear Chemistry has 13013 number of publications. Year wise distributions of the records revealed that publications growth is gradual from 1991 to 2000. It gained increased phase from the year 2010 to 2020. 2020 has the highest publications outcome with 826 having 1408 global citations which is followed by the year 2019 having 818 publications and 5142 global citations and the year 2017 indexed 763 scholarly publications with 11140 global citations. Year wise distribution of research publications also revealed that less number of records received more number of citations, the year 1992 got only 210 publications with highest citations score of 18818, it is followed by the year 2002 with 282 publications having 17428 citations while the year 2000 had 293 publications with 16272 citations. It is also inferred that initial yeari.e. 1991 to 2005 had 10000 and above global citations for 300 and below publications. The years 1989 and 1990 had a minimal number of publications and citations respectively with 26, 57 records and 249 and 1058 Global Citations respectively.

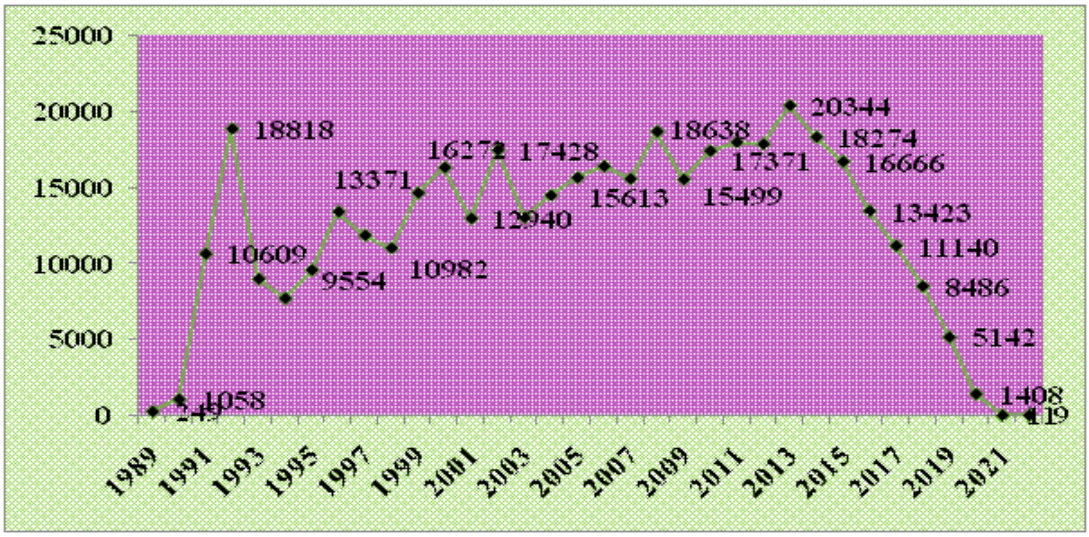

Figure 1: Year wise output with TGCS

Publication Formats

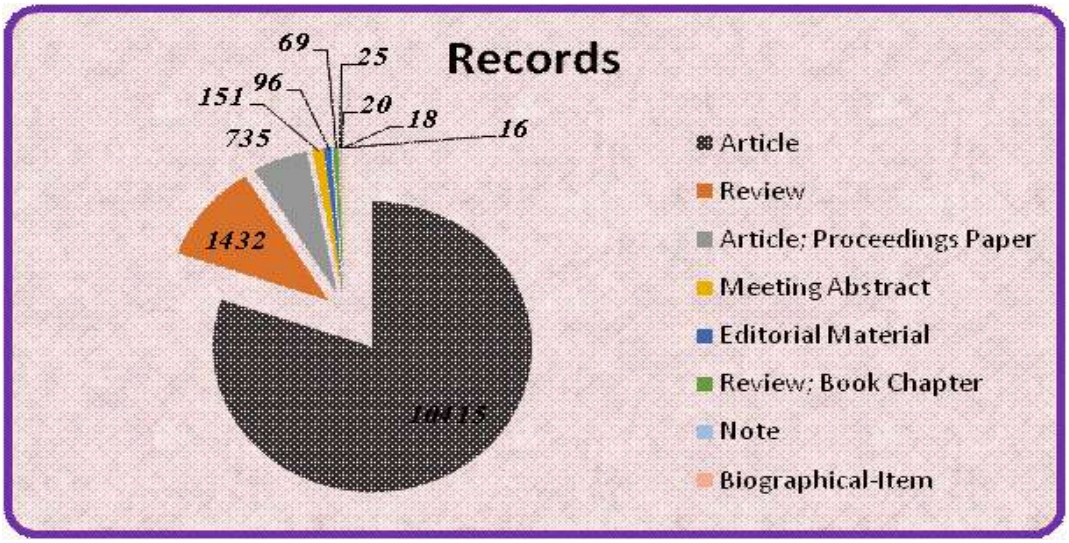

Figure 2: Document wise Distribution of Nuclear Chemistry Publications

As like any other research outcome, Nuclear Chemistry output also documented in eighteen formats of scholarly communication. Of which, journal articlesare the highest with 10415 (80%) which is followed by Reviews 1432 (11%) Conference Papers735 (5.6%) and Meeting Abstracts 151 (1.2%).

Author's Productivity

There are 42345 numbers of authors contributed 13013 publications across the globe on Nuclear Chemistry Research. The table revealed that there is no dominant authors as the records were distributed scattered, top contributor has only with 79 records by (Kennedy

