Mapping of the Indian Research Productivity of Biochemistry and Molecular Biology: A Scientometric Analysis

Vitthal T. Bagalkoti
Project Fellow, UGC/SAP/DRS-I
Department of Library and Information Science
Karnatak University, Dharwad - 580 001
Email: vitthallis@gmail.com

Siddanagouda C. Hosamani
MLISc Student,
Department of Library and Information Science,
Karnatak University, Dharwad- 580 001
Email: sidduch001@gmail.com

Abstract

Analyses were done on the Indian publication outputs on biochemistry and molecular biology literature during 1999-2013, on several parameters, including contribution and citation impact of the most productive countries, India's overall contribution, its growth rate and doubling time, citation impact, international collaboration, identification of the significant participating countries in India's international collaboration, and impact of leading Indian institutions and authors, and pattern of communication of Indian output in most productive journals. It explores how far the trends in Indian biochemistry and molecular biology output mirror those of the other upcoming countries and what the main differences among those countries. It discusses the findings in the light of the above-mentioned ongoing discussion on decline or emergence of Indian biochemistry and molecular biology.

Keywords

Scientometrics, Mapping, Biochemistry and Molecular Biology research, Relative Growth Rate, Impact Factor.

Electronic access

The journal is available at www.jalis.in

Journal of Advances in Library and Information Science
ISSN: 2277-2219 Vol. 3. No.3. 2014. Pp249-256

INTRODUCTION

Indian biochemistry and molecular biology literature is studied and compared with number of articles, citations, growth rate, doubling time, mean value, institutional collaboration, sources of collaboration, subject wise contribution of Indian researchers and international collaboration from 1999 to 2013. Scientometrics is the study of science through some quantitative measures of scientific information such as the number of scientific articles published in a given period of time and their citation impact. Many scientometric studies are having appeared in the literature focusing on the performance of science in the field of biochemistry and molecular biology. This analytical study encompassing records output on biochemistry and molecular biology from Web of Science. The present study aims to analyzing the research output of researchers in the field of biochemistry and molecular biology. The growth rate of research output in terms of productivity is analyzed from 1999 to 2013. The scientific productivity is examined to identify the pattern of research contribution in the field of biochemistry and molecular biology. The area-wise research performance is analyzed to identify the hot area of research in particular field. Further, an attempt is made to measure the performance of researchers and scientists their research concentration in the field of biochemistry and molecular biology and it is also analytical in nature in strengthening the empirical validity due to application of suitable statistical tools.

OBJECTIVES

The specific objectives of this study is to analyze the research performance of India in biochemistry and molecular biology research in national and global context, as reflected in web of science database during 1999 – 2013. In particular, the study focuses on the following objectives: (i) To identify and analyse the rate of growth of research productivity on biochemistry and molecular biology; (ii) To analyse the research collaboration; (iii) To identify the source of publications; (iv) To identify journal impact factor; (v) To assess the institution wise research concentration; and (vi) To identify country wise collaborative distribution of publications and high cited-papers.

METHODS AND MATERIALS USED

This study is based on the publications output as indexed by Web of Science database for the period

1999 – 2013. The study uses 15 years publications data on Indian biochemistry and molecular biology from Web of Science database. The growth rate of output in terms of research productivity is analyzed from 1999 to 2013. The subject-wise research performance is analyzed to identify hot area of research. Further, an attempt is made to measure the performance of researchers and their research concentration in the field of biochemistry and molecular biology.

RESULTS AND DISCUSSION

Table 1 depicts the biochemistry and molecular biology research output of World and India, Citations and Average Citations per publications of India. India has produced 35,864 publications, and received 2,65,740 citations during the period 1999-2013, Average Citations per Publication is 7.41. As per the web of science data, cumulative publications growth, the output of India had increased from 6,948 publications during 1999-2003 to 11,572 publications during 2004-2007, and 17,344 publications during 2008-2013. India's publications are gradually increased year by year. The global publications share of India during 1999-2013 was 4.15 %, which has increased from 2.52 in 1999 to 5.08 in 2013. This analysis proves that there is an increasing trend in the Indian biochemistry and molecular biology research.

The global research output in biochemistry and molecular biology research has increased from 51,436 in 1999 to 64,760 in 2013. The trend shows a steady and significant increase in the publications. In the same manner, the Indian research output in biochemistry and molecular biology too has increased from 2,54,126 in 1999-2003 to 2,96,018 by 2004-2008 and 3,14,956 in 2009-2013. The trend shows a higher steepness, indicating a faster increase in research output vis-à-vis global research output (Table 1).

