Summer 5-18-2017

Authorship Pattern and Collaboration Coefficient of India in Biotechnology research during 2001-2016: Based on Scopus Database

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Abstract

The study presents the growth trend about authorship pattern and author collaboration in the Biotechnology for sixteen years with the sample of 18918 articles which have been collected from Scopus database during year 2001-2016. A predefined search string has been used for data download. The five scientometric tools collaboration coefficient (CC), authorship pattern (AP), activity index (AI), Relative Growth Rate (RGR) and Doubling time of Literature (Dt.) have been used for the data analysis. The average number of authors per article for India has been counted as 4.92. In the study, the collaboration coefficient for 16 years (2001-2016) is noticed as 0.63 for India. The study shows that multi- authorship articles are higher in average and they are dominant over single authorship pattern. The science growth rate is always useful for the study, so that relative growth rate and doubling time of literature tools have been used for the study to explore needs of manpower and finance for future and present research activity. The mean of relative growth rate for sixteen year shows the decreasing rate and for last four years its pattern of publication is stable. The corresponding doubling time for different years [Dt (P)] gradually fallowed the increasing pattern. It has been found that majority of the Biotechnology researchers are working through team research or collaborative research rather than individual research. The average activity index of India for sixteen years is counted as 91.78. The highest AI year for India is 2016 with 180.3 whereas the lowest counted in 2001 with 42.38. The international collaboration pattern shows for India, United States is the most favoured nation.

Keywords

Scientometrics Analysis, Biotechnology, Collaboration coefficient, Authorship Pattern, Relative Growth Rate, Doubling Time of Publication, and Activity index.

1-Introduction-

India has 2nd largest population in the world after china but it is expected that it will cross china after 2030[1]. Recently some research findings and data analysis indicates that only India can fulfill the hunger needs of its large population after 2025. The India is suffering from the global warming effect which is causes of rainfall discontinuity that is affecting the agriculture production. It is expected that agricultural production of India will decrease 10% to 20% till 2030 so that India will face the bigger problem than expected. In this time India's GDP (Gross Domestic Product) is taking the higher peak in every year, but India still continue fighting with poverty, hunger, prize inflation, income differences, unemployment and global warming. Another hand India known as the largest and reputed democratic nation in the world so that it necessary to fight with these problems by enhancing research activity. The biotechnology can solve the India's problem which is above discussed so that we will conduct study in this article for current and future development of Indian biotechnology research activities.

2-Review of Literature-

Cronin, Shaw, and Berre [2] inspect the co-authorship and sub authorship collaboration in the scholarly journal literature of Psychology and Philosophy and they highlights the rates of co-authorship. They found that among a total of 2,707 articles of 2001, (74%) are single authored were dominant on other collaboration pattern. Basu & Kumar [3] studied about the scientific collaboration of India on international level for the period of 1990-1994. In the study, they found the growth feature of collaboration pattern by the using of Science Citation Index (SCI) database. Garg & Padhi,[4] examine the collaboration pattern of laser science and technology. In the study, majority of the papers related with domestic and international collaboration at the domestic and international level. The China, Israel, Netherlands, and Switzerland are dominate on the international level in research collaboration. They also examined the comparative study of G7 countries with China and found that the United States is top collaborator country for China compare to all the G7 countries. Shariatmadari & Mahdi [5] studied the existing barriers of research productivity and their data based on faculty member's perspectives of Islamic Azad University. Hadimani & Rajgoli [6] conducted study on Applied Engineering in Agriculture research field. The result shows that 128 articles were published in 2007 and a minimum number of 98 articles were published 2007. The authorship pattern revels that three-author articles higher than another pattern with 27.88 %, followed by 23.79 % of four-author articles, and 20.26 % of two-author articles.

3- Biotechnology research in India-

Biotechnology can be approached in to different angles. It describe by someone as "a field of technological activity in which biochemical, genetic, microbiological, and engineering techniques are combined with the pursuit of technical and applied aspects of research into biological materials and in particular, into biological processing" [7] India is the first few country in the developing world that understand the importance of biotechnology which is continue support and advanced the agriculture and health sectors. The National Biotechnology Board was set up in 1982 as in apex agency to spearhead the development of biotechnology in India. It is chaired by Science Member

of the Indian Planning Commission with representation from almost all prominent science and technology agencies in the country. The NTBT was formed with the specific purpose of identifying priority areas and for evolving a long-term plan for the country. The NTBT, through the " Long Term Plan in Biotechnology for India" in April 1983, spelt out priorities for biotechnology in India in view of national objectives such as self-sufficiency in food, clothing and housing, adequate health and hygiene, provision of adequate energy and transportation, protection of the environment, gainful employment, industrial growth and balance in international trade. In 1986, realizing the need for a separate department to promote and direct the development of biotechnology, the Government of India created a new department, Department of Biotechnology (DBT).

