

COLLABORATION AND AUTHORSHIP PATTERN IN BIOTECHNOLOGY RESEARCH IN INDIA AND ISRAEL DURING 2001-2016: A COMPARATIVE STUDY

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This paper analyzes the authorship and collaborative research activity in Biotechnology using Scopus database. The collected data was analyzed by the help of Three study related scientometric tools i.e. Collaboration Coefficient, Authorship pattern and Activity Index, During the 16 years' period, the multi- authorship articles are higher in number. The study found that the researcher in Biotechnology are moving toward team research or group research rather than solo research. The average Activity Index in India per year is 91.7, which is lower than that in Israel 100.71. The international collaboration shows that the United States has taken top position as compared to India and Israel.

Keywords: Scientometric Analysis; Biotechnology; Collaboration Coefficients (CC); Authorship Pattern (AP); and Activity index (AI).

INTRODUCTION

India and Israel are politically coming closer to each other during the last few years. No wonder than many pacts have been signed between India and Israel for science and technology development. Israel has developed many state of the art agriculture technologies to meet the challenges of dry environment. The Israeli scientists are continuously working to develop efficient water saving and crop genome technology for sustaining their agriculture in the worst weather conditions. Indian monsoon system many a times has failed to sustain agriculture, creating almost similar conditions as that in Israel. The bilateral ties between the two countries are therefore in the larger interests of both the countries.

It is interesting to compare the Israeli biotechnology research status with India because while the former has a small population but strong base of scientific research, the later has the world's second largest population and many productive biotechnology research institutes. The authorship pattern and collaborative coefficient along with Activity index will find out the actual relation of these two nations in biotechnology research. The study covers year wise distribution of publications, international collaboration, ranking of most prolific institutes etc.

REVIEW OF LITERATURE

Farahat [1] studied authorship patterns of nineteen Egyptian journals of agricultural science and found that multiple-authorship was dominant and co-authored papers accounted for in the 79 % sample. Zafrunnisha and Pullareddy [2] examined the authorship pattern and degree of collaboration in a sample of 141 Ph. D theses in psychology collected from universities and found dominance of multi-authored papers over single authored papers. The degree of collaboration has been calculated as 0.53. Here, the author has made an attempt to study on Indian chemistry literature which is published during the period 2000-2009 and indexed in SCI-Expanded database for

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authorship pattern and degree of collaboration. Gupta & Karisiddappa [3] inspected population genetics collaboration patterns which are defined as the specific area. The result shows that most of the highly productive authors are also highly collaborative in nature on local, national as well as international level. Kumbar [4] studied 1518 research papers indexed in SCOPUS database which had been published by the staff of University of Mysore during the period 1996-2006. It generalized that average citations per paper have upward growth pattern from 1.53 in 1996 to 2.62 in 2003. The international collaborative research activity in the university was confined to select few subjects, such as physics 38.4 %, biochemistry 35.6 %, and chemistry 28 %. Das & Sen [5] studied the authorship pattern on Journal of Biosciences in 2000. The result shows that 18.68 % articles were single authored, 52.71 % were double and triple-authored, and remaining 28.61 % were the joint collaboration of four or more authors. Nattar [6] conducted the study on Indian Journal of Physics during 2004 to 2008 and found that 238 articles were added in 2004, along with 200 articles in 2005 out of total 829 articles. Authorship pattern shows that two-authored articles were 275, followed by 221 three-authored articles, 136 four-authored articles. The study related to geographical distribution shows that 91.64 % of contributions were made from India; 1.5 % from Bangladesh, etc. Out of 13481 citations, 8851 were found from journals and 3303 were related to books.

OBJECTIVES OF STUDY

1. To know the year-wise comparative publication distribution of the country.
2. To measure the collaborative coefficient ratio of India and Israel.
3. To find out nature of authorship pattern in biotechnology research.
4. To measure the Activity Index of an individual country.