Table – 1: Research output of World and India in biochemistry and molecular biology

Year	World Publications	Indian Publications	Citations	ACPP	%
1999	51436	1318	14143	10.73	2.56
2000	48233	1192	15530	13.03	2.47
2001	48974	1280	16710	13.05	2.61
2002	51381	1486	18210	12.25	2.89
2003	54102	1672	24170	14.46	3.09
2004	57929	2086	25756	12.35	3.60
2005	58526	2096	27087	12.92	3.58
2006	58793	2358	24705	10.48	4.01
2007	59057	2404	21197	8.82	4.07
2008	61713	2628	20760	7.90	4.26
2009	62148	3056	17891	5.85	4.92
2010	61498	3040	16341	5.38	4.94
2011	62768	3424	13149	3.84	5.46
2012	63782	3874	8232	2.12	6.07
2013	64760	3950	1859	0.47	6.10
1999-2003	254126	6948	88763	12.78	2.73
2004-2008	296018	11572	119505	10.33	3.91
2009-2013	314956	17344	57472	3.31	5.51
1999-2013	**865100**	**35864**	**265740**	**7.41**	**4.15**

The growth of Indian publications were analysed by Relative Growth Rate (RGR) and Doubling time (Dt). RGR is a measure to study the increase in number of articles of time (Mahapatra 1985) and the Dt is directly related to RGR. It is the time required for articles to become double of the existing amount.

The total output of world and India has been shown in Table 2 (fifteen year) along with the relative growth rate and doubling time. The table shows that the relative growth rate of Indian research output decreases gradually from 0.64 to 0.12 in fifteen year's period (1999-2013). The doubling time (Dt) correspondingly increases from 1.08 to 5.94 in this

period. The mean growth rate & doubling time for the India is 0.22 and 3.47 respectively.

The following Table 2 represents the chronological distribution, RGR, Dt, and mean of RGR and Dt of Indian publications in the field of biochemistry and molecular biology during the period 1999–2013. From the Table 2 it is observed that the mean RGR for the first seven years is 0.332 and the Dt is 2.420, for the second eight years it is 0.108 and 4.395 respectively. Dt is the period of time required for a quantity to double in size or value. Hence it can be seen that the Dt is doubled during the second eight years. When the RGR is constant, the quantity undergoes exponential growth and has a constant Dt or period which can be calculated directly from the growth rate.

RGR decreased from 0.64 in 2000 to 0.12 in 2013. The mean relative growth for the first 7 years (1999-2005) showed a growth rate of 0.332 whereas the mean RGR for the last 8 years (2006-2013) reduced to 0.108. The corresponding Dt for different years gradually increased from 1.08 in 1999 to 5.94 in 2013. The mean Dt for the first 7 years was only 2.420 which was increased to 4.395 during the last 8 years. Thus the rate of growth of publication was decreased, the corresponding Dt was increased (Table 2).

Table – 2: Indian's research output and Relative Growth and Doubling Time of Biochemistry and Molecular Biology

Year	No. of publications	Cumulative	Log_e1	Log_e2	RGR	Mean RGR	Dt.	Mean Dt.
1999	1318	1318		7.18		0.332		2.420
2000	1192	2510	7.18	7.83	0.64		1.08	
2001	1280	3790	7.83	8.24	0.41		1.68	
2002	1486	5276	8.24	8.57	0.33		2.09	
2003	1672	6948	8.57	8.85	0.28		2.52	
2004	2086	9034	8.85	9.11	0.26		2.64	
2005	2096	11130	9.11	9.32	0.21		3.32	
2006	2358	13488	9.32	9.51	0.19		3.61	
2007	2404	15892	9.51	9.67	0.16		4.23	
2008	2628	18520	9.67	9.83	0.15		4.53	
2009	3056	21576	9.83	9.98	0.15		4.54	
2010	3040	24616	9.98	10.11	0.13		5.26	
2011	3424	28040	10.11	10.24	0.13		5.32	
2012	3874	31914	10.24	10.37	0.13		5.35	
2013	3950	35864	10.37	10.49	0.12	0.108	5.94	4.395

Sub-fields of research priority in biochemistry and molecular biology research in India

Out of 20 sub-fields identified, only five sub-fields witnessed increase in their activities from 1999–2006 to 2007–2013. Out of 20 sub-fields of biochemistry and molecular biology the two domains published more than 4000 publications, three domains published more than 2000 articles and other subjects produced 1000 and less than 1000 publications (Table 3).