At present, there are seven major agencies in India responsible for financing and supporting research in the realm of biotechnology apart from other sciences. They are: Department of Biotechnology (DBT), Department of Science and Technology (DST), Indian Council of Agriculture Research (ICAR), Indian Council of Medical Research (ICMR), University Grants Commissions (UGC), Department of Scientific and Industrial Research (DSIR), Council of Scientific and Industrial Research (CSIR) DBT, DST and DSIR are part of the Ministry of Science and Technology, while ICMR is with the Ministry of Health, ICAR with the Ministry of Agriculture and UGC with the Ministry of Human Resource Development. [8]

4-Objective of Study

1- To know the year wise publication distribution pattern of India.

2- To measure the collaborative coefficient ratio of India.

3-To find out nature of authorship pattern in biotechnology research.

4- To measure the Activity Index of India as the individual country.

5- To known the relative growth rate and doubling time of Biotechnology publications.

5-Data and Methodology

Methodology related to the principles and procedures which enhance the approaches to find the solution. In the scientometric study, various subject, type of indices are used. For the comparative study, these indices are studied and reviewed. An international online bibliographic database Scopus has been taken up for the study. Scopus is a bibliographic database which is containing abstracts and citations for academic journal articles. It covers nearly 22,000 titles from 5,000 publishers, along with 20,000 peer-reviewed journals in the scientific, technical, medical, and social sciences (including arts and humanities) studies.[9] It is owned by Elsevier and is available online by subscription. Searches in Scopus also associated with searches of patent databases.

The following search string (Biotechnology OR biomedicine OR bioremediation OR biosynthesis OR bioinformatics OR bioengineering OR biogenetics OR biomedicine OR cell biology OR biofuels) has been adopted for the extracting data of biotechnology. There are 18917 records available in Scopus database during the period of study 2001-2016. These records along with full bibliographical details such as Title, Authors, Source, Year, Abstract, Affiliation, Language, Document Type, etc. have been extracted from Scopus database. The extracted data from the database further processed and analyzed by using Microsoft Excel and SPSS (Statistical Package for Social Scientists) software. The extracted data has been tested by the scientometrics tools and techniques to ascertain the fulfillment of objectives and measurement methods which are discussed in below.

5.1 Collaborative Coefficient

The methodology of Collaboration Coefficient has been suggested by Ajiferuke[10]. It is based on the counting of fractional productivity defined by Price and Beaver[11]. It is given by following formula below:

$$CC = 1 - \frac{\sum_{j=1}^{k} \left(\frac{1}{j}\right) f_j}{N}$$

Here, *Fj* denotes the number of *j* authored research papers*;*

N denotes total number of research papers published;

and *k* is the greatest number of authors per paper.

It is observed by Ajiferuke, that CC will indicate zero when a single-authored papers dominate and counted 1-1/*j* then *j* authored papers being dominate. This implication shows that higher the value of CC, means higher the probability of multi or mega authored papers.

5.2 Activity Index

Activity Index accounted as relative research effort of a particular country in a given field and it is explained as

AI= {(given field's share in the country's publication output) / (given field's share in the world's publication output)} x 100

In this study activity index of India is being calculated for different years to see how India's research performance has changed in different years by using the suggested formula which has been given by Frame and further used by Sehubert and Braun (1986)[12], Price (1981)[13], Karki and Garg (1997)[14] characterize activity index as a counting methodology of relative research effort of a country in the given research field. Mathematically it counted as:

AI = { (Ii / Io) / (Wi / Wo) } x 100

Whereas

Ii = Indian output in the year i

Io = Total Indian output

Wi = World output in the year i

Wo = Total output

5.3-Relative Growth Rate and Double Time of publications

5.3.1 Relative Growth Rate (RGR)

It is recently noticed that science growth rate is always useful for the study, it may use to verify needs of manpower and finance for future and present research activity. The explosion of literature represents an aspect of the common growth of scientific communication. Wooster[15] has discussed, that number of journals are existed in the world at the single time, whereas some other estimates that a number of papers published annually at various times which were done by Vickery[16] Martyn[17] Gottschalk and Desmond.[18] The literature Growth studies on other scientific areas were included the work of Baker[19] in chemistry, Conard[20] in biology, Sengupta[21] in microbiology, physiology, and biochemistry. The Relative Growth Rate (RGR) counted the of increase number of articles/pages per unit of time. This definition is taken from the definition of relative growth rates. In the study of growth analyses of individual plants and it has been effectively applied in the field of botany, which in turn had its origin from the study of the rate of interest in the financial investment. The mean Relative Growth Rate (R) over the specific period of the interval can be calculated from the following equation:

$$1-2\overline{R} = \frac{\mathrm{Log}_{e2}W - \mathrm{Log}_{e1}W}{2^{T} - 1^{T}}$$

Whereas:

1-2R = mean relative growth rate over the specific period of interval
$\log_{e1} W$ = log of the initial number of articles/pages

$\mathrm{Log}_{e2} W$ = log of the final number of articles/pages after a specific period of interval
2T - 1T = the unit difference between the initial time and the final time

The year can be taken here as the unit of time. The RGR for both articles and pages can be calculated separately.

Therefore

$1\text{-}2^{R\ (aa\text{-}1Year\text{-}1)}$ can represent the mean relative growth rate per unit of articles per unit of a year over a specific period of interval.

$1-2^{R\,(pp\text{-}1Year\text{-}1)}$ can represent the mean relative growth rate per unit of pages per unit of a year over a specific period of interval.

5.3.2 Doubling Time (Dt)

A direct equivalence has existed between the relative growth rate and the doubling time. If the number of articles/pages of a subject doubles within a given period then the difference between the logarithms of numbers at the beginning and end of this period must be the logarithms of number 2. If the natural logarithm is used this difference has a value of 0.693. Thus the corresponding doubling time for each specific period of interval and for both articles and pages can be calculated by the following formula:

Therefore

$$\text{Doubling time} = \frac{0.693}{\overline{R}}$$

$$\text{Doubling time for articles Dt (a)} = \frac{0.693}{1-2^{\overline{R}\,(aa\text{-}1year\text{-}1)}}$$

$$\text{Doubling time for pages Dt (p)} = \frac{0.693}{1-2^{\overline{R}\,(pp\text{-}1year\text{-}1)}}$$

6-Scope and Limitation

The study covers sixteen year period between 2001 and 2016, both years are inclusive. Records during the period of study have been downloaded from SCOPUS online database. Generalization of study has been based on the downloaded data pertained to the sixteen years of the study period. India that falls in period and coverage of this study has alone been taken as a standard geographical entity for this research investigation. Any later proposal for the inclusion or exclusion of possible change of nomenclature after 2016 is not taken into the consideration for India of this study. The 18918 data have been used for the study.

7- Result and discussion

7.1 - Year wise distribution of publication-

The table 1 is showing that India's growth rate of biotechnology entered in the transition face after 2012. In the sixteen-year time spam 48.8 % of total publications added between years 2013 to 2016. The lowest has been counted in biotechnology research counted in 2001 with the 1.55% of total publications. After that, it is increasing every year and taken highest in 2014 with 13.29%

publication as a hole. The research publication year 2015 and 2016 has been noticed as decreasing year in the sixteen year period.

Table No.1 Year-wise distribution of publication

Year	Total article	Percentage of Article	cumulative
2016	2034	10.75	10.75
2015	2503	13.23	23.98
2014	2515	13.29	37.27
2013	2020	10.67	47.94
2012	1728	9.13	57.07
2011	1509	7.97	65.04
2010	1272	6.72	71.76
2009	1010	5.33	77.09
2008	900	4.75	81.84
2007	715	3.77	85.61
2006	629	3.32	88.84
2005	516	2.72	91.56
2004	454	2.39	93.95
2003	408	2.15	96.1
2002	411	2.35	98.45
2001	294	1.55	100
TOTAL	18918	100	

7.2 -Collaboration Coefficient-

The collaboration coefficient counted by the formula which is given in the data and methodology part 5.1. The measurement method of CC suggested by the Ajiferuke and define by Price and Beaver. The average CC 0.62 of India has been counted between years 2001-2016. In table 2 highest CC 0.76 come in 2005 and lowest 0.34 in 2016. The study reveals that Indian authors CC pattern has been decreased in year 2016. The two author Collaboration dominates on Indian collaboration pattern. There is 4249 two author collaboration has been seened in 18917 publications. It seems that three author pattern with 4208 publication is slightly less than single collaboration pattern. I also studied other countries collaboration pattern but I did not seen that two authors generally dominates on another collaboration pattern.

