A Scientometric Study of University Grants Commission Funded Research during 2013-2022

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Abstract

Purpose: *The aim of the present study is to find out different aspects like the impact of UGC-funded research, country collaboration, core journals, etc.*

Methodology: *The articles analysed in the present study have been collected from the Web of Science (WoS) database, and the period taken is from 2013 to 2022. 44481 articles have been retrieved in .txt format from the WoS database on April 20, 2023. The analysis has been done using Bibexcel, MS Eexcel and Vos Viewer.*

Findings: *It was found that out of 13 articles, 12 received citations. The CAGR value has been found to be 0.84%, which indicates the slow growth of UGC-funded research. 17 journals are found as core journals where researchers prefer to publish their research works. RSC Advances is the journal with the highest number of publications. From the network of author-assigned keywords, it was found that molecular docking, nanoparticles, crystal structure, x-ray diffraction, and oxidative stress are the most commonly used keywords by the researchers. It has been found that chemistry is the most researched area funded by UGC. The USA, South Korea, and Saudi Arabia are the countries with the most collaboration with Indian researchers.*

Limitation: *The current study is limited to the research articles available in the Web of Science database during 2013-2022, which were funded by UGC. There is scope for an in-depth analysis to find out the correlation between the amount spent by UGC on research and the impact of those research works in the practical field.*

Keywords: *Scientometric, UGC, Leimkhuler Model, Keyword Analysis, Country-wise Collaboration*

1. Introduction: Research is essential for a more knowledge-driven society. With research, we can rethink, restructure, and rebuild and contribute to the greater benefit of our country, economy, environment, and overall growth of this planet. Many research funding agencies, be they government or business organisations, provide funds for conducting research projects that have immense capabilities to bring about change in any sector. But the funding agencies always want to ensure that the amount they are spending on research has the greatest possible impact. Here comes the need to assess the impact of this funded research in the real sense and how it is helping others to pave a new way. Bibliometric and scientometric studies can help in this regard. The various indicators used in bibliometric and scientometric studies can help policymakers and funding agencies reevaluate and rethink their ways of spending and guide

them in funding quality research. Most of the funding agencies in India providing funds for research and development are government funding agencies. By sponsoring the research programmes of university and college teachers in a variety of subjects, the University Grants Commission, a statutory organisation established by the Department of Higher Education, Ministry of Education, Government of India, fosters excellence in research in higher education. UGC is providing research grants to university and college teachers in terms of major and minor research projects. This scientometrics study is carried out to assess UGC-funded research in terms of impact and research output, major sources of publication, keyword analysis, collaboration between countries, etc. for the period of 2013–2022.

2. Literature Review: Lewison (1998) studied the papers on gastroenterology published during 1988–94 and indexed in the Science Citation Index. The researcher determines the sources of funding for those research papers and their relative impact on papers, both funded and non-funded ones. The result indicates a greater growth in citation impact in funded research than in non-funded research. Zhao (2010) compares the research done in the library and information science fields that received funding with the research that did not receive funding. Out of the 7 journals selected for the study, it shows that a higher citation impact was shown for the funded article than the non-funded one. The percentage of articles receiving grants was mostly from information-oriented journals rather than library-focused ones. Ebadi & Schiffauerova (2015) evaluate the productivity of funded research and the impact of such findings. As an outcome of their study, they have found that there is a positive relationship between the funding of research and the quantity and quality of the scientific output. They have suggested that the increase in funding for the researchers gets them involved in larger projects and scientific teams. Kalachikhin (2017) discusses the importance of bibliometric studies in the allocation of funds to research organisations. Bibliometric studies can identify and incentivize the most active and high-performance research organisations based on the assessment of their scientific and technological potential. Morillo (2019) found that international funding results in greater collaboration and a higher citation rate for European Union-funded research. The study found that research funded by the EU funding agency receives more citations than research sponsored by other foreign funding sources. The author suggested that this could be the collaboration that exists in projects with European support. Srinivasaiah (2021) et al. evaluate the impact of DST-FIST funding on research publication in India during 2000–2020. The most prominent area of DST-FIST-funded research is chemistry, and it is the largest beneficiary of the DST-FIST funding. The annual percentage growth rate in research publications was 25.6%. Results have shown high levels of collaboration between countries. Kalita (2022) conducted a quantitative and qualitative analysis of research supported by the Department of Atomic Energy (DAE), Government of India. The study reveals an exponential growth in the immediacy index of research, and areas like biochemistry, biology, and medicine are ample areas for funding.