As per the sub-fields cumulative output in Indian biochemistry and molecular biology research during 1999–2013, the maximum research priority (4,571 publications, 19.07% share) is assigned to Biophysics in India during 1999–2013, followed by Chemistry(4,374 publications, 18.25% share), Biotechnology Applied Microbiology (2,592 publications, 10.81% share), Pharmacology Pharmacy (2,334 publications, 9.74% share), Cell Biology (2,189 publications, 9.13% share), Plant Sciences (1,219 publications, 5.09% share), Endocrinology Metabolism (766 publications, 3.20% share), Genetics Heredity (702 publications, 2.93% share) and Neurosciences Neurology (631 publications, 2.63% share).

Table- 3: Subjectwise distribution of Indian Contributions

Sl. No.	Subject	No. of publications	%	Cumulative	Cum.%
1	Biophysics	4571	19.07	4571	19.07
2	Chemistry	4374	18.25	8945	37.32
3	Biotechnology Applied Microbiology	2592	10.81	11537	48.13
4	Pharmacology Pharmacy	2334	9.74	13871	57.87
5	Cell Biology	2189	9.13	16060	67.00
6	Plant Sciences	1219	5.09	17279	72.09
7	Endocrinology Metabolism	766	3.20	18045	75.28
8	Genetics Heredity	702	2.93	18747	78.21
9	Neurosciences Neurology	631	2.63	19378	80.85
10	Computer Science	574	2.39	19952	83.24
11	Life Sciences Biomedicine Other Topics	541	2.26	20493	85.50
12	Engineering	483	2.02	20976	87.51
13	Toxicology	462	1.93	21438	89.44
14	Crystallography	459	1.91	21897	91.36
15	Immunology	455	1.90	22352	93.25
16	Mathematical Computational Biology	434	1.81	22786	95.06
17	Physiology	400	1.67	23186	96.73
18	Microbiology	308	1.28	23494	98.02
19	Environmental Sciences Ecology	253	1.06	23747	99.07
20	Spectroscopy	222	0.93	23969	100
	Total	**23969**	**100**		

Impact of journals of Indian contributions with more than 100 publications in biochemistry and molecular biology

Impact of journals of Indian contributions with more than 100 publications in biochemistry and molecular biology has been shown in table 4. Impact factor is a measure of the frequency with which the "average article" in journal has been cited in a given period of time. It is calculated for a journal based on a 3 years period. Impact factor of the biochemistry and molecular biology journals are mentioned in the Table 4along with total publications, total citations and average citations per papers.

Based on the average citations per paper the journal of *Plant Science*, published from Netherlands holds the first position (25.24), followed by *Journal of Biological Chemistry*, published from USA (24.40), *Nucleic Acids Research*, England (23.82), *Process Biochemistry*, Netherlands (22.74), *Bioorganic Medicinal Chemistry*, Netherlands (20.28), *Journal of Biochemistry*, England (16.56) and *FEBS Letters*, Netherlands (16.07).

Table-4: Impact of journals of Indian contributions in the journals

Sl. No.	Source/ Journal	Country	TP	TC	ACP	Impact Factor
1	Indian Journal of Biochemistry Biophysics	New Delhi	745	2651	3.56	1.03
2	Biochemical and Biophysical Research Communications	Netherlands	715	9535	13.34	2.548
3	Applied Biochemistry and Biotechnology	Germany	645	3341	5.18	1.239
4	Journal of Biological Chemistry	USA	639	15594	24.4	4.651
5	Bioorganic Medicinal Chemistry	Netherlands	612	12412	20.28	2.903
6	Process Biochemistry	Netherlands	481	10936	22.74	2.141
7	International Journal of Biological Macromolecules	Netherlands	462	3671	7.95	2.596