Table 1: Top 25 Authors 'Publications

Sl. No	Name of Author	No. of Publications	(%)	TLCS	TLCS/t	TLCSx	TGCS	TGCS/t	TLCR	TLCSb	TLCSe
1	Kennedy JD	79	0.6	441	17.23	134	1454	61.82	311	116	1
2	Burns PC	46	0.4	247	18.42	107	1915	149.32	182	61	19
3	Coperet C	37	0.3	301	36.96	125	2177	286.23	203	77	46
4	Levason W	34	0.3	134	6.20	41	1391	77.16	104	44	
5	Reid G	34	0.3	106	5.28	28	1121	68.03	108	46	
6	BarnerK.W	32	0.2	53	5.93	14	971	119.70	41	37	
7	Stibr B	32	0.2	151	5.71	49	550	21.86	117	36	
8	Wang Y	32	0.2	6	1.01	1	465	79.17	33	1	
9	Turler A	31	0.2	182	11.58	64	970	69.09	86	38	23
10	ThorntonPett M	30	0.2	217	7.34	72	668	22.62	93	54	0
11	Bould J	29	0.2	146	6.77	37	516	26.36	178	37	
12	Liu Y	29	0.2	5	0.93	4	487	80.82	21	3	
13	Schadel M	27	0.2	176	12.02	60	998	75.93	129	41	25
14	Chai ZF	26	0.2	31	4.12	24	770	119.52	55	11	
15	Emsley L	26	0.2	262	30.04	105	1776	204.96	116	56	40
16	Zhang J	26	0.2	21	2.85	12	1087	111.04	32	9	
17	Yang Y	25	0.2	22	4.54	6	244	43.31	21	3	
18	Zhang Y	25	0.2	3	0.25	1	745	88.56	13	0	
19	Li J	24	0.2	10	1.87	6	483	74.42	33	1	
20	Liu J	24	0.2	32	4.58	19	2239	308.14	15	8	7
21	Wang L	24	0.2	10	1.54	5	529	75.44	24	6	
22	Autschbach J	23	0.2	67	5.56	35	1210	128.30	70	21	8
23	Fontaine XLR	23	0.2	187	6.12	58	498	16.36	54	53	0
24	Lesage A	23	0.2	247	27.74	97	1664	187.09	119	50	36
25	Eichler R	22	0.2	133	9.88	55	694	52.29	89	36	21

*__TLCS –__Total Local Citation Score
*__TLCS/t-__ Total Local Citation Score per year
*__TLCSx-__Total local citation Score Excluding self-citation
*__TGCS-__ Total Global Citation Score
*__TGCS/t-__ Total Global Citation Score per year
*__TLCR-__ Total Local Citation Score reference
*__TLCSb-__Total Local Citation Score in the Beginning
*__TLCSe__- Total Local Citation Score in the end