3. Objectives of the Study: The present study aims to find and evaluate different aspects of UGC-funded research during 2013–2022. The objectives taken for the study are:
a) To measure the research output and impact of UGC-funded research.
b) To identify the major sources of publications preferred by the researchers.
c) To find out the publication trends in various subject categories.
d) To find out the top-performing institutions.
e) To understand the inter-country collaboration trend in UGC-funded research.

4. Research Methodology: The articles analysed in the present study have been collected from the Web of Science (WoS) database, and the period is taken from 2013 to 2022, i.e., 10 years. The query that was used to retrieve the data is given below.

https://www.webofscience.com/wos/woscc/summary/830bc91f-036e-4778-8116-9d80345d2069-8c6bb130/relevance/1

Using the query, 44481 articles have been retrieved in .txt format from the WoS database on April 20, 2023. The analysis has been done using Bibexcel, MS Excel, and Vos Viewer. The .txt files were merged with the help of Bibexcel, and different fields were extracted as per the requirements of the stated objectives. The VOSviewer software was used to draw the keyword collaboration map.

5. Research Output and Impact: The research output is related to the number of publications, and the impact is related to the citations earned by those publications. In a specific area, the research output may be higher, but that does not mean that those studies have more impact, and vice versa. The number of publications published during 2013–2022, and the citations received by those publications during that period, are given in Table 1. During the study window, a total of 44481 articles have received 705605 citations, out of which 41481 articles received at least one citation, while 3207 articles have not received any citations as of the date of data extraction. The cited and non-cited article ratio is 12.95:1, which reflects that out of 13 articles funded by UGC, one article remains uncited.

Table 1: UGC Funded Research Output during 2013-2022

Total Article	Total Citations	Articles with minimum one citation	Articles without any citation	Cited to non-cited ratio
44481	705605	41481	3207	12.95:1

Table 2: Year-wise Publication and Research Impact

Year	Publication	Citation in the published year	Immediacy Index
2013	3733	2032	0.544
2014	4263	2573	0.604
2015	4502	3135	0.696
2016	4816	3691	0.766
2017	4834	3481	0.720
2018	4818	3830	0.795
2019	4734	4359	0.921
2020	4420	4771	1.079
2021	4499	5233	1.163
2022	3862	3832	0.992

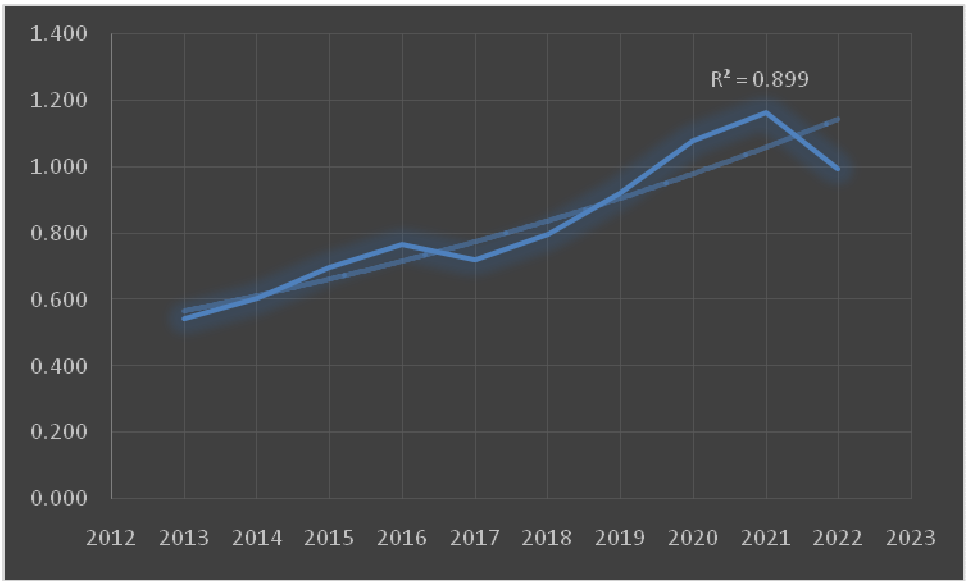

Fig. 1: Trend Line of Immediacy Index Growth

The immediacy index has been calculated to determine the research impact. The data related to the immediacy index is given in Table 2. Fig. 1 represents the variation of the immediacy index during the ten-year study period. An exponential trend line is drawn, yielding an R2 value of 0.899, which indicates that there is variation in the growth of the immediacy index during the period.