8	Journal of Plant Biochemistry and Biotechnology	India	447	1205	2.7	0.414
9	FASEB Journal	USA	441	356	0.81	5.704
10	Journal of Biochemistry	England	322	1886	16.56	2.719
11	Journal of Neurochemistry	USA	317	1232	3.89	3.973
12	Journal of Biomolecular Structure Dynamics	USA	313	1875	5.99	4.99
13	Journal of Carbohydrate Research	Netherlands	295	3337	11.31	2.044
14	Nucleic Acids Research	England	293	6980	23.82	8.278
15	Journal of Molecular Modeling	Germany	287	1162	4.05	1.984
16	Biomedical Chromatography	USA	279	1633	5.85	1.945
17	FEBS Letters	Netherlands	275	4418	16.07	3.582
18	Plant Science	Netherlands	271	6841	25.24	2.922
19	Chromatographia	Germany	261	1432	5.49	1.312
20	Molecular Biology Reports	Netherlands	259	1057	4.08	3.905

Indian institutions contribution and the various indices in the field of biochemistry and molecular biology literature

Based on the publications output for India in biochemistry and molecular biology, total of 20 institutions were identified as high productive between 314 and 4751 publications, with an average output 798 publication per institution during 1999-2013. These top 20 institutions together contributed 15,792 publications total research output by India in agriculture during 1999-2013. Of these 20 institutions, 7 institutions contributed publications output each above 20 institutions publications average (798 publications per institution) during 1999-2013. Institutions along with their publications outputs are: Council of Scientific Industrial Research (CSIR), New Delhi (4751 publications), Indian Institute of Technology (IIT), Mumbai (1611 publications Indian Institute of Science (IISC), Bangalore (1560 publications), University of Delhi, Delhi (814 publications), Centre for Cellular Molecular Biology India, Hyderabad (609 publications Tata Institute of Fundamental Research, Bangalore (553 publications), Banaras Hindu University, Varanasi (546 publications) (Table 5).

The average citation received per publications by total publications of these 20 top institutions varies from 8.01 to 19.49 with a average citation per publication during 1999-2013 was 12.8. Only eight institutions registered higher average citations per publication than the average of 20 institutions. These are: Jawaharlal Nehru Center for Advanced Scientific Research, Bangalore 19.49 citations per publication, followed by Institute of Microbial Technology India, Chandigarh (17.31citations per publication), BOSE Institute, Kolkata (16.91 citations per publication), Centre for Cellular Molecular Biology India, Hyderabad (16.06 citations per publication), Tata Institute of Indian Institute of Science (IISC), Bangalore (14.59 citations per publication), Fundamental Research, Bangalore (14.34 citations per publication (Table 5).

The average *h*-index of 20 institutions varies from 26 to 79, with the average value of *h*-index during 1999-2013. Only 16 out of 20 institutions had scored higher *h*-index values than the average values 0f 20 institutions. These are Council of Scientific Industrial Research (CSIR), New Delhi with *h*-index 79, followed by Indian Institute of Science (IISC), Bangalore (56), Indian Institute of Technology (IIT), Mumbai (53), University of Delhi, Delhi (46), Centre for Cellular Molecular Biology India, Hyderabad (46), BOSE Institute, Kolkata (44 Institute of Microbial Technology India, Chandigarh (42), awaharlal Nehru Center for Advanced Scientific Research, Bangalore (38), Indian Institute of Chemical Biology, Kolkata (37), Tata Institute of Fundamental Research, Bangalore (36), Bhabha Atomic Research Center, Mumbai (36), All India Institute of Medical Sciences, New Delhi (33) (Table 5).

Table-5: Indian institutions contribution and the various indices in the field of biochemistry and molecular biology literature

Sl. No.	Indian Research / Academic Institution	TP	TC	ACP	H-Index
1	Council of Scientific Industrial Research (CSIR), New Delhi	4751	63496	13.36	79

2	Indian Institute of Technology (IIT), Mumbai	1611	17553	10.9	53
3	Indian Institute of Science (IISC), Bangalore	1560	22753	14.59	56
4	University of Delhi, Delhi	814	10735	13.19	46
5	Centre for Cellular Molecular Biology India, Hyderabad	609	9781	16.06	46
6	Tata Institute of Fundamental Research, Bangalore	553	7928	14.34	36
7	Banaras Hindu University, Varanasi	546	5150	9.43	30
8	Indian Institute of Chemical Biology, Kolkata	534	6546	12.26	37
9	All India Institute of Medical Sciences, New Delhi	521	4984	9.57	33
10	Jawaharlal Nehru University, New Delhi	510	5042	9.89	30
11	Bhabha Atomic Research Center, Mumbai	455	5259	11.56	36
12	BOSE Institute, Kolkata	455	7695	16.91	44
13	University of Hyderabad, Hyderabad	446	4914	11.02	30
14	University of Madras, Chennai	440	4812	10.94	31
15	Aligarh Muslim University, Aligarh, Uttar Pradesh	401	3814	9.51	28
16	Indian Institute of Chemical Technology, Hyderabad	366	4239	11.58	30
17	Panjab University, Chandigarh	356	2853	8.01	26
18	Jawaharlal Nehru Center for Advanced Scientific Research, Bangalore	353	6880	19.49	38
19	Institute of Microbial Technology India, Chandigarh	350	6058	17.31	42
20	National Chemistry Laboratory Pune, Pune	341	3975	11.66	30