Highly Productive Journals

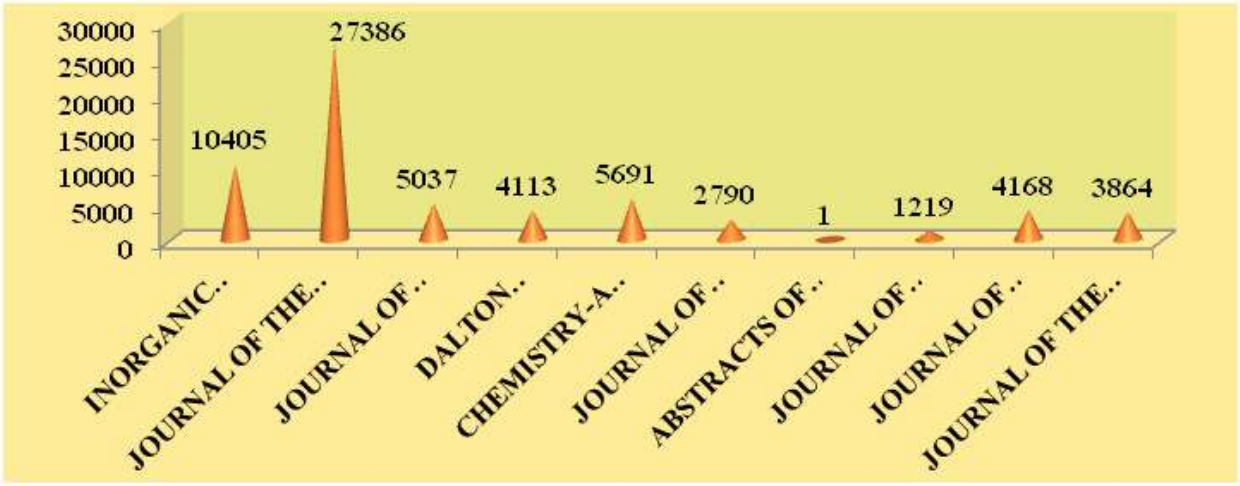

Figure 3: Highly Productive Journals

It is also revealed from the data there are 553553numbers of total cited references referred by the researchers in Nuclear Chemistry for the study period. Source wise distribution of Nuclear Chemistry as indexed by web of sciencerevealed that 2198 number of journals were published research articles and other scholarly communications on Nuclear Chemistry research. Of which,toptwenty-five journals consist 3461 number of research articles. The top three journals Inorganic Chemistry, Journal of The American Chemical Society, Journal of Chemical Physics were published 377, 276, 201 articles with 10405, 27386, 5037 global citations respectively. The Journal of American Chemical Society got the highest number of Global Citation Score 27386 which is followed by AngewandteChemie-International Edition 11305 followed by Coordination Chemistry Reviews 10824and Inorganic Chemistry 10405.

Most Productive Institutions

Among the Institutions, highly productive institutions were Chinese Academy of Sciences from China with 270 (2.1%) publications and received 6907 citations followed by Russian Academy of Sciences from Russia with 175 (1.3%) publications and 4567 citations, French National Centre for Scientific Research fromFrance with 137 (1.1%) publications and 7067 citations. The study found that 6 Institutes

