

Productivity of scientists of Rajiv Gandhi Centre for Biotechnology (RGCB): an analysis

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Analysis of 632 publications of RGCB scientists during 1995-2006 show that the publications of RGCB scientists include journal articles, conference papers, patents, book chapters and PhD guided. The year 2005-2006 with 112 articles (25.87 %) published is the most productive year in the case of journal articles. The productivity of the scientists of RGCB shows substantial growth both quantitatively and qualitatively with the development of the institution.

Introduction

Scientific productivity in form of intellectual contributions and communicated in written form is commonly considered to be of fundamental importance to scientific career advancement. In the last two decades there has been an unprecedented growth of scientometric studies in different fields mainly because the government and private organizations that invest large amounts of money for research activities need accountability. Moreover funding agencies, scientists and policy makers etc have required frequent assessment of research activities for varied reasons. Aaltojärvi¹, et al. conducted a study entitled 'Scientific productivity, web visibility and citation patterns in sixteen Nordic sociology departments'. In the study, the authors explored how Nordic sociology is represented on Google Scholar (GS), what its output and impact is, and what factors explain it. Thirteen per cent of scholars do not appear on GS, whereas only 15 per cent have more than 5 publications. Both the number of web hits (web visibility) and citations are influenced by the gender of the faculty member, type and age of publication. Kademani et al². examined the scientometric dimensions of productivity of scientists of the chemistry division at Bhabha Atomic Research Centre (BARC). Scientrometric analysis of 1733 papers published by the teams comprising total of 926 participating scientists at Chemistry Division of BARC during 1970-1999 in the domains: radiation & photochemistry and chemical dynamics (649), solid state studies (558), inorganic, structural and materials chemistry (460) and theoretical

chemistry (66) were analyzed for year wise productivity, authorship pattern and collaboration. Top ranking journals in which the scientists of the Chemistry Division, BARC published papers were from UK (471), India (326), The Netherlands (302), USA (277) and Switzerland (104).

Kumar and Garg³ offered insights into the field of the scientific productivity of researchers in India and China in their study entitled 'Scientometrics of computer science research in India and China'. An analysis of 2058 papers published by Chinese authors and 2678 papers published by Indian authors in the field of computer science during 1971-2000, indicates that India's output is significantly higher than the Chinese output. However, China is catching up fast.

A number of quantitative studies based on scientometric techniques have been reported to evaluate the research productivity of individuals, institutions, countries etc. Studies are also available to verify the fitness of classic laws of bibliometrics, factors of productivity and impact of research conducted in various countries. These studies are very much helpful to assess the development of science as well as in their application to library and information resource management.

Productivity studies at author, institution, country level and global levels have been carried out. The Rajiv Gandhi Centre for Biotechnology (RGCB) is a rather young institute set up in 1995. The present study analyses the publication productivity of the institute since its inception.

Rajiv Gandhi Centre for Biotechnology (RGCB)

Rajiv Gandhi Center for Biotechnology (RGCB) is an institute with a national character led by scientists & research students from various parts of India and a truly national agenda for translating biotechnology into reality at international standards. The foundation stone of RGCB was laid in November 1995, by the then Prime Minister Mr. P.V.Narasimha Rao. The President of India, His Excellency Dr. A.P.J Abdul Kalam, dedicated RGCB to the nation in November 2002. RGCB is the only institution of its kind within the country, exclusively devoted to biotechnology focusing on translational research. RGCB is undoubtedly Kerala's flagship for biotechnology research & development.

All RGCB research programs are created with the underlying concept of "bench to bedside" and "lab to land" seeking to promote better health care and improved productivity of spices and medicinal plants. The institute has highly focused research departments working on medical biotechnology and plant genetic engineering which includes Department of Molecular Microbiology (DMM), Department of Molecular Endocrinology & Reproduction (DMER), Department of Molecular Medicine and Cancer Biology (DMMC), Department of Neurobiology (DN) and Department of Plant Molecular Biology (DPMB). The institute has major interdisciplinary consortium research programs on

vaccine development, bioinformatics and bioprospecting for clinically bioactive compounds. A Program of Excellence in Translational Research (PETR) in collaboration with the Regional Cancer Center allows RGCB to carry out leading translational cancer research. True to its commitment to translating biotechnology for economic development, RGCB has started strong industrial collaboration and offers incubator facilities for start up biotech companies. RGCB has also not forgotten its social commitments to the State and provides critical services for the community.