The Cumulative Annual Growth Rate (CAGR) has been calculated for the UGC-funded research work during 2013–2022.

CAGR= [Publication at end period/Publication at end period]$^{1/\text{No of years}}$ – 1

= [3862-3733]$^{1/10}$ – 1

= 1.0084-1

= .0084

Therefore, % CAGR = 0.0084*100= 0.84 %

The CAGR value shows that the growth in UGC funded research is very low.

6. Major Sources of Publications: Bradford's law has been used to find the core journals in which the researchers have preferred to publish their research works. The number of publications has been taken as a measure of productivity. Bibexcel has been used to retrieve the data from the text files downloaded from the Web of Science database. In the process, the details of 44470 journal articles that have been distributed in 3437 journals were retrieved. As per Bradford's law, the total number of journals can be divided into three zones, such that each zone contributes approximately the same number of articles. Therefore, in this study, the distribution of 44470 articles in three equivalent zones requires 14823 articles in each zone. The three zones, with the number of articles and the number of journals, have been distributed as shown in Table 3.

Table 3 : Bradford's Distribution of Journal

Zone	No of Articles	No of Journals
1	14795	48
2	14961	256
3	14714	3133

The ratio of journal distribution in three different zones was:

48:256:3133= 1: 5.33: 65.27

But as per Bradford's law, it should be 1:5.33: $(5.33)^2$. It shows that the distribution is not in the form of $1:n:n^2$.

Percentage error is = [(65.27-28.41/28.41] *100= 129.73%

The percentage of error is very high and the distribution does not follow the Bradford's law of distribution. Therefore, the Leimkuhler model of distribution has been evaluated for the three zones to test the applicability of the fulfilment of Bradford's law.

The Bradford's multiplier for the Leimkuhler distribution, $K= (e^y Y_m)^{1/P}$

$= (1.781*1464)^{1/3}$

$= 13.76$

Where, e^y= 1.781 (Eular No)

Y_m= No. of citations in the productive journal

P= No. of zones of distribution

The number of journals in the nucleus zone as calculated by the Leimkuhler model is

R_0= T(K-1)/(K^P-1), where T= Total number of journals

$= 3437 (13.76-1)/(13.76^3-1)$

$= (3437*12.76)/2604.29$

$=16.84\sim 17$

The modified Bradford's distribution is

17: 17*13.76: $17*(13.76)^2$= 17:233.92:3218.74=3469.66

The % of error= {(Observed value-Expected Value)/Expected Value} *100

= {(3469.66-3437)/3437}*100

= 0.95%

The percentage of error is very negligible, and hence the modified Bradford's distribution can be accepted.

The 17 core journals with their impact factor, SJR value and quartile distribution are given in Table 4. The journal RSC Advances is in the top position as per the number of publications, with 1464. On the other hand, the journal with highest impact factor amongst the 17 core journals is the International Journal of Biological Macromolecules (I.F-8.025). The journal "Organic Letters" (SJR-1.56) has the highest SJR value followed by Chemical Communications (SJR-1.34).

Table 4: Core Group Journals Preferred by the Researchers

Sl no	No of article	Title	Impact factor	SJR Value	Quartile Distribution
1	1464	RSC Advances	4.036	0.68	Q2
2	778	Chemistryselect	2.307	0.38	Q2
3	774	New Journal Of Chemistry	3.925	0.6	Q2
4	580	Journal Of Molecular Structure	3.841	0.48	Q2
5	514	Tetrahedron Letters	2.032	0.39	Q3
6	468	Journal Of Organic Chemistry	0.862	0.39	Q3
7	446	Dalton Transactions	4.569	0.79	Q1
8	438	Scientific Reports	4.996	0.97	Q1
9	430	Journal Of Molecular Liquids	6.633	0.91	Q1
10	389	Journal Of Materials Science-Materials In Electronics	2.779	0.5	Q2
11	385	Organic & Biomolecular Chemistry	3.89	0.78	Q1
12	384	ACS Omega	4.132	0.69	Q1

13	383	International Journal Of Biological Macromolecules	8.025	1.19	Q1
14	368	Journal Of Alloys And Compounds	6.371	1.08	Q1
15	355	SpectrochimicaActa Part A-Molecular And Biomolecular Spectroscopy	4.831	0.64	Q2
16	335	Chemical Communications	6.065	1.34	Q1
17	302	Organic Letters	6.072	1.56	Q1

The top 20 most influential research articles are given in Table 5. The article titled "Precision and correctness in the evaluation of electrocatalytic water splitting: revisiting activity parameters with a critical assessment" is the most cited article during the ten year of study period and was published in 2018. This article got 816 citations. The source title of the paper is Energy & Environmental Science.