International collaboration

Collaboration has become a well established feature in the field of biochemistry and molecular biology literature. It is observed that there is a consistently increasing trend towards collaboration among various branches of biochemistry and molecular biology literature which leads o collaborative authorship in literature. Table 5 depicts the international collaborative papers of India with top 20 countries during 1999- 2013. The share international publications in the Indian biochemistry and molecular biology literature research output was among the different collaborative countries the USA ranked first with 2179 publications and 35,563 citations (16.32 ACP and 75 H-index), followed by Germany which ranked second with 572 publications and 10,081citations (17.62 ACP and 50 H-index), Japan ranked third with 429 publications and 7,690 citations. France 320 and England 316 publications ranked fourth and fifth respectively.

Table- 6: International collaboration

Rank by collaborative papers	Country	Total Publication (TP)	Total Citations (TC)	Average Citations per Publication (ACP)	H-Index
1	USA	2179	35563	16.32	75
2	Germany	572	10081	17.62	50
3	Japan	429	7690	17.93	43
4	France	320	6424	20.08	38
5	England	316	5887	18.63	36
6	South Korea	182	2038	11.2	23
7	Canada	177	3102	17.53	30
8	Italy	152	2563	16.86	24
9	Peoples R China	142	2422	17.06	23
10	Australia	141	1682	11.93	22
11	Saudi Arabia	116	702	6.05	13
12	Sweden	115	2770	24.09	24
13	Switzerland	110	2983	27.12	25
14	Taiwan	103	1101	10.69	18
15	Netherlands	99	1379	13.93	19

16	Singapore	97	1588	16.37	20
17	Denmark	85	2517	29.61	23
18	Belgium	83	1913	23.05	19
18	Spain	83	2225	26.81	22
19	Brazil	63	1692	26.86	16
19	Hungary	63	1323	21	20
19	Israel	63	1509	23.95	20
20	Scotland	60	1336	22.27	20

High cited papers from India

The top 10 most cited papers from India in biochemistry and molecular biology published during 1999 to 2013 received 458.50 citations per paper. Of these 10 papers, 3 are international collaborative papers. These 10 high cited papers were published in 8 journals including 2 papers in *Cell* Journal, 2 in Nucleic Acids Research, 1 each in *Archives of Biochemistry and Biophysics, Biomacromolecules, Biotechnology and Applied Biochemistry, Embo Journal, Genome Research* and *Process Biochemistry*. Citations received by these top 10 cited papers accumulated to 4,585 (1.73%) of all citations. Most of the papers are having multiple authors (Three or more authors), only two papers are having two authors. The top cited paper was 'Recent developments in ring opening polymerization of lactones for biomedical applications, authored by Albertsson, A. C. Varma, I. K. Mohan, Dinesh published in *Biomacromolecules* in the year 2003 and this paper received 682 citations, followed by 'Human Protein Reference Database-2009 update, authored by Prasad, T. S. Keshava, Goel, Renu, Kandasamy, Kumaran et al. published in *Nucleic Acids Research* in the year 2009, and this paper received 583 citations, 'Development of human protein reference database as an initial platform for approaching systems biology in humans' authored by Peri, S, Navarro, J. D., Amanchy, R. et al. published in *Genome Research* in the year 2003 and this paper received 579 citations, 'Nanoscale organization of multiple GPI-anchored proteins in living cell membranes' authored by Sharma, P., Varma, R., Sarasij, R. C. et al. published in Cell in the year 2004 this paper received 466. This shows that more research activities are being carried on in newly developing fields.