The Center has a Regional Facility for Genetic Fingerprinting which provides DNA analysis services for forensic & criminal investigations, paternity disputes, identification of wildlife remains, authentication of plants and seeds besides a battery of molecular diagnostics for genetic and infectious diseases. RGCB is also a major provider of laboratory and infrastructure services to other academic and research institutions. A small efficient administration runs the affairs of the center with gracious management from the Kerala State Council for Science, Technology and Environment. The institute is a major stakeholder in human resource development having one of the best doctoral programs in biotechnology.

Objectives of the study

1. To find out the gender-wise, department-wise, and form-wise productivity of scientists,

Table 1 — Gender-wise publication productivity of scientists

Department	Males		Females		Total	
	No. of Scientists	Publications	No. of Scientists	Publications	No. of Scientists	Publications
Molecular Endocrinology & Reproduction	2 (65.66%)	93 (55.02%)	1 (33.34%)	73 (43.98%)	3 (19.35%)	166 (26.27%)
Molecular Medicine and Cancer Biology	7 (53.85%)	148 (53.34%)	6 (45.15%)	130 (45.76%)	13 (44.83%)	278 (43.99%)
Molecular Microbiology	6 (100%)	59 (100%)	-	-	6 (29.69%)	59 (9.34%)
Neurobiology	2 (65.66%)	48 (94.12%)	1 (33.34%)	3 (5.88%)	3 (19.35%)	51 (8.07%)
Plant Molecular Biology	2 (50%)	42 (53.86%)	2 (50%)	36 (45.15%)	4 (13.79%)	78 (12.34%)
Total	19 (65.52%)	390 (61.71%)	10 (34.48%)	242 (39.29%)	29 (100%)	632 (100%)

Table 2 — Types of literature

Year	Journal articles Foreign(Indian)	Conf. papers	Patents	Book chapters	PhD guided	Total
1995-1996	30(4) (77.27%)	7 (15.91%)	2 (4.55%)	1 (2.27%)	-	44 (6.96%)
1997-1998	53(10) (83.89%)	13 (17.11%)	-	-	-	76 (12.03%)
1999-2000	51(10) (71.77%)	21 (24.71%)	1 (1.18%)	2 (2.35%)	-	85 (13.45%)
2001-2002	43(12) (62.5%)	27 (39.68%)	-	5 (5.68%)	1 (1.14%)	88 (13.92%)
2003-2004	98(10) (63.53%)	43 (25.29%)	7 (4.12%)	4 (2.35%)	8 (4.71%)	170 (26.90%)
2005-2006	102(10) (65.27%)	43 (25.44%)	9 (5.33%)	4 (2.36%)	1 (0.59%)	169 (26.74%)
Total	377(56) (69.51%)	154 (24.37%)	19 (3.01%)	16 (2.53%)	10 (1.58%)	632 (100%)

Table 3 — Degree of collaboration of journal articles

Year	One	Two	Three	Four	> Four	Total	Degree of collaboration C=Nm/ (Nm + Ns)
1995-1996	2 (5.88%)	1 (2.94%)	11 (32.35%)	1 (2.94%)	19 (55.88%)	34 (7.85%)	0.94
1997-1998	4 (6.35%)	6 (9.52%)	16 (25.40%)	16 (25.40%)	21 (33.33%)	63 (14.55%)	0.94
1999-2000	-	14 (22.95%)	20 (32.79%)	12 (19.67%)	15 (24.59%)	61 (14.09%)	1
2001-2002	1 (1.81%)	18 (32.73%)	8 (14.55%)	12 (21.82%)	16 (29.09%)	55 (3.46%)	0.99
2003-2004	4 (3.70%)	16 (14.81%)	37 (34.26%)	24 (22.22%)	27 (25%)	108 (24.94%)	0.95
2005-2006	4 (3.57%)	16 (14.29%)	37 (33.04%)	23 (20.54%)	32 (28.57%)	112 (25.87%)	0.95
Total	15 (3.46%)	71 (16.40%)	129 (29.79%)	88 (20.32%)	130 (30.02%)	433 (100%)	0.97

- To identify the types of communication channels preferred by the scientists to communicate their research work.
- To investigate the degree of collaboration of scientists, and
- To identify the prolific authors having large number of publications and the prolific journals in which more number of articles get published.