Table 5: Top 20 Most Influential Articles

Article Title	Publication Year	Source Title	Times Cited
Precision and correctness in the evaluation of electrocatalytic water splitting: revisiting activity parameters with a critical assessment	2018	Energy & Environmental Science	816
Colloidal CsPbBr3 Perovskite Nanocrystals: Luminescence beyond Traditional Quantum Dots	2015	Angewandte Chemie-International Edition	757
Mechanochemical Synthesis of Chemically Stable Isoreticular Covalent Organic Frameworks	2013	Journal Of The American Chemical Society	653
Chemically Stable Multilayered Covalent Organic Nanosheets from Covalent Organic Frameworks via Mechanical Delamination	2013	Journal Of The American Chemical Society	578
Synthesis of imidazo[1,2-a]pyridines: a decade update	2015	Chemical Communications	487
Magnetic magnetite (Fe3O4) nanoparticle synthesis and applications for lead (Pb2+) and chromium (Cr6+) removal from water	2016	Journal Of Colloid And Interface Science	503
An air-stable Dy (III) single-ion magnet with high anisotropy barrier and blocking temperature	2016	Chemical Science	433
Chemical sensing in two dimensional porous covalent organic nanosheets	2015	Chemical Science	433
Terahertz Conductivity within Colloidal CsPbBr3 Perovskite Nanocrystals: Remarkably High Carrier Mobilities and Large Diffusion Lengths	2016	Nano Letters	421

Insight into the Mechanism of Antibacterial Activity of ZnO: Surface Defects Mediated Reactive Oxygen Species Even in the Dark	2015	Langmuir	424
Selective Molecular Sieving in Self-Standing Porous Covalent-Organic-Framework Membranes	2017	Advanced Materials	418
Thiazole Schiff base turn-on fluorescent chemosensor for Al3+ ion	2014	Sensors And Actuators B-Chemical	401
Influence of the Donor Size in D-pi-A Organic Dyes for Dye-Sensitized Solar Cells	2014	Journal Of The American Chemical Society	394
Pharmaceutical cocrystals: walking the talk	2016	Chemical Communications	387
Fungal diversity notes 367-490: taxonomic and phylogenetic contributions to fungal taxa	2016	Fungal Diversity	392
Copper Cobalt Sulfide Nanosheets Realizing a Promising Electrocatalytic Oxygen Evolution Reaction	2017	ACS Catalysis	367
Hydrogen energy future with formic acid: a renewable chemical hydrogen storage system	2016	Catalysis Science & Technology	355
Designing band gap of graphene by B and N dopant atoms	2013	RSC Advances	356
Corrosion inhibition of mild steel in acidic solution by Tageteserecta (Marigold flower) extract as a green inhibitor	2014	Corrosion Science	355
Three Dimensional Ag2O/TiO2 Type-II (p-n) Nanoheterojunctions for Superior Photocatalytic Activity	2013	ACS Applied Materials & Interfaces	348

6.1 Publication Trends in Various Subject Categories: For mapping the terms VOSviewer software was used. Since the retrieved number of keywords is huge, the threshold frequency is set to 50 which means minimum occurrence of a keyword in all the journals should be at least 50. After defining the threshold frequency, a total of 223 keywords were obtained. The links between the terms describe the strength of their association with one another. It is quite prominent from the map that terms like- molecular docking, nanoparticles, crystal structure, x-ray diffraction, oxidative stress etc. are the most reflected research areas. To map the keywords, only author keywords have been used.

Along with the keyword analysis, the publication trend has been investigated with the help ofthe research areas given in the web of science database. The research areas with their respective publicationsare shown in Table 6. As like the keyword analysis, this also shows that prominent researched areaswhich has been funded by UGC. Around 46% of research has been done in the field of Chemistry followed by Material Science (15.18%) and Physics (14.98%).