METHODOLOGY

An international online bibliographic database called 'Scopus' has been taken for the study. Scopus is a bibliographic database containing abstracts and citations from articles of the academic journal. It covers nearly 22,000 titles over 5,000 publishers, which is included

20,000 are peer-reviewed journals in the scientific, technical, medical, and social sciences (including arts and humanities) [7]. In order to extract the records from Biotechnology literature for this study, 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. The total 18917 records were made available from the Scopus database for the period 2001-2016. These records have full bibliographical details such as Title, Authors, Source, Year, Abstract, Affiliation, Language, Document Type, etc. The data extracted from the database has been processed and analyzed using Microsoft Excel and SPSS (Statistical Package for Social Scientists) software. The extracted data were administrated by the scientometrics tools and techniques to ascertain the objectives of study.

Collaborative Coefficient (CC)

The counting methodology, Collaborative Coefficient, was first time used by Ajiferuke [8]. It is based on fractional productivity methods which is defined and further used by Price and Beaver [9]. The formula is given below:

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

Here, F_j indicate the number of j authored research papers;

N denotes the total number of research papers published,

And k is the highest number of authors per paper

The formula of Ajiferuke [8], also indicates that Collaborative Coefficient (CC) shows zero when the single-authored papers dominate and to $1-1/j$ as j -authored papers dominate. This implication denotes that higher value of CC, clearly account higher the probability of multi or mega authored papers.

Activity Index

Activity Index denotes as the relative research performance of any country in the given field and it is described as:

$$AI = \{(\text{given field's share in the country's publication output}) / (\text{given field's share in the world's publication output})\} \times 100$$

The activity index for India and Israel has been calculated for different years to see how the Indian and Israeli research activity changed during different years using the formula that was first explained by Frame and implement by Sehubert and Braun [10], Price [11], Karki and Garg [12] activity index certifies the relative research effort of a country to a given field. Mathematically:

$$AI = \{ (I_i / I_o) / (W_i / W_o) \} \times 100$$

Whereas

I_i = Indian output in the year i

I_o = Total Indian output

W_i = World output in the year i

W_o = Total output The method used for calculating AI has been explained below for research output by different nations in different blocks.

SCOPE AND LIMITATION

Records during the period of study (2001-2016) have been downloaded exclusively from SCOPUS

online database. Generalizations are based on the downloaded data pertaining to sixteen years period. Countries falling under study during the period have alone been taken into purview as the standard geographical entity for the purposes of present research investigation. The collected data consisted of 18917 for India and 3925 related to Israel for the purpose.

ANALYSIS AND RESULTS

Year-Wise Distribution of Publications

The table no. 1 shows that during the period under study, India's growth rate of publications got into double figure after 2013, and during four years from 2013 to 2016, publications in biotechnology touched 45% of the total, whereas published output of Biotechnology in Israel did not reach to double figure. Its highest growth rate has been noticed in 8.48 in 2014. As far as total published output in both countries is concerned, India's share has been 85.4 %, while remaining 14.6 % was contributed by Israel. The highest growth rate of Indian publications (13.29 %) and that of Israeli Publications (8.84) has been noticed in 2014.

Table 1: Year wise distribution of publication

INDIA				ISRAEL		
Year	Article	Percentage of individual Country	Percentage of both Country	Article	Percentage of individual Country	Percentage of both Country
2016	2034	10.75	10.68	201	5.12	1.06
2015	2503	13.23	13.17	326	8.30	1.72
2014	2515	13.29	13.34	333	8.48	1.76
2013	2020	10.67	10.66	330	8.40	1.74
2012	1728	9.13	9.23	278	7.08	1.46
2011	1509	7.97	8.06	246	6.26	1.30
2010	1272	6.72	6.81	269	6.85	1.42
2009	1010	5.33	5.35	252	6.42	1.33
2008	900	4.75	4.83	252	6.42	1.33
2007	715	3.77	3.84	236	6.01	1.24
2006	629	3.32	3.32	205	5.22	1.08
2005	516	2.72	2.72	219	5.57	1.15
2004	454	2.39	2.39	223	5.68	1.17
2003	408	2.15	2.15	202	5.14	1.06
2002	410	2.16	2.16	202	5.14	1.06
2001	294	1.55	1.55	151	3.84	0.79
Total	18917	100	85.4	3925	100	14.6

