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Ten years of Arabian Journal of Chemistry: A bibliometric analysis

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Abstract Since 2009, Scopus database is regularly covering the Arabian Journal of Chemistry (AJC). Ten years of continuous and successful journey motivated us to celebrate its contribution through the 1st comprehensive bibliometric study. For simplicity we will divide the abstract in four (4) parts. In part 1, the publications and citations details are provided. From 2009 to 2019, the total number of publications (TP) were found to be 2134, majorly comprising of research articles (n = 2009/94.14%) and reviews (n = 119/5.57%). The relative per year growth rate (%) from 2009, one way analysis of variance (ANOVA) and the doubling time was calculated. The details of impact per publication (IPP), SNIP, % self cit, citation per document, external cites per document, self-citations and total cites are also provided. In part 2, the lists of top ten (10) authors, institutions and countries are described with total number of publications (TP), h-index, total citations (TC), h-index without selfcitations (WSC) and total WSC. We also discussed and provided the list of top ten (10) most cited documents with TC, WSC and other Scopus metrics like Crossref citation indexes, Mendeley reader and field-weighted citation impact. In 3rd part, various other parameters were presented as visualization map, using VOSviewer. Precisely, the co-authorship, citations and co-citations patterns were described in detail. While, based on the co-words analysis of titles, abstract and authors keywords, we proposed the overall trend of publications in AJC. In part 4, we will specifically mention that in 2019, SCImago journal rank has declared AJC in Q1 (1st Quartile) state while Scopus has ranked it at 22nd (in 281 general chemical engineering journals) and 45th position (in 398 chemistry journals). From Web of Science (after 2009), we also retrieved the data

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about the journal AJC impact factor, 5 year impact factor, immediacy index and average journal impact factor percentile. The data confirms that AJC showed a continuous growth in the number of publications, citations, impact factor and ranking.

1. Introduction

Bibliometric analysis is the quantitative analysis of research articles, min-reviews and reviews, etc. The term Bibliometrics was introduced by Pritchard in 1969 (Pritchard, 1969). It helps in measuring the output of authors, journals, institutions and/or countries. This also helps in indentifying the national and international networks and decoding the development or pattern of publications in a particular field (Osareh, 2009). The primary focus of bibliometry is to study the pattern of scientific publications (Zeleznik et al., 2017). While, it also help in decoding the trends, correlation and relationship in the titles, abstracts and author keywords. One of the salient features of bibliometrics is to explore the growth of particular research area. For the purpose, citations and geographical distribution, etc. are critically analyzed (Kamdem et al., 2016, 2017).

Although bibliometric analysis has long been considered as a subfield of information and library sciences, it has considerably gained the attention of the scientific community since the past decade. This can be explained at least, in part by the fact that such studies provide a retrospective of the research trends covered by a particular journal. The authors also celebrated their decades of contributions. For example, the golden jubilee of the transportation research journal (Modaka et al., 2019), the forty years anniversary of computers & chemical engineering (Modak et al., 2020), the publication growth of safety science journal (Merigóa et al., 2019), the golden jubilee of quality & quantity journal (Mastur et al., 2019), the 30 years anniversary of the computer integrated manufacturing journal (Laengle et al., 2018a,b) and the 25 years of new emerging trends in group decision and negotiation journal (Laengle et al., 2018a,b). Interestingly in all of the stated reports the authors employed the Web of Science (WOS) for data retrieval. Majorly the authors tried to identify and cover various trends by using bibliometric parameters like number of publications, co-authorship, citation, co-citation, co-words analysis and bibliometric coupling. While, recently we performed the forty years bibliometric analysis of food chemistry (Kamdem et al., 2019) and celebrated the golden jubilee of chemico-biological interactions (Hassan et al., 2020). In all of the stated reports, the authors used VOSviewer software for analysis. Indeed, from these analyses, particularly those of top cited papers, it was possible to indicate some critical sub-areas of the journals that should be further developed.

The Arabian Journal of Chemistry (AJC) mostly publishes papers about organic, inorganic, physical, analytical and biochemistry. It has successfully completed its first decade. To the best of our knowledge no study has reported its bibliometric analysis. The purpose of the present report is to celebrate the 1st decade of AJC since 2009 and get some insights about the journal research trends. We will also explore the main contributors both in terms of individuals and institutions in a dynamic way. Furthermore, based on the most cited papers and authors, we also expect to give some qualitative indications to the journal further development, namely by identifying the main and the underdeveloped sub-areas of chemistry covered by the Arabian Journal of Chemistry

Through bibliometrics, we will cover the five (5) major aspects.

(1) The performance analysis.

The major objective of performance analysis is to find out the top ranked scientific actors (researchers, institutions and countries, etc.) in AJC. The analysis is purely based on the number of publications and citations. In this part, we will also determine the growth rate, doubling time and perform the one way ANOVA.

(2) The science mapping analysis (SMA):

On the other hand, SMA helps in defining the social structure of a particular research field by temporal representation. The graphical overview of the bibliographic data of AJC will be provided by using visualization of similarities (VOSviewer) software.

(3) The next question is what has been covered in a particular area, or in our case a particular journal (AJC)? For the purpose, the co-words analysis or co-occurrence technique can be applied.
(4) We will extend the idea, and will provide details about the top ten most cited documents.
(5) In the last section, we will provide details about the different indicators, which are used to describe the impact of a journal. For example, one of the key indicator is SNIP (source normalized impact per paper), developed by Henk Moed in 2009. Other indicators in the series are impact per publication (IPP) and percentage of self citations of a source (% self cit). These indicators have been calculated based on the Scopus data. Scopus also helps in defining the journal ranking based on the citescore. SJR (SCImago Journal Rank) provides information about the quartile (Q) data of the journals. Infact it also helps in ranking of a particular journal in the relevant category. The data about these parameters will be taken from Scopus. Infact, we will also provide the per year total cites, journal impact factor, impact factor without journal self cites, 5 year impact factor, immediacy index, citable items and % articles in citable items. The data will be retrieved from the journal citation report (JCR) or WOS. We believe that the ranking details will help to describe the overall quality and progress of the AJC.

2. Materials and methods

2.1. Source of information

Numerous databases such as Google Scholar, Web of Science, and Scopus have been used for bibliometric analysis and some authors have compared their effectiveness (Martín-Martín et al., 2018; Moral-Muñoz et al., 2020). Infact in March 2020, Michael Gusenbauer and Michael Gusenbaue published an interesting article. The authors systematically evaluated and compared the qualities of 28 search systems including WOS and Scopus. In analysis they applied 27 different evaluating criteria's. The authors concluded that it is very hard to identify and point out (collectively) the ranking of these international search engines or databases. Infact they provided the details about the limitations of all search systems and concluded that certain search systems perform better or worse than others. They also suggested that each researcher or reviewer must have considerable knowledge of the search engines or databases they intend to use (Gusenbauer and Haddaway, 2020).

In the current study, we used Scopus database (Elsevier BV Company, USA). The data was retrieved in June 2020 using the name "Arabian Journal of Chemistry" and ISSN of the journal. However, the publications from 2009 to 2019 were analyzed in detail. The authors collected and downloaded the data in csv format. Later it was quantitatively and qualitatively analyzed in Microsoft Excel 2013 for access type, year, author name, document type, key words, affiliations and country. While some ranking details was retrieved from the journal citation report (JCR) or WOS.

2.2. Visualization maps

Several authors have analyzed different software tools to show the spatial representation of the relationship among authors, institutions, countries, keywords, etc. (Bankar and Lihitkar, 2019; Moral-Muñoz et al., 2019, 2020). The list of software tools for conducting science mapping includes but not limited to Bibexcel, Bibliometrix, BiblioMaps, CiteSpace, CitNetExplorer, SciMAT, Sci^{2}Tool and VOSviewer. A recent study by Moral-Muñoz et al. (2020) revealed that these software tools have a variability of features and that almost all of them can import data downloaded from Scopus and Web of Science. Therefore, it is up to the user to use the software tool that could provide suitable indicators (e.g., total publications, number of citations, most cited papers) for the desired analysis.

Here, we decided to use VOSviewer version 1.6.9 for viewing and creating the desired bibliometric maps. Compared to others such as SciMAT, CiteSpace and Bibliometrix, Vosviewer has a great visualization with the capability of loading and exporting data from many sources such as Scopus, Web of Science, PubMed, Dimensions, and RIS format. In addition, it is possible to construct and visualize the co-occurrence networks of important terms extracted from the scientific literature (Cobo et al., 2011; Moral-Muñoz et al., 2020). The software was developed by Van Eck and Waltman for constructing and visualizing bibliometric networks. For more information, please see http://www.vosviewer.com/. By default, at most 1,000 lines are displayed and represent the 1,000 strongest links between items. The distance between two items in the visualization approximately indicates the relatedness of the items. The results are presented as network visualization maps.

2.3. Relative growth rate and doubling time

The relative growth rate was calculated as follow.

$$\%\mathbf{GR} = \frac{\text{Final Number} - \text{Initial Number}}{\text{Initial Number}} \times 100$$

The doubling time for publications can be calculated by using the following equation:

$$RGR_{1-2} = Log_{e\ 2}w - Log_{e\ 1}w/2^T - 1^T$$

where

RGR(1-2) is mean Relative Growth Rate over the specified period
$Log_{e\ 2}w$ = log of initial number of publications
$Log_{e\ 1}w$ = log of final number of publications
$2^T - 1^T$ = The unit difference between the Initial time and Final time

And;

$$DT = Log_e^2/GR$$

Where

GR = Growth rate.

2.4. Statistical analysis

The statistical analyses were performed using Eviews 8.0. ANOVA F test was applied to check the significance. Differences were considered significant if $p < 0.05$. Results are presented as means ± standard error of the mean.

3. Results and discussions

The results and discussion section is divided in the following sections.

The Performance Analysis
3.1 Section One (1): The Publication and Citation Structure of AJC
3.2 Section Two (2): The Top 10 Authors, Institutes and Countries
The Science Mapping
3.3 Section Three (3): The VOSviewer analysis
3.1.1 The construction of the Co-Authorship networks

(a) Co-Authorships by Authors
(b) The Institutional Co-Authorship Analysis
(c) The Country Co-Authorship Analysis

3.3.2 The Citations Analysis of Authors, Institutes and Countries
3.3.3 The Co-Citation Analysis
The Co-Words Analysis
3.3.4 The Co-Occurrence in Titles, Abstracts and Keywords
The Top Ten Most Cited Documents

3.4 Section Four (4): The Brief Description of the Top Ten (10) Most Cited Documents

The Ranking Details

3.5 Section Five (5): The Ranking Details of AJC

3.1. Section One (1): The Publication and Citation Structure of AJC

From 2009 to 2019, AJC has successfully published 2134 research documents. Four (4) types of documents are published by AJC, comprising of research articles (n = 2009/94.14%), reviews (n = 119/5.57%), errata (n = 4/0.8%) and editorial (n = 1/0.046). One document was undefined.

The list of per year publications is presented in Fig. 1**.** The highest number of documents were published in 2017 (n = 615), followed by 2019 (n = 519) and 2016 (n = 370). We will specifically mention that the number of publications regularly increased from 2009 (n = 17) till 2017 (n = 615). However a significant decline is noticed in 2018, where only 118 documents were published. Its hard to explain such a huge decline in a single year (2018), because it significantly depends on various factors i.e. authors, universities, research interests, submissions, subscriptions, editorial handling, tough decisions, rejections policies or acceptance criteria, reviewers quality and work ethics, etc.

Although the annual number of publications increased, but considerable fluctuations in growth rate can be observed as described in Table 1. Precisely the highest growth rate was observed for the year 2018–2019 (3.44%), followed by 2015–2016 (2.19%) and 2013–2014 (1.61%). By a close observation of the data in Table 1, it is apparent to see that the growth has consistently decreased from 2010 (n = 1.53) to 2013 (n = -0.18). The simple hypothesis is that a decrease in growth rate can increase the doubling time, or vice versa. Its important to note that doubling time is the time required to double the number of publications. This is exactly what we can observe in the data (Table 2). For example, a decreasing trend in the growth rate for the years 2010–2013 was observed i.e. 1.53, 0.53, 0.03 and −0.18, respectively. Consequently, a higher doubling time for the years 2010 to 2013 was found for the stated years i.e. 0.5, 0.9, 1.6 and 2.67. In the same vein, in 2014 a higher growth rate can be noticed i.e. 1.61, which lead to decrease doubling time (n = 1.5). The shortest doubling time was noticed for the years 2016 (n = 1.3) and 2017 (n = 1.3). The number of publications significantly decreased in 2018 (n = 118), which caused a significant decrease in growth rate (−0.81) with longest doubling time (n = 9.2). In conclusion, the average per year growth rate was found to be 0.879 and the average doubling time was 2.3 as shown in Table 2.