Table No. 2 Collaboration Coefficient of India

Year India	Single Authored Paper	Two-Authored Paper	Three Authored Paper	Four Author Paper	Mega-Authored Paper	Total	Collaboration Coefficient (CC)

2016	153	425	413	304	739	2034	0.34
2015	178	525	505	396	899	2503	0.64
2014	151	506	559	447	852	2515	0.65
2013	133	452	409	380	646	2020	0.64
2012	133	360	391	310	534	1728	0.63
2011	121	341	352	269	426	1509	0.62
2010	120	286	271	232	363	1272	0.61
2009	98	239	256	164	253	1010	0.60
2008	79	222	193	182	224	900	0.61
2007	86	175	178	122	154	715	0.58
2006	61	147	176	97	148	629	0.60
2005	49	126	118	108	115	516	0.76
2004	53	119	104	84	96	454	0.57
2003	58	102	104	58	86	408	0.56
2002	42	130	110	61	66	411	0.58
2001	57	94	69	47	41	294	0.51
Total	1572	4249	4208	3261	5642	18918	0.62

Note- Mega-authors (paper with >4 authors)

7.3- Authorship pattern-

The India's authorship pattern shows that single author involves in 2.02% of literature but they published 8.30% article of the total. The two authorship pattern dominates on single, three and four author publication pattern with 22.46% of the total article and 10.97% of author participation. It seemed that four author papers contribute 17.23% of the article but author participation is highest 18.83 %. There is 580 article related to ten plus author with 3.06% of an article but they involve 14.24% of the total author.

Table No. 4 Authorship pattern of India

Sl. No. INDIA	Number of authors(Unit)	No. of Articles	Total No. of Authors	Percentage(%) of articles	Percentage (%) of Authors
1	Single	1572	1571	8.30	2.02
2	Two	4249	8498	22.46	10.97
3	Three	4208	12624	22.24	16.29
4	Four	3261	13044	17.23	16.83
5	Five	2125	10625	11.23	13.71
6	Six	1395	8370	7.37	10.80
7	Seven	789	5523	4.13	7.12
8	Eight	478	3824	2.52	4.93
9	Nine	261	2349	1.37	3.03
10	Ten+	580	11037	3.06	14.24
11	Total	18918	77465	100	100

7.4-Relative Growth Rate and Double Time of publication-

The relative growth Rate[R(P)] and Doubling Time [Dt(P)] of Publication given in table no. 5. It has been noticed that the Relative growth Rate of Publication [R(P)] decrease from the rate of 0.873 from 2002 to 0.113 in 2016. The mean relative growth for first four years papers 2001-2004 shows a growth rate of 0.418 whereas the mean relative growth rate of remaining three blocks of four-year are reducing continuously and in the last block 2013-2016 it stay on 0.163 that shows huge difference compare to first block data. The corresponding doubling time for different years [Dt (P)] gradually increased from 0.793 in 2001 to 6.139 in 2016. The mean rate of doubling time shows in four blocks each has been taken within the four-year time span. From first to fourth block, it increased from 1.08 to 4.43. The rate of publication growth is decreased when corresponding doubling time increased.

Table No. 5 Relative Growth Rate and Double Time of publication

Year	No. of Articles	Cumulative No. of Article	Log1c	Log2c	[R(P)	Mean [R(p)	[Dt(p)	Mean [Dt(P)]
2001	294	294	-	5.683	-	0.418	-	1.08
2002	411	704	5.683	6.556	0.873		0.793	
2003	408	1112	6.556	7.013	0.457		1.516	
2004	454	1566	7.013	7.356	0.343		2.02	
2005	516	2082	7.356	7.641	0.283	0.253	2.44	2.75
2006	629	2711	7.641	7.905	0.264		2.625	
2007	715	3426	7.905	8.139	0.234		2.961	
2008	900	4326	8.139	8.372	0.233		2.974	
2009	1010	5336	8.372	8.582	0.210	0.205	3.3	3.37
2010	1272	6608	8.582	8.796	0.214		3.238	
2011	1509	8117	8.796	9.001	0.205		3.38	
2012	1728	9845	8.796	9.194	0.193		3.59	
2013	2020	11865	9.194	9.381	0.187	0.163	3.70	4.43
2014	2515	14380	9.381	9.573	0.192		3.60	
2015	2503	16883	9.573	9.734	0.161		4.30	
2016	2034	18917	9.734	9.847	0.113		6.132	