Methodology

A total of 632 publications were published by the scientists of RGCBS during 1995-2006 as per the website of the institution. These and the information about the publications given in the annual reports of RGCBS formed

the basic data for the study. All the bibliographic details of publications in hardcopy form and electronic form were scanned and all the data elements were transferred to spread sheet application. After validation, the data was analyzed as per the objectives of the study. The degree of collaboration is calculated using the formula given by K. Subramanian. As per the formula:

$$\text{Degree of collaboration, } C = \frac{Nm}{Nm + Ns}$$

Where

- C = Degree of collaboration in a discipline
 Nm = Number of multi-authored research papers in a discipline published during a year

Table 4 — List of source journals

Rank	Journal	Country of publishing	No. of Articles	Impact Factor
1	<i>Journal of Biological Chemistry</i>	USA	23	7.666
1	<i>Biochemical and Biophysical Research Communications</i>	USA	23	3.179
2	<i>Carcinogenesis</i>	USA	19	3.153
3	<i>Biochemistry</i>	USA	11	5.144
4	<i>Amala Research Bulletin</i>	INDIA	10	-
4	<i>Archives of Andrology</i>	USA	10	0.592
5	<i>Oncogene</i>	UK	8	6.517
5	<i>Molecular Carcinogenesis</i>	USA	8	2.589
5	<i>Current Science</i>	INDIA	8	0.567
5	<i>Biochemistry and Molecular Biology International</i>	USA	8	0.596
6	<i>Molecular and Cellular Biochemistry</i>	NETHERLANDS	7	1.547
6	<i>Journal of Ethnopharmacology</i>	IRELAND	7	2.049
6	<i>Indian Journal of Experimental Biology</i>	INDIA	7	-
6	<i>Pathology</i>	AUSTRALIA	7	5.423
6	<i>Current Cancer Drug Targets</i>	NETHERLANDS	7	5.39
7	<i>Zoo's Print Journal</i>	INDIA	6	2.98
7	<i>European Journal of Pharmacology</i>	NETHERLANDS	6	2.047
8	<i>Pollution Research</i>	INDIA	5	3.894
8	<i>Journal of cellular biochemistry</i>	USA	5	2.817
8	<i>Journal of Ethnopharmacology</i>	IRELAND	5	2.049
8	<i>FEBS Letters</i>	NETHERLANDS	5	3.270
8	<i>Biochimica et Biophysica Acta</i>	NETHERLANDS	5	2.500

Ns = Number of single authored research papers in a discipline published during the same year.

Analysis

Gender-wise publication productivity of scientists

The gender-wise publication productivity of scientists of RGCB during the period under study is given in Table 1. Male scientists are more in number than the female scientists. In RGCB altogether there are 29 scientists working in the five departments viz., Department of Molecular Microbiology (DMM), Department of Molecular Endocrinology & Reproduction (DMER), Department of Molecular Medicine and Cancer Biology (DMMC), Department of Neurobiology (DN) and Department of Plant Molecular Biology (DPMB). Out of the 29 scientists, 19 (65.52 per cent) are males and 10 (34.48 per cent) are females.

The analysis shows that males' level of normal count productivity (61.71 per cent) is higher than females (39.29 per cent) and there are considerable departmental differences in the number of publications. While

considering the average for the productivity measure, it is clear that the productivity of female scientists is higher than that of males. Nineteen male scientists have produced 390 papers with an average of 20.5 papers per male scientist. And 10 women scientists have produced 242 papers with 24.2 papers per women scientist. Department of Molecular Medicine and Cancer Biology is the highest producing department and the Department of Neurobiology has least productivity.

Types of literature

The productivity of scientists of RGCB were spread over variety of publication media like journal articles, conference papers, patents, book chapters and PhD guided. The form-wise distribution of productivity of the scientists of RGCB during the period under study is represented in Table 2.

It is clear from the Table 2 that the productivity of scientists of RGCB is in the form of journal articles, conference papers, patents, book chapters and PhD guided. The number of journal articles, conference papers, patents, book chapters and PhD guided increases

Table 5 — Rank list of scientists contributing journal articles and conference papers