We also tried to explore the variation in per year publications. For the purpose, we calculated the difference between individual year papers and average papers in Excel, 2007. The details are depicted in Table 1. The mean and the standard deviation were found to be 194 and 198.53, respectively. Furthermore, we applied ANOVA F test by Eviews 8.0. The *"p"* value was found to be (0.0000), which confirms the significance and model fitting. We also replicated the mean and standard deviation in Eviews calculus. The results are shown in Table 3.

Its worthy to note that citations play a fundamental role in elucidating or describing the quality of a journal. We provided the citation pattern of the AJC. The collected data is organized in a yearwise pattern and is presented in Table 4. The total citations for AJC yearly increased. Infact in the last three year, 2017, 2018 and 2019, it reached the pinnacle i.e. 1707, 3636 and 4959, respectively. The details about citation per document (based on the three years record), external citations per documents, self citations and total citations are also provided in Table 4. As apparent from the data the citations and external citations consistently increased yearwise. Similarly, when a reference is referred to an article from same previous journal is term as self-citation. Appropriate self-citation provides information about the originality of data but on the other side it carries some limitations like it has negative effect on the journal impact factor. One of significant disadvantage of self-citation is that it can bias the citation rate as multiple authors own single research document and their self-citation manipulate the citation rate. Moreover, it also cast negative shadows on author impact factor. In Table 4 we provided complete details of the self-citation data of AJC. In all years the % self-citations remained below 4%. In addition, our finding indicates that in 2010–2011 and 2016–2017, the % self-citations was zero percent (0.00%), which shows an impressive tendency.

In the same vein, we will also mention that the Centre for Science and Technology Studies (CWTS), Leiden University has developed CWTS Journal Indicators, which provides detail information about the quality or rankings of the journals. Based on the Scopus data, they provide and use four (4) indicators,

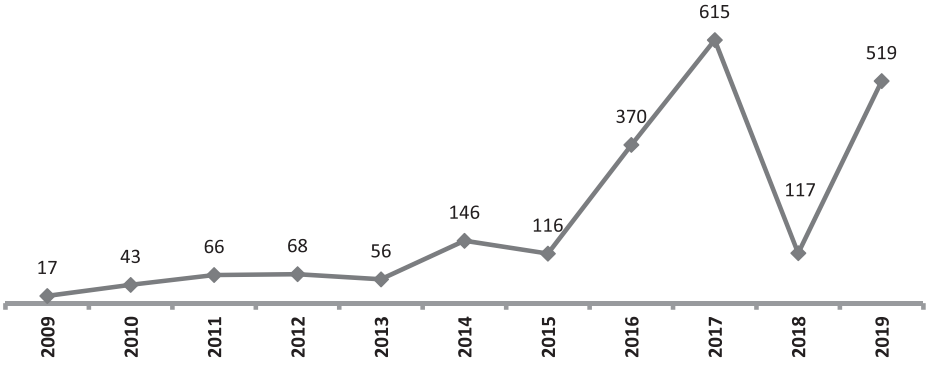


Fig. 1 List of per year publications.

Table 1 List of per year research growth rate (RGR) for Arabian journal of chemistry. Where Pi is number of initial papers and AP is average number of paper. The variance was found to be 39417.54 and standard deviation of 198.54.

Year	Number of Publications (#)	%age	RGR	% Growth	(Pi-AP)	(Pi-AP)2
2009	17	1.92	–	–	−176.909	31296.83
2010	43	4.85	1.53	152.94	−150.909	22773.55
2011	66	7.44	0.53	53.49	−127.909	16360.74
2012	68	7.67	0.03	3.03	−125.909	15853.1
2013	56	6.31	−0.18	−17.65	−137.909	19018.92
2014	146	16.46	1.61	160.71	−47.9091	2295.281
2015	116	13.08	−0.21	−20.55	−77.9091	6069.826
2016	370	41.71	2.19	218.97	176.0909	31008.01
2017	615	69.33	0.66	66.22	421.0909	177317.6
2018	118	13.19	−0.81	−80.98	−76.9091	5915.008
2019	519	58.51	3.44	343.59	325.0909	105684.1

Table 2 The doubling time calculations for Arabian journal of chemistry.

Years	Numbers	Cumulative	W1	W2	R(a) W2-W1	Mean R(a) (1–2)	Doubling Time Dt(a)	Mean Dt(a) (1–2)
2009	17	17	0.0	2.8	0.0	0.4	0.0	2.3
2010	43	60	2.8	4.1	1.3		0.5	
2011	66	126	4.1	4.8	0.7		0.9	
2012	68	194	4.8	5.3	0.4		1.6	
2013	56	250	5.3	5.5	0.3		2.7	
2014	146	396	5.5	6.0	0.5		1.5	
2015	116	512	6.0	6.2	0.3		2.7	
2016	370	882	6.2	6.8	0.5		1.3	
2017	615	1497	6.8	7.3	0.5		1.3	
2018	117	1614	7.3	7.4	0.1		9.2	
2019	519	2133	7.4	7.7	0.3		2.5	

Table 3 The ANOVA F test for all publications (from 2009 to 2019).

Test for Equality of Means of Papers				
Categorized by values of Papers				
Included observations: 11				
Method		df	Value	Probability
Anova F-test		(3, 8)	43.44751	0
Analysis of Variance				
Source of Variation		df	Sum of Sq.	Mean Sq.
Between		3	408519.3	136173.1
Within		8	25073.58	3134.198
Total		11	433592.9	39417.54
Category Statistics				
Papers	Count	Mean	Std. Dev.	Std. Err. of Mean
[0, 200)	9	91.43434	55.98391	18.6613
[200, 400)	1	370	NA	NA
[400, 600)	1	519	NA	NA
[600, 800)	1	615	NA	NA
All	12	193.9091	198.5385	57.31313

1. P (number of publications in the last three years).
2. IPP (impact per publication), It was previously known as RIP (raw impact per publication).
3. SNIP (source normalized impact per publication),
4. % self cit. (percentage of self citations of a source).

Herein, we provided the yearwise details of (P, IPP, SNIP and %self cit) as shown in Table 4. The P and IPP trends increased. While, the SNIP followed a regular trend in growth, except 2016 and 2017 where it decreased as compared with earlier years. In all years the % selfcitations remained below 4%.

Table 4 The per year citations details of all publications (from 2009 to 2019). P (number of publications in the last three years), IPP (impact per publication) and SNIP (source normalized impact per publication).

S#	Year	Citation per Document (3-years)	External Cites Per Document	Self Cites	Total Cites	P	IPP	SNIP	% Self Cit
1.	2010	0.412	0.412	0	7	17	0.24	0.33	0.00%
2.	2011	1.15	1.117	2	69	60	0.87	0.59	0.00%
3.	2012	1.81	1.754	7	228	126	1.51	1	3.70%
4.	2013	2.057	2.017	7	362	176	1.84	0.98	2.20%
5.	2014	2.455	2.38	14	459	186	2.24	1.6	3.40%
6.	2015	2.782	2.767	4	740	266	2.61	1.59	0.60%
7.	2016	3.13	3.102	9	986	315	2.89	2.24	0.00%
8.	2017	2.705	2.629	48	1707	632	2.45	1.8	0.00%
9.	2018	3.305	3.286	21	3636	1101	3.06	1.61	0.60%
10.	2019	4.508	4.444	71	4959	1101	4.26	2.35	1.60%

Infact, in 2010–2011 and 2016–2017, the % self-citations was zero percent (0.00%). The data confirms a significant growth in the stated parameters.

3.2. Section two (2): the top 10 authors, institutes and countries

This part of the manuscript is dedicated to the researchers, institutes and countries who have significantly contributed to AJC. The data obtained from Scopus will be presented on the basis of several bibliometric indicators or parameters. For example,

1. Total number of publications (TP),
2. Total number of citations (TC),
3. H-index,
4. Citation per paper or document (CPD) and
5. H-index with and without self-citations.
6. Self-citations

TP and TC are the two basic indicators used for evaluating the overall volume and quality of scientific publications. The indicator TP is used to depict the most productive authors, institutions, and countries. However the quality of publications is directly measured by the number of citations. Therefore TC indicator helps in measuring the quality of scientific papers. Infact it is used to acknowledge and trace the source/journal and the concept and methodology of a researcher. The C/P or average citations per paper are useful in comparative studies. Its worthy to note that H-index or H factor (high citations) was proposed by an American scientist, Hirsch in 2005. H-factor represents both the productivity and citation impact of a particular researcher or a group of researchers (such as departmental or institutional). H-index has been widely considered as a reliable and authentic parameter to quantify an individual's scientific achievements (Bornmann et al., 2007). The h-index is calculated by counting the number of publications for which an author has been cited at the same number of times. For instance, an h-index of 10 means that a scientist has published 10 articles and each has been cited at least 10 times. If the researcher's 11th publication was cited only 5 times, the h-index would remain at 10. Or in other words, if the scientist's 11th publication was cited 11 or more times, the h-index would rise to 11 (Bornmann et al., 2012). Both H-index and C/P offer further, more granular information on the journal publication's impact. Self-citation is a reference to an article from the same journal. It is an important indicator normally applied to decode the original quality of a document or a source.

We provided details of top 10 authors, institutes and countries. Its worthy to note above stated parameters i.e. number of publications, h-index, total citations (TC), h-index without self citations and total citations without selfcitations were added in the respective tables.

The list of top ten authors is provided in Table 5. Based on the number of publications Narasimhan, B. is top ranked author with (14) publications, followed by Isloor, A.M., Asiri, A.M, Salih, N and Salimon, J. with 12, 11, 11, 11 and 11 publications respectively.

The list of top 10 institutes is provided in Table 6. Based on the number of publications, King Saud University is the top ranked institute with 125 publications followed by King Saud King Abdulaziz University (n = 56), Islamic Azad University (n = 37), Cairo University (36), and Payame Noor University (n = 36). The yearwise publications details (from 2009 to 2019) about the top ten institutes are given in the Table 7. We will only mention the top three institutes here. KSU published the highest number of publications in the year 2017 (n = 27), followed by 2019 (n = 19) and 2016 (n = 17). KAU published the highest number of publications in 2012 (n = 16) however after that low increase in publications can be observed. Infact after 2013 five or less than five documents per years have been published. CU followed exactly the same trend. The highest documents were published in 2012 (n = 16), after that four or less than four documents were published each year. Infact in the last three years (2017–2019), only three publications are recorded.

We also analyzed the top three universities by Vosviewer. Three fundamental factors i.e. total number of co-authors, institutes and collaborations with international countries were elucidated. In KSU publications (n = 147), total 496 authors, 339 institutes and collaboration with 29 countries were observed. Which is significantly higher than KAU, where 232 authors, 166 institutes and 22 countries were found. In CU publications, total 127 authors, 86 institutes and only 8 collaborating countries were noted. Another important factor is funding. Collectively 21 funding sponsors were acknowledged. Precisely, Deanship of Scientific Research, King Saud University was acknowledged in 48 publications, followed by

Table 5 The list of top ten authors with total publications (TP), h-index, total citations (TC), h-index withoutself citations (WSC) and wsc.

S#	Author Name	TP	h-index	TC	h- index (WSC)	WSC	Citation Per Document
1.	Narasimhan, B.	14	6	96	6	87	7
2.	Isloor, A.M.	12	9	283	8	271	24
3.	Asiri, A.M.	11	5	59	5	52	5
4.	Salih, N.	11	8	253	7	226	23
5.	Salimon, J.	11	8	253	7	226	23
6.	Pal, M.	10	3	20	3	19	2
7.	Fun, H.K.	9	7	211	6	197	23
8.	Siddiqui, M.R.H.	9	8	122	7	94	14
9.	Yousif, E	9	7	237	6	212	26
10.	Asiri, A.M	8	5	62	5	54	8

Table 6 The list of top ten institutes with total publications (TP), h-index, total citations (TC), h-index withoutself citations (WSC) and wsc.

S#	Name of Institute	TP	h- Index	TC	h- index (WSC)	WSC	Citation Per Document
1.	King Saud University, Saudi Arabia (KSU)	125	25	2566	22	2350	21
2.	King Abdulaziz University, Saudi Arabia (KAU)	56	17	1791	17	1740	32
3.	Islamic Azad University, Iran (IZU)	37	11	434	11	406	12
4.	Cairo University, Egypt (CU)	36	11	467	9	409	13
5.	Payam Noor University, Iran (PNU),	36	11	255	10	246	7
6.	Aligarh Muslim University, India (AMU)	35	13	444	11	391	13
7.	National Research Center Cairo, Egypt (NRCC),	33	15	906	14	815	27
8.	Ain Shams University, Egypt (ASU)	31	13	717	13	655	23
9.	Centre National de la Recherche Scientifique, France (CNRS)	25	10	210	10	181	8
10.	Shahid Bahonar University of Kerman, Iran (SBU	25	10	266	10	249	11

King Saud University, College of Dentistry, King Saud University, which were acknowledged in 25 and 5 publications, respectively. In KAU publications, the University itself (King Abdulaziz University) was acknowledged in 21 publications, followed by Deanship of Scientific Research, King Faisal University and University Grants Committee, which was acknowledged. Both were acknowledged in only two publications, respectively. Sixteen (16) other sponsors were acknowledged in only one publication. In CU publications, only four sponsors were acknowledged. The highest was noted for Science and Technology Development Fund (in 2 publications), followed by Alexander von Humboldt-Stiftung, Cairo University and Deanship of Scientific Research, King Saud University, these three sponsored were acknowledged in three publications. We also provided the citations details of the top ten institutes. As shown in Table 7, the per year citations for all institutes increased.