7.5- India's Activity Index-

The India's activity index has been counted by the formula which is suggested by Braun (1986), Price (1981), Karki and Garg (1997). Formula describes in the data and methodology subpart 5.3 and its displays in table No. 7. Activity Index characterizes the relative research effort of a country to in a given research field. The activity index shows the upward growth rate from 2001 to 2016. It

seems that from 2001 to 2013 activity index rising up but for two years 2014 and 2015 it decreased eight points after that it getting new heights 180.2 in sixteen-year time. So that it can be says that activity index of India taken new place every year to achieve new heights in world biotechnology research.

Table no. 6 India's Activity Index

YEAR	INDIA
2016	2034 (180.7)
2015	2503 (138.4)
2014	2515 (137.9)
2013	2020 (146.4)
2012	1728 (127.4)
2011	1509 (121.5)
2010	1272 (95.2)
2009	1010 (80.2)
2008	900 (76.1)
2007	715 (68.3)
2006	629 (64.5)
2005	516 (52.2)
2004	454 (48.8)
2003	408 (39.2)
2002	410 (49.3)
2001	294 (42.2)
Average AI	(91.78)

9.6 International collaboration-

In the international collaboration, United States noticed as a top most collaboration country for India with 1414 publication and total of 7.45 % of collaboration. The second place has been captured by the South Korea which shows the India's partnership go through predefined boundary of countries. Germany acquires 3rd with 349 and 1.84% United Kingdom 321 with 1.69% at 4th place. It seems that only China as the neighbor country of India finds the place at 10th position with 169 total of 0.89% of total international collaboration.

Table No. 7 International Collaboration

Sr.No.	Country	Total collaboration	Percentage of collaboration
1.	United States	1414	7.45
2.	South Korea	380	2.00
3.	Germany	349	1.84
4.	United Kingdom	321	1.69
5.	Japan	276	1.45
6.	Australia	238	1.25
7.	France	214	1.12
8.	Saudi Arabia	201	1.05
9.	Canada	190	1.00
10.	China	169	0.89
11.	Italy	154	0.81
12.	Malaysia	117	0.61
13.	Spain	108	0.56
14.	Sweden	95	0.50
15.	Taiwan	94	0.49

7.7 top ten research institution of India-

The Indian Institute of Science taken top place along with 405 publication which is 2.13% of the total. Respectively Banaras Hindu University and Vellore Institute of Technology Publication 364 with 1.91% at in second place, Indian institute of technology Delhi at fourth place with 361 publications. The other institutes find their place in top ten are the University of Delhi, Indian agricultural Institute, Jawaharlal Nehru University, Indian Institute of technology (Kharagpur) the University of Kolkata at tenth place with 269 publications.

Table No. 8 top ten research institution of India-

Sr. No.	**Indian Institute**	**Collaboration**	**Percentage of total**

1.	Indian Institute of Science	405	2.13
2.	Banaras Hindu University	364	1.91
3.	Vellore Institute of technology	364	1.91
4.	Indian Institute of Technology Delhi	361	1.84
5.	University of Delhi	347	1.82
6.	Indian agricultural Institute	290	1.52
7.	Jawahar Lal Nehru University	281	1.48
8.	Indian Institute of Technology, Kharagpur	279	1.47
9.	University of Kolkata	269	1.41
10.	Bhabha Atomic Research Centre	263	1.38

Conclusion-

The study shows that India's biotechnology research growth rate is continue increasing from 294 publication in 2001 to 2515 in 2014. The rate of growth is slightly decreased in the year 2015 and 2016. The India's year wise growth rate has been touched double figure in 2013. In author collaboration, two authors dominated on other authorship collaboration pattern. The India's activity index 180.2 in the year 2016 has been noticed highest within 16 years. The average Activity Index of India has been counted 91.76 for sixteen year. The United States noticed as the top collaborative country for India. At institute level, Indian Institute of science acquired top rank with 405 publication at the institute label. The study shows that India's growth rate of biotechnology research is continue increasing from 2001 to 2014 by 294 to 2515 but in the year 2015-16 growth rate is slightly decreased.

Author Biography-

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