Collaboration Coefficient

The Collaborative coefficient (CC) is calculated by the formula given in the preceding paragraphs. The average CC of Israel i.e. 0.65 is higher than that of India i.e. 0.62. The two author collaboration pattern is dominated on other pattern

of author collaboration both in India and Israel. The highest CC (0.76) of India come in 2005 whereas that of Israel (0.69) has been noticed in 2015. The result shows that single collaboration is higher in Israel compared to India.

Table 2: Collaboration Coefficient India

Year	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	41	130	110	61	66	410	0.58
2001	57	94	69	47	41	294	0.51
Total	1571	4249	4208	3261	5642	18917	0.62

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

Table 3: Collaboration Coefficient Israel

Year	Single Authored Paper	Two-Authored Paper	Three Authored Paper	Four Author Paper	Mega-Authored Paper	Total	Collaboration Coefficient (CC)
2016	21	21	22	19	118	201	0.66
2015	21	29	38	31	207	326	0.69
2014	26	38	52	38	179	333	0.64
2013	36	54	51	39	150	330	0.63
2012	25	51	40	32	130	278	0.64
2011	21	34	35	40	116	246	0.66
2010	22	40	38	38	131	269	0.66
2009	27	42	28	31	124	252	0.64
2008	26	35	36	40	115	252	0.64
2007	24	42	38	28	104	236	0.63
2006	21	28	35	21	100	205	0.64
2005	19	38	29	25	108	219	0.65
2004	24	40	41	31	87	223	0.62
2003	19	34	30	33	86	202	0.64
2002	20	29	34	29	90	202	0.64
2001	21	23	23	21	63	151	0.61
Total	373	578	570	496	1908	3925	0.65

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

Authorship Pattern

The authorship pattern has been presented in table 4 and 5 of India and Israel. From the table, it is clear that two authorship pattern is mostly followed in both countries. The 5.15 % authors involve with 14.72 % in total Israeli publication and India's

10.97% authors are involved in 22.46% of total publication in the two authorship pattern. In Israel, 10.70% of author involve in six author publication where 16.83% Indian authors involve in four author publication patterns.

Table 4: Authorship Pattern India

S. No.	Number of Authors (Unit)	No. of Articles	Total No. of Authors	Percentage (%) of Articles	Percentage (%) of Authors
1	Single	1571	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
Total		18917	77465	100	100

Table 5: Authorship Pattern Israel

S. No	Number of Authors (Unit)	No. of Articles	Total No. of Authors	Percentage (%) of Articles	Percentage (%) of Authors
1	Single	373	248	9.50	1.62
2	Two	578	788	14.72	5.15
3	Three	570	1128	14.25	7.37
4	Four	496	1324	12.63	8.65
5	Five	556	1470	14.16	9.61
6	Six	370	1638	9.42	10.70
7	Seven	247	1358	6.29	8.87
8	Eight	155	1128	3.94	7.37
9	Nine	152	1008	3.87	6.59
10	Ten+	428	5205	10.90	34.03
Total		3925	15295	100	100

Activity Index

To measure the relative research effort of India and Israel a detailed account of activity index has been presented in Table 6. It calculated by the formula which is described in data methodology part that is suggested by Frame, Sehubert, and Braun (1986). The calculation shows that India followed an

upward trend in sixteen-year time where Israel shows zigzag pattern in activity index. Israeli maximum 116.9 Activity Index noticed in 2002 where the India's 180.2 Activity Index come in 2016. The lowest Activity Index of India 42 noticed in year 2002 and Israel 84.2 in 2008.