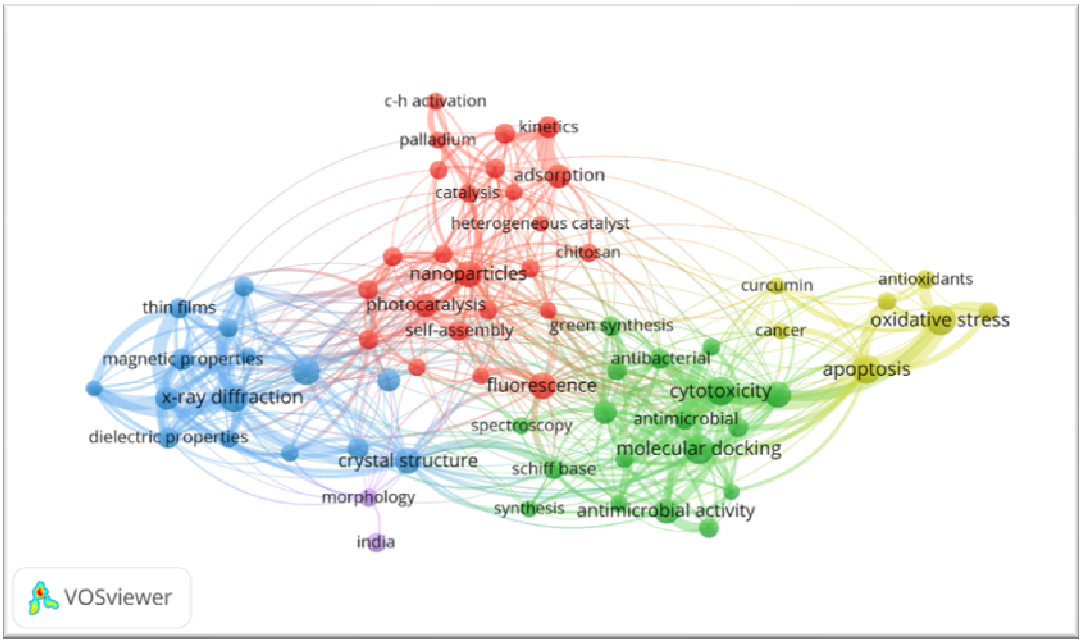

Fig. 2: Term Map

Table 6: Publication Trends as per Subject Category

Research Areas	No. of Publication	% of 44,481
Chemistry	20,361	45.78%
Materials Science	6,750	15.18%
Physics	6,661	14.98%
Engineering	3,307	7.44%
Science Technology Other Topics	3,241	7.29%
Biochemistry Molecular Biology	3,209	7.21%
Pharmacology Pharmacy	2,192	4.93%
Environmental Sciences Ecology	1,903	4.28%
Polymer Science	1,272	2.86%
Biotechnology Applied Microbiology	1,245	2.80%
Plant Sciences	1,167	2.62%
Energy Fuels	891	2.00%
Crystallography	883	1.99%
Optics	872	1.96%
Biophysics	861	1.94%
Mathematics	852	1.92%
Electrochemistry	787	1.77%
Food Science Technology	705	1.59%
Microbiology	681	1.53%
Cell Biology	638	1.43%
Computer Science	567	1.28%
Toxicology	560	1.26%
Spectroscopy	548	1.23%
Agriculture	540	1.21%
Geology	503	1.13%

6.2 Top Performed Institution: Table 7 represents the top ten institutions on the basis of number of publications. CSIR India is in the top position with 7496 (16.85%) publications and IIT System is in second position with 7009 (15.75%) publications.

Table 7: Top Ten Institution Yielding Highest Publication

Institution Name	Total Publication	% Share
Council Of Scientific Industrial Research CSIR India	7496	16.85
Indian Institute Of Technology System IIT System	7009	15.75
Academy Of Scientific Innovative Research ASCIR	3353	7.53
Banaras Hindu University BHU	2318	5.21
University Of Delhi	2263	5.09
Jadavpur University	2032	4.57
Department Of Science Technology India	1920	4.32
Panjab University	1819	4.09
Aligarh Muslim University	1581	3.55
CSIR Indian Institute Of Chemical Technology IICT	1414	3.18

6.3 Trend in Inter Country Collaboration: Table 8 represents the country wise publication share. It shows that India is in the top position with 43,928 articles. The USA is in second place with 1849 articles followed by South Korea.