In all publications (n = 2134), eighty eight (88) countries from different geographies have significantly contributed. The data is depicted in Table 8. Based on the number of publications, Asia can be declared as the top continent. 16 different countries have contributed in all (n = 1019/47.75%) publications. The top three countries in this region are India (n = 678), China (n = 126) and Malaysia (n = 104). Middle East is the 2nd dominant region, which has contributed in 817 publications (38.28%). The top three countries are Saudi Arabia (302), Egypt (282) and Iran (228). Twenty Nine (29) countries from Europe have contributed in 323 publications (or 15.14%). France (79), Turkey (43) and Italy (32) are the top three countries with maximum number of publications. Interestingly Africa has contributed with the same number of publication as Europe (323/15.14%). Precisely, 13 countries have contributed in all publications. Algeria (71), Tunisia (61) and Morocco (48) are the top three countries. South America, North America and Ociana have collectively contributed with only 125 publications. Although, 15 countries from these three regions were directly involved in publications.

Irrespective of the region, the list of top 10 countries is described in Table 9. Based on the number of publications, India is the country with the highest production with 678 (31.77%) documents, followed by Saudi Arabia (302/14.15%), Egypt (282/13.21%), Iran (228/10.68%) and China (126/5.90%), respectively. While, based on total citations, India (n = 7893) is the top country followed by Saudi Arabia (n = 5883), Egypt (n = 5410), Iran (n = 2170) and Malaysia (n = 1565). However based on the H-index, the top five countries are India (n = 42), Saudi Arabia (n = 36) Egypt (n = 32), Iran (n = 25), Malaysia (n = 22) and China (n = 20). Similarly, we can also depict the publications and

Table 7 The per year total publications (TP) and total citations (TC) details of the top ten universities. King Saud University, Saudi Arabia (KSU), King Abdulaziz University, Saudi Arabia (KAU), Islamic Azad University, Iran (IZU), Cairo University, Egypt (CU), Payam Noor University, Iran (PNU), Aligarh Muslim University, India (AMU), National Research Center Cairo, Egypt (NRCC), Ain Shams University, Egypt (ASU), Centre National de la Recherche Scientifique, France (CNRS) and Shahid Bahonar University of Kerman, Iran (SBU).

Institute			2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
(KSU)	**TP**	**125**	4	9	5	5	11	13	9	17	27	6	19
	TC	**2566**	**0**	**6**	**16**	**35**	**56**	**128**	**224**	**321**	**448**	**563**	**769**
(KAU)	**TP**	**56**	3	1	4	4	1	5	5	4	16	2	11
	TC	**1791**	**0**	**1**	**10**	**25**	**49**	**80**	**125**	**236**	**293**	**472**	**500**
(IZU)	**TP**	**37**	0	0	0	2	0	3	1	5	18	1	7
	TC	**434**	**0**	**0**	**0**	**7**	**4**	**13**	**20**	**49**	**94**	**115**	**132**
(CU)	**TP**	**36**	3	1	1	1	2	1	4	1	16	2	4
	TC	**467**	**0**	**2**	**5**	**17**	**7**	**13**	**37**	**48**	**78**	**120**	**140**
(PNU)	**TP**	**36**	0	1	0	2	1	1	2	8	15	1	5
	TC	**255**	**0**	**1**	**7**	**6**	**15**	**18**	**23**	**26**	**37**	**51**	**71**
(AMU)	**TP**	**35**	0	0	1	1	2	2	1	8	11	1	8
	TC	**444**	**0**	**0**	**1**	**4**	**5**	**21**	**32**	**51**	**72**	**103**	**155**
(NRCC)	**TP**	**33**	0	2	2	3	1	4	3	6	7	3	2
	TC	**906**	**0**	**1**	**14**	**35**	**39**	**52**	**86**	**128**	**164**	**181**	**206**
(ASU)	**TP**	**31**	0	1	5	3	3	3	1	8	4	1	2
	TC	**717**	**0**	**0**	**8**	**23**	**28**	**59**	**76**	**113**	**109**	**147**	**154**
(CNRS)	**TP**	**25**	0	1	0	0	1	2	0	2	6	1	12
	TC	**210**	**0**	**0**	**3**	**1**	**1**	**6**	**19**	**28**	**36**	**49**	**67**
(SBU)	**TP**	**25**	1	0	1	8	1	1	0	6	4	1	2
	TC	**266**	**0**	**1**	**2**	**7**	**13**	**22**	**32**	**42**	**40**	**63**	**44**

Table 8 Continents.

Continents	No of Countries	No of Pub	% age	H-Index	Total Citations
Asia	16	1019	47.75	51	16,048
Middle East	15	817	38.28	49	15,220
Europe	29	323	15.14	30	4106
Africa	13	323	15.14	35	4325
South America	10	60	2.81	10	364
North America	3	57	2.67	13	782
Ociana	2	8	0.37	5	131

Table 9 The list of top ten countries with total publications (TP), h-index, total citations (TC), h-index withoutself citations (WSC) and wsc.

#	Country	TP	h-index	TC	h- index (WSC)	WSC	Citation Per Document
1.	India	678	42	7893	40	7018	12
2.	Saudi Arabia	302	36	5883	34	5442	19
3.	Egypt	282	32	5410	31	4956	19
4.	Iran	228	25	2170	24	1948	10
5.	China	126	20	1283	19	1190	10
6.	Malaysia	104	22	1565	22	1384	15
7.	Pakistan	80	19	1204	18	1100	15
8.	France	79	17	755	15	624	10
9.	Algeria	71	17	689	14	599	10
10.	Tunisia	61	18	623	18	554	10

citations data as citation per document. In this way, the top five countries are Saudi Arabia (CPD = 19), Egypt (CPD = 19), followed by Pakistan (CPD = 15), Malaysia (CPD = 5) and India (CPD = 2).

We extended the idea and provide the per year publications details of the top ten countries. The details are provided in Table 10. India has published the highest number of publications (n = 211) in 2017, followed by 2016 (n = 151) and 2019 (n = 151). The 2nd country Saudi Arabia published the highest number of documents in the year 2017 (n = 75), followed by 2019 (n = 57) and 2016 (n = 36). Apart from 2018, an overall increasing number of publication trend is observed for India and Saudi Arabia. Egypt has published the highest number of documents in 2019 (n = 56), followed by 2018 (n = 41) and 2017 (n = 29). Interestingly the gradual and consistent increase in publications has been observed. We also provided the per year citations details for the ten countries. Overall (per year) an increasing trend in citations can be observed for all countries.

3.3. Section three (3): the VOSviewer analysis

Considerable literature is available which confirms the importance of analysis of co-authorship, citations, and co-citation networks, etc. It has a long history, with early work dating back to the 1960 s (Kessler, 1963). In the present study we analyzed the following parameters by Vosviewer. Precisely, we presented the results as "science mapping". The details of the analysis are given below.

3.3.1. Constructing the co-authorship networks

Co-authors, also called co-corresponding authors/senior authors/lead authors, are responsible to format and organize the information in written form. Co-authorship is an important aspect of scientific collaborations. It promotes team work among different scientific researchers to enhance productivity and achieve new scientific knowledge. Collaboration between co-authors may be intramural (i.e. between one department, institutes or any research group) or extramural (international collaboration) (Wolfgang and András, 2012). Infact, co-author analysis is considered as a powerful method used for the identification of leading authors, organizations and countries in particular research field. The scholarly publications of co-authors can be examined through different softwares to exhibit researcher's collaboration through graphical visualization (Nianxin et al., 2016). Its important to note that co-authorship defines the "link" between researchers. Infact, the co-authorship networks can be constructed for researchers/authors, research institutions, and countries.

(A) **Co-Authorships by Authors**

Co-authorship is a form of collaboration in which two or more authors contribute to a particular publication. In all publications (2134), the total numbers of authors were **6832**. To draw the co-authorship network in VosViewer, we defined the minimum number of published articles to be five (5) with zero citations. Ninety Nine (99) authors were found to meet the threshold. Inorder to construct the map, Vosviewer, has calculated the total link strength between the authors. In map, each node represents an author and the node size indicates the number of published articles. The link connecting two nodes stands for the cooperative relationship between two authors, and the thickness of the link stands for the intensity of cooperation. In Vosviewer map (Fig. 2A-D), several clusters were generated representing 99 items or authors.

1st of all, we will shortly introduce a few clusters. For example,

1. In yellow cluster, there are seven (7) items or authors, which are further connected with six authors in orange cluster.
2. In red cluster, there are 12 items and
3. In grey cluster there are 6 items

Table 10 The per year total publications (TP) and total citations (TC) details of the top 10 countries.

Country			2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
India	**TP**	678	1	3	17	17	21	52	31	151	211	23	151
	TC	7893	0	2	14	78	180	390	598	858	1275	1919	2579
KSA	**TP**	302	9	13	22	11	17	27	22	36	75	13	57
	TC	5883	0	7	35	95	150	288	468	717	950	1389	1784
Egypt	**TP**	282	6	10	17	17	11	22	22	56	80	12	29
	TC	5410	0	3	45	115	149	251	463	700	902	1266	1516
Iran	**TP**	228	1	3	3	14	3	11	17	43	88	4	41
	TC	2170	0	2	9	31	63	107	162	267	363	556	610
China	**TP**	126	0	1	2	0	1	1	3	12	33	27	46
	TC	1283	0	0	1	4	3	31	48	93	180	338	585
Malaysia	**TP**	104	0	2	0	3	3	11	7	16	27	11	24
	TC	1565	0	0	8	15	25	54	122	187	263	407	484
Pak	**TP**	80	1	1	1	1	0	7	3	8	26	10	22
	TC	1204	0	1	1	7	12	33	67	135	205	265	478
France	**TP**	79	1	2	2	2	4	6	1	11	21	3	26
	TC	755	0	0	9	13	20	29	60	96	126	169	233
Algeria	**TP**	71	0	1	5	3	2	9	5	15	19	0	12
	TC	689	0	0	3	15	30	45	57	91	110	145	193
Tunisia	**TP**	61	1	0	1	0	0	4	3	3	24	3	22
	TC	623	0	0	3	3	6	17	38	63	107	154	232

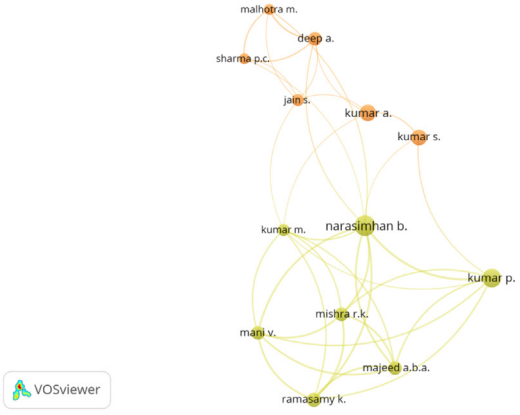
Before elaborating the above clusters, its important to note that each author in all clusters has (individually) atleast five (5) publications.

In the yellow cluster, if we consider "Narasimhan B." as the main author, he/she is connected with total 6 authors in yellow cluster named Kumar P., Majeed A.B.A., Ramasamy K., Mani V., Mishra R.K and Kumar, M. While, in the orange cluster Prof. Narasimhan B is connected with Kumar S., Deep A., Sharma PC., and Malhotra A M.

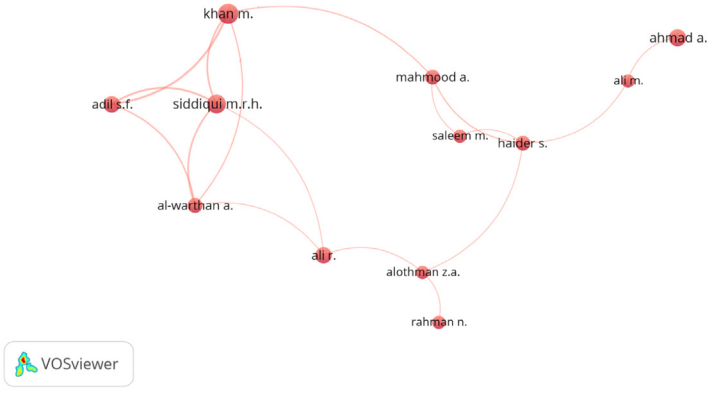
To understand it further, we explored the publication profile of "Narasimhan B." Based on the Scopus data, he/she has published 14 documents in AJC with twenty six (26) co-authors. From yellow cluster, Kumar P has co-authored 8 publications, Ramasamy K., Majeed A.B.A., Mani V and Mishra R.K. have co-authored 7, while, Kumar M has co-authored 4 publications with "Narasimhan B". From orange cluster, he/she has co-authored two publications with Deep A., and Malhotra, M. while, with Kumar, S. and Sharma, P. C., one publication has been co-authored. The total link strengths as derived by Vosviewer can also help in proper explanation. The highest link strength was recorded for Narasimhan B (n = 47), followed by Ramasamy K., (n = 37) Kumar P., (n = 37) Majeed A.B.A., (n = 37) Mani V (n = 37) and Mishra R.K. (n = 37). Since, low number of publications are jointly co-authored in orange cluster, therefore we found weak link strength as noted for Deep A (n = 12), Malhotra, M (n = 11), Sharma P., (n = 8) and Kumar S., (n = 5). The cluster is shown in Fig. 2A.