Author	No. of journal articles (Rank)	No. of conference papers (Rank)
Pradeep Kumar G	45(1)	14(5)
Malini Laloraya	41(2)	18(3)
Karunagaran, D.	34(3)	4(9)
Raghava Varman Thampan.	20(4)	1(11)
Ruby John Anto	19(5)	22(1)
Priya Srinivas	18(6)	18(3)
K. Santhosh Kumar	17(7)	-
Sanil George	16(8)	-
S. Asha Nair	16(8)	-
Moinak Banerjee	16(8)	-
M Radhakrishna Pillai	15(9)	-
V. V. Asha	15(9)	-
Jackson James	15(9)	21(2)
E. Sreekumar	13(10)	-
Sabu Thomas	13(10)	1(11)
S. Sreeja	12(11)	-
S. Manjula	11(12)	3(10)
R. Ajay Kumar	11(12)	-
Soniya E. V.	11(12)	10(7)
T.J.Rasool	11(12)	4(9)
Hari Krishnan. K	10(13)	-
Suparna Sengupta	9(14)	4(9)
M.G.Purushothama	9(14)	-
T R Santhosh Kumar	8(15)	-
R.V.Omkumar	7(16)	6(8)
George Thomas	6(17)	12(6)
G.S. Vinod Kumar	5(18)	17(4)
Sathish Mundayoor	4(19)	-
MayaDevi. M.	3(20)	-

with the growth and development of the institution. The analysis of distribution of articles in journals reveals that during the period under study, only 56 articles (12.93 per cent) were published in Indian journals. Most of the articles published by the scientists of RGCB were in the foreign journals. Out of the 433 articles, 377 articles (87.07 per cent) were published in foreign journals.

Degree of collaboration of journal articles

Two years-wise breakup of authorship pattern and the degree of collaboration of journal articles published by the scientists of RGCB during the period under study is given in Table 3.

In the case of journal articles published by the scientists of RGCB the authorship trend observed in the analysis is towards multi-authored papers. Single authored papers

were less in number which shows the general trend of working as groups. It is clear from the Table 3, that the degree of collaboration of journal articles published by the scientists is maximum (100 per cent) during 1999-2000. During this period all the journal articles published were multi-authored. In the period 2001-2002, degree of collaboration was found to be 99 per cent. During 2003-2004 and 2005-2006, collaboration was found to be 95 per cent and during 1995-1996 and 1997-1998, the collaboration was 94 per cent.

Most productive source journals

The most productive source journal can be obtained from the Table 4 which displays the rank list of journals (contains five or more articles) with impact factor in which articles were published by the scientists of RGCB during the period under study.

Analysis of the impact factor of top ranking journals shows that the journals in which most number of articles published were international journals having high impact factor. It is also found that majority of the journals are published from USA. This shows the quality of the articles produced by the scientists of RGCB.

Rank list of scientists contributing journal articles and conference papers

Pradeep Kumar, with 45 journal articles is the most prolific author during the period under study followed by Malini Laloraya with 41 articles. Karunagaran (34 journal articles) is at the third position followed by Raghava Varman Thampan (20 journal articles). In the case of conference papers, Ruby John Anto is ranked first with 22 papers followed by Jackson James with 21 conference papers during the period under study. Malini Laloraya and Priya Srinivas presented 18 conference papers each followed by G.S. Vinod Kumar (17 papers) who is at the fourth position.

Authorship pattern of conference papers

The year-wise breakup of authorship pattern of conference papers presented by the scientists of RGCB in various regional, national and international conferences are presented in Table 6.

In the case of conference papers published by the scientists of RGCB, the authorship trend observed in the analysis is towards multi-authored papers. Single authored

Table 6 — Authorship pattern of conference papers

Year	One	Two	Three	>Three	Total	Degree of collaboration $C=Nm/(Nm+Ns)$
1995-96	5 (71.42%)	-	2 (28.57%)	-	7 (4.54%)	0.29
1997-98	6 (46.15%)	2 (15.38)	2 (15.38)	3 (23.08)	13 (8.44)	0.54
1999-2000	7 (33.33%)	-	8 (38.10)	6 (28.57)	21 (13.64)	0.66
2001-02	3 (11.11%)	4 (14.81)	8 (29.63)	12 (70.59)	27 (17.53)	0.90
2003-04	8 (18.60%)	3 (7%)	12 (27.90%)	20 (46.51%)	43 (27.92%)	0.81
2005-06	11 (25.58%)	6 (13.95%)	8 (18.60)	18 (41.86)	43 (27.92%)	0.74
Total	40 (25.97%)	15 (9.74%)	40 (25.97%)	59 (38.31%)	154 (100%)	0.74

papers were less in number which shows the general trend of working as groups. It is clear from the Table 6 that the degree of collaboration was maximum (90 per cent) during 2001-2002. Degree of collaboration was 81 per cent during 2003-2004 and 66 per cent during 1999-2000. About 54 per cent collaboration was found in 1997-1998. Degree of collaboration was minimum (29 per cent) during 1995-1996.