Table 8: Country-wise Publications

Country Name	No. of Publication	% of share
India	43,928	98.76%
USA	1,849	4.16%
South Korea	830	1.87%
Saudi Arabia	809	1.82%
Peoples R China	635	1.43%
Germany	627	1.41%
Japan	513	1.15%
England	497	1.12%
Spain	396	0.89%
France	370	0.83%

It is evident from the publication that India has collaborated on at least one paper with 98 countries during the study period. The USA, South Korea and Saudi Arabia are the countries with the most collaboration with Indian researchers. Countries with at least 100 publications that collaborated with India is depicted in Fig. 3. The no of citation per publication is also calculated for each country and depicted in the Fig. 3. From the figure, it can be understood that though some of the countries have high collaboration with India, their citations per article are low. Despite having fewer publications compared to the USA and South Korea, South Africa has the highest citation per article ratio of all collaborative countries.

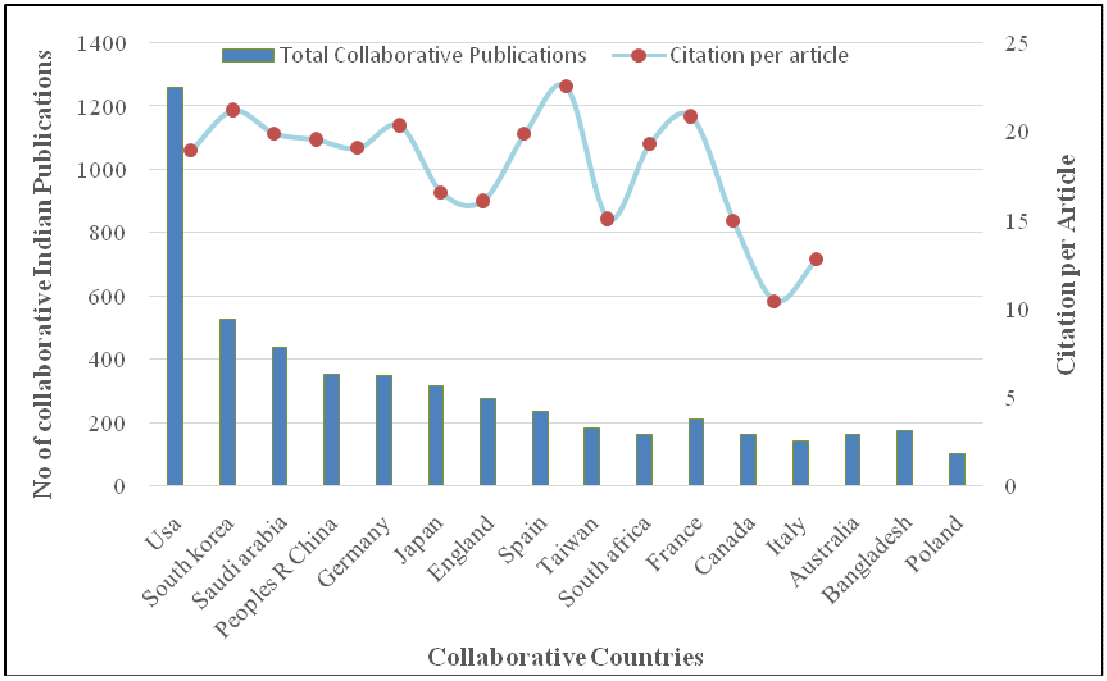

Fig 3: Countries Collaborated with India (≥100 Collaborative Publications)

7. Conclusion: The research output published during 2013-2022 which was funded by UGC has been used for the present study. During this period, 44481 articles were retrieved from the WOS database. It has been seen that out of 13 articles there remain one article uncited. The % CAGR value has been found to be 0.84% which indicates the slow growth of UGC funded research. To find out the core journals, Bradford's law was applied but the dataset does not follow the same. Therefore, Leimkuhler's modification of Bradford's law was applied later. 17 journals were found to be core journals where researchers prefer to publish their research works. RSC Advances is the journal with the highest number of publications. Out of 44481 articles the most cited article was Precision and correctness in the evaluation of electrocatalytic water splitting: revisiting activity parameters with a critical assessment with 816 citations. From the network of author assigned keywords it was found that molecular docking, nanoparticles, crystal structure, x-ray diffraction, oxidative stress are the most commonly used keywords by the researchers. It was found that Chemistry is the most researched area funded by UGC. It is found from the country collaboration that India has collaborated on at least one paper with 98 countries during the study period. The USA, South Korea and Saudi Arabia are the countries with the most collaboration with Indian researchers. The current study is limited to the research articles available in the Web of Science database during 2013–2022, funded by UGC. The findings may be different if you consider other databases like SCOPUS, Google Scholar, etc. There is scope for an in-depth analysis to find out the correlation between the amount spent by UGC on research and the impact of those research works in the practical field.

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