Its worthy to note that in research publication Prof. Narasimhan B, focused on the synthesis, antimicrobial, anticancer, antiviral evaluation and QSAR studies of various complexes or compounds like N-substituted benzene sulfonamides, p-coumaric acid, diazenyl schiff bases, gallic acid benzohydrazides, propionic acid and monochloroacetic acid derivatives.

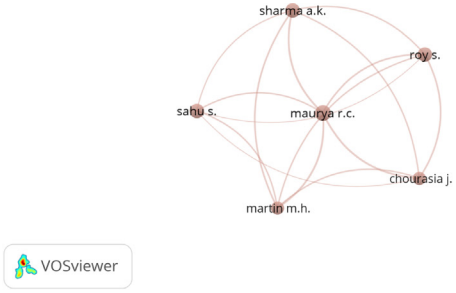
The next cluster is red, where total 12 items are merged together. If we consider Siddiqui M.R.H. as the focal point, it can be seen that he is connected with five authors named Ali, R., Al-Warthan, Adil S.F, Khan M and Kamal A. To understand it further, from Scopus we retrieved the publica-



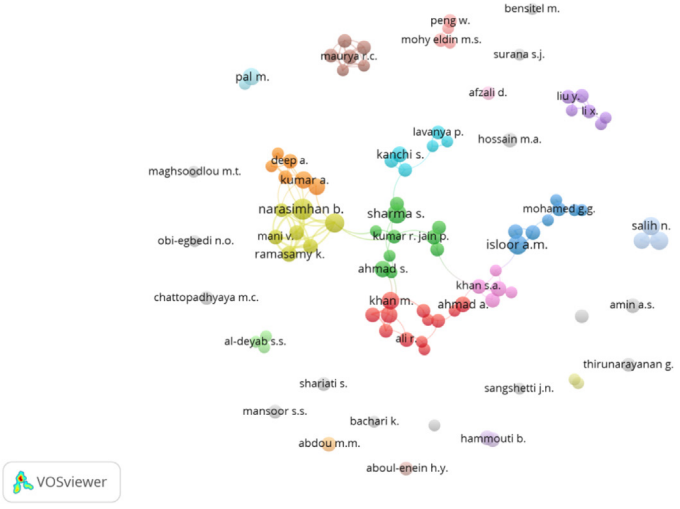
A) List of authors in Co-authorship analysis (Yellow and Orange Cluster)



B) List of authors in Co-authorship analysis (Red cluster)



C) List of authors in Co-authorship analysis (Grey cluster)



D) List of authors in Co-authorship analysis (All clusters

Fig. 2 List of authors in Co-authorship analysis (A-D).

tion details of Siddiqui M.R.H. Total publications was found to be nine (9), co-authored by thirty eight (38) authors. Al-Warthan, A. has co-authored six (6), Adil, S.F has co-authored five (5), Khan M has three (3), Ali, R and Kamal A has co-authored one (1) publication with Siddiqui M.R.H. The cluster is shown in Fig. 2B.

While, in most of the publications Prof. Siddiqui Focused on studies synthesis, characterization, density functional theory (DFT) calculations, thermal studies and catalytic oxidations of Pd graphene nanocomposite, gold & silver nanoparticles, copper-manganese mixed oxide nanoparticles, substituted pyrroles and rhenium oxocomplex.

In grey cluster, Maurya R C., has been considered as the principal author. From Scopus we retrieved the publication details. In total he/she has seven (7) publications with sixteen co-authors. With Chourasia, J., Martin, M.H., and Sharma, A.K. five (5), with Roy, S., (4) and with Sahu S three (3) documents are mutually published. The highest link strength was recorded for Maurya R,C (22). For others the strength was found to be fifteen (n = 15). The cluster is shown in Fig. 2C. While, all clusters are described in Fig. 2D.

In his research Prof Maurya R C., principally focused on the synthesis, characterization, and 3D-molecular modeling and analysis of oxovanadium(IV) complexes, octa-coordinate mono- and binuclear-dioxouranium(VI) complexes, schiff bases derived from 4-butyryl-3-methyl-1-phenyl-2-pyrazolin-5-one, penta-coordinated manganese(II) chelates, *cis*-dioxomolybdenum(VI) complexes and oxoperoxomolybdenum(VI) chelates.

(B) The Institutional Co-Authorship Analysis

In all published documents, 4265 different institutions or departments were found. One hundred and seven (107), of them were directly involved in atleast three (3) publications. with zero (0) citations. The institutional co-authorship network is shown in Fig. 3.

There are total sixty eight (68) clusters in Fig. 3A-F. We will briefly describe only three (3) clusters.

In red cluster there are total seven (7) items or institutes (Fig. 3). If we consider, Department Of Chemistry, Quaid-I-Azam University, Islamabad, 45320, Pakistan as the principal institute in the cluster, it is apparent that it is further connected with

Department Of Environmental Science & Engineering, China University Of Geosciences, Wuhan, China
Institute Of Biochemistry, University Of Sindh, Jamshoro 76080, Pakistan
Institute Of Chemistry, University Of The Punjab, Lahore, 54590, Pakistan

Some other individual clusters with names of the departments of universities are described in Fig. 3B-F.

(C) The Country Co-Authorship Analysis

Country co-authorship analysis is an important form of co-authorship analysis (13–15). It can reflect the degree of communication and the most influential countries in a particular field. In total, 93 countries were directly involved in all publications in AJC. 54 countries were found from the data, with atleast five (5) publications and zero (0) citations. The size of circles represents the number of publications of the country and the thickness of lines depicts the size of collaboration. The data is presented in Fig. 4.

Since India the top leading country with maximum publications (n = 678), therefore we analyzed it on Vosviewer. The total authors in all publications were found to be 1948. However, forty three authors have atleast five publications. The top five authors are Narasimhan B (n = 14), followed by Isloor A. M. (n = 12), Kumar P (n = 12), Sharma S (n = 12) and Kumar A (n = 10).

We also noted more than 160 departmental or universities affiliations in India's publications. The highest was recorded for Aligarh Muslim University (n = 35), followed by King Saud University (n = 25) and Jamia Hamdard Faculty of Pharmacy (n = 21). By a closer inspection of the image, it can be observed that India has a diverse co-authorship network with 44 countries. The top five in this series are Saudi Arbia (n = 47), followed by Malaysia (n = 17), South Korea (n = 17), South Africa (n = 12) and China (n = 6).

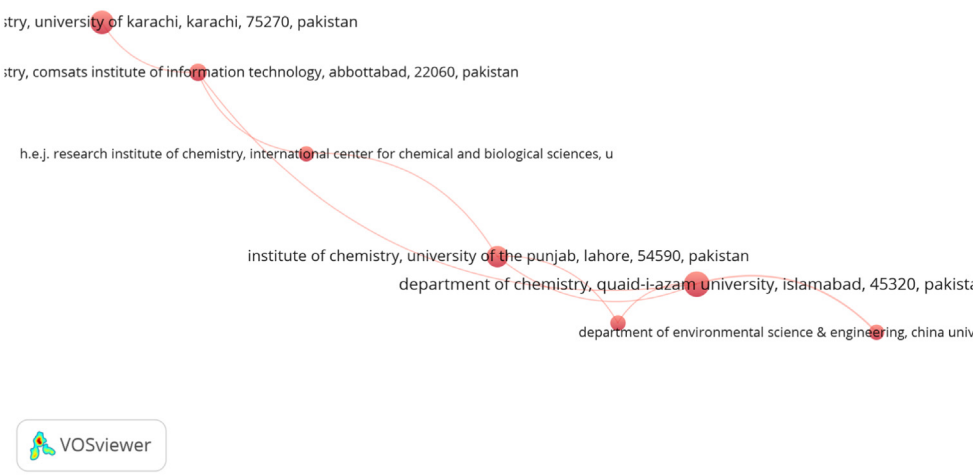
We also selected Saudi Arabia, another dense region found in the map. In total publications (n = 302), the highest collaboration was found with Egypt (n = 112), followed by India (47), Pakistan (n = 9), Tunisia (n = 6), South Korea (n = 13), Malaysia (10), China (n = 6), Japan (n = 6), Jordan (n = 6) and USA (n = 7).

Based on the number of publications, Egypt was the third highest country (n = 282). Which collaborated with Saudi Arabia (n = 112), Japan (n = 9), USA (n = 5) and South Korea (5). Yemen, Libya, Sudan, Germany, India and Kuwait were affiliated in 5 or less than 5 publications.

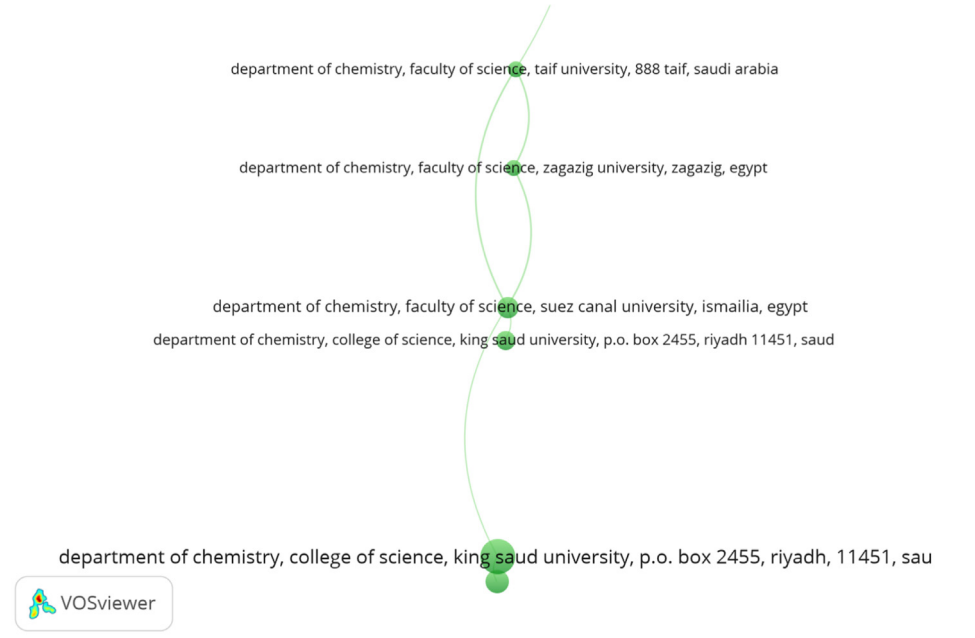
The scientific collaboration between authors may also help in developing social network between institutes and countries. Infact a single author's contribution may help in institutional and international networking. For the purpose we focused on a single author and university to know their networking details.

Prof. Narasimhan, B. has the highest number of publications (n = 14), with 13 research articles and one review. Total twenty six (n = 26) co-authors have been found. Institutionally, Maharshi Dayanand University's affiliation was found in all 14 publications, along with Universiti Teknologi Mara, I.S.F. College of Pharmacy, Akal College of Pharmacy, Guru Jambheshwar University of Science and Technology, KU Leuven, Kurukshetra University, Quaid-i-Azam University, Rega Institute for Medical Research. Briefly, these institutes were from India, Malaysia, Belgium and Pakistan.