Table 6: Activity Index of India and Israel

Country Activity Index		
Year	India	Isarael
2016	2034 (180.7)	201 (85.2)
2015	2503 (138.4)	326 (87.7)
2014	2515 (137.9)	333 (87.9)
2013	2020 (146.4)	330 (115)
2012	1728 (127.4)	278 (98.5)
2011	1509 (121.5)	246 (92.1)
2010	1272 (95.2)	269 (97.7)
2009	1010 (80.2)	252 (96.1)
2008	900 (76.1)	252 (103.5)
2007	715 (68.3)	236 (109.3)
2006	629 (64.5)	205 (99.6)
2005	516 (52.2)	219 (107)
2004	454 (48.8)	223 (115.9)
2003	408 (39.2)	202 (95.1)
2002	410 (49.3)	202 (116.9)
2001	294 (42.2)	151 (103.9)

International collaboration

The Table 7 shows highest collaboration for both India and Israel with United States 1414 and 1131 publications respectively. Both countries did not find any place in their top ten

international collaboration list. The result also shows that second and third country Germany and United Kingdom have at same collaboration place both for India and Israel.

Table 7: International Collaboration

India			Israel	
S. No.	Country	Collaboration	Country	Collaboration
1.	United States	1414	United States	1131
2.	South Korea	380	Germany	345
3.	Germany	349	United Kingdom	215
4.	United Kingdom	321	France	162
5.	Japan	276	Italy	149
6.	Australia	238	Canada	135
7.	France	214	Netherlands	94
8.	Saudi Arabia	201	Spain	89
9.	Canada	190	Australia	73
10.	China	169	China	73

Most Prolific Institute

The following table gives an account of total number of publications from top ten Institutes in both the countries. India's Indian Institute of Science with 405 publications acquires 1st rank, followed by B.H.U. (364) and Vallure Institute of Technology

(364). Similarly, Israel Weizmann Institute of Science with 814 publications occupies 1st place, followed by Israel Hebrew University with 747 publication and Tel Aviv university 530 publications.

Table 8: Most Prolific Institute

India			Israel	
S. No.	Institute Name	Publication	Institute Name	Publication
1.	Indian Institute of Science	405	Weizmann Institute of Science Israel	814
2.	Banaras Hindu University	364	Hebrew University of Jerusalem	747
3.	Vellore Institute of technology	364	Tel Aviv University	530
4.	Indian Institute of Technology Delhi	361	Ben-Gurion University of the Negev	482
5.	University of Delhi	347	Technion – Israel Institute of Technology	364
6.	Indian agricultural Institute	290	Agricultural Research Organization of Israel	353
7.	JawaharLal Nehru University	281	Tel Aviv University, Sackler Faculty of Medicine	314
8.	Indian Institute of Technology, Kharagpur	279	Hebrew University-Hadassah Medical School	253
9.	University of Kolkata	269	Bar-Ilan University	203
10.	Bhabha Atomic Research Centre	263	Tel Aviv University George S. Wise Faculty of Life Sciences	179

CONCLUSION

Looking at the total scenario of publications in both the countries, Israel though a smaller country in population and area than India is much ahead in biotechnology research activity. India's year wise growth rate touched double figure in 2013, whereas Israel's published output grew in single digit only from 2001-2016. The collaboration coefficient of Israel dominated over that of India by the average of 0.65 CC in a year. Double author collaboration pattern dominated in both countries' research profile in biotechnology field. In multiple authorship pattern, Indian publications showed four author pattern whereas that of Israel, it is six authorship pattern. The country activity index of India in the year 2016 is highest (180.2), whereas that of Israel is 116.2 in the year 2002. The average Activity Index (100.71) of Israel in sixteen-year is higher than that of India (91.76). The result shows highest collaboration for both India and Israel with United States. Both India and Israel did not find any place in their top ten collaborative countries' list. Indian Institute of Science with 405 publications and Weizmann Institute of Science Israel with 814 publications acquired top rank in both countries. The study indicates that still closer collaboration between India and Israel is the need of the hour.

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