Table 2: Productive Institutions

Sl. No	Name of Institution	No. of Publication	Percent	TLCS	TGCS
1	Chinese Academy of sciences, China	270	2.1	189	6907
2	Russian Academy of sciences, Russia	175	1.3	157	4567
3	Scientific Research National Center,Paris	137	1.1	124	7067
4	UniversityCalifornia Berkeley, California	135	1.0	236	7680
5	Los Alamos Nationalof Laboratory, United States	118	0.9	89	1730
6	Argonne National of Laboratory, Chicago	102	0.8	198	3161
7	CNR	98	0.8	73	3081
8	Universityof Cambridge, United Kingdom	98	0.8	89	2953
9	Universityof Leeds, England	96	0.7	344	2847
10	Spanish National Research Council, Europe	92	0.7	116	2974
11	Paul Scherrer Institute, Switzerland	92	0.7	337	3894
12	University of Tokyo, Japan	92	0.7	88	3311
13	Bhabha Atomic Research Center, Maharashtra	90	0.7	113	1605
14	Universityof Manchester, England	90	0.7	87	2565
15	Oak Ridge National Lab, Tennessee	85	0.7	56	2296
16	Universityof Illinois, Chicago	85	0.7	170	4696
17	Universityof Notre Dame, Indiana	85	0.7	360	4448
18	Northwesternof University, Illinois	83	0.6	115	4932
19	Unknown	78	0.6	8	1313
20	Universityof Calif Davis, California	76	0.6	45	2748
21	University of Oxford, England	76	0.6	51	2432
22	Tech Universityof Munich, Germany	73	0.6	120	2295
23	Universityof Wisconsin, Wisconsin	72	0.6	81	2316
24	Universityof Michigan, Michigan	69	0.5	124	4611
25	Swiss federal institute of technology, Switzerland	68	0.5	161	2468

are recorded more than 100 publications each, 25 institutes with more than 50 each publications. It is also inferred that institutions with less number of publications received more number of citations.

Country wise Distribution of publicationson Nuclear Chemistry

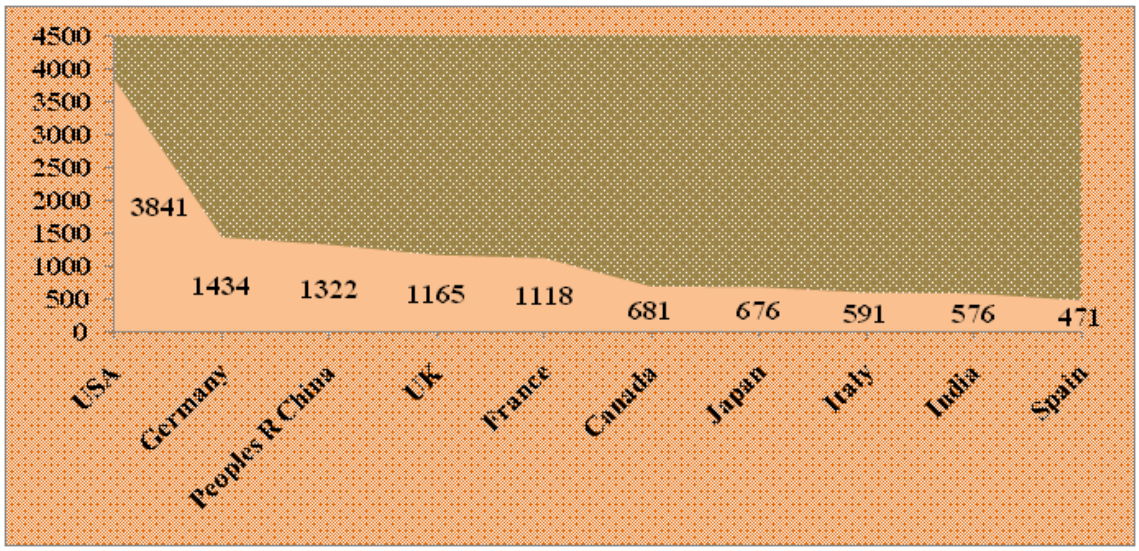

Figure 4: Country wise Distribution of publications

Country wise distributions of research publications on Nuclear Chemistry revealed that 119 numbers of global nations carried out Nuclear Chemistry research. Top twenty-five nations contributed 15591 number of articles. USA, Germany, China and UK were the top four contributors with 3841, 1434, 1322, 1165 publicationsrespectively. India is in ninth position with 576 (4.4) articles that are having 11148 global citations. USA, Germany, China and UK received highest number of global citations respectively of 160749, 50409, 27369, and 45703.