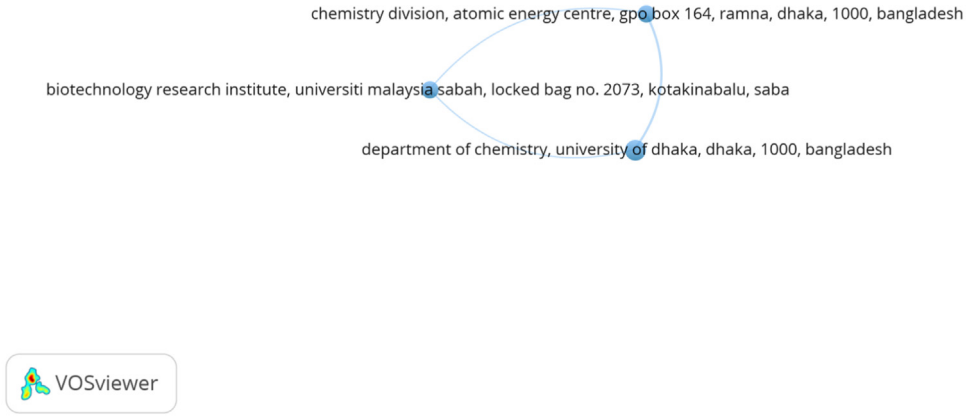
Similarly, the King Saud University was found to be the top university with maximum i.e. one hundred and twenty five (125) publications. These mainly comprised of research articles (108), reviews (14) and three (3) errata. Precisely, 394 authors have been found in all publications (n = 125). Some of the top authors from this University is Khan, M (10), Siddiqui, M.R. H., (n = 9) and Isloor A.M (8) publications. Based on Vosviewer analysis more than 250 organizations were affiliated in all publications. Twelve (n = 12) of them were involved in atleast three (3) publications. More than one hundred and twenty (n = 120) different universities were affiliated in all publications. Some of the examples are, National Institute of Technology Karnataka, Jeonbuk National University, Alexandria University, Princess Nourah bint Abdulrahman University, Aligarh Muslim University, , Al-Azhar University,



A) The institutional co-authorship network

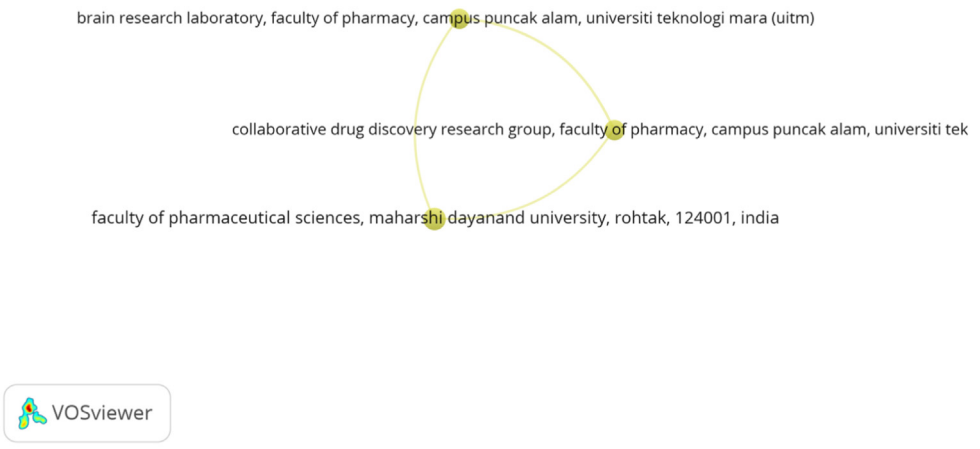


B) The institutional co-authorship network

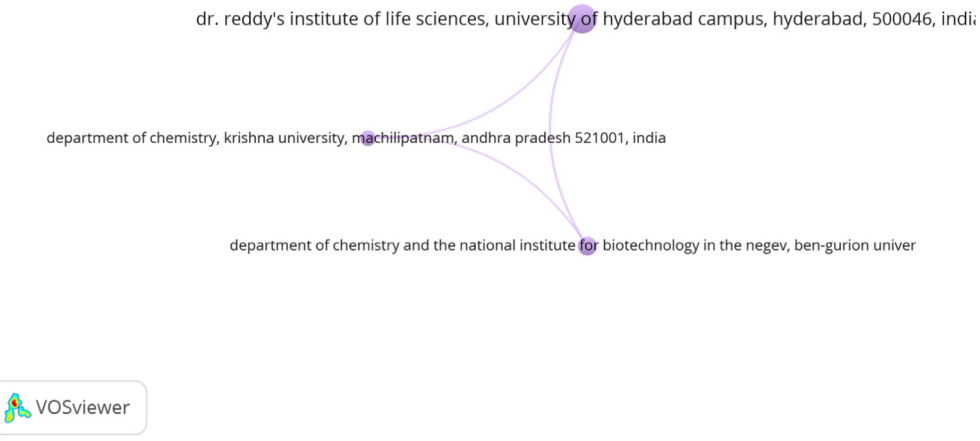


C) The institutional co-authorship network

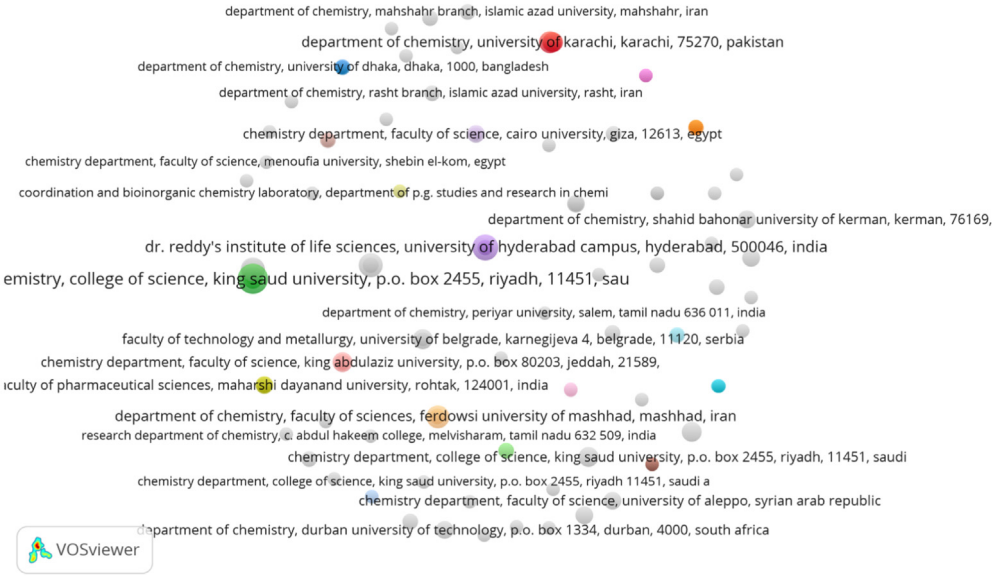
Fig. 3 The institutional co-authorship network (A-F).



D) The institutional co-authorship network



E) The institutional co-authorship network



F) The institutional co-authorship network

Fig. 3 (*continued*)

University of Tanta, Umm Al Qura University and Minia University etc.. All authors and/or institutes from 26 different countries like Egypt, India, South Korea, Pakistan, USA, China, Japan, Malaysia, Yemen, Australia, Germany, Jordan,

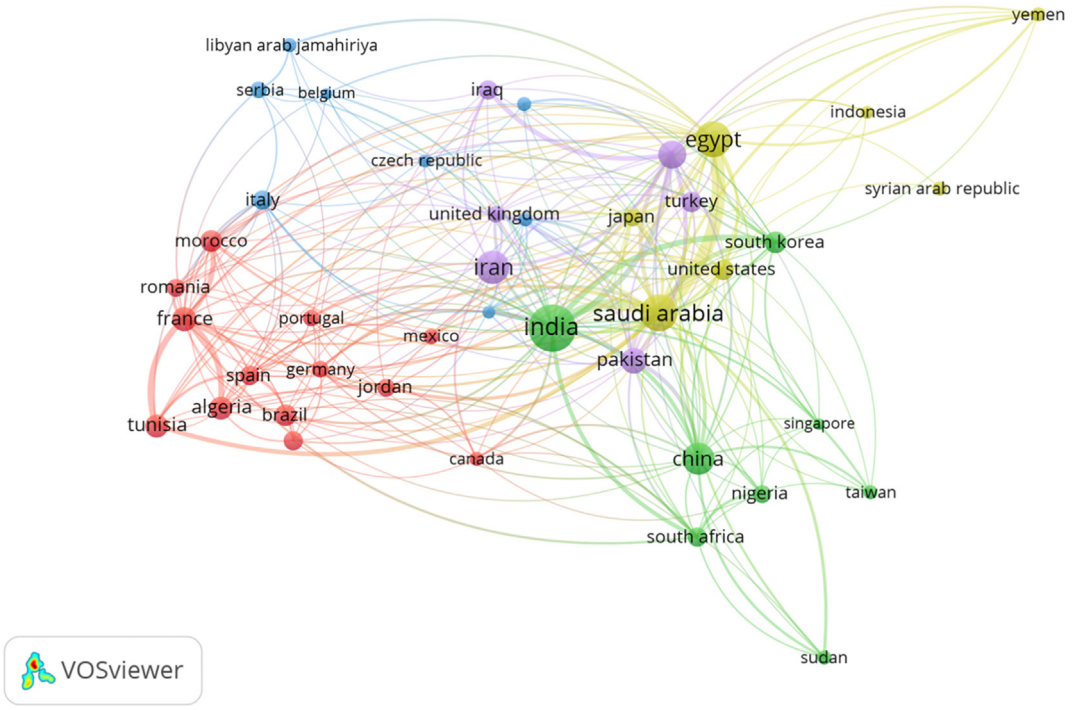


Fig. 4 The Country Co-Authorship Analysis.

Qatar, Sudan, Turkey, Belgium, Brazil, Ethiopia, France, Netherlands, Oman, Palestine, Portugal, Romania, Spain and Tunisia.

3.3.2. Citations analysis of authors, institutes and countries

When any scientific document like book, report, conference paper, and essay are referred or cited to another paper known as source paper is termed as citation. Citation determines the importance of any paper by its influence in citation network. Thus giving acknowledgment to the work of author which is cited in the reference list. It is worthy to note that the document which an author select for citation must be relevant to the work in which it is cited. The nature of citation is an attractive aspect to study for researchers because of its easy availability and unobtrusive nature. The scientific impact of an individual publication is of pivotal importance which can be measure by "citation impact indicators", thus providing information not only about individual's paper but also indicate information of Journal impact factor and the h index (Ludo, 2016). Citation analysis can be carried out using four different units in bibliometric analysis such as, authors, countries, and institution of affiliation and the most influential documents.

In AJC, total 6832 authors were involved in all publications. 74 authors were found with atleast five (5) publications and 50 citations. Al-warthan A. was found with highest citations (825) followed by Aboul-Enein H.Y. (619), and Kamoun E.A. (520). However, irrespective of the number of publications, the highest citations were recorded for Barakat M.A. (1439) followed by Al-Warthan A (825), Ammar R.A.A. (768), Aboul-Enein H.Y. (619) and Abou El-Nour K.M.M. (584). Its worthy to note that four (4), six (6), two (2) six (6) and two (2) published documents were observed for above stated authors with exact writing format of their names.

Institutionally, the highest citations were recorded for Chemistry Department, Faculty Of Science, Cairo University, Giza, Egypt (268) followed by Department Of Chemistry, College Of Science, Al-Nahrain University, Baghdad, Iraq (237), Department Of Chemistry, College Of Science, King Saud University, Saudi Arabia (212), Chemistry Department, Faculty Of Science, Benha University, Benha, Egypt (177) and Chemistry Department, Faculty Of Science, Zagazig University, Zagazig, Egypt (166).

While, irrespective of the number of publications, the highest citations were recorded for Department of Environmental sciences, Faculty Of Meteorology And Environment, King Abdulaziz University (Kau), Jeddah, Saudi Arabia (1273), followed by Chemistry Department, College Of Science, King Saud University, Riyadh, Saudi Arabia (588), Chemistry Department, College Of Science, King Faisal University, Al-Ahsa, Saudi arabia (584), Ataturk University, Faculty Of Arts And Sciences, Department Of Chemistry, Erzurum, Turkey (549), and Gaziosmanpaşa University, Faculty Of Science And Arts, Department Of Chemistry, Tokat, Turkey (549),

3.3.3. Co-citation analysis

In 1973 Henry Small introduced the concept of co-citation analysis. The major application is to understand a subject similarity between two documents. The two documents are said to be co-cited when they (both) appear in the reference list of a third document (Small, 1973). When two items (such as documents, journals and authors) are cited in a citing item's reference list, they have a co-citation relationship. In other words, the co-citation analyses can generate various paradigms or clusters to exhibit the research trends and links within institutions, sources and authors. (McCain, 1986).

Co-Citations By Number of Cited References

Reference co-citation analysis is an important mean to detect the structure and evolutionary path of a specific domain. The reference co-citation analysis was conducted to see the trend within the cited references. Total, 77,867 cited references were noted in all publications. Out of that, 9 references were cited at least 10 times as shown in Table 11.

The Journal Co-Citation Analysis

Journal co-citation is of strong interest to the collection manager concerned with developing core journal lists, selecting journals and evaluating collections that serve particular research-oriented constituencies. The journal co-citation analysis is not only an efficacious way to study the structure and characteristics of a subject, but also reveals the overall structure of the subject and the characteristics of a journal (Hu et al., 2011). VOSviewer was used to plot the journal co-citation network.