Rank list of scientists contributing patents

Patents are one of the most important criteria in calculating the productivity and position of scientists. The rank list of scientists who have obtained patents are listed in Table 7.

D. Karunakaran (4 patents) is the scientist with most number of patents obtained during the period under study. K.SanthoshKumar and Ruby John Anto (3 patents each) are at the second position followed by Suparna Sengupta, Pradeep Kumar. G and V.V. Asha (2 patents each). Satish Mundayoor is at the fourth position with one patent during the period under study.

Findings and discussion

Analysis shows that in RGCB altogether there are 29 scientists are working in the 5 departments and it is found that male scientists are more in number than the female scientists. There were remarkable differences in the

Table 7 — Rank list of scientists contributing patents

Number of Patents	Author	Rank
4	Karunakaran D.	1
3	K.Santhosh Kumar	2
3	Ruby John Anto	2
2	Suparna Sengupta	3
2	Pradeep Kumar.G	3
2	G.S.Vinod Kumar	3
2	V.V.Asha	3
1	Satish Mundayoor	4

department-wise productivity of scientists of RGCB. Analysis shows that the productivity of female scientists is higher than that of males. Nineteen male scientists have produced 390 papers that is an average of 20.5 papers per male scientist. And 10 women scientists have produced 242 papers that mean 24.2 papers per women scientists. Department of Molecular Medicine and Cancer Biology are found to be the highly productive department and the Department of Neurobiology has the fewest publications. It is found that 2003-2004 is the most productive period and 1995-1996 is the least productive year. The period 1995-1996 became the least productive year because at that time the institution was at the initial stages of its growth. The research productivity of the scientists of RGCB is growing substantially.

The productivity of scientists of RGCB are spread over variety of publication media like journal articles, conference papers, patents, book chapters and PhD guided. All these type of publications increases with the growth and development of the institution. The publication, and typically the "paper" is the tangible product of research in science organizations. The year 2005-2006 with 112 articles (25.87 %) published is the most productive year in the case of journal articles. The least productive year in the case of journal articles is 1995-1996 with 34 journal articles (7.85%). The fact that publication of invited review articles or chapters provides a good opportunity for establishing authority in a specific field of research may be the reason for increasing number of productivity. The number of conference papers presented by the scientists of RGCB also increases with the development of the institution. The up coming scientist must have the necessary oral communication skills and some good material to present to warrant an invited presentation. Here is the importance of scientific productivity and the need to link this to opportunities of exposure and promotion at meetings, symposia, and lecture series. Promotion and self promotion help to foster this link and thus, assist good scientific productivity to receive appropriate attention at scientific meetings and symposia. Also participation in scientific meetings and symposia provides an important means of communication at a more personal level than is possible through publication. The year 1995-96 is the least productive year in the case of conference papers published by the scientists of RGCB and 2003-2004 and 2005-2006 are the most productive years (43 papers).

The authorship pattern of journal articles published by the scientists of RGCB reveals that multi- authored papers are more than single authored papers. Most of the papers were written by three or more authors. Since scientific research is a team generally the multi-authored papers will be more than individual works. This general trend can be observed clearly in the authorship pattern of journal articles; conference papers presented and book chapters. Scientific collaboration often is viewed as a

virtue, so much so that several public policies actively encourage scientific collaboration at both the individual and institutional levels. The collaboration trend among the scientists towards multi-authored papers is indicative of the highly specialized areas of scientific work that they were engaged in. The most prolific authors identified in the study are holding important positions in RGCB which shows that publication productivity is one of the important indicators to identify the scientists for career advancements with additional responsibilities.

Conclusion

Evaluation of the productivity of institutional research and developmental activities highlights the contribution of the institution and the individual scientists engaged in research. Productivity analysis of the scientists of RGCB also provides some insights into the complex dynamics of research activity and it will enable the science policy makers and science administrators to make available adequate facilities and direct the research activities in a proper direction. RGCB as a national institute plays significant role in global optimization and application in drug modeling; bar-coding life; artificial intelligence based on biological process; neural networking; prediction of carbohydrate and protein structure and function; and learning based process control for manufacturing. The productivity of the scientists of RGCB shows substantial growth both quantitatively and qualitatively with the development of the institution. The PhD produced and the patents obtained show the importance and quality of the researches conducted by the scientists of RGCB.

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