Degree of Collaboration

The degree of collaboration is defined as the ratio of the number of collaborative research papers to the total number of research papers in the discipline during a certain period of time. The formula suggested by Subramanyam (1983) is used. It is expressed as

C=Nm/Nm+NsC

= 11750/11750+1263

C = 0.90

Where,

C is the degree of collaboration in a discipline.

Nm is the number of multi-authored research papers in the discipline published during a year.

Ns is the number of single authored papers in the discipline published during the same year.

Table 3: Degree of Collaboration

Year/Author	1	2	3	4	5	6	7	8	9	10 & above	Total Records
1989	9	8	-	2	4	1	1	1	-	-	26
1990	19	8	11	7	4	2	3	2	1		57
1991	31	61	35	28	21	14	4	3	1	2	200
1992	42	45	35	34	25	8	10	4	1	6	210
1993	45	41	37	33	20	19	9	4	2	1	211
1994	48	45	47	35	18	12	4	5	4	3	221
1995	34	61	42	35	30	17	8	-	2	6	235
1996	43	78	41	52	28	11	7	3	3	4	270
1997	36	42	51	38	19	14	8	8	1	13	230
1998	27	58	56	46	38	18	8	8	3	6	268
1999	40	53	55	44	24	18	16	6	3	7	266
2000	45	72	49	37	29	20	18	10	7	6	293
2001	34	53	44	48	32	20	23	10	4	4	272
2002	45	49	61	37	36	24	12	8	3	7	282
2003	36	61	45	27	30	22	14	6	11	10	262
2004	40	57	60	50	34	24	16	7	6	7	301
2005	47	48	65	36	42	37	23	16	6	5	325
2006	44	69	66	74	45	28	29	14	5	11	385
2007	40	45	67	62	46	30	21	19	8	26	364
2008	36	62	63	75	63	40	28	13	15	21	416
2009	45	69	72	65	67	43	26	15	12	16	430
2010	32	76	75	69	64	59	37	10	9	20	451
2011	50	64	88	85	83	66	31	13	8	28	516
2012	48	84	89	92	68	63	37	28	16	30	555
2013	54	88	90	89	102	63	36	34	26	41	623
2014	30	88	109	109	88	67	56	29	24	60	660
2015	45	82	112	108	98	79	68	51	25	53	721
2016	35	75	106	108	111	75	57	37	35	60	699
2017	47	71	114	112	115	91	52	52	27	82	763
2018	44	74	113	120	91	121	69	45	46	78	801
2019	43	78	111	109	104	105	80	58	37	93	818
2020	40	67	114	115	115	93	71	62	43	106	826
2021	1	3	3	6	6	3	-	1	2	2	27
Unknown	8	3	2	1	3	4	1	1	3	3	29
Total	**1263**	**1938**	**2128**	**1988**	**1703**	**1311**	**883**	**583**	**399**	**817**	**13013**

The degree of collaboration is determined using this formula based on this study, the result of degree of collaboration C = 0.90. i.e., 90 percent is of articles published in collaborated manner among the global research.

Bradford's Law

Bradford's Law of Scattering describes a quantitative relation between journals and the papers that have published sources. The scientific journals are arranged in order of their decreasing productivity of articles on a given sample data,

Table 4: Bradford's Law of Scattering

	Number of Journals	Number of Articles	Total Number of Articles	Cumulative Number of Articles
First Zone	1	377	377	377
	1	276	276	653
	1	201	201	854
	1	198	198	1052
	2	162	324	1376
	1	147	147	1523
	1	142	142	1665
	1	133	133	1798
	2	129	258	2056
	1	126	126	2182
	1	122	122	2304
	1	121	121	2425
	1	117	117	2542
	3	103	309	2851
	1	97	97	2948
	1	96	96	3044
	1	90	90	3134
	1	86	86	3220
	1	85	85	3305
	1	80	80	3385
	1	76	76	3461
	1	68	68	3529
	3	65	195	3724
	1	56	56	3780
	2	55	110	3890
	2	54	108	3998
	2	53	106	4104
	2	52	104	4208
	2	51	102	4310
	2 (42)	50	100	**4410**
Second Zone	2	48	96	4506
	1	47	47	4553
	1	46	46	4599
	1	45	45	4644
	1	44	44	4688
	4	42	168	4856
	1	41	41	4897
	2	40	80	4977
	3	39	117	5094
	3	38	114	5208
	2	37	74	5282
	3	36	108	5390
	4	35	140	5530
	1	34	34	5564
	4	33	132	5696
	2	32	64	5760
	2	31	62	5822
	4	29	116	5938
	4	28	112	6050
	3	27	81	6131
	4	26	104	6235
	4	25	100	6335
	10	24	240	6575
	4	23	92	6667