Total cited sources were found to be 13278. Precisely, 38 sources were selected with 300 citations. The list of top ten co-cited sources is described in Table 12. Some of the top sources are J. Hazard. Mater, J. Am. Chem. Soc, Eur. J. Med. Chem, Corros. Sci. and Tetrahedron lett.

Table 11 List of top 10 Co-Cited References.

S#	Cited reference	Citations
1.	Ho, Y.S., Mckay, G., Pseudo-Second Order Model For Sorption Processes (1999) Process Biochem., 34, pp. 451–465	18
2.	Langmuir, I., The Adsorption Of Gases On Plane Surfaces Of Glass, Mica And Platinum (1918) J. Am. Chem. Soc., 40, pp. 1361–1403	18
3.	Geary, W.J., (1971) Coord. Chem. Rev., 7, p. 81	16
4.	Rahman, N.A., Halim, H., Gotoh, H., Harada, E., Validation Of Microscopic Dynamics Of Grouping Pedestrians Behavior: From Observation To Modeling And Simulation (2017) Eng. Heritage J., 1 (2), pp. 15–18	13
5.	Halim, H., Abdullah, R., Nor, M.J.M., Aziz, H. A., Rahman, N.A., Comparison Between Measured Traffic Noise In Klang Valley, Malaysia And Existing prediction Models (2017) Eng. Heritage J., 1 (2), pp. 10–14	12
6.	Furusjo, E., Svenson, A., Rahmberg, M., Andersson, M., The Importance Of Outlier Detection And Training Set Selection For Reliable Environmental Qsar Predictions (2006) Chemosphere, 63, pp. 99–108	10
7.	Hassan, S.R., Zaman, N.Q., Dahlan, I., Influence Of Seed Loads On Start Up Of Modified Anaerobic Hybrid Baffled (Mahb) Reactor Treating Recycled Paper Wastewater (2017) Eng. Heritage J., 1 (2), pp. 05–09	10
8.	Mosmann, T., Rapid Colorimetric Assay For Cellular Growth And Survival: Application To Proliferation And Cytotoxicity Assays (1983) J. Immunol. Methods, 65, pp. 55–63	10
9.	Sukor, N.S.A., Jarani, N., Fisal, S.F.M., Analysis Of Passengers' Access And Egress Characteristics To The Train Station (2017) Eng. Heritage J., 1 (2), pp. 01–04	10
10.	Halim, N.I.A., Phang, I.C., Salicylic Acid Mitigates Pb Stress In Nicotiana Tabacum (2017) Sci. Heritage J., 1 (1), pp. 16–19	9

3.3.4. Co-Occurrence in titles, abstracts and keywords

Co-words can effectively reflect the latest tend and hotspots in a particular discipline or field. Infact, it provides auxiliary support for scientific research. Infact, the keywords analysis is a vital method that can effectively describe the strength of association between keywords in textual data. In this part, we focused on co-occurrence of words in titles, abstracts and keywords of the publications.

The co-word cluster mapping by VOS viewer revealed that in all titles (n = 2134) (Fig. 5), there are total 6481 terms. 102 terms were repeated at least 10 times. While, in abstract total 33,269 words were found. 136 of them repeated at least 50 times as shown in Fig. 6.

In all the 2134 publications, total 6617 authors key words were compiled. Among them, 84 keywords appeared atleast 10 times as shown in Fig. 7.

Furthermore, we categorized the co-words of titles (Table 13), abstract (Table 14) and author keywords (Table 15) to depict the overall trend of publications. While the summary for the co-words of titles, abstracts and keywords are provided in Figs. 8–10.

It can be concluded that although the number and percentage of different common words varies in each category (titles, abstract and keywords). But majorly the publications focused on the following major areas or themes.

a) **Compounds/Chemicals**

To investigate broader review of AJC publications in terms of chemicals/compounds, we compiled the words such as benzimidazole, biodiesel, graphene oxide, indole, heavy metals, metal complexes, pyrazole, schiff base, schiff bases, methylene blue, tio2, metal complexes. Moreover, to explore the progress in elemental analysis we added the words like graphene, iron, lead, cadmium, copper, coumarin etc. We also added the words like green synthesis, green chemistry, and synthesis to this class.

b) **Nanoparticles**

Nanoparticles are the nano size particles of matter that are the subject of study in different domains such as chemistry.

Table 12 List of top 10 co-cited sources with name of the journal and total citations.

S#	Source	Citations
1.	J. Hazard. Mater.	1346
2.	Eur. J. Med. Chem.	1111
3.	J. Am. Chem. Soc.	1107
4.	Tetrahedron lett.	881
5.	J. Med. Chem.	806
6.	Corros. Sci.	803
7.	Bioorg. Med. Chem. Lett.	691
8.	Talanta	654
9.	Bioorg. Med. Chem.	641
10.	Tetrahedron	598

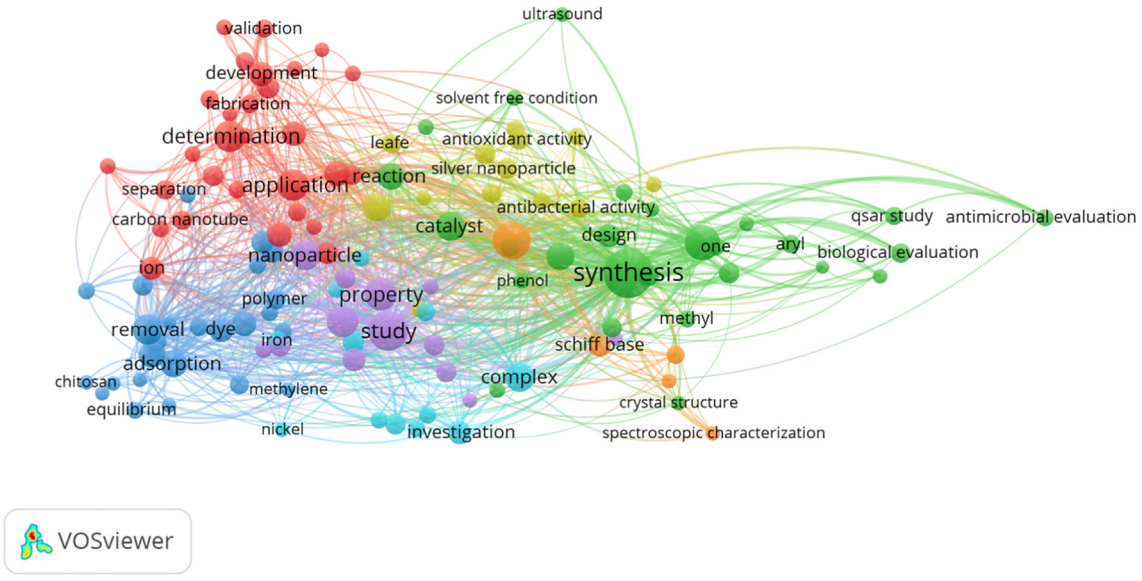


Fig. 5 Co-words analysis of titles.

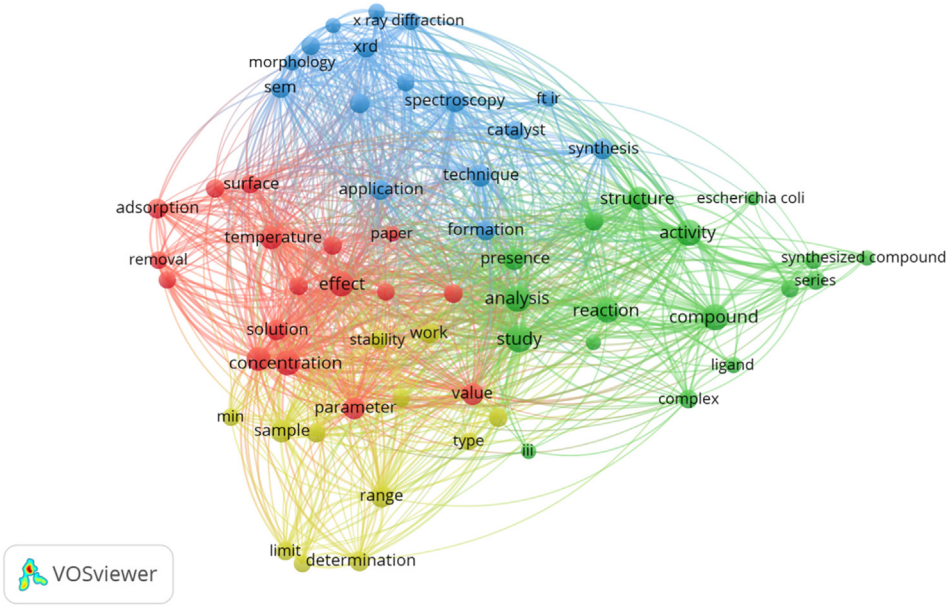


Fig. 6 Co-words analysis of abstracts.

There exist multiple applications of nanoparticles in different industrial sectors such as agriculture, medical, environment to name a few. Nanoparticle like silver are extensively implemented for antimicrobial coating, wound dressing, and in bio medicinal devices. Under this title, we collected different words like nanocomposite, nanocomposites, nanoparticle, and nanoparticles.

c) Instrumental Analysis or Characterizations

For analysis of the surface morphology, density, size of particles, splitting of mixture into various components, crystal structure, identification and quantification of various components, different instrumental tools are used. In this category we added cyclic voltammetry, conductivity, density functional theory, eis, electrochemical impedance spectroscopy, fluorescence, FTIR, GC–MS, Hplc, HPTLC. XRD, X-ray diffraction, voltammetry, potentiometry, photoluminescence, RP-HPLC, SEM, NMR, spectrophotometry, QSAR, spectroscopy, TEM, thermal analysis, PCA, solid phase extraction, ultrasound, microwave, microwave irradiation, and optimization, etc.

d) Kinetics and Thermodynamic

Different parameters such as time, temperature, pressure etc are used to elaborate the rate of reaction. It also helps in understanding the mechanism of reaction. To further explore and understand the research trend in this field, we collected relevant words like kinetic, isotherm, kinetics, sorption, thermo-

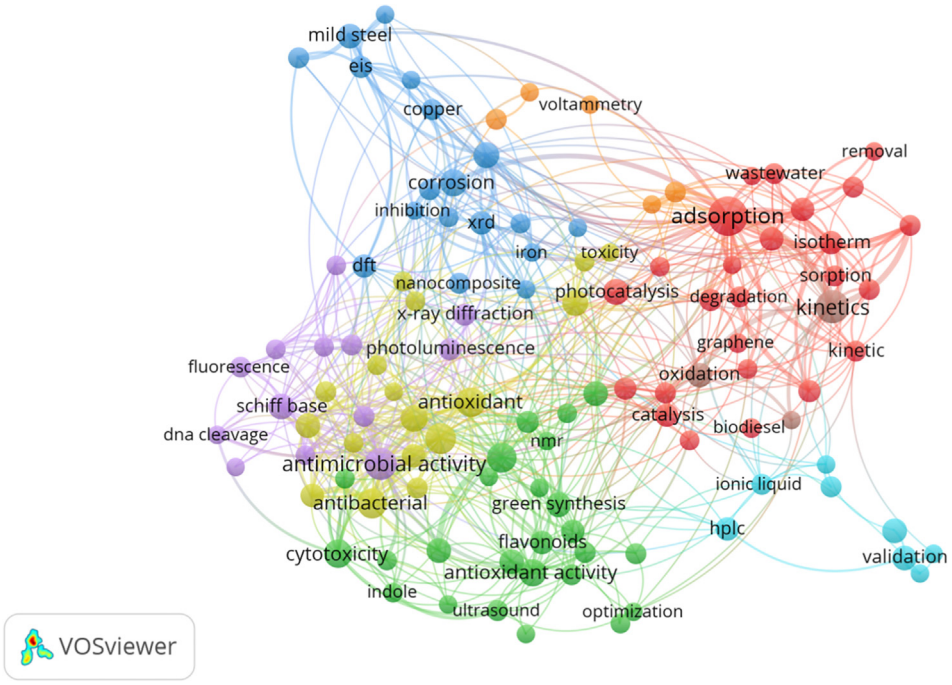


Fig. 7 Co-words analysis of keywords.

dynamics, thermal properties, activated carbon, adsorption, optical properties, polarization, and oxidation in this category.

e) **Biological Screening**

Biological screening tool is used as promising strategy for the identification of innovative antimicrobial and anti-inflammatory agents. This tool is used for over half a century and is modified constantly in order to develop novel natural and synthetic therapeutic agents. Under this title, we compiled those words that indicate the focus of researchers in this domain. The words like anti-inflammatory, anti-inflammatory activity, antibacterial, antibacterial activity, anticancer, anticancer activity, antifungal, antifungal activity, antimicrobial, antimicrobial activity, antioxidant, antioxidant activity, biological activity, apoptosis, dna cleavage are compiled in this class.

f) **General Words**

Under this class, we collected those keywords that are frequently used in all group of research. Oxidative stress, removal, response surface methodology, and validation

We can conclude that the overall publications focused on synthesis or using standard compounds, drugs or nanoparticles, their characterizations, kinetics & thermodynamics and their biological efficacies.