Table-4 High cited papers from India

Sl. No	No. of Citations received	Title of the paper	Authors	Source	Year of publication
1	682	Recent developments in ring opening polymerization of lactones for biomedical applications	Albertsson, AC; Varma, IK	Biomacromolecules	2003
2	583	Human Protein Reference Database-2009 update	Prasad, T. S. Keshava; Goel, Renu; Kandasamy, Kumaran; et al.	Nucleic Acids Research	2009
3	579	Development of human protein reference database as an initial platform for approaching systems biology in humans	Peri, S; Navarro, JD; Amanchy, R; et al.	Genome Research	2003
4	466	Nanoscale organization of multiple GPI-anchored proteins in living cell membranes	Sharma, P; Varma, R; Sarasij, RC; et al.	Cell	2004
5	438	Cold, salinity and drought stresses: An overview	Mahajan, S; Tuteja, N	Archives of Biochemistry and Biophysics	2005
6	413	Notch signaling is a direct determinant of keratinocyte growth arrest and entry into differentiation	Rangarajan, A; Talora, C; Okuyama, R; et al.	Embo Journal	2001
7	375	New developments in solid state fermentation: I-bioprocesses and products	Pandey, A; Soccol, CR; Mitchell, D	Process Biochemistry	2000

8	354	Advances in microbial amylases	Pandey, A; Nigam, P; Soccol, CR; et al.	Biotechnology and Applied Biochemistry	2000
9	352	Endocytosis by random initiation and stabilization of clathrin-coated pits	Ehrlich, M; Boll, W; van Oijen, A; et al.	Cell	2004
10	343	Human protein reference database - 2006 update	Mishra, Gopa R.; Suresh, M.; Kumaran, K.; et al.	Nucleic Acids Research	2006

CONCLUSION

Scientometric analysis is also extremely essential to plan appropriate measures to be taken to upgrade the research activities. A detail scientometric analysis of biochemistry and molecular biology research performance of India and its comparison with other countries is very important to obtain a clear picture and to take necessary measures to upgrade the research performance. It is important to evaluate the research performance of major biochemistry and molecular biology research institutes of the country and to compare their performance among themselves and similar institutes of other countries.

The present study analyses the growth of literature published by the researchers in India for 1999-2013 as reflected in Web of Science (WoS) database. India has produced 35,864 publications, and received 2,65,740 citations during the period 1999-2013, Average Citations per Publication is 7.41. As per the web of science data, cumulative publications growth, the output of India had increased from 6,948 publications during 1999-2003 to 11,572 publications during 2004-2007, and 17,344 publications during 2008-2013. India's publications are gradually increased year by year. This analysis proves that there is an increasing trend in the Indian biochemistry and molecular biology research.

REFERENCES

1. Bala, A., & Gupta, B. M. (2010). Mapping of Indian neuroscience research: A scientometric analysis of research output during 1999-2008. *Neurology India*, *58*(1), 35-41.

2. Bala, A., & Gupta, B. M. (2010). Research Activities in Biochemistry, Genetics and Molecular Biology during 1998-2007 in India: A Scientometric Analysis. *DESIDOC Journal of Library & Information Technology*, *30*(1), 3-14.

3. Balasubramani, R., & Murugan, C. (2011). Mapping of Tapioca (Sago) Research in India: A Scientometric Analysis. Library Philosophy and Practice 2011, Retrieved from http://unllib.unl.edu/LPP/ on 20/05/2014.

4. Essays, UK. (November 2013). Epilepsy Research in India Biology Essay. Retrieved from http://www.ukessays.com/essays/biology/epilepsy-research-in-india-biology-essay.php?cref=1.

5. Gupta, B. M., & Bala, A. (2011). Mapping of asthma research in India: A scientometric analysis of publications output during 1999-2008. *Lung India*, *28*(4), 239-246.

6. Gupta, B. M., & Bala, A. (2013). Parkinson's disease in India: An analysis of publications output during 2002-2011. *International Journal of Nutrition, Pharmacology, Neurological Diseases*, *3*(3), 254-262.

7. Gupta, B. M., Bala, A., Mueen Ahmed, K. K., & Gupta, Ritu. (2014). Liver disorders: A scientometric study of publication outputs from India during 2003-2012. *International Journal of Medicine and Public Health*, *4*(1), 9-16.

8. Journal Impact Factors, http://www.sciencegateway.org/impact/ retrieved on 15/06/2014.

9. Kademani, B.S. et. al. (2006). Nuclear Science and Technology research in India: A study based on INIS (1970-2002) database, *Malaysian Journal of Library and Information Science, 11*(1), 23-48.

10. Karpagam, R. et al… (2011). Mapping of nanoscience and nanotechnology research in India: a scientometric analysis, 1990–2009. *Scientometrics*, *89*, 501–522.