	5	22	110	6777
	5	21	105	6882
	4	20	80	6962
	8	19	152	7114
	8	18	144	7258
	10	17	170	7428
	13	16	208	7636
	11	15	165	7801
	18	14	252	8053
	12	13	156	8209
	13	12	156	8365
	16	11	176	8541
	26 (219)	10	260	**8801**
Third Zone	32	9	288	9089
	30	8	240	9329
	44	7	308	9637
	51	6	306	9943
	83	5	415	10358
	109	4	436	10794
	157	3	471	11265
	317	2	634	11899
	1114 (1937)	1	1114	**13013**
	2198		**13013**	

they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus, where the number of periodicals in the nucleus and succeeding zones will be 1: n: n^2, wherein is a multiplier.

According to Bradford's distribution, the relationship between the zone is 1: n: n2i.e. 42:219:1937 which does not fit into Bradford's distribution. This shows that core contributions are given by journals, i.e. less than Bradford's formulated and the final zones contain a very large number of journals, i.e much more than the Bradford's formula. This is a clear indication that core zone is more concentrated and the other zone is much extended showing the scattering of journals. When this analysis is done for a wider range of periods, the extent of scattering can increase. Hence, the analysis of data clearly discounts Bradford's Law of Scattering.

CONCLUSION

The study could reveal that the global research outcome onNuclear Chemistry research is moderate, the research is scattered between institutions and among the journals, source and authors. While the collaborative research is encouraged with thedegree of collaboration of 90 percent. Though India is ninth position it has only 576 research publication indexed in Web of Science for the entire study period. Hence it is imperative for Indian universities and research organizations to encourage scientific research on Nuclear Chemistry and the publication outcome of the indexed journals.

REFERENCES

1. Agyeman, E. A., & Bilson, A. (2015). Research focus and trends in nuclear science and

technology in Ghana: a bibliometric study based on the INIS database. *Library Philosophy and Practice*, 0_1.

2. Ho, Y. S., & Fu, H. Z. (2016). Mapping of metal-organic frameworks publications: a bibliometric analysis. *Inorganic Chemistry Communications*, *73*, 174-182.
3. Ho, Y. S., BiawLeng Lim, L., & Monge-Nájera, J. (2018). Brunei publications in the Science Citation Index Expanded (1973-2016): Bibliometrics and comparison with other tropical countries. *Revista de Biología Tropical*, *66*(3), 1090-1100.
4. Maléchaux, A., Le Dréau, Y., Artaud, J., & Dupuy, N. (2020). Exploring the Scientific Interest for Olive Oil Origin: A Bibliometric Study from 1991 to 2018. *Foods*, *9*(5), 556.
5. Mingers, J., &Leydesdorff, L. (2015). A review of theory and practice in scientometrics. *European Journal of Operational Research*, *246*(1), 1-19.
6. Srinivasaragavan, S., & Gayathri, S. (2021). Assessment of Research Productivity on Cyanobacteria: A Scientometric Study. *Library Philosophy and Practice.*
7. Tomaszewski, R. (2020). Application of bibliometric analysis to letters journals in organic chemistry. *The Serials Librarian*, *79*(1-2), 91-106.
8. Van Leeuwen, T., &Tijssen, R. (1993). Assessing multidisciplinary areas of science and technology: A synthetic bibliometric study of Dutch nuclear energy research. *Scientometrics*, *26*(1), 115-133.

❖❖❖