3.4. Section four (4)

The Brief Description of The Top Ten (10) Most Cited Documents

We also identified the most influential papers in total publications (2634), on the basis of citations. 105 publications were found with atleast 50 citations, or 32 documents showed atleast 100 citations. The details of the top 10 documents are described in Table 16.

In the top most cited review (1261 citations), the author focused on removal of heavy metal from industrial wastewater by discussing innovative techniques such as absorption on new absorbents, electrodialysis, membrane filtration and photocatalysis. They cited 94 references and concluded that membrane filtration and new adsorbent are the two most efficient methods used for treatment of metals contaminated wastewater. Lime precipitation method is used for removal of inorganic effluents. Based on simplicity, cost effectiveness, photocatalysis will be promising method in near future (Barakat, 2011).

In 2nd most cited review (584 citations) the authors discussed the synthesis and applications of nanoparticles (NP) with size less than 100 nm. NP exhibits significant chemical, physical and biological properties which attract the attention for wide range of applications in various domains. They exhibit different properties as compared to bulk materials like high surface, particles size and quantum confinement. The authors concluded that silver NPs are influenced shape, size and are varied by synthetic methods, reducing agents and stabilizers (Abou El-Nour et al., 2010).

In 3rd most cited (366 citations) document the author principally discussed the antioxidant efficacy of tannic acid, a natural polyphenol of plant origin. Different in vivo analytical methods such as DDPH, ABTS, total antioxidant activity, total reducing ability and hydrogen peroxide scavenging, superoxide anion radical scavenging, $Fe3+$ reducing power and metal chelating on ferrous ions activities were performed against reference antioxidant scavenging compounds. Tannic acid showed promising results in all applied techniques. The study showed that tannic acid being effective antioxidant can be used as food preservative agents or nutraceuticals (Gulcin et al., 2010).

Table 13 Different categories of co-words in the titles.

Compounds/ Chemicals	#	Analytical Technique	#	Kinetics	#
Activated carbon	11	Analysis	81	Adsorption	66
Aryl	22	Characterization	218	Kinetic	22
Carbon	29	Crystal structure	12	Kinetic study	11
Chloro	11	Spectrophotometric determination	24	Equilibrium	17
Complex	98	Spectroscopic characterization	12	Oxidation	49
Copper	38	Ultrasound	12	**Total**	165
Dihydro	10	Microwave	28		
Dye	51	Optimization	19	**Other Applications**	#
Heavy metal	13	Qsar study	22	Application	105
Iron	19	Quantification	15	Catalyst	78
Ion	50	**Total**	443	Corrosion	30
Lead	15			Corrosion inhibition	19
Metal complex	21	**Nanomaterials**	#	Degradation	32
Methyl	19	Gold nanoparticle	15	Photocatalytic degradation	13
Mild steel	17	Nanoparticle	74	Wastewater	26
Nickel	11	Silver nanoparticle	29	Water sample	14
Oxo	11	**Total**	118	**Total**	317
Phenol	12				
Phenyl	29	**General Words**	#	**Biological Screening**	#
Schiff base	36	Design	43	Antibacterial activity	28
Silica	16	Part	16	Antimicrobial activity	31
Zinc	12	Development	46	Antimicrobial evaluation	18
Aqueous medium	19	iii	40	Antioxidant activity	28
Aqueous solution	70	Influence	23	Biological activity	17
Chemical composition	19	Novel	34	Biological evaluation	26
Ionic liquid	19	One	21	Cytotoxicity	12
Derivative	174	Leafe	23	Flavonoid	11
Efficient synthesis	10	Interaction	27	Essential oil	25
Preconcentration	14	Fabrication	13	Extraction	43
Poly	36	Validation	20	Pharmaceutical formulation	15
Pot synthesis	20	Presence	19	Pharmacological evaluation	11
Synthesis	565	**Total**	325	Vitro	14
Green synthesis	21			Effect	117
Stability	36	**Study**	#	Removal	93
Structure	31	Comparative study	12	Property	130
Water	43	Evaluation	77	Separation	21
Solvent free condition	13	Investigation	40	**Total**	640
Preparation	59	Determination	131		
Reaction	61	Theoretical study	11		
Total	1761	Study	259		
		Review	30		
		Simultaneous determination	18		
		Total	578		

In the 4th most cited document (362 citations) the authors focused on metals nanoparticles (NPs) properties and its application in various areas. The size of NPs can range from 1 to 100 nm. On the bases of shape, properties or size nanoparticles are classified into different classes like flullerenes, metal NPs, polymeric NPs, and ceramic NPs. Due to their high surface and nanoscale size they possess unique physical, optical and chemical properties. They are suitable for commercial applications due to certain characteristic like reactivity and toughness. However, stability of heavy metals like Pb, Hg, and tinnaoparticles lack its degradation thus causes environmental toxicities (Khan et al., 2019).

In this report (5th highly cited document with 310 citations) the authors studied the ability of activated carbon prepared from coconut husk with H2SO4 activation (CSAC). It was characterized by FTIR and SEM. They also studied various physiochemical parameters including contact time, adsorbent dosage, particles size, pH of dye solution. Chemisorption, intra-particles diffuse, pseudo-first and second order was also calculated. Thermodynamics parameters like Gibbs free energy, entropy and enthalphy were also calculated. Data was evaluated by different Langmuir, Freundlich, Temkin isotherms (Aljeboree et al., 2017).

In this study (6th most cited document with 293 citations) the authors synthesized or prepared the activated carbon from Ficuscaricabast (FCBAC) and they explored methylene blue (MB) uptake by FCBAC. Various parameters like initial dye concentration, contact time, adsorbent doasage, temperature, and pH os solution were calculated. Langmuir, Freundlich and Temkin isotherm models were used to show adsorption

Table 14 Different categories of co-words in the abstracts.

Compounds/ chemicals	#	Analytical technique	#	Biological Screening	#
Acid	446	13c nmr	76	Antibacterial activity	91
Aqueous solution	150	1 h nmr	146	Antimicrobial activity	110
Complex	210	Analysis	548	Antioxidant activity	66
Compound	589	Condensation	85	Agent	209
Concentration	514	Electron microscopy	130	Escherichia coli	99
Concentration range	81	Elemental analysis	168	Extraction	105
Copper	62	Characterization	85	Model	256
Dye	93	Fourier	90	Plant	95
Ethanol	61	Ft ir	123	Staphylococcus aureus	78
Metal ion	69	Ftir	124	Pseudomonas aeruginosa	53
Methanol	79	G ml	78	Vitro	66
Methyl	91	Electrochemical impedance spectroscopy	51	Treatment	136
Mixture	134	X ray diffraction	151	Activity	517
Ion	199	Xrd	187	Efficiency	196
Molecule	143	Spectroscopy	268	Effect	479
Ligand	130	Mobile phase	63	Influence	79
Phenyl	73	Technique	348	Removal	162
Poly	65	Tem	97	Recovery	110
Synthesis	291	Sem	188	Property	366
Synthesized compound	107	Tga	73	**Total**	3273
Composition	137	Transmission electron microscopy	77		
Derivative	282	Quantification	59	**General Words**	#
Drug	153	Flow rate	71	Accuracy	81
Catalyst	196	Precision	82	Basis	81
Product	205	Sample	284	Series	218
Degradation	91	**Total**	3652	Addition	175
Solution	276			Advantage	74
Solvent	142	**Kinetics**	#	Change	118
Stability	155	Adsorption	217	Development	78
Preparation	118	Adsorption process	62	Case	71
Structure	401	Condition	381	Iii	100
Water	187	Contact time	70	Increase	163
Nanoparticle	170	Kinetic	124	Type	154
Range	291	Langmuir	80	Use	143
Amount	149	Mechanism	197	Value	340
Nature	122	Min	141	Work	198
Total	6662	Oxidation	119	First time	62
Application	189	Rate	178	Formation	202
Corrosion	63	Reaction	449	Interaction	155
Total	252	Order	200	Level	134
		Room temperature	74	Limit	120
Study	#	Temperature	315	Number	86
Comparison	75	Parameter	313	One	72
Detection	139	Thermodynamic parameter	55	Term	62
Determination	239	Time	338	Presence	320
Experimental data	63	Process	265	Size	159
Morphology	103	Surface	193	Respect	56
Paper	106	**Total**	3771	**Total**	3422
Study	653				
Present study	105				
Detection limit	67				
Data	308				
Total	1858				

equilibrium. The authors concluded that the adsorption of MB on FCBAC follow second order kinetics and the process was endothermically spontaneous in nature (Pathania et al., 2017).

In the 7th highly cited documents (286 citations) the authors briefly discussed the economic benefits of nanotechnology around the globe. Researchers are interested in the study of nanomaterial manufacturing due to its various applications in several fields. Electrospinning technique, widely used in 20th and 21th centuries is applied for manufacturing of nanomaterial due to its fabricated nanostructures potential.

Table 15 Different categories of co-words in the keywords.

Compounds/ Chemicals	#	Biological Screening	#	Analytical Technique	#
Activated carbon	18	Anti-inflammatory	16	Potentiometry	10
Catalyst	11	Antibacterial	39	Characterization	22
Chitosan	12	Antibacterial activity	43	Crystal structure	10
Copper	14	Anticancer	18	Cyclic voltammetry	12
Coumarin	11	Anticancer activity	12	Density functional theory	13
Heavy metals	19	Antifungal	23	Dft	14
Indole	12	Antifungal activity	25	Dna cleavage	11
Ionic liquid	15	Antimicrobial	30	Eis	18
Lead	14	Antimicrobial activity	56	Ftir	12
Metal complexes	10	Antioxidant	39	Gc–ms	13
Methylene blue	11	Antioxidant activity	30	Hplc	17
Mild steel	19	Biological activity	13	Hptlc	11
Preconcentration	15	Biosorption	11	X-ray diffraction	17
Pyrazole	12	Cytotoxicity	33	Xrd	21
Schiff base	27	Essential oil	20	Microwave	15
Schiff bases	16	Extraction	16	Microwave irradiation	18
Green chemistry	13	Flavonoids	19	Ultrasound	15
Green synthesis	22	Inhibition	11	Spectrophotometry	25
Synthesis	44	**Total**	454	Spectroscopy	12
Solvent effect	10			Qsar	22
Total	325	**Study**	#	Sem	26
		Response surface methodology	10	**Total**	334
Other Applications	#	Thermal analysis	13		
Corrosion	32	**Total**	23	**General words**	#
Corrosion inhibition	13			Validation	24
Catalysis	20	**Kinetics**	#	Oxidative stress	11
Heterogeneous catalyst	11	Adsorption	103	Fluorescence	11
Photocatalysis	19	Isotherm	20	**Total**	46
Wastewater	15	Kinetic	15		
Wastewater treatment	11	Kinetics	60	**Nanomaterials**	#
Water treatment	11	Thermal properties	10	Gold nanoparticles	12
Total	132	Thermodynamics	14	Nanocomposite	11
		Oxidation	27	Nanoparticles	23
		Sorption	15	Silver nanoparticles	17
		Total	264	**Total**	63

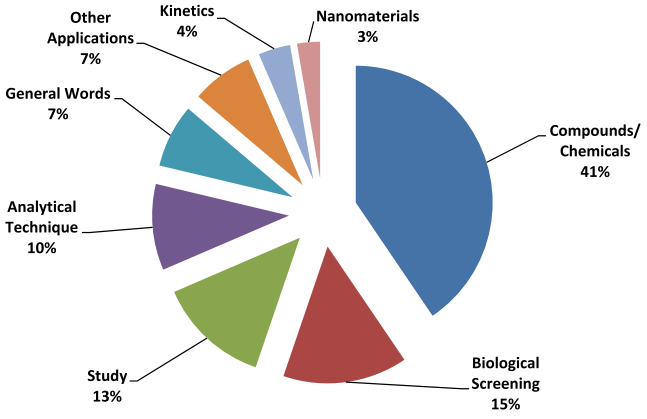


Fig. 8 Co-words categories in titles.

However, the authors focused on many operational parameter like polymer concentration, applied electric field, solution conductivity that affect nanofibers fabrication and its application

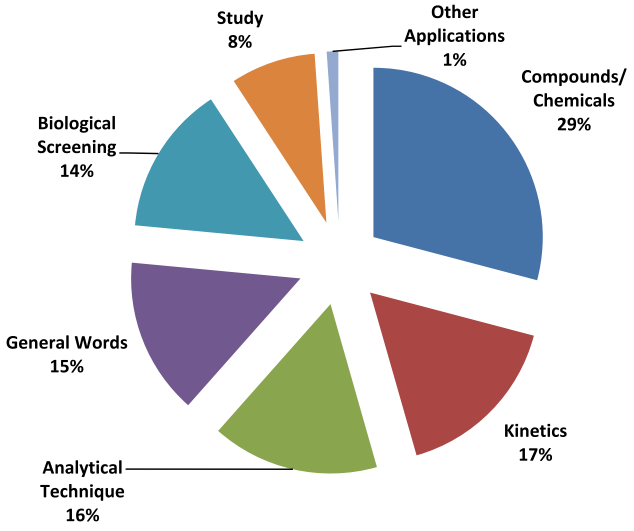


Fig. 9 Co-words categories in abstract.

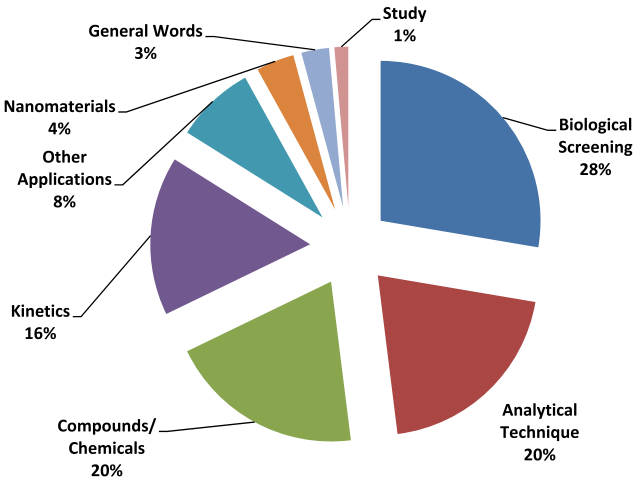


Fig. 10 Co-words categories in keywords.

in several fields like biosensors, desalination, filteration, wound dressing and tissue engineering (Haider et al., 2018).

In this report which is the 8th most cited (246 citations), the authors prepared silver nanoparticles in olive leaf extract and evaluated its antibacterial activity against resistant bacterial isolates. Synthesized silver nanoparticles were characterized by UV–Vis spectroscopy, XRD, SEM, TGA. Furthermore, effects of extract concentration, pH, temperature, contact time and shape of Ag nanoparticles were also calculated. The AgNps inhibit bacterial growth at concentration of 0.03–0.07 mg/ml which indicated its promising antibacterial potential at lower concentration and can be a good nutraceutical for future (Khalil et al., 2014).

The author studied (9th most cited document with 243 citations) polyvinyl alcohol polymers (PVA/polymers) blends hydrogel using crosslinking types for polymeric dressing material. The purpose of the study was to investigate the biocompatible synthetic polymers like starch, alginate, chitosan and their derivatives. The authors highlighted that these blended polymers have several medical applications like wound dressing, artificial material, drug delivery and are used for other medicinal purposes (Kamoun et al., 2015).

This is the 10th most cited document (229 citations) where, the authors focused on superhydrophobic surfaces and its efficacy both in academic and industry. Corrosion of metals had become a serious threat to various appliances and systems like automobiles, aircrafts, pipelines and naval vessels. Superhydrophobic surfaces has an inherent range of useful properties which are beneficial to industrial applications. Researchers are keen and working to introduce procedures for the fabrication of such useful surfaces by employing simple methods and investigating effects of surface properties, such as morphology,

Table 16 List of top 10 most cited research article with year of publication, total citations (TC), without selfcitations (WSC), crossRef citation indexes, mendeley reader and field-weighted citation impact. The scopus metrics for (Crossref citation indexes, Mendeley reader and field we..) is for all citations. Field-Weighted Citation Impact shows how well this document is cited when compared to similar documents. A value greater than 1.00 means the document is more cited than expected.

S#	Authors	Title	Year	TC	WSC	CrossRef Citation Indexes	Mendeley Reader	Field-Weighted Citation Impact
1.	Barakat M. A., et al.,	New Trends In Removing Heavy Metals From Industrial Wastewater	2011	1224	1221	816	3126	4.67
2.	Abou El-Nour K.M. M., et al.,	Synthesis And Applications Of Silver Nanoparticles	2010	564	563	413	1568	1.48
3.	Gain I., et al.,	Radical Scavenging And Antioxidant Activity Of Tannic Acid	2010	356	350	236	437	6.73
4.	Khan I., et al.,	Nanoparticles: Properties, Applications And Toxicities	2019	298	298	195	3222	35.47
5.	Aljeboree A.M., et al.,	Kinetics And Equilibrium Study For The Adsorption Of Textile Dyes On Coconut Shell Activated Carbon	2017	292	264	93	683	28.2
6.	Pathania D., et al.,	Removal Of Methylene Blue By Adsorption Onto Activated Carbon Developed From Ficus Carica Bast	2017	271	270	64	605	26.14
7.	Haider A., et al.,	A Comprehensive Review Summarizing The Effect Of Electrospinning Parameters And Potential Applications Of Nanofibers In Biomedical And Biotechnology	2018	245	244	139	1238	11.98
8.	Khalil M. M.H., et al.,	Green Synthesis Of Silver Nanoparticles Using Olive Leaf Extract And Its Antibacterial Activity	2014	237	234	148	554	9.63
9.	Kamoun E. A., et al.,	Crosslinked Poly(Vinyl Alcohol) Hydrogels For Wound Dressing Applications: A Review Of Remarkably Blended Polymers	2015	235	229	124	658	3.36
10.	Mohamed A.M.A., et al.,	Corrosion Behavior Of Superhydrophobic Surfaces: A Review	2015	220	218	186	505	3.07

roughness, and surface chemistry on surface wetting and stability (Mohamed et al., 2015).

3.5. Section five ranking details of AJC

3.5.1. Journal Citation Report (JCR)

a) **Total Cites**

Its worthy to note that the total sum of citation received by a journal from all those journals indexed in JCR (Journal Citation Report), in that year is termed as total cites. Table 17 gives detailed information about total cites of AJC. From our data we analyzed that total cites consistently increased from 2011 to 2019.

b) **Three (3) years Impact Factor**

Impact factor or journal impact factor is a parameter used to measure the average citation received to an article in the preceding two years duration. The Impact factor is calculated for any journal after a minimum period of three years of publication. IF and IF with self cites, is calculated for AJC. From 2011 to 2016, it shows a regular increasing trend but in 2017 and 2018 it decreases as shown in Table 17.

c) **Five (5) Year Journal Impact Factor**

Another parameter used to indicate the annual productivity of a journal is 5- Years Impact Factor. This indicator was introduced in 2009 by JCR. It reflects the total number of times the published article, cited by other JCR listed journals in the last five years. It gives a broader vision of total citation data. It is considered as long term citation trend in journal. We cannot implement 5-year impact factor to an individual author's document, organizations, research group, and countries. Infact, it could be considered as five-year window. Since the AJC was launched from 2009, therefore the 5 years impact cannot be applied on 2011–13. The highest 5-years impact was recorded for the year 2016 i.e. 5.388. In other words it remained higher than 4 in 5 years. The data is presented in Table 17.

d) **Immediacy Index**

The immediacy index indicates that how rapidly an article from a journal is cited by other in the same current year it is published and become a part of literature. High immediacy index of a journal increase the citation chances of a research document in the same year of publication. Similarly, it is also helpful for the publishers to assess a journal. To evaluate the immediacy Index of AJC, we divided it into three phases as shown in Table 17. For the years 2011–13 it was increased. While in 2014–16 it followed a zig-zag pattern. In 2017–18 it increase from 0.308 to 2.314.

e) **Citable Items**

Citable items included all those research documents or items such as review, articles, and editor letters, proceedings papers that are identified by Web of Science (WOS) and are most cited by other articles are term as citable items. Table 17 shows detail information about citable Items. It followed an increasing trend except in the year 2015 (116) and 2018 (121) respectively.

f) **% Articles in Citable Items**

The percentage of total number of articles that are counted in total countable items is termed as % article in citable items. It indicates the original research of any journal. We analyzed the % articles in citable items of AJC. Above 90% per year results were obtained for % articles in citable items (as shown in Table 17).

3.5.2. SCImago quartile data and Scopus journal ranking of AJC

a) **CiteScore**

This measure the annual average citation received by research article issued in a journal series. This parameter was introduced in 2016 by Elsevier. It gives comprehensive review about journal impacts. It can be calculated as;

CiteScore = citation count in N documents / documents (N-3) – (N −1)

Table 17 The per year total cites, journal impact factor, impact factor without journal self cites, 5 year impact factor, immediacy index, citable items and % articles in citable items retrieved from the journal citation report (JCR).

S#	Year	Total Cites	Journal Impact Factor	Impact Factor Without Journal Self Cites	5 Year Impact Factor	Immediacy Index	Citable Items	% Articles in Citable Items
1.	2019	8485	4.762	4.691	4.57	1.797	502	93.63
2.	2018	6620	3.298	3.278	4.039	2.314	121	97.52
3.	2017	4266	2.969	2.897	4.008	0.909	614	95.44
4.	2016	2784	4.553	4.508	5.388	0.308	237	91.98
5.	2015	1712	3.613	3.598	4.136	0.741	116	90.52
6.	2014	945	3.725	3.417	3.39	0.418	146	95.21
7.	2013	561	2.684	2.684	n/a	0.604	53	92.45
8.	2012	299	2.266	2.202	n/a	0.343	67	91.04
9.	2011	103	1.367	1.317	n/a	0.242	66	95.45

Table 18 The per year SCImago quartile (Q) data and Scopus journal ranking details.

SNIP (Source-Normalized Impact Per Paper)		2.349								
SCImago Quartile Data										
Years	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
General Chemical Engineering	Q3	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q1
Chemistry (Miscellaneous)	Q4	Q3	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q1
Scopus Journal Ranking (Citescore rank and trend)										
Years										
General Chemical Engineering	–	151/257	86/286	54/270	55/273	45/278	59/277	48/278	30/273	22/281
Chemistry (Miscellaneous)	–	230/251	143/359	93/366	91/373	78/376	96/370	81/369	59/375	45/398
SJR (SCImago Journal Rank)	0.133	0.262	0.353	0.360	0.549	0.555	0.554	0.591	0.605	0.779

Where, N = Number of published documents,
(N-3) – (N –1) = Number of published documents in three consecutive years.

b) **Scimago Journal Rank (SJR)**

This parameter is based on the Scopus data. It works on the centrality concept that was first introduced in social network analysis. It has multiple applications that included the recognition of the most influential person's in social network, identification of major infrastructure of nodes in internet, etc. SJR also gives detail information about quartiles. Base on quartiles the journal is classified into four categories.

1) Q1, covered top 25 of journal list,
2) Q2 occupied 25–50% of groups on journal's list,
3) Q3 represented 50 to 75% of groups in list.
4) Q4 covered 75 to 100% groups in the journal list.

From 2010 to 2019, the Quartile of AJC is shown in Table 15. In 2019 it entered Q1 state. However, the exact ranking, number of total journals and percentile of AJC is obtained from Scopus database, which is displayed in Table 18. It's apparent from the data that AJC consistently improved the ranking in two broad categories i.e. general chemical engineering and chemistry (miscellaneous). This confirms the growth, quality and ranking of AJC.

Limitations

There are some limitations in our study. We used Scopus database, which has a wide range of data and is convenient for bibliometric analysis. However, other databases such as Web of Science were not included in the study. Furthermore, we did not verify the Scopus data, for example, comparing the number of citations identified in Scopus with Web of Science. Another limitation of the work is that it was very "difficult" to deal with duplicates or several forms of writing for each type of unit. (i.e., USA and United States of America, etc.). Similarly the co-words analysis was based on the title, abstract or keywords, only. The full text publications were not thoroughly analyzed for co-occurrence of words, etc. More over in the future, it will be interesting to compare the AJC with other relevant journals in different relevant categories.

4. Conclusion

From 2009 to 2019, AJC has published 2134 documents. We calculated the relative growth rate, doubling time and also performed ANOVA analysis of publications. The bibliometric analysis was performed with principal focus on several indicators like total number of publications (tp), total number of citations (tc), h-index, citation per paper or document (cpd) and h-index with and without self-citations. Based on these parameters, the details of the top 10 most prolific authors and universities are provided. We also noted that AJC has a wide range of authors from all over the world. For example, eighty eight (88) countries from different geographies have significantly contributed in all publications. Based on the number of publications the top five countries are India, Saudi Arabia, Egypt, Iran and China. We also briefly discussed the top ten (10) most cited documents. By VOSviewer, we analyzed and discussed the co-authorship, citations and co-citations patterns in all publications. The common trend in publications were decoded and described on the basis of co-words analysis. We also retrieved data from SCImago journal rankings, which confirmed the Q1 state of AJC in 2019. While, details about the AJC impact factor, its 5 year impact factor, immediacy index and average journal impact factor percentile confirm that AJC is following a right direction. From the analysis of the most cited publication and authors, it was possible to see that AJC paper have a good permeation in important subareas of chemistry such as nanoparticles, instrumental analysis or characterizations, kinetics and thermodynamic, and biological screening. The importance of the AJC to the international scenario has been confirmed by its very good recent released CiteScore (8.2) and Impact Factor (4.762).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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